PRENATAL DIAGNOSIS
Prenat Diagn 2011; **31**: 809–813.
Published online 21 June 2011 in Wiley Online Library
(wileyonlinelibrary.com) **DOI:** 10.1002/pd.2771

Overcoming number numbness in prenatal risk communication

Stefania Pighin[1,2]*, Jean-François Bonnefon[1] and Lucia Savadori[2]

[1]*CNRS and University of Toulouse, Toulouse, France*
[2]*Department of Cognitive Science and Education, University of Trento, Rovereto, Trento, Italy*

Objective Efficient prenatal risk communication hinges upon parents' grasp of statistical information. When forming their subjective representation of a probability, pregnant women may focus on inappropriate factors and ignore the appropriate factors.

Method The present research investigates the subjective probability that pregnant women derive from statements of the form 'There is a 1 in X chance that the baby will have condition Y,' where the number X and the severity of the condition Y were orthogonally manipulated.

Results Study 1 showed that when judging how big is a 1 in X chance that a child will be affected by condition Y, pregnant women ($n = 336$) were sensitive to the severity of Y, but selectively numb to the objective number X. Study 2 ($n = 461$) replicated this pattern, but also showed that numerical numbness could be overcome by a simple intervention, namely, a quick comment that 1 in X was 'above average.'

Conclusion Practitioners must be aware that when forming a subjective probability assessment, pregnant women might be inappropriately sensitive to the severity of Y, and inappropriately numb to the number X, and that a simple communicative intervention can help in overcoming this selective number numbness.

KEY WORDS: genetic counselling; risk communication; probability assessment; communicative intervention; severity

INTRODUCTION

When prenatal diagnosis became a routine part of prenatal care, risk communication turned out to be a relevant component of prenatal counselling, affecting important variables like anxiety, distress, and decision making (Austin, 2010). Providing risk information to pregnant women concerning the presence of possible diseases in a developing fetus is a key component of prenatal counselling, influencing women's risk perception, and possibly leading to better understanding and better decisions (Ahl *et al*., 1993; Hallowell *et al*., 1997). While in professional and academic communications the word 'risk' is frequently used as synonym of 'probability,' risk is a multifaceted concept that includes several factors such as the numeric probability, the nature of the potential negative outcome, and the context (Patt and Schrag, 2003). Most of the existing literature focusses on the numeric probability component, and, as stated by Austin (2010) in an exhaustive literature review on the concept of risk in genetic counselling, what is actually measured and debated in scientific discussions is not the accuracy of patients' risk perception, but rather the relationship between patients' subjective perception of numeric probability and the objective numeric probability provided for a given outcome.

As a matter of fact, communicating quantitative information is a requirement for effective decision-making in health communication (Fischoff, 1999). Different formats are available to communicate clinical risks, varying from verbal labels to graphical representations to raw numbers (see also Smerecnick *et al*., 2009). However, the limited time devoted to prenatal counselling in daily medical practice, as well as the feeling of precision afforded by raw numbers, make this format particularly appealing for practitioners (Edwards *et al*., 1999; Schwartz *et al*., 1999; Lobb *et al*., 2003; Michie *et al*., 2005). Accordingly, it is more common to inform pregnant women that 'there is a 1 in 307 chance that your child will be affected by Down syndrome,' than to show them a graphical display of the same information.

A critical question, then, is whether pregnant women have an adequate grasp of this kind of numerical information (Hoffrage *et al*., 2000). To enhance the effectiveness of health care communication, it is necessary to understand how pregnant women form a subjective probability judgement out of raw numbers, and to design interventions to help them do better, if needed. These are the two goals of this article.

More precisely, we focus on the subjective probability that pregnant women derive from statements of the form 'There is a 1 in X chance that the baby will have condition Y,' where we orthogonally manipulate the number X and the severity of the condition Y. Ideally, the magnitude of the subjective probability assessment should depend on the number X, but not on the severity of Y. There are reasons to believe, however,

*Correspondence to: Stefania Pighin, Department of Cognitive Science and Education, University of Trento, Corso Bettini, 31, 38068 Rovereto (TN), Italy. E-mail: stefania.pighin@unitn.it

Received: 8 September 2010
Revised: 24 March 2011
Accepted: 25 March 2011
Published online: 21 June 2011

that expecting mothers will do just the opposite, and that the subjective meaning of a numeric probability (as the meaning of risk) depends on the nature of the outcome to which the numeric probability is related (see below, as well as Rothman and Kiviniemi, 1999; Michi *et al*., 2005; Shiloh, 2006). As for the effect of the raw number X, indeed, it is well known that laypersons (but also practitioners) have serious difficulties in translating probabilities into meaningful concepts (Gigerenzer, 2002; Gigerenzer and Edwards, 2003). Research on numeracy skills (Lipkus *et al*., 2001; Peters *et al*., 2006) showed in particular that roughly 20–30% people, even when highly educated, incorrectly understand probabilities presented in a ratio format such as 1 in X. Conversely, previous research would suggest that the severity of the condition Y might affect the subjective magnitude of a given probability to develop Y. Research conducted on the subjective interpretation of probability phrases like 'it is possible that you will be affected by Y' showed that the subjective probability increased with the severity of Y (Bonnefon and Villejoubert, 2006; Weber and Hilton, 1990). Although not in the medical domain, these results were extended to raw numbers by Patt and Schrag (2003) who investigated individuals' subjective probability assessments in the climate change field, showing that individuals are more likely to use greater likelihood qualifiers to describe a severe meteorological event (such as a hurricane) than to describe a mild meteorological event (such as a snow flurry), and to unambiguous, objective graphical representation of probability by Harris *et al*. (2009).

The first purpose of the present research is to investigate whether the subjective probability assessment that pregnant women derive from a statement such as 'There is a 1 in X chance that your child will be affected by condition Y' is appropriately influenced by the raw number X; and whether it is inappropriately influenced by the severity of the condition Y. Study 1 will provide baseline results on these two counts. The second purpose of the present research is, although, to develop and to test an appropriate intervention to attenuate possible biases related to the subjective numeric probability assessment.

METHODS

Study 1

Study 1 involved pregnant women, users of a website dedicated to pregnancy and babies. An e-mail notification advertising the opportunity to take part in a research on risk communication in the prenatal medical domain was sent to 50,000 registered users of the Italian web site www.gravidanzaonline.it. Participants volunteered to take part in the research and filled in a questionnaire on the Web for free.

The study employed a 2 (risk level: 1 in 28, 1 in 307) × 2 (severity of the condition: Down syndrome vs insomnia) between subjects design, and participants were randomly assigned to one of four experimental conditions. Data were entered in an analysis of variance. A between-subject design is ecologically appropriate here, because pregnant women are not commonly communicated different risk levels for the same condition. Participants were asked to read the following scenario:

> Elisa is a 30 year old pregnant woman. While talking with her gynaecologist during a visit, the gynaecologist says: 'There is a risk of [1 in 28; 1 in 307] that your child will be affected by [Down syndrome; insomnia].'

Participants were asked to provide their subjective probability assessment ('In your opinion, the probability of [1 in 28; 1 in 307] that Elisa's child is affected by [Down syndrome, insomnia] is:'). They responded using a 7-point scale anchored at *extremely low* and *extremely high*. Participants also provided their subjective probability assessment from the point of view of the gynaecologist (In your opinion, the gynaecologist thinks, but does not say, that the probability of [1 in 28, 1 in 307] that Elisa's child is affected by [Down syndrome, insomnia] is:'), using a similar response scale. At the end of the task, and as a manipulation check, participants were asked to rank Down syndrome and child insomnia in order of severity.

Study 2

Study 2 was conducted in order to test the effectiveness of a simple communicative intervention that might eliminate participants' numbness to numbers. The same recruitment method was employed. Participants' IP addresses were recorded and compared with that of participants to Study 1, in order to avoid repeat participants. The experiment used the same design and scenarios as in Study 1, to one modification: While half of participants were randomly assigned to the replication group (straightforward replication of Study 1), the other half was randomly assigned to the intervention group, in which the gynaecologist final remark was 'This risk value is above average.' This means that the experiment used a 2 (risk level: 1 in 28, 1 in 307†) × 2 (severity of the condition: Down syndrome vs insomnia) × 2 (intervention: absent vs present) between subjects design, and participants were randomly assigned to one of eight experimental conditions. Data were entered in an analysis of variance.

Just as in Study 1, participants rated their own subjective probability assessment, as well as their assessment of how large the probability was for the gynaecologist.

Finally, participants rated on a 5-point scale (anchored at *extremely improbable* and *extremely probable*) whether the triviality of the risk could be a reason why the gynaecologist might decide not to provide a descriptive comment to it. In the replication group (i.e. when the communicative intervention was absent), the question read as follows:

† Both risk values (i.e. 1 in 28 and 1 in 307) are indeed 'above average' and relevant to the chance of having a child affected by Down syndrome for a 30 years old woman, and to the chance of having a child affected by insomnia.

DOI: 10.1002/pd

> The gynaecologist communicated to Elisa some information concerning her risk of having a child affected by [Down syndrome, insomnia]. He provided her with a numerical value, i.e. [1 in 28, 1 in 307]. He did not comment on this value. Could this be because he thought that any comment would be trivial?

In the intervention group (i.e. when the communicative intervention was present), the phrasing of the question had to be modified to accommodate the fact that the gynaecologist did provide a descriptive comment:

> The gynaecologist communicated to Elisa some information concerning her risk of having a child affected by [Down syndrome, insomnia]. He provided her with a numerical value, i.e. [1 in 28, 1 in 307], and with a comment on this value. If he had not provided this comment, could this be because he would have thought that any comment would be trivial?

RESULTS

Study 1

Participants were 342 pregnant women (mean age = 33, *SD* = 4.77). The manipulation check confirmed that Down syndrome was accurately identified as the most severe of the two conditions (99.4% of responses). Because the responses to the two subjective probability questions were highly correlated, an index of subjective probability was computed by averaging these two responses.

Figure 1 displays the mean values of the subjective probability index as a function of the raw numerical risk level, and of the severity of the condition. The visual inspection of Figure 1 suggests two phenomena. First, judgments clearly appear to be sensitive to the irrelevant factor, that is, the severity of the condition. Second, judgments appear to be partially numb to the relevant factor, that is, the raw numerical risk level. Participants appear to have been sensitive to this factor for Down syndrome, but not for child insomnia.

This visual analysis was confirmed by the results of a 2×2 analysis of variance. First, the analysis detected a main effect of the severity of the condition, $F(1{,}332) = 68$, $p < 0.001$, $\eta^2 p = 0.12$. Overall, participants judged that the probability of Down syndrome (M = 5.0, *SD* = 1.3) was larger than the probability of insomnia (M = 3.9, *SD* = 1.1). Second, the analysis detected a main effect of the numerical risk level ($F(1{,}332) = 19$, $p < 0.001$, $\eta^2 p = 0.05$), but this main effect was qualified by a significant interaction between the two factors, $F(1{,}332) = 6$, $p = 0.015$, $\eta^2 p = 0.02$. Indeed, the difference between the two risk levels was only significant for Down syndrome ($p < 0.001$), but not for insomnia ($p = 0.16$).

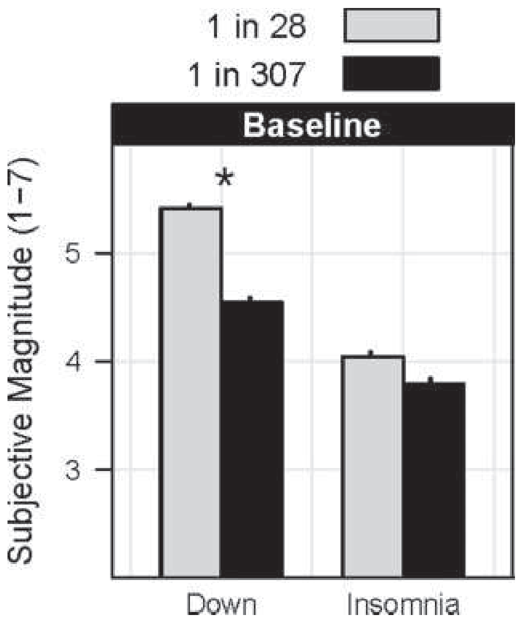

Figure 1—Mean values of the subjective probability index as a function of the raw numerical risk level, and of the severity of the condition in Study 1

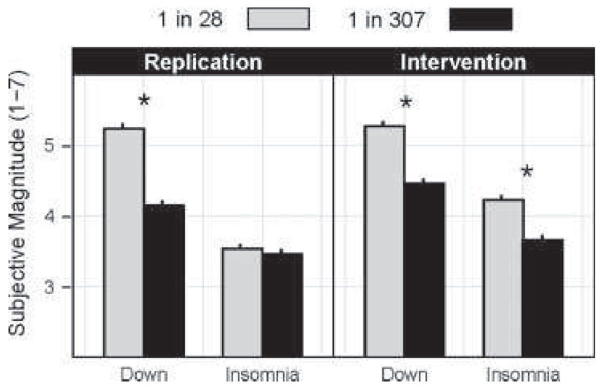

Figure 2—Mean values of the subjective probability index as a function of the raw numerical risk level, and of the severity of the condition, in the replication and in the intervention group

Study 2

Study 2 involved 461 pregnant women (mean age 33, *SD* = 4.5). As in Study 1, an index of subjective probability was computed by averaging the two dependent measures.

Figure 2 displays the mean values of the subjective probability index as a function of the raw numerical risk level, and of the severity of the condition, in the replication as well as in the intervention group. The visual inspection of Figure 2 suggests that results in the replication group were the same as in Study 1, whereas our intervention had the expected effect in the intervention group. That is, participants who were told that a risk of 1 in X of condition Y was 'above average' became sensitive to the value of the number X when forming a subjective probability assessment, even when the severity of Y was mild.

DOI: 10.1002/pd

This interpretation of Figure 2 is confirmed by statistical analysis. Results in the replication group perfectly replicated the pattern of results obtained in the baseline study. The analysis of variance first detected a main effect of the severity of the disease, $F(1,227) = 39$, $p < 0.001$, $\eta^2 p = 0.15$. Overall, participants rated the subjective probability of Down syndrome (M = 4.7, *SD* = 1.7) as larger than that of insomnia (M = 3.5, *SD* = 1.3). A main effect of risk level was detected, $F(1,227) = 9$, $p = 0.003$, $\eta^2 p = 0.04$, but it was again qualified by a significant interaction effect, $F(1,227) = 7$, $p = 0.009$, $\eta^2 p = 0.03$. Indeed, the difference between the two risk levels was only significant for Down syndrome ($p < 0.001$), but not for insomnia ($p = 0.74$).

In the intervention group, although, the analysis no longer detected an interaction effect ($F < 1$, $p = 0.47$, $\eta^2 p < 0.001$), but only a main effect of severity ($F(1,226) = 31$, $p < 0.001$, $\eta^2 p = 0.12$), and a main effect of risk level ($F(1,226) = 17$, $p < 0.001$, $\eta^2 p = 0.07$). Critically, risk level had a significant effect both for Down syndrome ($p < 0.001$), and for insomnia ($p = 0.02$).

Finally, recall that participants rated how probable it was that the decision not to comment on the risk value might be due to the triviality of doing so. In the replication group, participants thought that this was likely the case for insomnia (average standardized score of +0.4), but this assumption disappeared in the intervention group (average standardized score of +0.1), a significant difference ($F = 4$, $p = 0.04$) which suggests that the absence of a minimally descriptive comment did suggest, in the specific case of insomnia, that the risk was not worth thinking about.

DISCUSSION

Given that pregnant women tend to remain registered to the website after their child is born, and that the proportion of the 50,000 registered users that were pregnant at the moment of the study is therefore unknown, it is not possible to calculate an exact response rate in this online research. This unfortunately represents a limitation for the present research, entailing the possibility that a selection bias occurred. Nevertheless, our two studies clearly showed that when forming a subjective probability assessment from a statement such as 'There is a 1 in X chance that the child will be affected by condition Y,' pregnant women were inappropriately sensitive to the severity of Y, and inappropriately numb to the number X.

This last result, though, was restricted to a condition of mild severity (insomnia), and did not appear for a severe condition (Down syndrome). We hypothesized that this selective numbness to numbers derived from the lack of a minimally descriptive comment about the number. That is, we hypothesized that when the condition was mild, not commenting on the number X sent a signal to pregnant women that this risk was not worth thinking about. This interpretation, however, cannot apply when the condition is severe (Down syndrome), as it is hard to imagine that the risk of Down syndrome is not worth thinking about. Consequently, participants were oblivious to the number X when the condition was mild (insomnia), but not when the condition was severe (Down syndrome). From this hypothesis, we designed a simple intervention with the goal of neutralizing the signal, and engaging the participants attention so that they would appropriately process the number X. Our intervention simply consisted on commenting that the 1 in X risk was 'above average,' which is likely true of any risk that a practitioner would care mentioning to a pregnant woman. Results showed that our intervention was successful. When the 1 in X risk was commented as being above average, participants appropriately factored the number X in their subjective probability assessments, ensuring that patients give their full cognitive consideration to the numbers they are communicated, even when these numbers relate to conditions they might perceive as mild.

CONCLUSIONS

In prenatal counselling, practitioners are frequently required to communicate statistical information to pregnant women. Whereas the communication of statistical information is only one of the components of counselling, it is clear that effectively patients' participation in health decision-making is possible only through complete and correct interpretation of such information (Edwards *et al*., 2008). Thirty years of research on clinical risk communication issued the warning that different ways of presenting the same statistical information might influence subjective assessments and later decisions (Bryant and Norman, 1980; Cranney and Walley, 1996; Hux and Naylor, 1995; Kalet *et al*., 1994). To minimize these presentation biases, it is tempting to stick to the most objective rigorous format for communicating statistics, that is, the numerical format. There is no guarantee, although, that presenting information in numerical format will attenuate biases in the interpretation of statistical risk, as demonstrated by our two studies. Even when risk information is conveyed by raw numbers, pregnant women's probability assessments resulted to be mainly influenced by the severity of the outcome they were asked to evaluate, rather than the statistical information provided. This result is coherent with Patt and Schrag's (2003) finding that people are more likely to choose more certain sounding probability descriptors (e.g. very likely) to discuss a 10% probable severe meteorological event, than to discuss a 10% probable mild meteorological event.

As preliminary studies suggested, providing qualitative labels alongside numeric values can affect health decisions (Peters *et al*., 2004), and should be preferred to providing raw numbers only (Weinstein, 1999). As shown in our second study, practitioners may use a minimally descriptive comment in order to overcome pregnant women's selective number numbness: they just need to comment that 'this risk value is above average.' This intervention ensures that patients give their full

DOI: 10.1002/pd

cognitive consideration to the numbers they are communicated, even when these numbers relate to conditions they might perceive as mild. When receiving a great deal of information, inattention to conditions that are not life-threatening or life-impairing may be a way for patients to focus their attention on outcomes that are likely to change the course of pregnancy. However, patients may be mistaken about the severity of some outcomes. These conditions that patients might consider as mild can have substantial impact on the well-being of children and parents alike, which makes it important that pregnant women do not manifest an inappropriate numbness to numbers when they are at stake. This is what our intervention can achieve. Most importantly, this substantial improvement can be achieved for free, and without any need for preparation.

Ideally, a clear instruction about when to use the communicative intervention proposed should be provided. Nevertheless, following the libertarian paternalism perspective suggested by Sunstein and Thaler (2003), when contextual influences render patients' preferences unclear, health professionals should be free to self-consciously employ communicative strategies that are likely to steer patients' preferences in the direction of their well-being. Following such approach, health professionals should use or not the communicative intervention proposed here, accordingly to their self-conscious evaluation of the communicative situation. In particular, when pregnant women might underestimate the relevance of a risk and thus neglect the possibility to avoid consequences for the fetus (e.g. through dietary changes, medical treatments, therapies), the use of a minimally descriptive comment to the raw numbers is seems warranted.

Note also that the communicative intervention we advocate did not disrupt the subjective probability assessment of a severe outcome, allaying the concern that it should only be used for mild outcomes, and the practical problem of defining a threshold between mild and severe.

The current findings only hold for a specific comment (i.e. 'This risk value is above average'). As a consequence, further research will have to explore the effects of different linguistic formulations of the same comment ('This risk value is higher than expected'), as well as the effect of other comments such as 'This risk value is below average,' or 'This risk value is lower than expected,' which may serve other purposes such as neutralizing an inappropriate sensitivity to severity. Finally, our finding that a simple comment improves the interpretation of medical probabilities, raises the question of whether another simple comment may inadvertently decrease the accuracy of this interpretation.

ACKNOWLEDGEMENT

Financial support for this study was provided by the European Commission ('Special Advances in Foetal and Neonatal Evaluation Network' Project N°: LSHB-CT-2004-503243) and by grant ANR-07-JCJC-0065-01.

REFERENCES

Ahl AS, Acree JA, Gipson PS, McDowell RM, Miller L, McElvaine MD. 1993. Standardization of nomenclature for animal health risk analysis. *Rev Sci Tech Off* **12**: 1045–1053.

Austin JC. 2010. Re-conceptualizing risk in genetic counseling: implications for clinical practice. *J Genet Couns* **19**: 228–234.

Bonnefon JF, Villejoubert G. 2006. Tactful, or doubtful? Expectations of politeness explain the severity bias in the interpretation of probability phrases. *Psychol Sci* **17**: 747–751.

Bryant GD, Norman GR. 1980. Expressions of probability: words and numbers. *NEJM* **302**: 411.

Cranney M, Walley T. 1996. Same information, different decisions: the influence of evidence on the management of hypertension in the elderly. *Br J Gen Pract* **46**: 661–663.

Edwards A, Elwyn G, Gwyn R. 1999. General practice registrar responses to the use of different risk communication tools in simulated consultations: a focus group study. *BMJ* **319**: 749–752.

Edwards A, Gray J, Clarke A, *et al*. 2008. Interventions to improve risk communication in clinical genetics: systematic review. *Patient Educ Couns* **71**: 4–25.

Fischhoff B. 1999. Why (cancer) risk communication can be hard. *J Natl Cancer Inst Monogr* **25**: 7–13.

Gigerenzer G. 2002. *Reckoning with Risk: Learning to Live with Uncertainty.* Penguin Books: London.

Gigerenzer G, Edwards A. 2003. Simple tools for understanding risks: from innumeracy to insight. *BMJ* **327**: 741–744.

Hallowell N, Green JM, Statham H, Murton F, Richards MPM. 1997. Recall of numerical risk estimates and counsellees' perceptions of the importance of risk information following genetic counselling for breast and ovarian cancer. *Psychol Health Med* **2**: 149–169.

Harris AJL, Corner A, Hahn U. 2009. Estimating the probability of negative events. *Cognition* **110**: 51–64.

Hoffrage U, Lindsey S, Hertwig R, Gigerenzer G. 2000. Communicating statistical information. *Science* **290**: 2261–2262.

Hux JE, Naylor CD. 1995. Communicating the benefits of chronic preventive therapy: does the format of efficacy data determine patients' acceptance of treatment? *Med Decis Making* **15**: 152–157.

Kalet A, Roberts JC, Fletcher R. 1994. How do physicians talk with their patients about risk?. *J Gen Intern Med* **9**: 402–405.

Lipkus IM, Samsa G, Rimer BK. 2001. General performance on a numeracy scale among highly educated samples. *Med Decis Making* **21**: 37–44.

Lobb EA, Butow PN, Meiser B, *et al*. 2003. Women's preferences and consultants' risk communication in familial breast cancer consultations: impact on patient outcomes. *J Med Genet* **40**: e56–e56.

Michie S, Lester K, Pinto J, Marteau TM. 2005. Communicating risk information in genetic counselling: an observational study. *Health Educ Behav* **32**: 589–598.

Patt AG, Schrag DP. 2003. Using specific language to describe risk and probability. *Clim Change* **61**: 17–30.

Peters E, Slovic P, Hibbard J. 2004. *Evaluability Manipulations Influence the Construction of Choices Among Health Plans (Report No. 04-02)*. Decision Research: Eugene, OR.

Peters E, Västfjäll D, Slovic P, Mertz CK, Mazzocco K, Dickert S. 2006. Numeracy and decision making. *Psychol Sci* **17**: 407–413.

Rothman AJ, Kiviniemi MT. 1999. Treating people with information: An analysis and review of approaches to communicating health risk information. *J Natl Cancer Inst Monogr* **25**: 44–51.

Schwartz LM, Woloshin S, Welch HG. 1999. Risk communication in clinical practice: putting cancer in context. *J Natl Cancer Inst Monogr* **25**: 124–133.

Shiloh S. 2006. Illness representations, self-regulation, and genetic counselling: a theoretical review. *J Genet Couns* **15**: 325–337.

Smerecnick CMR, Mesters I, Verweij E, de Vries NK, de Vries H. 2009. A systematic review of the impact of genetic counselling on risk perception accuracy. *J Genet Couns* **18**: 217–228.

Sunstein CR, Thaler RH. 2003. Libertarian paternalism is not an oxymoron. *Univ Chic Law Rev* **20**: 1159–1202.

Weber EU, Hilton DJ. 1990. Contextual effects in the interpretations of probability words: Perceived base-rate and severity of events. *J Exp Psychol Hum Percept Perform* **16**: 781–789.

Weinstein ND. 1999. What does it mean to understand a risk? Evaluating risk comprehension. *J Natl Cancer Inst Monogr* **25**: 15–20.