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The Influence of Explanatory Images on Risk Perceptions and Treatment Preference

Raluca Cozmuta, MD¹, Evan Wilhelms, PhD², Diana Cornell, MD³, Julia Nolte, PhD⁴, Valerie Reyna, PhD⁴, and Liana Fraenkel, MD, MPH^{3,5}

¹Emory University School of Medicine, Atlanta, GA, 30322

²The College of Wooster, Wooster, Ohio 44691

³Yale University School of Medicine, New Haven, CT, 06520

⁴Human Neuroscience Institute, Cornell University, Ithaca, NY 14850

⁵VA Connecticut Healthcare System, West Haven, CT, 06516

Abstract

Objective—To examine whether providing patients a series of balance scales (BS) depicting a reciprocal relationship between achieving disease control and increasing the risk of infection influences treatment preference.

Methods—Participants were randomized to receive a description of a medication in which risk of infection was described using one of four formats: numbers only, numbers + icon array (IA), numbers + BS, or numbers + IA + BS (i.e. combination). We compared the likelihood of starting the medication across the four formats, and whether the influence of risk formats varied by numeracy and gist risk appraisals.

Results—Mean (SE) likelihood was higher among participants randomized to the combination format [3.85 (0.09)] compared to those viewing the BS [3.56 (0.09), $p = 0.0222$] or numbers alone formats [3.51 (0.09), $p = 0.0069$]. Viewing an IA alone was associated with a lower likelihood of starting the medication among participants lower in numeracy and endorsing a risk avoidant non-compensatory gist risk appraisal. Conversely, viewing an IA, with or without the BS, was associated with a greater likelihood of starting the medication among those with higher numeracy and compensatory risk appraisals.

Conclusion—Adding explanatory images to IAs increases the likelihood to take a medication in patients with low numeracy and a non-compensatory gist risk appraisal. Explanatory images may be a feasible approach to improve willingness to try medication among subjects who are especially risk averse and believe that any risk is unacceptable.

Informed consent and decision making requires that patients are aware of which treatment options are available to them and understand the expected benefits and the possible risks associated with each alternative. Effectively communicating risk-related information is an

essential component of this process. Extant research has documented the difficulties physicians have communicating risk information and the negative impact of poor risk communication on treatment initiation and adherence.(1) Reluctance to accept effective treatment associated with the remote possibility of a serious adverse event is widespread and contributes to undertreatment and poor outcomes. For example, fear of osteonecrosis of the jaw and/or atypical fractures is a commonly cited reason for discontinuation of oral bisphosphonates where adherence to treatment among women with osteoporosis is 35% or less after one year.(2) Similarly, low adherence rates in rheumatoid arthritis, which vary between 30% and 80%, are in part due to underweighting of perceived need and overweighting of adverse events.(3)

Several approaches have been shown to improve understanding of numerical information. Visual aids such as icon arrays (IAs) and stacked bar graphs improve comprehension, in part by reducing people's tendency to ignore the base rate or denominator.(4) Adding risk labels in the form of verbal phrases such as "common" or "rare" to percentages improves comprehension and increases willingness to use a medication compared to percentages only. (5) Use of verbal phrases alone (i.e., without reference to numeric estimates), however, leads to overestimation of risk, and is not recommended.(6) Yet, even with visual aids, comprehension remains poor among many patients, particularly those with low numeracy.(7)

To address this gap, researchers have begun to examine non-numeric approaches to improve risk communication. For example, patient testimonials or narratives improve some decisional-related outcomes, such as confidence in, and satisfaction with, decision making. (8) Whether testimonials result in an increased likelihood of patients making an informed choice is not known. Hertwig and others (9) demonstrated that decisions made based on probabilistic descriptions of possible outcomes versus those made based on personal experiences lead to significantly different choices: description leads to overestimation of rare risks, while experience generally results in the opposite effect, as rare risks are seldom encountered. A recent study found that presenting patients with descriptive information as well as an experience format (a series of slides illustrating potential outcomes) was associated with higher knowledge scores compared with descriptive information alone.(10) However, there are several limitations associated with experienced tasks, most notably the difficulty required to attend to an experienced condition with numerous possible outcomes and/or a large denominator.

Analogies have long been used to explain complex ideas, and may also be an approach to improve understanding of medical risk information. In one study, Galesic and Garcia-Retamero found that analogies had a modest impact on risk comprehension in participants recruited from the general population.(11) However, the analogies used were abstract (e.g., comparing use of mammograms to detect breast cancer to use of a car alarm to detect a thief stealing a car). Because patients' understanding of how treatment impacts their disease may have a strong impact on treatment decisions,(12) we sought to examine whether an analogy explaining mechanism of action would improve risk communication. Since patients are particularly concerned about taking medications which can suppress their immune system, (13) we assessed whether a series of explanatory images representing how disease and treatment influence their health using a series of balance scales (BS) (included in the

Appendix) could influence risk perceptions and treatment preference. BS were chosen because they are a familiar analogy used to depict competing influences.

We developed a series of three BS depicting a reciprocal relationship between achieving disease control and increasing the risk of infection. The BS present an integrated view of the risks and benefits of the treatment and adhere to the IPDAS recommendation to balance the information across options.⁽¹⁴⁾ We then compared the likelihood of starting a medication and risk perceptions among participants randomized to view risk presented as numbers only, numbers plus an IA, numbers plus the BS, or numbers plus both the IA and BS. In addition, because of the known influence of numeracy and gist appraisals on risk perceptions and treatment preference, we examined whether the influence of risk formats would vary by these two factors.⁽⁷⁾ We hypothesized that BS (alone or in combination) would increase likelihood of starting the medication compared to the numbers only format, and that the effect of the BS would be greater in participants with low numeracy and a non-compensatory risk-avoidant gist appraisal compared to their counterparts.

Methods

All English-speaking patients receiving care at an academic rheumatology practice, who had at least three visits in any 12 consecutive months between May 2014 and November 2016, were mailed a survey and a preaddressed stamped envelope. At the end of the survey, participants were given the opportunity to mail back their contact information to be entered into a raffle to win one of eight Amazon \$50 gift cards.

Participants were asked to imagine that their symptoms had worsened and that their physician was recommending a new medication using the following scenario:

Imagine that for the past 3 weeks your disease is getting worse even though you are taking your medications. You feel more tired and have a lot more pain. You are having trouble doing the activities you were able to do a month ago. You are also having trouble keeping up with your responsibilities. Your blood tests show that your disease is worse. You see your rheumatologist who tells you about a different medication that may help you. The medication is taken as a pill once a day. It is covered by your insurance and it does not interact with your other medications. This new medication helps about 65% (65 per 100) of people. The only serious side effect is the risk of an infection that needs to be treated in the hospital for about 5 days with intravenous antibiotics. These infections most commonly happen in the lungs (called pneumonia), skin or kidneys.

The medication was described using eight scenarios (manipulated using a 2×4 design). We varied the probability of infection (2% or 0.2%) and the risk presentation format. Risk was described using one of four formats: numbers only, numbers + IA (hereafter referred to as IA), number + BS (hereafter referred to as BS), or numbers + IA + BS (hereafter referred to as combination). The BS are illustrated in the Appendix. Administration, benefit, and cost were held constant. Both factors were between-subject, and each subject responded to a single, randomly-assigned scenario.

Likelihood of starting the medication was measured on a 5-point scale anchored by Not likely at all and Very likely. We measured risk perceptions by asking participants how risky they thought the medication was and how worried they were about the risk of infection, both measured on 5-point scales. Likelihood of starting and risk perceptions were treated as continuous variables. Gist risk appraisals related to the risk of infection were measured by asking participants to choose one of the following five statements: 1) This is a serious side effect, but the chance is so small that there is basically no risk to worry about. 2) This is a serious side effect, but the chance is small (acceptable). 3) This is a serious side effect, and the chance is too large (unacceptable). 4) Even though the chance is small, this side effect is unacceptable. 5) It doesn't matter how small the probability is, the only thing that matters is that I can get this side effect. Participants were classified as non-compensatory risk-avoidant (option 5) versus compensatory.

Lastly, we collected demographic and clinical characteristics. Numeracy was measured using the 8-item (each scored on a 6-point scale, range 1–6) Subjective Numeracy Scale. Participants with an average numeracy score of less than four were classified as having lower numeracy. Gist risk appraisals and numeracy were measured after the scenario was read and the dependent variables (likelihood of starting the medication and risk perceptions) were measured. The study was determined to be exempt by our institution's Human Research Protection Program.

Results

A total of 2093 surveys were mailed and 655 participants returned completed surveys. The mean age (SD) was 59.2 (14.4) years (range 21–90). The mean patient global impact score was 4.9 (2.8) and the median disease duration was 10 years (range 0.5 to 62 years). Most were woman (78%), Caucasian (84%), and 49% were college graduates. Participants' characteristics did not differ across the four risk presentation formats (Table 1).

The mean likelihood of starting the medication did differ across risk presentations formats (Table 1). Likelihood was significantly higher among participants randomized to view the combination format compared to those viewing either the BS [$p = 0.0222$] or numbers alone formats [$p = 0.0069$]. Mean differences remained unchanged after adjusting for the probability of infection. The mean difference in likelihood between the combination and IA format was not significant ($p = 0.1752$), as were all other comparisons. No significant differences were found in risk perceptions (riskiness or worry) or gist risk appraisals across the four formats.

We conducted follow-up ANOVAs distinguishing groups based on numeracy and gist risk appraisal, respectively. We found a significant interaction between format and numeracy (main effect of format $F = 4.28$, $p = 0.0052$; main effect of numeracy $F = 5.69$, $p = 0.0173$; interaction $F = 3.04$, $p = 0.0285$) in predicting likelihood of starting the medication. For those lower in numeracy, likelihood to start the medication was significantly greater among those viewing the combination than the IA array format (Figure 1). In contrast, participants with higher numeracy viewing either format with an IA were more likely to start the medication, compared with numbers alone or BS formats (all least square mean differences

$p < 0.05$) (Figure 1). We also found a significant interaction between format and gist risk appraisal (main effect of format $F = 4.75$, $p = 0.0028$; main effect of gist appraisal $F = 98.90$, $p < 0.0001$; interaction $F = 5.04$, $p = 0.0019$). Participants with a non-compensatory risk-avoidant gist appraisal were more likely to start the medication when viewing risk formats including the BS [all least square means differences significant ($p < 0.05$), except between the combination format and numbers only format ($p = 0.2944$)] (Figure 2). Participants with compensatory gist appraisal were more likely to take the medication when viewing a risk format including an IA than the numbers only or BS formats (all least square mean differences $p < 0.05$) (Figure 2). In both ANOVAs, the main effects and interactions remained significant after adding variables known to affect treatment preferences (age, patient global impact and current medications) as covariates.

Discussion

In this study, we found that likelihood of starting a medication was influenced by the format used to present risk-related information. Perhaps, more importantly, our results demonstrate that formats differentially influenced patients depending on their numeracy and gist risk appraisals. Specifically, the effect of an IA reversed depending on individual differences: Viewing an IA alone (without the BS) was associated with *lower* likelihood of starting the medication among participants who were lower in numeracy and endorsed a non-compensatory risk-avoidant gist appraisal. Conversely, viewing an IA, with or without the BS, was associated with *greater* likelihood of starting the medication among those with higher numeracy and compensatory risk appraisals (i.e., beliefs that risks and benefits balance one another). Format effects were generally smaller for the numerate and those with compensatory risk appraisals. Indeed, the largest effects of format were observed by providing a BS to those whose risk appraisals were categorically avoidant rather than compensatory. These results are consistent with previous studies demonstrating that added nonnumeric information, whether in the format of qualitative labels or familiar comparisons, influences risk evaluations, particularly among those with lower numeracy.⁽⁵⁾ Moreover, they illustrate that visual aids are not uniformly beneficial, and their effects depend on numeracy as well as individuals' conceptual representations of the relationship between risks and benefits. We did not find any association between risk perceptions (riskiness or worry) and risk presentation format, suggesting that perceived riskiness and worry did not mediate the relationship between risk presentation format and likelihood of starting the medication. This result is in keeping with previous research showing no direct effect of IAs on perceived riskiness or worry.⁽¹⁵⁾

To the best of our knowledge this is the first study using a randomized experimental design to examine the influence of explanatory images on a treatment decision compared to the well-studied IA in a large patient population. Unlike other decision support tools which typically describe risks and benefits separately, the BS provide patients with an integrated view of both the risks and benefits of treatment. Important limitations include the use of a hypothetical scenario, which does not replicate decisions taking place in clinical practice. In addition, baseline measures of risk perceptions and willingness were not included in this study and thus we could not adjust for these factors in the analyses. Our participation rate was 31.3%, which limits the generalizability of our results. We studied the impact of a single

analogy in a single scenario and the impact of meaningful analogies should be examined across different contexts.

In summary, our findings suggest that adding explanatory images to IAs increases willingness to accept risk in patients with low numeracy and a non-compensatory risk-avoidant gist appraisal, but when not accompanied by an IA, has no effect in higher numeracy patients. These results add to the literature demonstrating the mixed effect of risk presentation formats, and highlight the need to personalize the use of visual aids. Moving forward, informational tools should avoid using IAs alone given their negative impact on patients with low numeracy and those that are especially risk averse. Future research should examine how to best design and incorporate explanatory images into informational materials and decision support tools.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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References

1. Peters E, Hibbard J, Slovic P, Dieckmann N. Numeracy skill and the communication, comprehension, and use of risk-benefit information. *Health Aff (Millwood)*. 2007; 26:741–8. [PubMed: 17485752]
2. Cheng LI, Durden E, Limone B, et al. Persistence and compliance with osteoporosis therapies among women in a commercially insured population in the United States. *J Manag Care Spec Pharm*. 2015; 2:824–33. 33a.
3. van den Bemt BJ, Zwikker HE, van den Ende CH. Medication adherence in patients with rheumatoid arthritis: a critical appraisal of the existing literature. *Expert Rev Clin Immunol*. 2012; 8:337–51. [PubMed: 22607180]
4. Fagerlin A, Zikmund-Fisher BJ, Ubel PA. Helping patients decide: ten steps to better risk communication. *J Natl Cancer Inst*. 2011; 103:1436–43. [PubMed: 21931068]
5. Sinayev A, Peters E, Tusler M, Fraenkel L. Presenting numeric information with percentages and descriptive risk labels: a randomized trial. *Med Decis Making*. 2015; 35:937–47. [PubMed: 25952743]
6. Buchter RB, Fechtelpeter D, Knelangen M, Ehrlich M, Waltering A. Words or numbers? Communicating risk of adverse effects in written consumer health information: a systematic review and meta-analysis. *BMC Med Inform Decis Making*. 2014; 14:76.
7. Reyna VF, Nelson WL, Han PK, Dieckmann NF. How numeracy influences risk comprehension and medical decision making. *Psychol Bull*. 2009; 135:943–73. [PubMed: 19883143]
8. Shaffer VA, Zikmund-Fisher BJ. All stories are not alike: a purpose-, content-, and valence-based taxonomy of patient narratives in decision aids. *Med Decis Making*. 2013; 33:4–13. [PubMed: 23065418]
9. Hertwig R, Barron G, Weber EU, Erev I. Decisions from experience and the effect of rare events in risky choice. *Psychol Sci*. 2004; 15:534–9. [PubMed: 15270998]

10. Fraenkel L, Peters E, Tyra S, Oelberg D. Shared medical decision making in lung cancer screening: experienced versus descriptive risk formats. *Med Decis Making*. 2016; 36:518–25. [PubMed: 26442791]
11. Galesic M, Garcia-Retamero R. Using analogies to communicate information about health risks. *Appl Cogn Psychol*. 2013; 27:33–42.
12. Petrie KJ, Jago LA, Devcich DA. The role of illness perceptions in patients with medical conditions. *Curr Opin Psychiatry*. 2007; 20:163–7. [PubMed: 17278916]
13. Singh JA, Qu H, Yazdany J, Chatham W, Dall'era M, Shewchuk RM. Barriers to medication decision making in women with lupus nephritis: a formative study using nominal group technique. *J Rheumatol*. 2015; 42:1616–23. [PubMed: 26178276]
14. Abhyankar P, Volk RJ, Blumenthal-Barby J, et al. Balancing the presentation of information and options in patient decision aids: an updated review. *BMC Med Inform Decis Making*. 2013; 13:S6.
15. Han PKJ, Klein WMP, Killam B, Lehman T, Massett H, Freedman AN. Representing randomness in the communication of individualized cancer risk estimates: effects on cancer risk perceptions, worry, and subjective uncertainty about risk. *Patient Educ Counsel*. 2012; 86:106–13.

Significance and Innovations

- To the best of our knowledge, this is the first study using a randomized experimental design to examine the influence of explanatory images on a treatment decision compared to the well-studied IA in a large patient population.
- The likelihood of starting a medication is influenced by the format used to present risk-related information. More importantly, our results demonstrate that formats differentially influenced patients depending on their numeracy and gist risk appraisals.
- Explanatory images may be a feasible approach to improve willingness to try medication among subjects who are especially risk averse and believe that any risk is unacceptable.

Figure 1.
Impact of numeracy on the association between likelihood* and format.

Figure 2.
Impact of gist risk appraisal on the association between likelihood* and format.

Table 1

Participant Characteristics and Treatment Preferences

Characteristic	Numbers (n= 163)	IA (n= 159)	BS (n= 155)	Combination (n= 178)	F ^a or Chi-square ^b test	P value
Mean age (SD)	59.2 (13.1)	59.3 (16.1)	59.5 (14.1)	58.8 (14.3)	0.07 ^a	0.9777
Female (%)	121 (75)	123 (77)	131 (85)	137 (78)	5.51 ^b	0.1379
Race					12.52 ^b	0.4045
Caucasian (%)	138 (87)	129	123	144	0.53	
African American (%)	19 (12)	16	15	19	0.48	
College Graduate (%)	78 (48)	81 (51)	73	86 (48)	0.53 ^b	0.9120
Mean numeracy (SD)	4.3 (1.1)	4.4 (1.0)	4.3 (1.1)	4.3 (1.2)	0.48 ^a	0.6959
Median disease duration (range)	10 (1–62)	10 (1–53)	10 (1–53)	10 (1–46)	0.03 ^a	0.9912
Mean patient global impact (SD)	4.0 (2.7)	4.0 (2.7)	4.2 (2.8)	4.1 (2.9)	0.17 ^a	0.9151
Current DMARD (%)	112 (69)	117 (74)	101 (65)	118 (66)	3.10 ^b	0.3760
Non-compensatory (%)	18 (11)	16 (10)	11 (7)	18 (10)	1.60 ^b	0.6593
Likelihood of starting the medication *	3.5 (0.1)	3.7 (0.1)	3.6 (0.1)	3.9 (0.1)	2.92	0.0333

* Least Square Mean (SE)