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Which measures of perceived vulnerability predict protective intentions—and when?

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Abstract

Assessing perceived vulnerability to a health threat is essential to understanding how people conceptualize their risk, and to predicting how likely they are to engage in protective behaviors. However, there is limited consensus about which of many measures of perceived vulnerability predict behavior best. We tested whether the ability of different measures to predict protective intentions varies as a function of the type of information people learn about their risk. Online participants ($N=909$) read information about a novel respiratory disease before answering measures of perceived vulnerability and vaccination intentions. Type-of-risk information was varied across three between-participant groups. Participants learned either: (1) only information about their comparative standing on the primary risk factors (*comparative-only*), (2) their comparative standing as well as the base-rate of the disease in the population (+*base-rate*), or (3) their comparative standing as well as more specific estimates of their absolute risk (+*absolute-chart*). Experiential and affective measures of perceived vulnerability predicted protective intentions well regardless of how participants learned about their risk, while the predictive ability of deliberative numeric and comparative measures varied based on the type of risk information provided. These results broaden the generalizability of key prior findings (i.e., some prior findings about which measures predict best may apply no matter how people learn about their risk), but the results also reveal boundary conditions and critical points of distinction for determining how to best assess perceived vulnerability.

Keywords Perceived vulnerability · Risk perceptions · Vaccination intentions · Prevention · Health decision making · Comparative risk

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Perceived vulnerability has a central role in many theories of health behavior and behavior change (e.g., the health belief model, Janz and Becker, 1984; protection motivation theory, Rogers, 1975; extended parallel process model, Witte, 1992). Indeed, numerous studies confirm that perceptions of vulnerability are associated with health-protective behaviors, such as vaccination (Brewer et al., 2004, 2007), smoking cessation (Costello et al., 2012; Jacobson et al., 2014), and cancer screening (Lipkus et al., 2000; McCaul et al., 1996). However, there are numerous ways of measuring perceived vulnerability, and there are empirical inconsistencies in how well some types of measures predict prevention and screening behavior (Janssen et al., 2011; Klein, 2002; Taber & Klein, 2016; Waters et al., 2013; Zajac et al., 2006). No clear consensus has emerged on which type of measures are best (although see Brewer et al., 2007; Institute of Medicine, 2012; and Kaufman et al., 2020 for some recommendations). The present study examined whether the ability of different measures of perceived vulnerability to predict protective intentions might vary as a function of the type of information people learn about their vulnerability.

Types of measures of perceived vulnerability

The numerous measures of perceived vulnerability can be organized in various ways (e.g., see Ferrer and Klein, 2015; Kaufman et al., 2020). Here, we will briefly review key definitional distinctions that are most applicable for the present paper; each of these distinctions will be discussed in more detail later. The first distinction concerns the verbal-vs.-numeric properties of the response options (e.g., Dillard et al., 2012; Weinstein et al., 2007; Windschitl and Wells, 1996). Specifically, some perceived vulnerability measures (which we will refer to as *absolute-verbal*, see Table 1) ask people to rate the likelihood of an event on an ordinal scale with a small number of points (e.g., 7) that are labeled with verbal likelihood phrases (e.g., "very likely"). Others, however, have a numeric-probability emphasis and offer scales with a 0-100% continuum (referred to here as *absolute-numeric*, see Table 1). A second distinction is between absolute vs. comparative measures (Klein, 1997, 2002; Lipkus et al., 2000; Weinstein, 1999). Absolute measures of perceived vulnerability ask an individual about only their own level of vulnerability, whereas social-comparative measures inquire about an individual's vulnerability in comparison to typical others of the same age and gender or to a specific referent (e.g., best friend). These are typically referred to as *comparative* measures (see Table 1). A third distinction is between vulnerability measures that target deliberative versus non-deliberative or experiential perceptions of vulnerability (e.g., Ferrer and Klein, 2015; Windschitl, 2002). Deliberative risk questions are aimed at beliefs based in people's logical, rule-based evaluations. Experiential perceptions of risk are said to be more holistic, intuitive reactions and more likely to be guided by "gist" or heuristic judgments (Ferrer et al., 2016). One example of a deliberative item is "How likely are you to get [Disease] X?," whereas non-deliberative questions might ask "How vulnerable do you feel to [Disease] X?," or "How does your chance of [Disease] X seem to you?" We will use the term *experiential* to refer to a measure of this latter type used in our study (see Table 1). A fourth, and final, distinction concerns a category of measures that are relevant to perceived vulnerability, but technically ask about constructs that are either distinct from or go beyond just the construct of perceived vulnerability, such as those asking about concern or other affective measures like worry or fear (see our *concern* item in Table 1). These constructs are logically dependent on not just perceived vulnerability, but also perceived severity of an outcome (which, by conventional definition, are two key components of perceived risk, Darker, 2013; Janz and Becker, 1984; Rogers, 1975). Measures from each of these different categories are tested in the present research.

Variations in the type of information people learn about their vulnerability

The main goal of this work was to test whether the success of different measures of risk for predicting prevention intentions varies as a function of what type of information people learn about their vulnerability. When people initially learn about their personal vulnerability to a hazard or disease, there are many ways in which the vulnerability-relevant information can be encountered and represented. Consider three possibilities for how a person might initially learn about their vulnerability to a parasitic infection. First, by reading a short newspaper article, a person might learn about the existence of, and risk factors for, the parasitic infection. The article might mention nothing about statistics like base rates, but still provide some indication of whether the person has risk factors (or mitigating factors) that make the person more or less at risk than the average person. In other words, reading the news story could give people a sense of their social-comparative vulnerability to this infection. Second, a similar news story might include information about the general absolute prevalence or numeric base rate of the disease in the general population, which would give the person a hint at their own absolute objective vulnerability. Third, imagine all this information was on a website, but was also accompanied by a general risk-assessment survey, which upon completion gives the person their precise numeric likelihood of developing the parasitic infection, given how they answered questions about their local environment, habits/behaviors, and other characteristics. In all three of these situations, a person would learn something about their relative vulnerability to the parasitic infection, but the situations still differ in the type of information people have pertaining to their overall absolute vulnerability.

Critically, our study featured a manipulation that varied the type of risk information learned about a novel disease—allowing us to test how different measures of subjective vulnerability perform as predictors of prevention decisions/intentions as a function of the type of risk information people are given. Past work has examined how different types of risk information (e.g., comparative vs. absolute; statistical vs. narrative) influence affective and behavioral responses (Dillard & Hisler, 2015; Emmons et al., 2004; Klein, 1997; Lipkus and Klein, 2006; McCaul et al., 2003). However, the foci of those studies were primarily on how different types of risk information might push responses low or higher, not on how well different risk perception measures would predict decisions/intentions.

The logic of our design

The overall logic of our design was as follows: Across three conditions, we presented people with information about a novel disease. In all conditions, participants learned about two risk factors—related to where they lived and how much time they spent outdoors—which allowed participants to determine *something* about how personally vulnerable they were to the disease. However, the type of information they learned about their vulnerability differed across the three conditions. These three conditions roughly parallel the three examples we described above about different information one could get from news stories about a new disease. In a *comparative-only* condition, participants were only able to discern their comparative standing—that is, they could only assess whether each risk factor suggested they were below, at, or above average risk for the disease. In a *comparative + base-rate* condition (hereafter referred to as + base-rate), they learned the numeric base rate for the disease, and then they could assess whether each risk factor suggested they were below, at, or above this base-rate risk for the disease. Finally, in a *comparative + absolute-chart* condition (hereafter referred to as + absolute-chart), they could assess whether each risk factor suggested they were below, at, or above average risk for the disease, but they were also directed to a chart where they could find the specific, absolute numeric risk value to which their status corresponded. To summarize, in all three conditions, participants were given information that could allow them to approximate their comparative-risk standing (whether they were below, at, or above average risk for the disease), but the conditions differed in whether that could be done in the context of also knowing a generalized base rate or absolute individualized risk information.

After presenting the risk information, we solicited perceptions of vulnerability using several different measures. We also informed participants about a hypothetical vaccination, and we solicited vaccination decisions and other preventative intentions. These data allowed us to examine how various perceived-vulnerability measures perform as predictors of prevention decisions/intentions, and how this performance might vary depending on the type of risk information that people received.

The specific comparisons of interest

Because we included several measures of perceived vulnerability, jointly comparing the predictive validity of all these measures across the three conditions would be problematic for expositional and statistical reasons. Therefore, our strategy for this paper is to organize analyses and discussions around four research questions (or "comparisons of interest"). A common reference point across all four is the predictive performance of a standard measure of perceived absolute vulnerability using a typical 7-point scale with verbal anchors (i.e., absolute-verbal). Each research question examined how well an alternative measure performs relative to this standard one in predicting prevention intentions, and whether the advantage of one or the other measure shifts depending on the type-of-information condition (see Table 1 for the measures and their response-scale properties). Treating the performance of the absolute-verbal scale as a standard of comparison can be justified by the fact that it is a very common and straightforward way of asking people about perceived vulnerability (Diefenbach et al., 1993; Kaufman et al., 2020b; Weinstein et al., 2007; Windschitl & Wells, 1996). This strategy is primarily organizational and does not preclude comparisons across other measures.

Comparison 1: absolute-numeric (100 pt) vs. absolute-verbal (7 pt) measures

The first comparison of interest involves the 100-point absolute-numeric measure (vs. the 7-point absolute-verbal measure). In line with existing literature, we expected the absolute-verbal measure to generally outperform the absolute-numeric measure at predicting prevention intentions (Dillard et al., 2012; Liao et al., 2013; Weinstein et al., 2007; Windschitl & Wells, 1996, although see Gurmankin Levy et al., 2006). However, past work has not compared the superiority of an absolute-verbal measure across different formats in which people learned about their risk. Here, we mention three possibilities. First, the more intuitive nature of the absolute-verbal scale could make it a better predictor of protective decisions/intentions regardless of type of risk presentation (Windschitl & Wells, 1996). However, perhaps it is only superior when people do not have explicit risk values as input (i.e., in the comparative-only condition) and the absolute-numeric measure will predict prevention intentions more accurately when people have a better sense of what their numeric vulnerability is. A contrary possibility is that learning about one's numeric risk (i.e., in the + absolute-chart condition) makes an absolute-numeric risk measure perform relatively poorly at predicting prevention intentions. When given an explicit value of their risk, people may simply reenter that value on a 100-point measure instead of responding with a value that better reflects their intuitive sense of uncertainty and thus their likelihood of engaging in prevention behaviors (Windschitl, 2002).

Comparison 2: comparative versus absolute-verbal (7 pt) measures

The second comparison of interest involved the comparative measure (vs. the absolute-verbal measure). Past studies comparing the predictive performance of absolute and comparative measures have produced mixed results. In some papers, the zero-order correlations between perceived vulnerability measures and intentions/behavior are as high or higher when the vulnerability measures are comparative as when they are absolute (e.g., Edmonds et al., 2021; Klein, 2002; Krosnick et al., 2017; Portnoy et al., 2014; Renner and Reuter, 2012; Rose, 2010). In others, comparative measures were not significantly predictive even though absolute measures were (e.g., Gurmankin Levy et al., 2006; Hay et al., 2016; Janssen et al., 2011), or did not add any predictive value beyond the absolute measure (Dillard et al., 2011, 2012). Again, past work did not examine this superiority question across different risk presentation types. Our prediction about this matter was based on a response compatibility idea (Fischer & Hawkins, 1993; Hawkins, 1994; Slovic et al., 1990; Tversky et al., 1988). By design, all three of our conditions provided information that allowed people to draw inferences about their comparative risk standing, but only two conditions provided direct information relevant to absolute levels of risk (i.e., the + base-rate and + absolute-chart conditions). Based on the response-compatibility idea, when the risk information primarily allows people to judge their comparative risk but not their absolute risk (i.e., the comparative-only group), the comparative measure should be superior to the absolute-verbal measure in predicting protective intentions. And when the risk information gives people a clear indication of their absolute level of risk, such as in the + absolute-chart condition, the absolute-verbal and comparative measures would be on more equal footing as predictors of protective intentions.[1]

[1] As a secondary issue relevant to this second research question, we also compared how well direct comparative measures, rather than indirect comparative measures, fare as predictors of protective intentions. Past work suggests that direct comparative measures tend to predict behavior better than indirect (e.g., Rose, 2010), but it was unclear if this pattern would hold when participants were given absolute risk information about others (as in the + absolute-chart condition).

Comparison 3: experiential versus absolute verbal (7-pt) measures

The third comparison of interest was about the possible superiority of an experiential (or non-deliberative) measure in predicting protective intentions, over and above the absolute-verbal measure. Various studies suggest that non-deliberative perceptions of vulnerability can often outperform deliberative perceptions in predicting relevant behavioral intentions (Dillard et al., 2012; Ferrer et al., 2016, 2018; Janssen et al., 2011, 2012, 2014; Weinstein et al., 2007). However, would this superiority hold even in a condition in which the presentation of the risk communication allowed people to determine their absolute numeric likelihood of the relevant outcome (our + absolute-chart condition)? We had no a priori directional predictions about this question, but we considered it a crucial question to answer.

Comparison 4: concern versus absolute verbal (7-pt) measures

Finally, we also tested how an affective measure of concern would compare to the absolute-verbal measure in predicting protection decisions across risk presentation type. Previous research has shown that affective measures of concern or worry often perform quite well in predicting protection motivation and behavior change/intentions (Ferrer et al., 2016, 2018; Hay et al., 2016; Kiviniemi & Ellis, 2014; McCaul et al., 1996; Peters et al., 2006). Given this, and that models of risky decision making posit that such decisions are influenced by both the perceived likelihood of experiencing a health outcome and the perceived severity of that outcome (Janz & Becker, 1984; Rogers, 1975), it is possible that a measure that is sensitive to both constructs might predict preventative actions better than measures sensitive to only one of these constructs, regardless of the type of information available.

Method

Participants & design

The data were collected online from participants contacted via Amazon's Mechanical Turk (MTurk); participants were paid $0.75. Of note, the data were collected prior to the COVID-19 pandemic in the spring of 2016. Prior to data collection, we set a sample-size target of 900 participants. This target was based on an informal estimate of what would provide reasonable power for detecting differences in correlations on a between-subjects basis (also Schönbrodt and Perugini, 2013). A total of 909 cases with complete data were collected (incomplete cases were removed, but no other exclusion criteria were applied). Performance on recall and attention check measures were generally high (as reported later). Participants were 59.4% female, 39.3% male, 76.2% white, and an average of 36.4 ($SD = 11.92$) years old. There were three between-subject conditions, defined by the type of risk information participants received: comparative-only, +base-rate, and +absolute-chart. There was also a between-subject counterbalancing factor varying whether participants responded to the set of risk questions before or after they responded to prevention-intention questions about a vaccine.

Disease description

First, all participants viewed the same introductory description about a novel disease.[2] Specifically, they were presented with an illustrated description of a disease called "Respiratory Capsulatum Infection" or RCI; they were told that RCI is a fungal infection caused by breathing airborne mold particles from soil or bird droppings, and that it leads to fever, chills, chest pain, shortness of breath, and heavy coughing which can last for two weeks and become serious in certain cases. They also learned about two risk factors that influenced the likelihood of infection. The specific way in which they learned this information was part of the main manipulation and is detailed in the next section, but in all conditions the two risk factors were: their area of residence, and how much time they spent outside. First, living in a rural area meant that the participants were at higher risk than if they lived in an urban area (with suburban dwellers falling somewhere in-between). Second, spending more time outside (i.e., more than 6 h a week) engaging in activities, such as gardening or playing sports, also put participants at greater risk. The description of RCI, while mostly constructed by the authors, was loosely based on the fungal infection known as Histoplasmosis (CDC, 2022); the major symptoms and certain risk factors were true. See supplementary materials for full text of the disease description and each risk information condition (described next).

Type of risk information manipulation

Crucially, the presentation of the two risk factors described above was manipulated. In the comparative-only condition, participants received information about the relative influence of the risk factors but nothing about their absolute standing. Specifically, participants were told "If you live in or near *rural* areas then you are *more* at risk than the average person for getting RCI. If you live in *urban* areas, then you are at *less* risk than the average person. Regarding the second risk factor, they were told "If you spend more than 6 hours per week doing activities outdoors (such as walking, hiking, gardening, mowing the lawn, or playing sports), then you are at *more risk* than the average person for getting RCI. If you spend less than 4 hours per week, you are at *less risk*."

In the +base-rate condition, participants were provided with the numeric base rate for RCI in addition to the information about the risk factors: "For the average adult, the chance of getting RCI within the next 3 years is 8% (that is, an 8-in-100 chance). However, living in or near *rural* areas *increases* the chance of getting RCI. Living in *urban* areas *decreases* the chance of RCI.". For the second risk factor, they were again reminded of the 8% chance of getting RCI and then told that "spending more than 6 hours per week doing activities outdoors … *increases* the chance of getting RCI. Spending less than 4 hours per week doing the activities *decreases* the chance of RCI."

The +absolute-chart condition informed participants that their "chance of getting RCI depends on where you live (rural more at risk) and how much time you spend doing activities outdoors… (more time outdoors leads to more risk)". Then, they were directed to a chart to find their %-chance of getting RCI within the next 3 years. This chart laid out the absolute numeric risk information for each level of the risk factor (see supplementary materials for complete chart). To find their risk level, participants would look at the portion of the chart that applied to them (e.g., "Urban" and "4–6 hours of outdoor activities") and see the corresponding percentage (i.e., 6%). Each of these three conditions required participants to draw their own inferences about their level of risk based on their standing on each risk factor.

Primary measures

After reading about RCI and the risk factor information, participants encountered the primary measures. Whether participants answered the main set of risk estimates or the protective intention items first was counterbalanced, and participants who were asked about their protective intentions first were asked to answer the risk estimates as if they did not have the preventative vaccine.

[2] Using a fabricated infection ensured that participants would not have pre-existing notions or attitudes about the infection and would not be aware of any potential course of action to prevent it. Additionally, participants were asked to "assume all of the provided information is correct" to allow for a more realistic test of participants' perceptions of vulnerability. Therefore, despite the fictional nature of this study we felt that the benefits of using a fabricated infection outweighed the potential negatives.

Risk Estimates

The set of risk estimates always started with five perceived-vulnerability items about the self, and these five items were always randomized (uniquely per participant). Table 1 shows those five items.

We also solicited, in random order, participants' perceptions of the average persons' chance of getting RCI on both the verbal and numeric scales. These responses were used in computing indirect comparison estimates—by subtracting each respondent's estimate of the average person's risk from their estimate of self-risk.

Protective intentions

Participants were informed that a nasal spray had been developed that could remove the risk of RCI for about three years. Other information was included about the vaccine including the price ($10), the ingredients (all natural), and the side effects (a mild sore throat for three days). Participants were then asked to consider the vaccine information and their risk factors and decide if they would buy and use the nasal spray (four response options: *definitely no*, *probably no*, *probably yes*, or *definitely yes*). Participants also indicated if they would accept the nasal spray if it was offered for free using the same response scale, and they were asked to briefly explain why they would or would not get the nasal spray in an open-ended question. Finally, they indicated how interested they would be in obtaining additional information about avoiding RCI (1 = *not at all*, 5 = *extremely*), as well as how likely they are to take other preventative steps to avoid contracting RCI (1 = *very unlikely*, 5 = *very likely*). These items always appeared in the same order and the z-scored responses were combined to form a composite measure of protective intentions (a = 0.85).

Table 1 *Perceptions of Vulnerability Measures*

Measure	Question	Response Scale
Absolute-Verbal [1]	How likely are you to get RCI in the next three years?	1 (very unlikely) to 7 (very likely)
Absolute-Numeric [1]	Estimate your chance of getting RCI within the next three years.	0 – 100%
Comparative [2]	How does your chance of getting RCI within the next three years compare with the chance for the average person your age?	-3 (much less likely) to + 3 (much more likely)
Experiential [3]	How does your chance of getting RCI over the next three years seem to you? Overall, it seems:	1 (extremely low) to 7 (extremely high)
Concern [4]	Given the likelihood and severity of RCI, how big of concern is RCI to you?	1 (very small concern) to 7 (very big concern)

[1]Weinstein et al., 2007
[2]Lipkus et al., 2000
[3]Windschitl, 2003
[4]Ferrer et al., 2016

Additional measures

After completing the vulnerability estimates and protective intentions, participants responded to a variety of other items in the order described below. Participants were asked about RCI severity, as well as what their conditional risk of RCI would be both with and without the nasal spray. Next, participants indicated how easy it was to make risk judgments. They also reported their standing on the two risk factors; where they currently live (urban, suburban, or rural area) and how much time they spend each week doing activities outdoors (0–3 h, 4–6 h, 7 or more hours). Next, participants completed the Threat Orientation Measure (Thompson et al., 2006). There were also several recall/attention check measures, for which performance was generally high (between 76.9 and 95.3% accuracy depending on the question). Consistent with our a priori plans, we did not use these data as exclusion criteria. Finally, they responded to demographic questions and an item asking about their overall health and how much they engage in preventative health actions. See supplementary materials for the full text of all measures and a link to the data.

Statistical analysis

To answer our four research questions, we calculated bivariate correlations[3] between each measure of perceived vulnerability and the composite measure of protective intentions[4] in each condition. We report direct comparisons of these correlations across conditions, as well as separate regressions per condition to determine whether each measure had predictive power beyond the absolute-verbal measure.

[3] All reported correlations are Pearson's r, which has been shown to be robust to violations (see Bishara and Hittner, 2012 for a discussion). However, computing Spearman's rank-order correlations yields the same results across all analyses with two discrepancies noted in text.

[4] The pattern of the inferential results across these correlations was the same when analyzing the single item measure of vaccination intentions rather than the composite.

Comparing correlations across conditions allowed us to focus on differences in overall predictive utility rather than differences in slopes (see Rohrer and Arslan, 2021) as a regression on the full sample would do (although see footnoted results in each section).

Results

Results of preliminary interest

As preconditions for an appropriate test of our research questions, it was important that our participants displayed some natural variation on each of the two main risk factors for RCI—living location and time spent outside. We were able to get a diverse sample across both risk factors. Specifically, 30.8% reported living in urban areas, 46.5% in suburban areas, and 22.8% in rural areas. In terms of how much time our participants spent outside each week, 49.6% reported spending between 0 and 3 h, 30.9% spent between 4 and 6 h, and 19.5% spent 7 or more hours outside each week.[5]

Although our main research questions did not concern whether the mean levels for perceived risk or protective intentions differed across conditions, it is useful to examine this as a preliminary matter. As can be seen in Table 2, mean differences did exist on three of our risk estimates. For example, mean risk perceptions on the absolute-numeric measure were lower in the +base-rate and +absolute-chart conditions than in the comparative-only conditions. However, there were no significant differences in either the single item vaccination intention measure or in the protective intentions composite measure across the three conditions. The grand mean for the vaccination intention measure, which was on a 4-point scale, was 2.51, which is essentially at the midpoint of 2.5. More specifically, 14.7% of the overall sample said definitely no about the vaccine, 33.9% said probably no, 37.5% said probably yes, and 13.9% said definitely yes.

Also relevant to note when considering mean differences is that participants consistently reported greater perceptions of vulnerability and protective intentions when asked about their protective intentions first (as opposed to responding to the vulnerability measures first). This was true for all measures except the absolute-numeric measure for which there was no difference ($p = .120$). Participants who answered the protective intentions questions first were subsequently aware of the existence of the vaccine while answering the vulnerability questions, which was not the case for the other judgment order. It is possible that, given that they knew RCI was serious and common enough to warrant the production of a vaccine, they felt more at risk. More important for our research question, this counterbalancing of order did not significantly interact with the condition manipulation and therefore will not be discussed further.

Table 2 *Means (SD) for Primary Measures for Full Sample and by Condition*

	Full Sample	Comparative-Only Condition	+Base-Rate Condition	+Absolute-Chart Condition
Vaccination Intention	2.51 (0.91)	2.57 (0.96)	2.48 (0.86)	2.46 (0.90)
Protective Intention Composite[1]	−0.001(0.83)	0.029 (0.87)	−0.020 (0.80)	−0.015 (0.82)
Absolute-Verbal	2.50 (1.48)	2.68 (1.62)[a]	2.35 (1.35)[b]	2.46 (1.43)[ab]
Absolute-Numeric	16.33 (19.76)	23.72 (23.83)[a]	11.10 (13.61)[b]	13.65 (17.77)[b]
Comparative	−0.52 (1.53)	−0.55 (1.52)	−0.54 (1.56)	−0.48 (1.50)
Experiential	2.61 (1.44)	2.72 (1.56)[a]	2.44 (1.34)[b]	2.66 (1.39)[ab]
Concern	2.75 (1.71)	2.81 (1.82)	2.63 (1.68)	2.82 (1.62)
Indirect Comparative – Verbal	−0.23 (1.31)	−0.23 (1.41)	−0.26 (1.19)	−0.21 (1.31)
Indirect Comparative – Numeric	-1.39 (13.07)	-2.58 (16.78)	−0.77 (11.28)	−0.72 (9.59)
Severity	3.37 (1.00)	3.40 (1.00)	3.28 (1.00)	3.42 (0.98)

Note. Means with different superscripts differ from each other at $p < .05$

[1] = Recall that the protective intention composite variable was created from the four z-scored protective intention items (a = 0.85). The two indirect comparative indexes were created computed by subtracting each respondent's estimate of the average person's risk from their estimate of self-risk. This was done separately for verbal and numeric scales.

[5] Participants' actual standing on these risk factors (calculated as an aggregate) was positively correlated with all measures of perceived vulnerability (all rs were significant and between 0.27 and 0.52), indicating that participants were paying attention and were engaged with the scenario in a meaningful way.

Table 3 *Correlations between Primary Measures for the Full Sample*

Variable	1	2	3	4	5	6	7	8	9
1. Vaccination Intentions	-								
2. Protective Intention Composite	0.87**	-							
3. Absolute-Verbal	0.44**	0.51**	-						
4. Absolute-Numeric	0.35**	0.41**	0.71**	-					
5. Comparative	0.37**	0.42**	0.59**	0.44**	-				
6. Experiential	0.45**	0.53**	0.85**	0.68**	0.61**	-			
7. Concern	0.50**	0.62**	0.71**	0.56**	0.50**	0.71**	-		
8. Indirect Comparative – Verbal	0.21**	0.20**	0.58**	0.31**	0.47**	0.45**	0.28**	-	
9. Indirect Comparative – Numeric	0.19**	0.20**	0.40**	0.43**	0.43**	0.42**	0.27**	0.60**	-
10. Severity	0.25**	0.34**	0.17**	0.14**	0.05	0.18**	0.32**	− 0.02	0.01

Note. ** $p < .001$

Finally, Table 3 shows a large set of correlations between our primary measures in analyses conducted on the full sample (i.e., not broken down by condition). From this table, various patterns of preliminary interest can be observed, such as the fact that all the perceived risk measures were significantly associated with protective intentions.

Main results: predictive power per condition

Recall that our main research interest was in how the different risk estimates predicted protective intentions across the different risk information conditions. Our description of the key results will be in four subsections, organized around the four research questions we posed earlier.

Comparison 1: absolute-numeric (100 pt) vs. absolute-verbal (7 pt) measures

Our first research question compared the predictive power of two measures of perceived absolute vulnerability – the 7-point absolute-verbal and 100-point absolute-numeric measure. On a sample-wide basis, responses on both the absolute-verbal measure, $r(902) = 0.51$, $p < .001$, and the absolute-numeric measure, $r(904) = 0.41$, $p < .001$, were significantly correlated with protective intentions. However, the former correlation was significantly greater than the latter, $z = 4.55$, $p < .001$.

Of more interest was how these measures fared when broken down by risk information condition (see Fig. 1). Examining the comparative-only condition first, both the absolute-verbal, $r(314) = 0.53$, $p < .001$, and the absolute-numeric, $r(316) = 0.51$. $p < .001$, measures of vulnerability were highly correlated with protective intentions and did not differ from each other, $z = 0.64$, $p = .52$. However, in the + base-rate condition, the absolute-verbal measure, $r(304) = 0.49$, $p < .001$, outperformed the absolute-numeric measure, $r(302) = 0.31$, $p < .001$, $z = 3.59$, $p < .001$. Similarly, in the + absolute-chart condition, the absolute-verbal measure, $r(280) = 0.50$, $p < .001$, also outperformed the absolute-numeric measure, $r(282) = 0.37$, $p < .001$, $z = 2.93$, $p = .003$.[6]

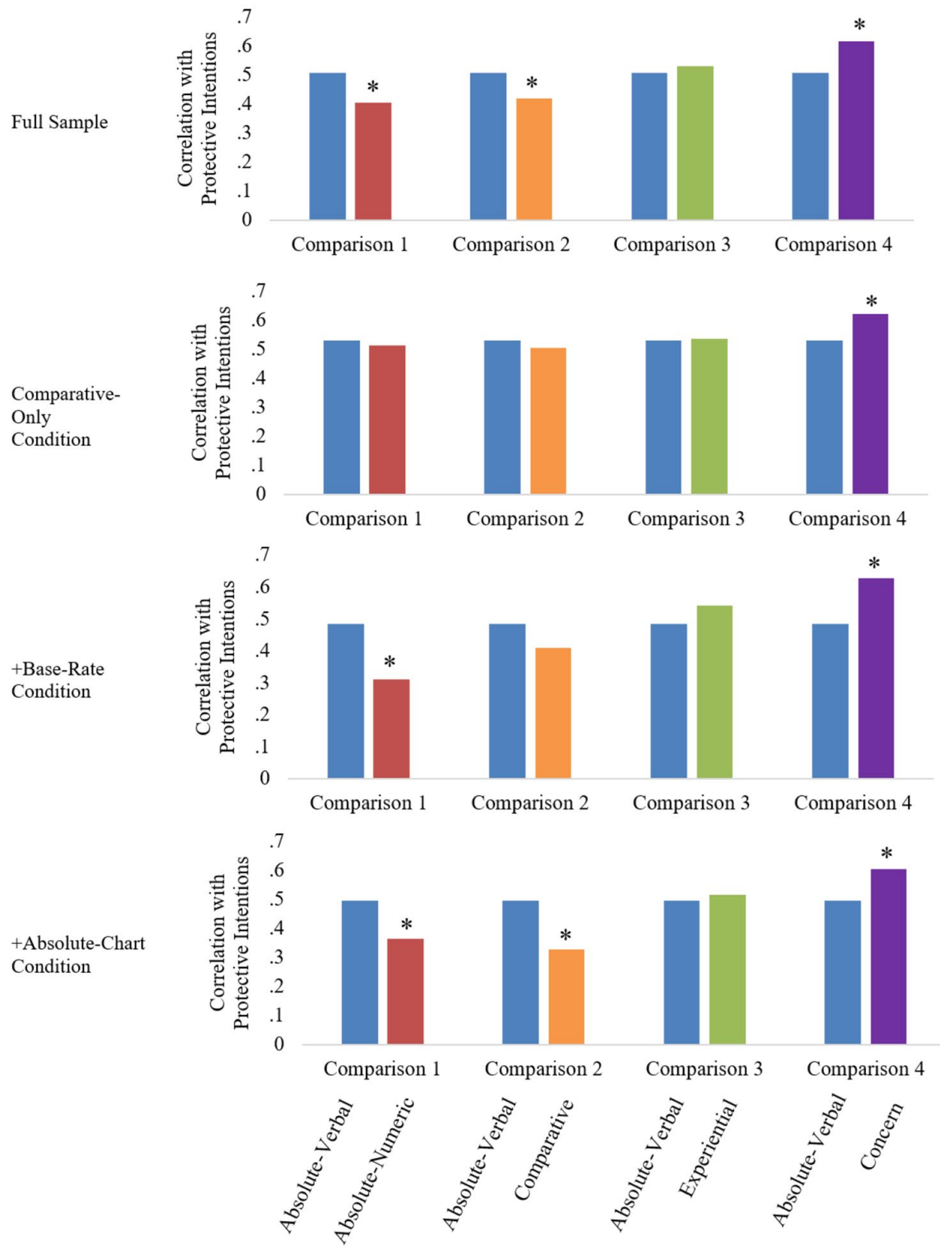
A different way of examining these same correlations is to test whether, for a given measure, its correlation with protective intentions differed across the three conditions. Starting with the absolute-verbal measure, we find that it was highly correlated with protective intentions across all conditions (all rs > 0.48), and these correlations did not significantly differ from each other (all ps > 0.45). However, the absolute-numeric measure performed best in the comparative-only condition, $r(316) = 0.51$. $p < .001$, with lower correlations in the + base-rate, $r(302) = 0.31$, $p < .001$ and + absolute-chart $r(282) = 0.37$, $p < .001$ conditions (ps = 0.002 and 0.024, respectively). In other words, the association of the absolute-verbal responses with intentions did not shift across the manipulation of the type of risk information, while the association of the absolute-numeric responses with intentions did shift.

We also conducted a series of regression analyses. Per condition, we regressed the protective intention composite on both the absolute-verbal and absolute-numeric responses, to determine whether a given measure had predictive utility beyond the other measure. The absolute-verbal measure was a strong predictor across all conditions, while the absolute-numeric measure remained a significant predictor just in the comparative-only condition (see Table 4). In the two remaining conditions, it added no predictive value beyond the absolute-verbal measure.[7] Analyses of R^2 change would

[6] Although the pattern remains the same, when comparing the Spearman correlations, the difference between the absolute-verbal $r(280) = 0.50$, $p < .001$, and absolute-numeric correlations $r(282) = 0.42$, $p < .001$ is no longer significant, $z = 1.90$, $p = .057$.

[7] In a regression on the full sample, in which we dummy coded for conditions (using the comparative-only condition as the reference group) and also included two- and three-way interactions, the two-way interactions were not significant. However, a three-way interaction (verbal measure x numeric measure x + absolute-chart condition dummy) was significant ($p = .047$), supporting that the relative importance of the two measures in predicting protective intentions was different in the + absolute-chart condition than in the comparative-only condition. The analogous interaction involving the

Fig. 1 Correlations Between Each Measure of Perceived Vulnerability and Protective Intentions. *Note.* This figure is organized by the comparisons discussed in the paper. Specifically, results for Comparisons 1–4 are displayed from left to right. Because the results for the absolute-verbal measure serve as the common standard across the comparisons, the blue bars representing those data are repeated per comparison. Asterisks indicate which measures are significantly different from the absolute-verbal measure at $p < .01$. Given that the bars represent correlations and not means, error bars are not included



necessarily reveal the same conclusions; relative to a model with just the absolute-verbal variable as a predictor, the addition of the absolute-numeric variable as a predictor leads to a significant R^2 change in the comparative-only condition, but not in the other two conditions.

These correlation and regression results suggest that, when people learn only about their comparative risk standing, either verbal or numeric measures perform well to predict protective intentions, but in the other two conditions, participants' responses on the absolute-verbal scale were more reflective of their subsequent protective intentions than their responses on the absolute-numeric scale. Given that participants in these two conditions received actual risk percentages, their responses on the 100-point absolute-numeric scales were likely anchored on, or constrained by, the numbers they received, even though those numbers did not necessarily reflect the internal uncertainty that drove their behavior. Consistent with this notion, the mean risk perceptions on the absolute-numeric judgment were lower in the +base-rate and +absolute-chart conditions than in

+base-rate condition was not significant ($p = .202$). As mentioned in the Statistical Analysis section, these regressions test for differences in slopes and are therefore not as pertinent to our main focus on overall differences in predictive utility (see Rohrer and Arslan, 2021).

Table 4 *Regression Analysis Summary Predicting Protective Intentions with Absolute-Verbal and Absolute-Numeric Measures*

	Comparative-Only Condition ($n=316$)				+Base-Rate Condition ($n=303$)				+Absolute-Chart Condition ($n=282$)			
	B	*SE B*	*β*	Overall R^2	*B*	*SE B*	*β*	Overall R^2	*B*	*SE B*	*β*	Overall R^2
Absolute-Verbal	0.18	0.05	0.34***	0.30	0.27	0.04	0.46***	0.25	0.25	0.04	0.44***	0.25
Absolute-Numeric	0.008	0.003	0.23**		0.003	0.004	0.06		0.004	0.003	0.08	

*** $p<.001$; ** $p<.01$

the comparative-only conditions, staying relatively closer to the 8% base rate. We also observed higher variance on the absolute-numeric measure in the comparative-only condition than the +base-rate and +absolute-chart conditions (see Table 2). A part of this higher variance might be attributable to the slightly greater presence of 50% responses in the comparative-only condition (8.5% of responses) than in the +base-rate (1.3%) and +absolute-chart (4.6%) conditions. If enough 50% responses reflected confusion or just an expression of complete uncertainty about probability rather than an estimate of probability, then this could have reduced the correlation between estimates on the absolute-numeric scale and protective intentions (Bruine de Bruin & Carman, 2012; Bruine de Bruin et al., 2000; Fischoff & Bruine de Bruin, 1999). The fact that this correlation was greater in the comparative-only condition than in the other two conditions suggests that the 50% responding in the comparative-only condition was not an important factor.

Comparison 2: comparative versus absolute-verbal (7 pt) measures

Next, we compared the comparative measure of vulnerability to the absolute-verbal measure. Across the whole sample, the absolute-verbal measure, $r(902)=0.51$, $p<.001$, outperformed the comparative measure, $r(903)=0.42$, $p<.001$, $z=3.34$, $p<.001$.[8] Again, our research question was about the relative strength of these correlations when broken down within condition (see Fig. 1). We had hypothesized that there might be a response compatibility effect with each measure performing strongest in the "compatible" condition.

In the comparative-only condition, responses on both the comparative measure, $r(315)=0.51$, $p<.001$, and absolute-verbal measure, $r(314)=0.53$, $p<.001$, were significantly correlated with protective intentions. The strength of these correlations was not significantly different, $z=0.60$, $p=.55$. In the +base-rate condition, both the comparative measure, $r(304)=0.41$, $p<.001$, and absolute-verbal measure, $r(304)=0.49$, $p<.001$, were again significantly associated with protective intentions. Although the strength of the correlation with the absolute-verbal measure was directionally greater, this difference was not significant,

[8] Recall that we also calculated indirect comparative estimates by subtracting each respondent's estimate of the average person's risk from their estimate of self-risk. This was done separately for verbal and numeric question formats. Consistent with previous research (Rose, 2010; see also Ranby et al., 2010), both types of indirect comparative estimates performed worse (i.e., had lower correlations with intentions) than did either the absolute-verbal estimates or the direct comparative estimates (see Table 3 for correlations). Therefore, the rest of this section describes only results relevant to the direct comparative estimates.

$z = 1.67$, $p = .09$. Finally, in the + absolute-chart condition, both measures were again significantly correlated with protective intentions, but the absolute-verbal measure, $r(280) = 0.50$, $p < .001$, outperformed the comparative measure $r(280) = 0.33$, $p < .001$, $z = 3.35$, $p < .001$.[9]

When examining the individual measures across the conditions, we see that the predictive power of the comparative measure varied. Specifically, the comparative measure performed best in the comparative-only condition ($r = .51$), followed by the + base-rate condition ($r = .41$), and the + absolute-chart condition ($r = .33$); only the difference between the comparative-only condition and the + absolute-chart conditions was statistically significant, $z = 2.64$, $p = .008$. Recall from the previous section that the absolute-verbal measure was highly correlated with protective intentions across all conditions (all rs > 0.48) and these correlations did not significantly differ from each other (all ps > 0.45).

Per condition, we also regressed the protective intentions composite on both the absolute-verbal and comparative responses. The absolute-verbal measure was a consistently strong predictor regardless of condition (see Table 5). However, the comparative measure predicted protective intentions most strongly in the comparative-only condition, but its predictive power decreased in the + base-rate condition and became non-significant in the + absolute-chart condition, mirroring the correlation analyses.[10]

These results provide mixed support for our response compatibility hypothesis. Based on the compatibility hypothesis, the comparative measure should perform better than the absolute-verbal measure in the comparative-only condition, but this was not the case. However, the predictive power of the comparative measure significantly dropped as participants had more than just comparative information on which to assess their risk (i.e., the correlation was smaller in the + absolute-chart condition than in the comparative-only condition). This is consistent with the response compatibility hypothesis. The correlational results for the + base-rate condition fell between these other two conditions, which is also consistent with the response compatibility hypothesis,

Table 5 *Regression Analysis Summary Predicting Protective Intentions with Absolute-Verbal and Comparative Measures*

	Comparative-Only Condition ($n = 315$)				+Base-Rate Condition ($n = 305$)				+Absolute-Chart Condition ($n = 281$)			
	B	*SE B*	*β*	Overall R^2	*B*	*SE B*	*β*	Overall R^2	*B*	*SE B*	*β*	Overall R^2
Absolute-Verbal	0.19	0.03	0.36***	0.33	0.23	0.04	0.39***	0.27	0.26	0.04	0.45***	0.25
Comparative	0.16	0.03	0.28***		0.09	0.03	0.18**		0.05	0.03	0.09	

*** $p < .001$; ** $p < .01$

9 Regarding indirect comparative estimates, both the verbal and numeric forms of those estimates performed worse than the absolute-verbal measure across all conditions.

10 In a regression on the full sample, in which we dummy coded for conditions (using the comparative-only condition as the reference group) and also included two- and three-way interactions, the two-way interaction between the comparative measure and the + absolute-chart condition dummy was significant ($p = .007$) as well as the three-way interaction between both predictors (comparative and absolute-verbal) and the + absolute-chart condition dummy ($p = .044$), indicating that the predictive power of the comparative measure was significantly different between the comparative-only condition and + absolute-chart condition. The analogous interactions for the + base-rate condition were not significant (ps = 0.099 and 0.586).

because the absolute information in that condition was less complete; participants were just given a base-rate, without any direct information about absolute standing.

Comparison 3: experiential versus absolute verbal (7-pt) measures

Next, we examined how the absolute-verbal measure of risk performed compared to an experiential (i.e., how the chance of getting RCI "seems") measure. It is important to first note that these two variables were very strongly correlated in the full sample ($r = .85$), as well as within each condition (range = 0.80 to 0.88). This makes it unlikely, but not impossible, that one variable would be a better predictor than the other.

In full-sample correlations, both the absolute-verbal, $r(902) = 0.51$, $p < .001$, and the experiential measures, $r(905) = 0.53$, $p < .001$, were significantly associated with protective intentions, and the two correlations did not differ from each other ($z = 1.61$, $p = .11$). This was the case within each condition as well (see Fig. 1 for correlations). Specifically, in each condition, both measures were significantly correlated with protective intentions and did not differ from each other (comparative-only: $z = 0.26$, $p = .79$, +base-rate[11]: $z = 1.91$, $p = .06$, +absolute-chart: $z = 0.72$, $p = .47$). Not surprisingly then, inferential tests of whether the correlations between experiential responses and protective intentions differed between any of the three conditions were not significant (all $ps > 0.66$).

Given the high correlation between the two predictor variables, the regression analyses must be interpreted with caution because of the high potential for multicollinearity issues. In two of the three conditions, both variables remained significant predictors (see Table 6).[12]

The fact that we did not find differences regarding the predictive powers of the absolute-verbal versus experiential responses is consistent with the predictors being, as already noted, highly correlated. This itself is an interesting finding that will be revisited the Discussion.

Comparison 4: concern versus absolute verbal (7-pt) measures

Finally, our last comparison of interest was between the absolute-verbal measure and a measure of concern. Across the whole sample, both the concern measure $r(903) = 0.62$, $p < .001$, and the absolute-verbal measure, $r(902) = 0.51$, $p < .001$, were strongly correlated with protective intentions, but the concern measure performed significantly better ($z = 5.49$, $p < .001$). This was also true across all three conditions (see Fig. 1 for correlations; comparative-only condition: $z = 2.77$, $p = .006$; +base-rate condition: $z = 3.97$, $p < .001$; +absolute-chart condition: $z = 2.88$, $p = .004$). The regression analyses tell a similar story – while both measures were significant predictors across all conditions (with one exception), the beta weights are much stronger for the measure of concern in each instance (see Table 7).[13]

We had speculated that the superior performance of the concern measure might be because concern taps perceived severity as well as perceptions of vulnerability. Consistent with this assumption, participants' perceptions of severity were more strongly correlated with concern, $r(902) = 0.32$, $p < .001$, than with absolute-verbal estimates of vulnerability, $r(901) = 0.17$, $p < .001$, $p < .001$ (see Table 3). However, when we controlled for severity perceptions, the association between concern and protective intentions, $r(899) = 0.57$, $p < .001$, was still stronger than the association between absolute-verbal estimates and protective intentions $r(898) = 0.49$, $p < .001$, $z = 4.01$, $p < .001$.[14]

Discussion

Prior studies have examined differences in the ability of various types of measures to predict health-relevant decision making (e.g., Dillard et al., 2012; Janssen et al., 2011; Klein, 2002; Rose, 2010). However, in any single study, the *way* in which participants received information about their risk level is not typically manipulated. This is an important gap in the literature, given that, in everyday contexts, people can learn about their risk levels in different ways. Our findings largely supported and generalized the conclusions emerging from past work, such as the superiority of affective measures like concern, but they also produced some points of distinction, such as conditions under which absolute-numeric

[11] When this comparison is tested using Spearman correlations, the experiential correlation $r(305) = 0.55$, $p < .001$, is slightly stronger than the absolute-verbal correlation $r(304) = 0.49$, $p < .001$; $z = 2.07$, $p = .039$.

[12] Interaction tests from a regression on the full sample were affected by spurious multicolinearily issues (some variance inflation factors were above 10), so are not reported here.

[13] In a regression on the full sample, in which we dummy coded for conditions (using the comparative-only condition as the reference group) and also included two- and three-way interactions, none of the interactions were significant ($ps > 0.204$), again indicating that the predictive ability of the concern measure is not affected by risk-information type.

[14] For researchers interested in choosing the two or three measures that would maximize the prediction of protective intensions, they might be interested to know that in a regression that includes concern and experiential responses as predictors, adding absolute numeric and/or absolute verbal responses does not significantly improve the R^2 value of the model, but adding comparative responses does.

Table 6 *Regression Analysis Summary Predicting Protective Intentions with Absolute-Verbal and Experiential Measures*

	Comparative-Only Condition ($n=315$)				+Base-Rate Condition ($n=306$)				+Absolute-Chart Condition ($n=281$)			
	B	*SE B*	*β*	Overall R^2	*B*	*SE B*	*β*	Overall R^2	*B*	*SE B*	*β*	Overall R^2
Absolute-Verbal	.13	.05	.24*	.30	.08	.05	.14	.30	.12	.05	.21*	.28
Experiential	.18	.06	.33**		.26	.05	.43***		.20	.06	.34***	

*** $p<.001$; ** $p<.01$; * $p<.05$

estimates will not predict prevention intentions well. Next, we will highlight these generalizations and distinctions.

Our first comparison of interest explored the predictive superiority of absolute-verbal measures over absolute-numeric measures and found that, consistent with much of the previous literature (e.g., Dillard et al., 2012; Liao et al., 2013; Windschitl and Wells, 1996, Weinstein et al., 2007), the absolute-verbal measure generally predicted protective intentions better. However, there was one situation in which the absolute-numeric measure did as well as the absolute-verbal measure. This happened when participants had no numeric risk information (i.e., the comparative-only condition). As discussed earlier, we suspect that only when participants had no numeric risk values to serve as anchors or constraints did the numeric responses largely reflect the same intuitive uncertainty that drives the prevention decisions. These results might suggest some possible qualifiers to findings in the existing literature. For example, Gurmankin Levy and colleagues (2006) found that 100-point, absolute-numeric estimates of breast cancer risk correlated most strongly with annual mammogram adherence, followed by a 5-point absolute-verbal estimate and a comparative estimate. In their study, much like in our comparative-only condition, participants were not given any numeric information about their risk for breast cancer. It is possible, however, that if the participants in the Gurmankin Levy et al. (2006) study had been given numeric estimate of their individualized breast cancer risk, the absolute-numeric measure might have been outperformed by the 5-point absolute-verbal measure in predicting annual mammogram adherence.

Our second comparison of interest examined the predictive validity of the absolute-verbal versus the comparative measure, the area of literature with the most mixed evidence. The absolute-verbal measure was a stronger predictor overall. The fact that this was true regardless of condition broadens the generalizability of conclusions from other studies that did not manipulate risk-information type (Dillard et al., 2012; Gurmankin Levy et al., 2006; Hay et al., 2016; Janssen et al., 2011). We also found that comparative measures tended to add predictive validity beyond what an absolute-verbal measure could do. This, too, is consistent with prior work (Edmonds et al., 2021; Klein, 2002; Krosnick et al., 2017; Portnoy et al., 2014b; Renner & Reuter, 2012). However, a boundary condition was evident. When people received specific, numeric information about their risk (in the +absolute-chart condition), the responses on the comparative measures did not add any predictive power beyond what was accounted for by the absolute-verbal measure. Also recall that the size of correlations between comparative measures and the prevention decision dropped as more absolute numeric risk information was provided (i.e., from $r=.51$ in the comparative-only condition to $r=.33$ in the

Table 7 *Regression Analysis Summary Predicting Protective Intentions with Absolute-Verbal and Concern Measures*

	Comparative-Only Condition ($n=316$)				+Base-Rate Condition ($n=304$)				+Absolute-Chart Condition ($n=280$)			
	B	*SE B*	β	Overall R^2	*B*	*SE B*	β	Overall R^2	*B*	*SE B*	β	Overall R^2
Absolute-Verbal	0.09	0.04	0.17**	0.40	0.06	0.04	0.11	0.40	0.08	0.04	0.14*	0.37
Concern	0.24	0.03	0.50***		0.27	0.03	0.55***		0.25	0.03	0.50***	

*** $p<.001$; ** $p<.01$; * $p<.05$

+absolute-chart condition). The fact that the relative predictive strength of comparative measures deteriorated when numeric information was added is—to some degree—consistent with a response compatibility hypothesis (Fischer & Hawkins, 1993; Hawkins, 1994; Slovic et al., 1990; Tversky et al., 1988). However, our full set of results provide only mixed support for that hypothesis. An extreme version of that idea—suggesting that comparative measures would be predictively superior in a comparative-only condition—was clearly not supported.

Next, we investigated how the experiential measure would perform compared to the absolute-verbal measure. Across conditions, we found that the experiential measure did quite well in predicting protective intentions, even in the +absolute-chart condition. This finding supports and generalizes conclusions from research that did not manipulate type of risk information provided (Dillard et al., 2012; Ferrer et al., 2016, 2018; Janssen et al., 2011, 2012, 2014; Weinstein et al., 2007). But the absolute-verbal measure was also a strong predictor. In fact, it was very highly correlated with the experiential measure, and the experiential measure did not outperform the absolute-verbal measure in any condition despite previous research that suggested it might (Dillard et al., 2012; Ferrer et al., 2016, 2018; Janssen et al., 2011, 2012, 2014; Weinstein et al., 2007). It is possible the specific wording of this experiential measure was simply too similar to the absolute-verbal measure to show a difference. Perhaps a different experiential measure (such as "How easy is it for you to imagine yourself developing RCI in the future?" or "I feel very vulnerable to RCI.", Ferrer et al., 2016) would have predicted protective intentions more strongly.

The last comparison of interest was between concern and the absolute-verbal measure. Across the board, the measure of concern was most strongly correlated with prevention intentions, providing generalization validity to previous research that did not manipulate risk-information type (Ferrer et al., 2016, 2018; Hay et al., 2006; Kiviniemi & Ellis, 2014; McCaul et al., 1996; Peters et al., 2006). This might, in part, be because measures of concern capture both perceived susceptibility as well as severity (Janz & Becker, 1984; Rogers, 1975). Even after accounting for perceived vulnerability expressed on the absolute-verbal scale, concern added unique predictive power in all conditions. This finding is consistent with the position that affective constructs like worry and concern have a role that is importantly distinct from that of perceived susceptibility (Ferrer et al., 2016; Magnan et al., 2009; Portnoy et al., 2014a; Slovic et al., 2002).

Limitations and future directions

Key limitations of our work are as follows. First, although we selected many of the most commonly considered risk measures, our list was certainly not exhaustive, and we only used one version of a measure as a representative of a given class of measures. It would be instructive to include, for example, other affective measures such as worry or fear to see if all affective measures are equally strong predictors as concern was.

Second, all our conditions communicated information that participants could use to infer something about their comparative standing, which leaves open the question of what would happen in learning contexts that did not readily allow for comparative inferences. For example, it is unclear how the results might look if people completed online risk calculators that presented a personalized risk estimate, but without indicating whether that risk is comparatively high or low. Related to this, our manipulation technically varied not just *how* people learned about their vulnerability, but *what* they learned – with participants in the +base-rate and +absolute-chart conditions getting more information than those in the comparative-only condition. By providing someone with information about risk factors, they are then able to infer their comparative standing, so it is empirically challenging to truly separate the different types of information in a way that is still ecologically valid.

Third, for all the participants in the study, they were learning about a completely novel disease (fictitious but plausible). This was done intentionally to adequately manipulate what people knew about the disease, and mirrors what many may have experienced during the initial stages of the COVID-19 pandemic in that it was a novel health threat with limited information available about individual vulnerability. However, given the novelty of the disease in the present study, we cannot be sure how results would shift if participants had, for example, a longer learning history for risk factors of a disease (e.g., as in the case of heart disease) but just recently were made aware of their own numeric likelihood of experiencing it. The use of a fictitious disease could also help explain why our experiential measure did not outperform the absolute-verbal measure. If experiential measures typically tap more gut-level, affective beliefs about the disease, it is possible that the lack of existing affective beliefs about this study's disease robbed the experiential measure of its extra predictive power in a way that does not happen when people are asked about their risk for a well-known, affectively-laden disease like breast cancer.

Last, the way we have conceptualized what makes the "best measure" of perceived vulnerability is strictly by examining its ability to predict protective intentions and therefore, any recommendations that can be made from this work necessarily assumes that is the researcher's intention. However, there are other valuable ways to assess measures of perceived vulnerability (such as accuracy in estimating a person's actual risk) that might lead to different conclusions about "best measures." These limitations provide fodder for future research.

Conclusions

Recently, a group of experts developed a list of suggestions for researchers wanting to assess risk perceptions (particularly about smoking but more generally too; see Table 2 from Kaufman et al., 2020). The suggestions emphasized variety—urging the inclusion of both absolute and comparative measures, as well as measures that are affective and experiential. Our results lend further support for the variety-is-good recommendation, by showing that all these measures are predictive across different ways in which risk information might be represented as people learn about their risk. With that said, our research also might help researchers who would need to prioritize some measures over others (e.g., because of survey length constraints). For example, if a researcher is interested in a perceived vulnerability measure that best predicts who might later be interested in preventative options, experiential measures of perceived vulnerability would tend to be excellent predictors regardless of what type of risk information was provided or salient when people learned about their risk. Measures of concern, which capture more than just perceived vulnerability, would be even more predictive. Meanwhile, it might be useful for researchers to know that the predictive utility of numeric measures and comparative measures could vary depending on the type of risk information that is salient, and they might choose to prioritize absolute-verbal measures over these measures.

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Data availability The data that support the findings of this study are available on the Open Science Framework at https://osf.io/n37r5/?view_only=9a9120571a4f48088e7db3aa26b51dc5.

Code Availability Not Applicable.

Declarations

Conflicts of interest/Competing interests All authors report no conflicts of interest.

Ethics approval This project was approved by the University of Iowa Institutional Review Board.

Consent to participate All participants provided informed consent prior to participating.

Consent for publication Not Applicable.

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