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Eliciting Risk Perceptions: Does Conditional Question Wording Have a Downside?

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Background. To assess the impact of risk perceptions on prevention efforts or behavior change, best practices involve conditional risk measures, which ask people to estimate their risk contingent on a course of action (e.g., "if not vaccinated"). **Purpose.** To determine whether the use of conditional wording—and its drawing of attention to one specific contingency—has an important downside that could lead researchers to overestimate the true relationship between perceptions of risk and intended prevention behavior. **Methods.** In an online experiment, US participants from Amazon's MTurk (N = 750) were presented with information about an unfamiliar fungal disease and then randomly assigned among 3 conditions. In all conditions, participants were asked to estimate their risk for the disease (i.e., subjective likelihood) and to decide whether they would get vaccinated. In 2 conditional-wording conditions (1 of which involved a delayed decision), participants were asked about their risk if they did not get vaccinated. For an unconditional/benchmark condition, this conditional was not explicitly stated but was still formally applicable because participants had not yet been informed that a vaccine was even available for this disease. **Results.** When people gave risk estimates to a conditionally worded risk question after making a decision, the observed relationship between perceived risk and prevention decisions was inflated (relative to in the unconditional/benchmark condition). **Conclusions.** The use of conditionals in risk questions can lead to overestimates of the impact of perceived risk on prevention decisions but not necessarily to a degree that should call for their omission.

Highlights

- Conditional wording, which is commonly recommended for eliciting risk perceptions, has a potential downside.
- It can produce overestimates of the true relationship between perceived risk and prevention behavior, as established in the current work.
- Though concerning, the biasing effect of conditional wording was small—relative to the measurement benefits that conditioning usually provides—and should not deter researchers from conditioning risk perceptions.
- More research is needed to determine when the biasing impact of conditional wording is strongest.

Keywords
risk perception, health behavior, conditional wording, measurement

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When it comes to soliciting risk perceptions for understanding their impact on behavior change or prevention adoption, there is an important distinction between conditional and unconditional question wording.[1] Conditional wording specifies a behavior or situation on which a respondent's risk estimate should be based (e.g., "*If you continue smoking*, what's your chance of lung cancer . . ."; "*If you don't get the flu vaccine*, what is your chance of getting a severe flu . . ."). Unconditional wording omits the conditional and solicits a more general estimate ("What's your chance of lung cancer . . ."; "What is your chance of getting a severe flu . . .").

Conditional wording has been identified as more appropriate than unconditional wording in many research contexts because when unconditional wording is used, some participants might engage in risk reappraisal.[1–9] As in Brewer et al.,[1] we are using the term *risk reappraisal* to refer to instances in which people lower their risk estimates because they anticipate taking (or have already taken) an action that presumably lowers their risk. Imagine a situation in which perceptions of high risk truly motivate people to engage in prevention behavior. However, assume that a researcher trying to study this relationship measured risk perception with an unconditioned item ("What is your risk . . . ?"). If people who would normally feel at high risk and are inclined to engage in prevention behavior instead report being at low risk because they reappraise their risk under the assumption of engaging in preventive behavior, this would weaken or even eliminate what would otherwise be a strong positive correlation between risk perceptions and prevention intentions.

While we endorse this concern about unconditional risk estimates, the present project was designed to test the possibility that the conditioning of risk perception items might lead to overestimates of the causal impact of subjective risk on prevention behaviors. Shortly, we will describe 3 psychological processes that might play a role in our predicted result, but we hasten to point out that our study does not isolate and separately test those mechanisms. Before getting into the psychological processes, it is helpful to offer a reminder of a statistical reality: the observed statistical relationship between risk estimates and whether people do or don't adopt a precaution is, by definition, shaped by the difference in risk estimates of precaution adopters versus nonadopters. Moreover, when a factor causes the risk estimates of adopters and nonadopters to become more polarized (i.e., risk estimates of adopters become higher and risk estimates of nonadopters become lower), this would necessarily produce a stronger, more positive relationship between risk estimates and behavior.

To begin our discussion of potentially relevant psychological mechanisms, we note that when a conditional is added to a solicitation of a risk estimate, this inherently makes one particular piece of information quite salient at the very moment a participant formulates an estimate of risk. For example, by adding, "If you don't get a flu shot . . ." when asking "What is your likelihood of a severe flu . . .," this presumably brings a respondent's vaccination status to a very high level of salience or mental accessibility. As established in research on focalism, once a piece of information is made selectively salient, people overweight that information—at the expense of other relevant information—when forming judgments or other responses.[10–12]

It is possible that selective salience or focalism triggered by the inclusion of a conditional in a risk question could ultimately inflate the observed relationship between subjective risk and behavior. The reason for this is that the conditional and selective salience could affect precaution adopters differently than nonadopters. For example, in the context of a flu vaccine decision, adopters, as opposed to nonadopters, are likely to believe that a flu vaccine is useful for preventing the flu. So, a conditional that asks them to imagine not getting the vaccine is focusing their attention on a risk-increasing hypothetical. The impact of this hypothetical could have inordinate weight and essentially push the risk estimate higher than if a conditional were not made immediately salient (although still understood as applying). In contrast, nonadopters are likely less affected by the increased salience of the conditional, because the conditional is not—from their perspective—a risk-increasing hypothetical (nonadopters had no intentions to get vaccinated to begin with). If so, then the differential impact of focalism on adopters versus nonadopters would necessarily inflate the statistical relationship between risk estimates and behavior in the overall sample.

This focalism process is not the only reason why a salient conditional added to a risk question could ultimately inflate the observed relation between risk estimates and

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behavior. We mention 2 other possibilities, the first of which involves consistency justification. Various research shows that people sometimes distort their perceptions and opinions to reduce cognitive dissonance or create consistency between their beliefs and behaviors.[13–17] It seems plausible that the presence and salience of a conditional could enhance people's interest in making their response to a risk question generally support or line up with their behavioral decision. For example, people who are *not planning* to get the flu vaccine might feel generally uncomfortable/inconsistent saying that their flu risk is high, and people who *are planning* to get the flu vaccine might feel uncomfortable/inconsistent saying that their flu risk is low. However, these consistency pressures are likely more acute and exert more influence on the risk estimation process when the conditional ("if you don't get the vaccine . . .") draws attention to the prevention decision. If so, then the presence of the conditional—by exacerbating consistency pressures and polarizing the risk estimates of adopters versus nonadopters—would yield an inflated relationship between risk estimates and prevention intentions.

The other possible reason why the risk perception-prevention behavior relationship might be inflated with conditional-question wording is related to the notion of loss aversion. When a conditional refers to *not* engaging in a prevention behavior, adopters might construe this as a loss, whereas nonadopters would not. Adopters would tend to be people who regularly get flu shots, so the conditional is essentially asking about a loss relative to their normal reference point (the safety afforded by a vaccine they would normally get). Given that people sometimes anticipate strong reactions to outcomes that are losses,[18] adopters could make exaggerated adjustments to their risk estimates when considering the loss of safety. Nonadopters—who typically do not get vaccinated and who might not think flu shots are effective—would be less likely to construe the conditional as asking about a loss in protection. Therefore, they would be less likely to make exaggerated adjustments.

We have highlighted 3 possible reasons (focalism, consistency justification, and loss aversion) why conditional wording might differentially affect adopters versus nonadopters—causing a polarization of risk estimates in line with intended prevention behavior, which necessarily inflates the empirical relationship between conditional risk estimates and prevention decisions. Despite the theoretical plausibility of these 3 reasons, we know of no study testing any of them in this context. Our experiment did not test among them but instead tested whether we would find evidence for the effect that they each predict. Namely, that the conditioning of risk perception items might lead to inflated estimates of the relationship between subjective risk and prevention behaviors.

Experiment Overview and Rationale

In our experiment, which had 3 between-subject conditions, all participants were introduced to risk-factor information about an unfamiliar disease and eventually made both risk-perception estimates and prevention-intention decisions about the disease.

There was a specific reason for using an unfamiliar disease. Because the goal of the study was to test whether conditional risk questions could lead to overestimates of the relationship between perceived risk and prevention decisions, we needed a benchmark/control condition in which we could capture an unbiased estimate of the relationship between risk estimates—solicited with unconditional wording—and prevention intentions. Creating this condition required that the study use a disease/prevention context for which participants were not already familiar with prevention options. If participants had been familiar with the prevention options, they could have engaged in risk reappraisal, which, as discussed earlier, could artificially deflate the observed relationship between risk estimates and prevention intentions.

As depicted in Figure 1, the first step in the study for all conditions was for participants to view a presentation about the disease and risk-factor information, allowing them to develop a sense of their own vulnerability to the disease. After this point, the 3 conditions differed. In the benchmark/control condition, participants were asked an unconditional risk-perception question before they learned about and responded to a vaccine option. In a conditional-question wording condition, participants learned about and made a decision about an existing prevention behavior for the disease, and then they were asked to provide risk estimates that were conditional on not engaging in the prevention behavior. A third condition was called the conditional-wording (DD) condition, where "DD" stands for delayed decision. In this condition, participants learned about the existence of the vaccine before responding to a conditional-risk question. However, they were not asked for a vaccination decision until after they provided risk estimates.

We expected that risk perceptions would be generally predictive of people's prevention decisions. More importantly, our main preregistered prediction was that this relationship would be significantly stronger in the conditional-question wording condition than in the benchmark/control condition (hereafter called just the benchmark condition). This would reflect that conditional risk questions can

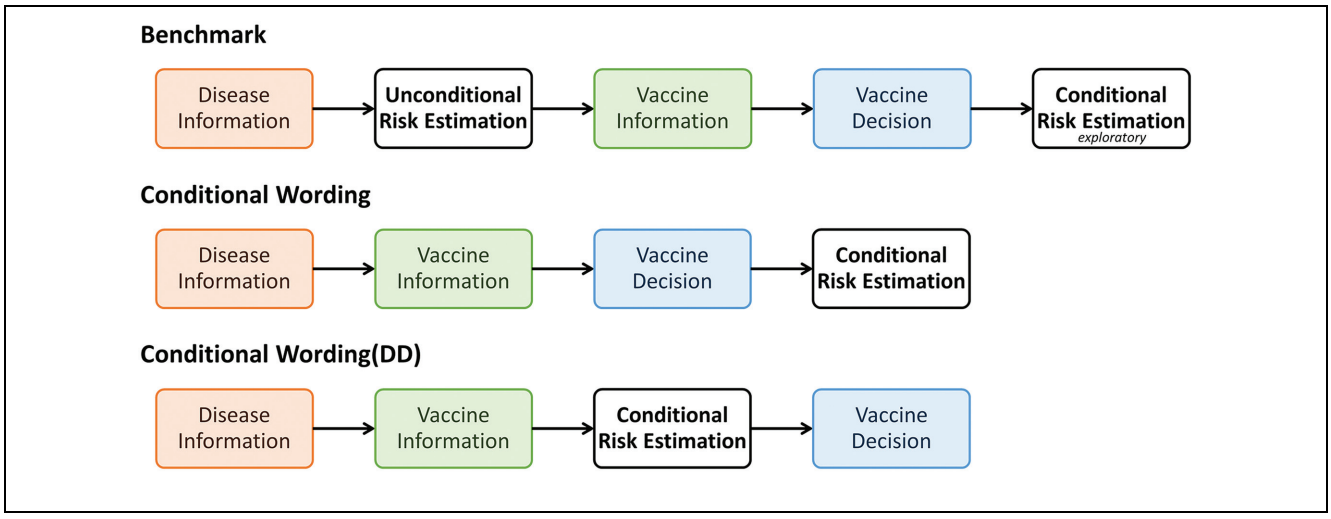

Figure 1 Experimental sequence in each question-wording condition.

artificially inflate the relationship between reported perceptions of risk and prevention decisions. Our rationale for including the conditional-wording (DD) condition was that, if there was a difference between the benchmark and conditional-wording condition, then it would be important to know if the effect of conditionals would extend to a situation in which the precaution decision was only anticipated, not completed. We were unsure whether it would, as some of the proposed mechanisms that could bias risk estimates (e.g., consistency justification) might be significantly impactful only when respondents had already committed to a prevention decision.

This study was preregistered on Open Science Framework.[i] Study materials, data, and analysis code are available at https://osf.io/ahbp6/.[ii]

Methods

Participants and Design

As preregistered, we collected data until 750 participants (54.7% male, 44.8% female, 0.4% nonbinary/third gender, M_{age} = 41.4) passed our attention checks. An additional 95 participants completed the study but did not pass the attention checks and were therefore excluded from our analysis, as detailed in the preregistration. The sample size was determined based on work by Schönbrodt and Perugini,[19] which indicates that correlations typically stabilize around a sample size of 250. To achieve stable estimates of correlations for comparisons across conditions, we therefore aimed for a sample size of 250 within each of our 3 experimental conditions.

Data for this study were collected online during the COVID-19 pandemic. Each participant was paid $ 0.90, and all participants were residents of the United States. Participants were randomly assigned to 1 of 3 between-subjects conditions: a benchmark condition (n = 246), a conditional-wording condition (n = 251), and a conditional-wording (DD) condition (n = 253).[iii]

Procedure and Materials

All participants first viewed introductory information about a disease called histoplasma Marneffei (HM) reactivity, a disease that was fabricated but loosely based on a real but largely unknown disease called *histoplasmosis*. HM reactivity was described as an airborne fungus that exists virtually everywhere, is said to affect approximately one-third of the US population at some point in their lives, and has many symptoms that affect quality of life. Each participant was told that HM reactivity most commonly affects people within a certain age range, which was always adjusted to broadly include the age of the participant. Participants also learned about a series of risk factors (e.g., living in warmer climates, living near green spaces, and having allergies). From this information, participants were able to form perceptions of their level of risk for HM reactivity.[iv]

From here on, the procedure differed between the 3 conditions (see Figure 1). In the benchmark condition, participants first gave unconditional risk estimates. Specifically, they were asked to estimate their risk on both a verbal scale ("How likely do you think it is that you will suffer from a spell of HM reactivity within the next 5 years?" 1 = *not at*

Table 1 Sociodemographic Characteristics and Exposure to Risk Factors

Sociodemgraphic Characteristics	Value
Age (y)	41.42 (12.47)
Gender (%)	
Male	54.7
Female	44.8
Nonbinary/third gender	0.4
Race (%)	
White	83.2
Black or African American	7.6
American Indian or Alaska Native	0.5
Asian	5.7
Native Hawaiian or Pacific Islander	0.1
Other	2.8
Hispanic/Latino/Spanish origin or decent, *y,n* (%)	7.1
Political affiliation (%)	
Democrat	48.7
Republican	21.8
Independent	26.4
Other	1.6
No preference	1.5
Political ideology (1 = *extremely liberal*; 7 = *extremely conservative*)	3.41 (1.75)
Exposure to HM reactivity risk factors,[a] *y,n* (%)	
I live where it's warm or has a warm season.	85.3
I live near trees, grasses, or other plants.	86.9
I grew up in a home with pets that have hair.	72.3
I grew up in a home with secondhand smoke.	39.1
I have allergies that affect my eyes or lungs.	38.1

[a]On average, participants were exposed to 3 out of 5 risk factors ($\bar{x} = 3.22$, $s = 1.17$). The amount of risk factors that participants were exposed to was positively correlated with risk estimates ($r = 0.295$, $P < 0.001$) and decisions to get vaccinated ($r = 0.258$, $P < 0.001$).

all likely; 7 = *extremely likely*) and then a numerical scale ("What would you estimate is the chance that you will get HM reactivity within the next 5 years?" 1 = *0%*; 11 = *100%*). These verbal and numeric questions and scales are similar to those commonly found in risk perception studies.[20,21] Only after responding to the risk perception measures did participants learn anything about the existence of a vaccine for HM reactivity. The vaccine was said to be a nasal spray, effective for up to 2 y, associated with mild side effects (mild fever and fatigue for up to 2 d), and cost $47 after insurance. Vaccine intentions were assessed with, "Given all this, would you get the vaccine?" (*no*/*yes*). Participants were also asked how sure they were on a (1 = not sure at all; 5 = very sure). On an exploratory basis, we next had these participants in the benchmark condition give a second set of risk estimates, but this time the questions used conditional wording (identical to the question wording described below).

In the conditional-wording condition, after participants learned about HM reactivity, they were informed about the HM reactivity vaccine and indicated whether they would get the vaccine or not (and how sure they were). Only then did they provide risk estimates. The wording of risk perception questions was identical to the benchmark condition, except that the conditional statement, "If you do not get the vaccination, . . ." was added to the beginning of the questions.

In the conditional-wording (DD) condition, after participants learned about HM ractivity, they learned about the vaccine, then estimated their risk of getting HM reactivity conditional on not getting vaccinated, and then indicated whether they would get the vaccine or not. In other words, it differed from the original conditional-wording condition only in that the question that solicited a vaccine decision from participants was delayed until after participants estimated their risk.

After participants responded to the main measures, they answered a series of exploratory measures, demographic questions, and recall checks. See Section A and Section B of the supplemental materials for a full report of the exploratory measures and Table 1 for the sociodemographic characteristics of participants.

In all conditions, participants were unable to go back to prior measures once they moved on to the next screen. This prevented participants from, for example, retroactively modifying ratings of perceived risk after learning about vaccines.

Analysis Plan

To prepare for our main analyses, we created composite risk estimates by z-scoring verbal and numeric risk estimates and then averaging the two z-scores per participant.[v] We then computed Pearson correlations of the relationship between vaccination decisions and composite risk estimates. After doing Fisher's r-to-z transformations, we used the z statistic to compare the strength of correlations of composite risk estimates with vaccination decisions between conditions.[22] For our main preregistered analysis, we used logistic regression to evaluate the effect of question wording on the relationship between perceived risk and vaccination intentions. Specifically, we tested for a significant interaction between composite risk estimates and question wording,[23] which would indicate that the association between perceived risk and intended prevention behavior differed as a function of wording.[vi] To include the conditional-wording condition and the conditional-wording (DD) condition as predictors, we used dummy coding with the benchmark condition as the reference category. In the final

Table 2 Correlations between Risk Perceptions and Prevention Behavior

Condition	Type of Risk Estimate	Measure	$\bar{x}$	s	Range	Correlation 1	2	3
Benchmark	Unconditional	1. Verbal risk estimate	3.85	1.59	1–7			
		2. Numeric risk estimate	4.73	2.56	1–11	0.873		
		3. Composite risk estimate	0.00	0.97		0.968	0.968	
		4. Vaccine decision	Yes (54.9%)	No (45.1%)		**0.393**	**0.362**	**0.390**
Benchmark (exploratory)	Conditional	1. Verbal risk estimate	3.72	1.61	1–7			
		2. Numeric risk estimate	4.78	2.62	1–11	0.895		
		3. Composite risk estimate	0.00	0.97		0.973	0.973	
		4. Vaccine decision	Yes (54.9%)	No (45.1%)		**0.500**	**0.394**	**0.459**
Conditional wording	Conditional	1. Verbal risk estimate	3.60	1.36	1–7			
		2. Numeric risk estimate	4.76	2.27	1–11	0.829		
		3. Composite risk estimate	00.00	0.96		0.956	0.956	
		4. Vaccine decision	Yes (47.4%)	No (52.6%)		**0.462**	**0.445**	**0.475**
Conditional-wording (DD)	Conditional	1. Verbal risk estimate	3.59	1.49	1–7			
		2. Numeric risk estimate	4.90	2.44	1–11	0.860		
		3. Composite risk estimate	0.00	0.96		0.964	0.964	
		4. Vaccine decision	Yes (52.2%)	No (47.8%)		**0.468**	**0.479**	**0.491**

All correlations were significant at $P < 0.001$. For composite risk estimates, verbal and numeric estimates were first z scored and then averaged. In bold are correlations between risk estimates and vaccine decisions.

regression model, composite risk estimates, conditional-wording condition (0 = benchmark; 1 = conditional wording), conditional-wording (DD) condition (0 = benchmark; 1 = conditional wording [DD]), and their interactions were included as predictor variables, with vaccine decisions (0 = no; 1 = yes) being the outcome variable. We also conducted a similar, exploratory analysis on a within-participant basis, using only risk estimates from participants in the benchmark condition. Composite risk estimates, question wording (0 = unconditional; 1 = conditional), and their interaction were included as predictor variables, with vaccine decisions being the outcome variable. Standard errors were clustered at the participant level.

Results

Sociodemographic Characteristics and Risk Factors

Table 1 includes general sociodemographic characteristics of our participants. The table also displays the percentages of participants who reported being exposed to each of 5 risk factors, namely, the 5 factors that were said to increase one's risk of getting HM reactivity.

Preliminary Information about Risk Perceptions. For both verbal ($\bar{x} = 3.68$, $s = 1.49$) and numeric risk estimates ($\bar{x} = 4.80$, $s = 2.42$), participants' average risk estimates were significantly below the scale midpoint, $t(749) = -5.87$, $P < 0.001$, $d = 0.21$, 95% CI [−0.43, −0.21], and $t(749) = -13.61$, $P < 0.001$, $d = 0.50$, 95% CI [−1.38, −1.03]. Moreover, as shown in Table 2, verbal and numeric risk estimates were strongly correlated with one another in each of the conditions. Composite risk estimates did not differ significantly across conditions, $F(2, 747) = 0.42$, $P = 0.66$, $\eta_p^2 = 0.001$.

Preliminary Information about Vaccine Intentions. Roughly half of the participants (48.5%) indicated that they would get vaccinated against HM reactivity, and the mean vaccine intentions did not differ significantly among conditions, $\chi^2(2) = 2.85$, $P = 0.24$. On average, people were "mostly" sure about their decision, $\bar{x} = 3.20$, $s = 0.79$.

Analysis of the Risk Perception and Vaccine Decision Relationship. One way of examining differences in the relationship between risk perceptions and vaccine decisions is to compare the point biserial correlations per condition. Table 2 shows the relevant correlations in the far-right column. Most relevant is whether the correlation in the conditional wording condition ($r = 0.475$) was greater than in the benchmark condition ($r = 0.390$). Although directional, this difference was not statistically significant, $z = -1.15$, $P = 0.126$. Similarly, there were no significant differences between correlations in the conditional wording (DD) condition

Table 3 Logistic Regression with Composite Risk Estimates and Condition Predicting Vaccine Decisions.

Predictor	β	SE β	Wald	*df*	*P*	Exp(B)	95% CI for Exp(B)		Model Fit		
							Lower Bound	Upper Bound	χ^2	*df*	*P*
									173.14	5	<0.001
Constant	−0.256	0.140	3.359	1	.067	0.774					
Risk estimates	0.855	0.148	33.229	1	<0.001	2.351	1.758	3.144			
Conditional wording (0 = benchmark, 1 = conditional wording)	0.471	0.202	5.422	1	0.020	1.602	1.077	2.382			
Conditional-wording (DD) (0 = benchmark, 1 = conditional wording [DD])	0.177	0.201	0.777	1	0.38	1.194	0.805	1.771			
Risk estimates × conditional wording	0.527	0.253	4.330	1	0.037	1.694	1.031	2.784			
Risk estimates × conditional wording (DD)	0.381	0.229	2.770	1	0.096	1.463	0.935	2.292			

Nagelke's $R^2 = 0.275$, Cox and Snell $R^2 = 0.206$.

($r = 0.491$) and the benchmark condition, $z = -1.39$, $P = 0.082$.

For our main, preregistered, analysis of the relationship between risk perception and vaccine decisions, we conducted a logistic regression to see if the slope for the relationships differed between conditions (see Table 3). The results of the logistic regression showed that composite risk estimates were a significant predictor of intentions to get vaccinated (OR = 2.35, 95% CI [1.76–3.14], $P < 0.001$). Moreover, assignment to the conditional-wording condition was also a significant predictor of vaccination decisions (OR = 1.60, 95% CI [1.08−2.38], $P = 0.020$). Most importantly, assignment to the conditional-wording condition significantly interacted with composite risk estimates to predict intentions to get vaccinated (OR = 1.69, 95% CI [1.03–2.78], $P = 0.037$). In other words, risk estimates in the conditional-wording condition were a significantly better predictor of vaccination intentions than risk estimates in the benchmark condition. In contrast, assignment to the condition-wording (DD) condition was not a significant predictor (OR = 1.19, 95% CI [0.81–1.77], $P = 0.38$), and we did not find a significant interaction between composite risk estimates and assignment to the condition-wording (DD) condition (OR = 1.46, 95% CI [0.94–2.29], $P = 0.096$). However, the pattern of results generally matched the one from the conditional-wording condition.

Within-Participant Analyses from the Benchmark Condition. Recall that participants within the benchmark condition also answered exploratory, conditional risk estimates after they had already given unconditional risk estimates and indicated a vaccination decision. This allowed us to assess the impact of question wording on an exploratory, within-participant basis. In a comparison of correlations, we found that the correlation between risk estimates and vaccination decisions was significantly stronger for conditional question wording ($r = 0.459$, $P < 0.001$) than for unconditional question wording ($r = 0.390$, $P < 0.001$), $z = -3.73$, $P < 0.001$. The fact that this inferential result for the correlations was significant even though the between-participant comparison of correlations was not significant might be due to the better statistical power of a within-participant comparison. We also found that, in a logistic regression, risk estimates significantly interacted with question wording to predict vaccine decisions, OR = 1.24, 95% CI [1.09–1.41], $P < 0.001$. Said differently, for participants who gave both unconditional and conditional risk estimates, conditional risk estimates were significantly more predictive of vaccination decisions than unconditional risk estimates were.[vii]

General Discussion

Our main research question was whether adding a conditional to a risk question can influence risk estimates in a way that would artificially inflate the empirical relationship between perceived risk and prevention decisions. By using an unfamiliar disease context and thereby precluding a risk-reappraisal problem, we created a situation in which data from our unconditional-wording condition, which we called our benchmark condition, provided a

good baseline measurement of the degree to which risk perceptions predicted prevention decisions. We found that the presence of a conditional (in the conditional-wording condition) led to a significantly stronger relationship between risk estimates and vaccination decisions, compared with when unconditional wording was used in the benchmark condition. The fact that conditional wording affected risk estimates in a way that inflated the observed relationship means that when researchers use conditional wording, they might overestimate the true relationship between perceived risk and prevention behavior. This biasing effect of conditional wording was not significant when the solicitation of a vaccination decision was delayed until after risk estimates were made (as in the conditional-wording [DD] condition), but the general pattern of results was comparable.

Further support for a biasing impact of conditionals comes from our exploratory within-participant comparison. This involved participants who were asked to report their perceived level of risk twice, once unconditionally and once conditionally after learning about the existence of a vaccine and making a decision about it. There was a stronger relationship between risk estimates and prevention behavior when the risk estimates were from conditionally worded questions than from unconditionally worded questions.

The analyses above involved a composite that collapsed across verbal and numeric risk estimates (as specified in the preregistration). Because verbal and numeric risk estimates can sometimes be differentially predictive of prevention behavior[3,21,24] and because numeric estimates can exhibit a spike of 50% responses that might influence their predictive utility,[25–27] it is useful to note conclusions from additional analyses in which verbal and numeric risk estimates were not combined (see Section D in the supplemental materials for details). Verbal and numeric risk estimates were strongly correlated, and the correlations with prevention decisions did not differ across verbal and numeric versions of the risk estimates. Results for logistic regressions that were done separately with verbal and numeric estimates were generally similar to those reported above.

Should Researchers Avoid Using Conditionals?

Although researchers are often interested in choosing measures that are maximally predictive of other constructs of interest, they would not want to overestimate the true magnitude of an important relationship. Given that we have just established that conditional wording could yield an overestimate of the true perceived risk/behavior relationship, should researchers stop using conditionals? In short, no. The effect of conditionals in our study was generally small relative to the negative impacts that omitting conditionals can have in many types of studies. Past studies have established that the conditioning of risk estimates is an effective way to avoid the issue of risk reappraisal and increase question clarity and have documented substantial shifts in correlational strength between risk and behavior for conditional versus unconditional risk estimates.[4,6,8,9,28,29] Given that unconditional question wording is almost always subject to risk-reappraisal issues under real-world constraints, the benefits that conditional question wording provides likely outweigh the biasing impact of conditionals in most instances.

That being said, researchers should nonetheless exercise caution when conditioning risk perception items on future behaviors and when drawing conclusions about the true relationship between perceptions of risk and prevention behavior. Although we found only a small biasing effect of conditionals, it is quite possible that the extent to which conditional question wording biases responses varies depending on the context and behavior specified by the conditional. For example, it is possible that conditionals that ask people to assume the omission of a preventive behavior for which they have a long history, or for which they can vividly envision consequences, might have a stronger impact than the conditionals we used in the present study. Studies investigating the role of emotionally laden imagery in judgment have consistently demonstrated that affective reactions are used as cues for judgment,[30,31] and the same could apply to judgments of risk. If affect-rich conditionals trigger stronger reactions from respondents, this would result in a more significant polarization of risk estimates along prevention decisions and larger overestimates of the relationship between subjective risk and prevention behavior. Researchers should be concerned about this possibility, given that conditioned risk perception questions are often used to investigate affect-rich topics (e.g., risk of cancer, risk of HIV, risk of COVID-19).[3,4,29] Future research should focus on determining when the biasing effect of conditionals is most pronounced.

Limitations and Future Research

Data collection for this study was limited to MTurk participants who were residents of the United States. As such, we can only speculate about the extent to which these findings generalize to other populations outside of the United States and to those who do not have access

to the Internet. Additional research should aim to replicate these findings with other populations.

Conclusions from the present study may be viewed as limited by the use of an unfamiliar disease. As discussed earlier, we used an unfamiliar disease on purpose to assess (in the benchmark condition) the relationship between perceived risk and prevention decisions without interference from risk reappraisal. We also reported earlier that an exit measure suggested that participants generally adopted the assumption that HM reactivity was real. Nevertheless, the study does not provide direct evidence of what results would look like if we could have somehow used a highly familiar disease yet set up the same tests that precluded interferences from risk reappraisals. With that said, we do not have any particular reason to suspect that the disease we used, which was generally based on a real disease, created a spurious or unrepresentative finding. We also note that the general pattern of risk estimates and the observed direction and magnitude of the relationship between perceived risk and prevention behavior seem comparable with other studies that have used well-known diseases such as COVID-19 to study related questions.[4]

A related limitation was that we were able to measure only intended prevention behavior rather than actual prevention behavior. Because we used an unfamiliar disease, it was not possible to obtain measures of actual behavior at a later time point. Past research on risk perception wording has often relied on measures of behavioral intentions instead of actual behavior,[4,6] and measures of behavioral intentions and actual behavior are substantially correlated.[32–34] Nonetheless, future research should incorporate measures of actual prevention behavior to provide further insights into the relationship between risk perception and prevention and how it is affected by question wording.

More research is also needed to determine which underlying mechanism (or combination of mechanisms) is driving the observed biasing effect of conditionals. In this article, we have suggested 3 potential mechanisms—focalism, consistency justification, and loss aversion—that could cause conditionals to systematically affect risk estimates in a manner that inflates measurements of the subjective risk-prevention behavior relationship. Although we did not test for this, we suspect that all 3 mechanisms could have an influence on conditional risk estimates and that the degree to which each mechanism plays a role varies across contexts. Future research is needed to address this empirically.

Another target of future research should be to test the same effect as we have done here, but with a prevention measure that is continuous rather than dichotomous. Prevention behaviors and/or measures of them are often dichotomous (e.g., a person either does or does not get a vaccination, as measured in Brewer et al.[1] and Weinstein et al.[21]). But they may also be conceptualized and measured as a continuous variable (e.g., smoking rate). It would be useful to test whether the current effect generalizes in that regard. The 3 mechanisms we have speculated about might operate differently when a conditional specifies a level or a future behavior when there are more than just 2 levels that can be considered.

Lastly, and more broadly, the findings of the present work should be linked to the large literature on causal reasoning. There is clearly a close conceptual relationship between reasoning about cause-and-effect relationships (e.g., the causal link between not getting vaccinated and getting a disease) and formulating probabilistic inferences.[35–39] One subarea of further exploration would be to explore how question wording affects causal reasoning procedures more broadly (e.g., for diagnostic v. predictive reasoning).

Conclusion

Moving forward, researchers examining the extent to which perceptions of risk motivate health behavior change should certainly not refrain from conditioning risk perception items on specific future behaviors. While we find that conditional statements can inflate measurements of the relationship between perceived risk and prevention behavior, they account for only small changes in measurement. However, researchers should be mindful of the biasing effect of conditionals when interpreting estimates of the relationship between perceived risk and prevention behavior, and more research is needed to determine when the biasing effect of conditionals is most pronounced.

Author Note

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Supplemental Material

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Notes

i. Preregistration: https://doi.org/10.17605/OSF.IO/WY4B3.
ii. See Section F of the supplemental materials for details about a smaller, preliminary study ($N = 171$) in which we piloted the paradigm for examining the impact of conditionals on the relationship between subjective risk and prevention behavior.
iii. None of the relevant demographic or baseline variables differed significantly across conditions (all P values >0.05).
iv. Data from an exit measure revealed that participants generally adopted the assumption that HM reactivity was real (95.3% of participants). Only 4.7% of participants said they actively doubted whether HM reactivity was real (see Section A of the Supplemental Materials for details).
v. Recall that in the benchmark condition, the main unconditional risk questions were later followed by exploratory conditional risk questions. Composites for the main and exploratory measures were computed separately.
vi. On an exploratory basis, we conducted the same analysis but separately for verbal and numeric risk estimates. See Section D of the supplemental materials for the full results of this analysis. We also conducted an exploratory analysis using a quasi-continuous—rather than dichotomous—measure of vaccine intentions (Section E).
vii. See Section C of the supplemental materials for full regression results.

References

1. Brewer NT, Weinstein ND, Cuite CL, Herrington JE. Risk perceptions and their relation to risk behavior. *Ann Behav Med*. 2004;27:125–30.
2. Johnson BB, Kim B. Cross-temporal relations of conditional risk perception measures with protective actions against COVID-19. *Soc Sci Med*. 2023;324:115867.
3. Kaufman AR, Twesten JE, Suls J, et al. Measuring cigarette smoking risk perceptions. *Nicotine Tob Res*. 2020;22(11):1937–45.
4. Kim Y, Chung S. Risk-likelihood perceptions and preventive behaviors against infectious diseases: testing different types of risk-likelihood perceptions in the context of MERS and COVID-19. *Health Commun*. 2023;38(10):2221–34.
5. Kim HK, Chung S, Kim Y, Lee S. Conditional risk perception and protection behavior: testing the behavior motivation hypothesis and the risk reappraisal hypothesis. *Soc Sci Med*. 2022;298:114868.
6. Ronis DL. Conditional health threats: health beliefs, decisions, and behaviors among adults. *Health Psychol*. 1992;11(2):127–34.
7. Van der Pligt J. Risk perception and self-protective behavior. *Eur Psychol*. 1996;1(1):34–43.
8. Van Der Pligt J. Perceived risk and vulnerability as predictors of precautionary behaviour. *Br J Health Psychol*. 1998;3(1):1–14.
9. Waters EA, Ackermann N, Wheeler CS. Specifying future behavior when assessing risk perceptions: implications for measurement and theory. *Med Decis Mak*. 2019;39(8):986–97.
10. Chambers JR, Windschitl PD. Biases in social comparative judgments: the role of nonmotivated factors in above-average and comparative-optimism effects. *Psychol Bull*. 2004;130(5):813–38.
11. Schkade DA, Kahneman D. Does living in California make people happy? A focusing illusion in judgments of life satisfaction. *Psychol Sci*. 1998;9(5):340–46.
12. Wilson TD, Wheatley T, Meyers JM, Gilbert DT, Axsom D. Focalism: a source of durability bias in affective forecasting. *J Pers Soc Psychol*. 2000;78(5):821–36.
13. DeKay ML, Patiño-Echeverri D, Fischbeck PS. Distortion of probability and outcome information in risky decisions. *Organ Behav Hum Decis Process*. 2009;109(1):79–92.
14. Festinger L. Cognitive dissonance. *Sci Am*. 1962;207(4):93–106.
15. Kostopoulou O, Russo JE, Keenan G, Delaney BC, Douiri A. Information distortion in physicians' diagnostic judgments. *Med Decis Mak*. 2012;32(6):831–9.
16. Levy AG, Hershey JC. Distorting the probability of treatment success to justify treatment decisions. *Organ Behav Hum Decis Process*. 2006;101(1):52–8.
17. Levy AG, Hershey JC. Value-induced bias in medical decision making. *Med Decis Mak*. 2008;28(2):269–76.
18. Tversky A, Kahneman D. Advances in prospect theory: cumulative representation of uncertainty. *J Risk Uncertain*. 1992;5:297–323.
19. Schönbrodt FD, Perugini M. At what sample size do correlations stabilize? *J Res Pers*. 2013;47(5):609–612.
20. Rodriguez SA, Tiro JA, Baldwin AS, Hamilton-Bevil H, Bowen M. Measurement of perceived risk of developing diabetes mellitus: a systematic literature review. *J Gen Intern Med*. 2023;38(8):1928–54.
21. Weinstein ND, Kwitel A, McCaul KD, Magnan RE, Gerrard M, Gibbons FX. Risk perceptions: assessment and relationship to influenza vaccination. *Health Psychol*. 2007;26(2):146–51.
22. Cohen J, Cohen P, West SG, Aiken LS. *Applied Multiple Regression/Correlation Analysis for the Behavioral Sciences*. New York: Routledge; 2013.
23. Rohrer JM, Arslan RC. Precise answers to vague questions: issues with interactions. *Adv Methods Pract Psychol Sci*. 2021;4(2):25152459211007368.
24. Stuart JOR, Windschitl PD, Bossard E, et al. Which measures of perceived vulnerability predict protective intentions—and when? *J Behav Med*. 2023;46(6):912–29.
25. Bruine de Bruin W, Fischbeck PS, Stiber NA, Fischhoff B. What number is "fifty-fifty"? Redistributing excessive 50% responses in elicited probabilities. *Risk Anal*. 2002;22(4):713–23.
26. Bruine de Bruin W, Carman KG. Measuring subjective probabilities: the effect of response mode on the use of

focal responses, validity, and respondents' evaluations. *Risk Anal*. 2018;38(10):2128–43.
27. Fischhoff B, Bruine De Bruin W. Fifty–fifty = 50%? *J Behav Decis Mak*. 1999;12(2):149–63.
28. Brewer NT, Chapman GB, Gibbons FX, Gerrard M, McCaul KD, Weinstein ND. Meta-analysis of the relationship between risk perception and health behavior: the example of vaccination. *Health Psychol*. 2007;26(2):136–45.
29. van der Velde FW, Hooykaas C, van der Pligt J. Conditional versus unconditional risk estimates in models of AIDS-related risk behaviour. *Psychol Health*. 1996;12(1): 87–100.
30. Finucane ML, Alhakami A, Slovic P, Johnson SM. The affect heuristic in judgments of risks and benefits. *J Behav Decis Mak*. 2000;13(1):1–17.
31. Rottenstreich Y, Hsee CK. Money, kisses, and electric shocks: on the affective psychology of risk. *Psychol Sci*. 2001;12(3):185–90.
32. Armitage CJ, Conner M. Efficacy of the theory of planned behaviour: a meta-analytic review. *Br J Soc Psychol*. 2001;40(4):471–99.
33. Fishbein M, Ajzen I. *Belief, Attitude, Intention, and Behavior: An Introduction to Theory and Research*. Reading (MA): Addison-Wesley; 1975.
34. Hagger MS, Cheung MWL, Ajzen I, Hamilton K. Perceived behavioral control moderating effects in the theory of planned behavior: a meta-analysis. *Health Psychol*. 2022;41(2):155–67.
35. Buehner MJ, Cheng PW, Clifford D. From covariation to causation: a test of the assumption of causal power. *J Exp Psychol Learn Mem Cogn*. 2003;29(6):1119–40.
36. Meder B, Mayrhofer R, Waldmann MR. Structure induction in diagnostic causal reasoning. *Psychol Rev*. 2014;121(3):277–301.
37. Perales JC, Catena A, Cándido A, Maldonado A.Rules of causal judgment: mapping statistical information onto causal beliefs. In: Waldmann MR, ed. *The Oxford Handbook of Causal Reasoning*. New York: Oxford; 2017. p 29–51.
38. Sloman SA, Lagnado D. Causality in thought. *Annu Rev Psychol*. 2015;66:223–47.
39. Waldmann MR, Cheng PW, Hagmayer Y, Blaisdell AP.Causal learning in rats and humans: a minimal rational model. In: Chater N, Oaksford M, eds. *The Probabilistic Mind. Prospects for Bayesian Cognitive Science*. New York: Oxford; 2008. p 453–84.