

ORIGINAL ARTICLE

Compliance with social norms in the face of risks: Delineating the roles of uncertainty about risk perceptions versus risk perceptions

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Abstract

Social norms are often considered as behavioral guidelines to mitigate health and environmental risks. However, our understanding of the magnitude of their impact on risk-mitigating behaviors and how perceptions of risks affect the magnitude remains limited. Given the increasing importance of understanding factors influencing behavioral responses to health and environmental risks, this research examines whether the relationship between social norms and behavioral intention to mitigate health and environmental risks is a function of (1) risk perceptions and (2) uncertainty about risk perceptions. A cross-sectional survey involving a national sample ($N = 803$) across three health and environmental risks (i.e., infectious diseases, climate change, and water shortage) is conducted. The results reveal a three-way interaction between descriptive norms, uncertainty about susceptibility, and uncertainty about severity on behavioral intention to mitigate the risk. Individuals exhibit the strongest intention to engage in risk-mitigating behaviors when they perceive prevailing social norms and are uncertain about their susceptibility to the risk and the severity of the risk. Moreover, injunctive norms interact with uncertainty about susceptibility to influence behavioral intention, such that the more uncertain individuals feel about their vulnerability to a risk, the stronger the impact of injunctive norms is on behavioral intention. Neither descriptive nor injunctive norms interact with perceived risks to influence behavioral intention. This study contributes valuable insights into the interplay between social norms, uncertainty about perceived risk, and behavioral intention, and offers valuable theoretical and practical implications.

KEYWORDS

behavioral intention to mitigate risk, perceived susceptibility and severity, social norms, uncertainty about perceived susceptibility and severity

1 | INTRODUCTION

Scholars across various disciplines have shown an enduring interest in understanding the impact of social norms on regulating and promoting behaviors to mitigate health and environmental risks. Likewise, public health and environment interventions also use social norms to motivate the public to engage in health promotion (Neville et al., 2021) and environmental protection behaviors (Nyborg, 2018) as if compliance with social norms is an automatic and effective risk mitigation response. This assumption essentially posits that individuals' tendencies to comply with social norms to mitigate risks

become stronger when their perceived risks intensify. However, this assumption has rarely been tested. Moreover, some theoretical arguments and empirical evidence directly contradict this assumption and posit that rather than strengthening, risk perceptions can weaken the impact of social norms on risk-mitigating behaviors (e.g., Kittel et al., 2021; Lazić et al., 2021), which call for more systematic inquiries into this complex phenomenon.

The notion of uncertainty serves as a motivation for normative compliance (Griskevicius et al., 2006; Tesser et al., 1983), is a fundamental element in risk judgment (Johnson & Slovic, 1995; Orom et al., 2020, and can trigger adop-

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tion of desired behavior when the right amount of uncertainty is effectively communicated (de Bruin & Carman, 2012). Uncertainty sits in the intersection between social norms, risk judgment, and behavioral decisions, and therefore, reintroducing the concept of uncertainty about risk (Huang & Yang, 2020) may reconcile the inconsistencies observed in the literature and bring greater clarity to further our understanding of whether and to what extent individuals comply with social norms in the face of risks.

Given their close ties to health and environmental risk behaviors (Rhodes et al., 2020) and their distinct effects on decision-making process (Cialdini & Trost, 1998), this study attends to two types of social norms: descriptive and injunctive norms (Cialdini et al., 1990). Descriptive norms concern the extent to which a behavior is popular and prevalent in a reference group, whereas injunctive norms pertain to the degree of social approval or sanction of the behavior in the reference group (Cialdini et al., 1990). How descriptive and injunctive norms differentially influence risk-mitigating behaviors is understudied. Thus, this research is set up to (1) examine whether the effects of social norms on behavior are moderated by perceived risk and uncertainty about perceived risks, and (2) explore whether the effects of social norms, conditioned upon risk uncertainty and perceptions, vary depending on the type of norms.

2 | EXISTING RESEARCH AND THEORETICAL PERSPECTIVES

2.1 | The role of social norms in risk mitigation

Social norms play a central role in behavioral decisions as they provide decisional cues and regulate behaviors as health and environmental risks surface (Bubeck et al., 2013, Bubeck et al., 2018). Research has largely supported the powerful impact of (perceived) social norms on motivating health and environmental behaviors and argued favorably for the use of social norms in public health and environmental interventions to elicit behavior changes (Rhodes et al., 2020).

However, little is known regarding the boundary conditions in which the effect of social norms on risk mitigation increases or diminishes, and for two reasons, this research proposes two possible moderating factors—risk perceptions and uncertainty about perceived risk—for the social norm-behavior relationship. First, since social norms provide a decisional guidance for individuals in the face of threats to physical health (Griskevicius et al., 2006), it is intuitive to believe that as perceived risks heightens, so is individuals' compliance with social norms. However, without empirical testing, this intuition can lead to a dangerous practice of blindly employing social norms interventions to risk mitigation. Thus, it's theoretically and practically significant to examine how risk perceptions influence normative compliance. Second, compliance with social norms to mitigate physical risks is often discussed in conjunction with or as a

result of uncertainty experienced in risk assessments (Gelfand et al., 2021; van Kleef et al., 2019). However, risk perceptions and uncertainty about risk perceptions are conceptually distinct, and the distinction has not been adequately discussed, which may contribute to the inconsistent even contradictory findings of the interaction between risks and social norms observed in the literature (Griskevicius et al., 2006; Kittel et al., 2021). The remainder of the manuscript will (1) elaborate on the conceptual distinction between risk perceptions and uncertainty about risk perceptions, and (2) review the theoretical accounts and existing empirical evidence for the relationships between normative compliance and (a) risk perceptions and (b) uncertainty about risk perceptions.

2.2 | Conceptual differences between risk perceptions and uncertainty about risk perceptions

A clear conceptual distinction between uncertainty about perceived risks and risk perceptions must be made before we proceed. Risk perceptions, according to previous research (Witte, 1992; Yang et al., 2014), concern the extent to which individuals deem a risk entails serious consequences (i.e., perceived severity) and whether they are personally vulnerable to the risk (i.e., perceived susceptibility). Uncertainty about risk perceptions is central to how individuals cope with risks via information acquisition (Brashers et al., 2002; Powell et al., 2007; Slovic, 1993) and closely ties to compliance with social norms (Eriksson, 2019; Lapinski & Rimal, 2005). The psychometric paradigm of risk perceptions positions uncertainty at the center of risk perceptions, and the perceptions and judgment of a risk depend on a series of factors, such as availability of scientific knowledge, seriousness of consequences, and risk immediacy (Slovic, 1993). The extent to which individuals are certain about their risk judgment is coined by researchers as uncertainty about risk perceptions and functions as a metacognition of risk perceptions (Huang & Yang, 2020). According to Huang and Yang (2020), uncertainty about risk perceptions concerns the extent to which individuals feel certain and confident about their subjective evaluations of risks.

We can derive uncertainty about susceptibility and uncertainty about severity when marrying risk perceptions and uncertainty about risk perceptions. Uncertainty about susceptibility specifically concerns whether people feel certain about their perceived likelihood of the risk affecting them, whereas uncertainty about severity is the extent to which individuals feel confident about their evaluation of the seriousness of the consequences entailed by a risk. One may perceive a heightened likelihood of being affected by a risk and believe the risk will cause significant harm but simultaneously feel unsure about their judgments, which may change as more information is available, sought, or processed (Brashers, 2001). One may also perceive a risk is serious and personally vulnerable to it, and at the same time feel certain and confident about their risk judgment. Similarly, one may think a

risk is unlikely to affect them and does not carry serious consequences, and at the same time, feel great or little confidence in the evaluation.

2.3 | Interplay between social norms and perceived risk

Previous research grounded in the literature regarding the intersection between fundamental motives and conformity to norms indicates that heightened risks augment desires to comply with social norms. Because many self-protective behaviors involve a process of being more cohesive with the group (e.g., strategically imitating others, Wickler, 1968) to increase the probability of survival, people mimic others to enhance their sense of safety when facing danger (Dijksterhuis et al., 2000). For example, in a study conducted by Griskevicius et al. (2006, Study 1), some participants were led to believe they were in a dangerous situation, which resulted in stronger intentions to follow the majority's opinions about a painting than participants who did not believe that they were in danger, suggesting that perceived danger enhanced conformity to social norms. Griskevicius et al. (2006) explained their findings by arguing that compliance with social norms functioned as a defensive mechanism and offered a sense of protection to alleviate risks. In the same vein, Murray and Schaller (2012) observed that salient disease threats enhanced individuals' conformist attitudes, and Wu and Chang (2012) found that increased vulnerability to pathogen threats resulted in people's stronger endorsement of a group majority's opinion. However, this body of research also suffers from methodological flaws, one of which being the disconnect between the risk under assessment and the behavior under influence of social norms (Zhuang, Schrodt, & Guan, 2024).

On the other hand, a growing body of research primarily driven by literature on information processing and social norms, presents a contradiction to the notion that risks enhance the effects of social norms on behavior. Social norms, especially descriptive norms, have largely been conceptualized as heuristic cues and provide individuals with a mental shortcut to arrive at an actionable decision (Cialdini & Trost, 1998; Wang et al., 2023). However, as risks enhance, which is theorized to activate systematic information processing (Li & Huang, 2020), social norms, especially descriptive norms, may become insufficient to formulate or sustain a decision to facilitate risk mitigation, and as a result, the likelihood to comply with social norms diminishes. Although limited, some evidence has been gathered to support this prediction. For example, Kittel et al. (2021) examined the interaction between social norms and risk perceptions against the backdrop of the COVID-19 pandemic and reported that increasing risk perceptions eroded the effects of social norms on Austrians' engagement in COVID-19 preventive measures. Another study (Zhuang, 2021) experimentally induced descriptive norms and risk in the contexts of COVID-19 and

meningitis and showed that risks attenuated the effect of descriptive norms on intention to begin preventive measures against infectious diseases. Collectively, this body of research indicates that rather than magnifying, perceived risks weaken the impact of social norms on behavior such that people comply with social norms to a lesser extent when they perceive a greater degree of risks.

As forementioned, risk perceptions consist of perceived susceptibility, referring to one's perceived vulnerability to experiencing a risk, and perceived severity, focusing on the perceived seriousness of the consequences associated with the risk (Floyd et al., 2000; Witte, 1992). Nevertheless, empirical research conducted to date has not distinguished how these two risk perceptions may vary in their interactions with social norms on behavioral intention. Given these rather puzzling findings in the literature, two research questions are asked.

RQ 1. *How do social norms interact with perceived susceptibility (RQ1a) and perceived severity (RQ1b) to affect behavioral intention?*

RQ 2. *Is there a three-way interaction effect between social norms, perceived susceptibility, and perceived severity on behavioral intention?*

2.4 | Interplay between uncertainty about perceived risk and social norms

Individuals are motivated to follow social norms when uncertainty about a given situation increases and action cues are ambiguous (Lapinski & Rimal, 2005). Given that uncertainty is an integral part of risk judgments, it's reasonable to argue that when confronted with a health or environmental risk, individuals naturally feel uncertain about the risk, and are primed to look for ways to manage uncertainty and guard their safety as a coping mechanism. What other members of a social group do (i.e., descriptive norms) and think is appropriate (i.e., injunctive norms) signals collective expectations and behavior codes, which individuals can rely on as behavioral guidance to mitigate risks (Zhang et al., 2022). Therefore, instead of perceived risks, uncertainty about perceived risks may have a more meaningful and stronger effect on individual motivation to comply with social norms. That is, when individuals lack confidence and certainty in their evaluations of a risk, they are more likely to seek guidance by observing others in a social group and derive cues for the right actions to be taken. Conversely, if individuals are certain and feel confident about their evaluation of a risk, the need for relying on social norms to derive action cues decreases because their risk perceptions are sufficiently indicative of what behavior ought to be performed to manage risks. Therefore, social norms are less impactful when people feel certain about their risk perceptions and more powerful when people are not confident about their risk assessments. As such, we advance a

hypothesis to test the interaction between uncertainty about risk perceptions and social norms.

H 1. *The effect of social norms on behavioral intention strengthens as uncertainty about susceptibility (H1a) and uncertainty about severity (H1b) increase.*

It is also possible that the interaction between social norms and uncertainty about susceptibility is further strengthened by individual's uncertainty about severity. That is, the additive interaction between social norms and uncertainty about susceptibility is manifested more among individuals who feel uncertain about their evaluations of the seriousness of the risk outcomes. The interaction weakens among individuals who feel greater certainty about their evaluations. Hence, a second hypothesis is advanced.

H 2. *There is a three-way interaction between social norms, uncertainty about susceptibility, and uncertainty about severity on behavioral intention such that the interaction between social norms and uncertainty about susceptibility on behavioral intention will further amplify as uncertainty about severity increases.*

Descriptive and injunctive norms, albeit both providing behavioral cues, are distinct in how they are processed (Cialdini & Trost, 1998) and dictate cognitive deliberation (Melnyk et al., 2011). Specifically, descriptive norms largely function as heuristic cues and mental shortcuts, and therefore are processed effortlessly. Relative to descriptive norms, injunctive norms serve as systematic cues (Cialdini & Trost, 1998), and facilitate a more in-depth elaboration of obtained information and motivates people to more carefully scrutinize the obtained information (Jacobson et al., 2011, 2021; Kredentser et al., 2012). This theoretical distinction in how descriptive and injunctive norms affect information processing helps connect with the literature on risk perceptions. Research has been consistently suggesting that greater risk perceptions are related to more systematic information processing whereas weaker risk perceptions tend to motivate people to engage in heuristic information processing (Hubner & Hovick, 2020; Meijnders et al., 2001; Trumbo, 1999). Therefore, it is possible that the impact of descriptive norms on behavior is intensified when individuals risk perceptions are low, and the effect of injunctive norms is strengthened when greater risks are perceived. On the other hand, uncertainty is considered as a constraint on cognitive information processing (Tversky & Kahneman, 1974), so it is possible that under greater level of uncertainty about risk assessments, individuals are more likely to comply with descriptive norms than injunctive norms, since theoretically the former is processed and elaborated on less effortfully than the latter (Cialdini & Trost, 1998). However, empirical studies conducted thus far to explore the relationship between social norms, risk perceptions, and information processing are limited. Moreover, it is also unclear whether people's ability to process information and involvement in the issue would

change because of varying levels of uncertainty about risk perceptions. Thus, instead of making a specific prediction, we ask the following research question to probe whether the relationships posited in H1-2 and RQ1-2 vary depending on the types of social norms.

RQ 3. *How do the types of social norms influence the relationships posited in H1-2 and RQ1-2?*

3 | METHODS

3.1 | Power analysis, participants, and procedure

A priori power analysis was conducted using G*Power 3.1. Given that prior research was not informative in terms of the effect size of the interaction between social norms and risk perceptions, the sample size was determined by a small (i.e., 0.15) effect size, 95% power, and 0.05 margin of error. The sample size desired to detect predicted effects was $n = 119$. After the three topical areas were taken into consideration, the obtained sample size ($N = 803$) exceeded the required sample size.

A national sample consisting of 803 participants (44.5% males, $M_{age} = 46.59$, $SD_{age} = 17.91$, range 18–92 years old) recruited from PureSpectrum participated in this cross-sectional online survey study housed in Qualtrics survey platform. Seventy-seven percent of the participants identified themselves as White/Caucasians, followed by 11.2% Black/African Americans, 4.0% Asian/Asian Americans, 6.0% Multiracial, and 1.5% American Indians /Alaska Natives. Twelve-point six percent of the participants identified themselves as Hispanic/Latinx. Over 30% of the participants (34.1%) completed a 2- or 4-year college degree, followed by 28.1% of the participants who graduated from college, and 10.3% of the participants completed a graduate degree. Employment status was also included to assess potential differences in risk perceptions and behavioral intentions based on socioeconomic factors. Forty-nine percent of the participants were full- or part-time employed, followed by 22.4% of the participants who retired, and 17.2% of them who were unemployed. Thirty-three percent of the participants identified themselves as a Democrat, followed by 30.2% of the participants who identified themselves as a Republican, and 30.7% of them who identified themselves as an Independent.

This study received the Institutional Review Board (IRB) approval at the university which the author was affiliated with. Upon arriving at the survey site, participants first read the informed consent, and only participants who agreed to participate in this study proceeded to answer questions. Participants were randomly assigned to one of three topical conditions (e.g., infectious diseases, climate change, and water shortage). In each topical condition, participants responded to questions assessing their perceptions of descriptive and injunctive norms, perceived severity and sus-

TABLE 1 Descriptive statistics and reliability of focal variables.

Measure	Infectious disease			Climate change			Water shortage			Total		
	<i>M</i>	<i>SD</i>	α/r	<i>M</i>	<i>SD</i>	α/r	<i>M</i>	<i>SD</i>	α/r	<i>M</i>	<i>SD</i>	α/r
BI	5.59	1.45	0.91	4.76	1.49	0.93	5.08	1.44	0.93	5.15	1.50	0.92
DN	69.37%	25.72%	NA	48.83%	31.75%	NA	44.03%	30.46%	NA	54.16%	31.37%	NA
IN	6.03	1.15	0.95	5.03	1.31	0.93	5.06	1.31	0.92	5.38	1.34	0.93
UNC-SUSC	4.35	1.42	0.71	3.79	1.63	0.78	4.30	1.49	0.70	4.15	1.53	0.74
UNC-SEV	4.31	1.36	0.82	4.03	1.67	0.90	4.08	1.53	0.81	4.14	1.59	0.86
PER-SUSC	4.67	1.59	0.85	4.88	1.76	0.95	4.13	1.54	0.83	4.56	1.66	0.88
PER-SEV	4.57	1.24	0.90	5.09	1.48	0.95	5.65	1.17	0.88	5.10	1.37	0.90

Abbreviations: BI, behavioral intention; DN, descriptive norms; IN, injunctive norms; PER-SEV, perceived severity; PER-SUSC, perceived susceptibility; UNC-SEV, uncertainty about severity; UNC-SUSC, uncertainty about susceptibility.

TABLE 2 Zero-order correlations.

	1	2	3	4	5	6	7	8
1. Behavioral intention	1.00							
2. Descriptive norms	0.32**	1.00						
3. Injunctive norms	0.61**	0.40**	1.00					
4. Uncertainty about susceptibility	0.11**	0.15**	0.14**	1.00				
5. Uncertainty about severity	0.07*	0.16**	0.15**	0.53**	1.00			
6. Perceived susceptibility	0.32**	0.15**	0.26**	-0.05	0.03	1.00		
7. Perceived severity	0.44**	0.06	0.26**	0.04	-0.04	0.39**	1.00	
8. Political ideology	-0.13**	-0.04	-0.07	-0.01	-0.04	-0.09*	-0.09*	1.00

* $p < 0.05$, ** $p < 0.01$.

ceptibility, uncertainty about the severity and susceptibility, and behavioral intention to mitigate the health/environmental risk. Demographic information was recorded at the end before participants exited the study. Participants received monetary compensations for their participation, which was agreed upon by the specific vendor through which participants were recruited. The median duration of completing this study was 9 min.

3.2 | Measures

Unless noted otherwise, all measures were administered as a 7-point Likert type scales, with response options ranging from 1 = *strongly disagree* to 7 = *strongly agree*. Items worded in the opposite direction were reverse coded. Confirmatory factor analyses were conducted, and scale reliability was evaluated prior to the computation of composite scores. Descriptive statistics and scale reliability were reported in Table 1 and zero-order correlations of focal variables were reported in Table 2. Full measures containing all items were available in the Supporting Information.

3.2.1 | Perceived descriptive norms

Perceived descriptive norms were assessed with a single item, which asked participants to indicate the percentage of people they know engaged in the respective risk mitigation behavior. Participants indicated their responses using a slider scale, ranging from 0% to 100% with 5% as an increment unit. For example, participants assigned to the infectious disease condition were asked to indicate the percentage of people they know take preventive measures such as handwashing to prevent infectious disease.

3.2.2 | Perceived injunctive norms

Perceived injunctive norms were assessed with a four-item scale to evaluate the extent to which people the participants know approved of risk mitigation behavior. Specifically, participants were asked to indicate whether individuals they knew embrace/support/approve of risk mitigation behaviors and whether they think it is a good idea.

3.2.3 | Perceived susceptibility

Perceived susceptibility was measured by a three-item scale adopted from Witte (1996). An example item was “I will likely contract infectious diseases such as the flu/be influenced by climate change/be affected by water shortage sometime in my life.”

3.2.4 | Perceived severity

Perceived severity was measured by a four-item scale adopted from Witte (1996). An example item was “The impact of infectious diseases such as the flu/climate change/water shortage on human health is substantial.”

3.2.5 | Uncertainty about susceptibility

Perceived uncertainty about susceptibility to a risk was measured by a scale consisting of three items adopted from Huang and Yang (2020). An example item was “I am uncertain whether infectious disease/climate change/water shortage will affect me personally.” A reverse-coded item was removed due to a low factor loading. With the two retained items, scale reliability was not assessed. Instead, a bivariate correlation was reported in Table 1.

3.2.6 | Uncertainty about severity

Severity uncertainty was measured with a scale of four items adopted from Huang and Yang (2020). Example items were “The magnitude of the negative consequences of infectious diseases/climate change/water shortage is unclear,” and “it is unclear how bad the consequences of infectious diseases/climate change/water shortage will be.” One item was eliminated due to a low factor loading.

3.2.7 | Behavioral intention

Behavioral intention to engage in risk mitigation behaviors was measured with a scale of four items adopted from (Fishbein & Ajzen, 2010). Example items included “I intend to take actions to prevent infectious diseases/slow down the progress of climate change/conserves water,” and “I plan to act to prevent infectious diseases/slow down the progress of climate change/conserves water.”

3.3 | Determination of covariates and analytic approaches

A series of one-way ANOVAs and bivariate correlations were performed to examine the extent to which demographic

variables influenced behavioral intention beyond topical conditions, which was used as a covariate inclusion criterion. The results showed that political identity was significantly related to behavioral intention, $F(2, 797) = 10.59, p < .001$, such that participants who identified themselves as a Republican ($M = 4.74, SD = 1.63$), Independent ($M = 5.00, SD = 1.45$), and Other ($M = 4.02, SD = 1.48$) rated lower behavioral intention than participants who identified as a Democratic ($M = 5.54, SD = 1.23$). Other demographic variables (e.g., gender, age, race/ethnicity, income, education) were not associated with behavioral intention. Thus, together with the topical condition¹, political identity was controlled for in subsequent analyses.

To test the hypotheses and answer research questions, Model 3 in PROCESS Macro (Hayes, 2018) was used. Specifically, mean-centered social norms were entered as the independent variable, behavioral intention was entered as the outcome variable. To test *H1* and *H2*, mean-centered uncertainty about susceptibility and severity were entered as moderators, and to answer *RQ1* and *RQ2*, perceived susceptibility and severity were entered as moderators. In all analyses, topics and political identity were entered as covariates. *RQ3*, which asked whether the relationships predicted in *H1-2* and *RQ1-2* would vary as a function of the types of social norms, was answered descriptively.

4 | RESULTS

4.1 | Preliminary findings

Overall, as indicated by results yielded from one-sample *t*-tests, participants exhibited strong behavioral intention to (1) prevent infectious diseases and (2) take actions to mitigate the negative impact of climate change and conserve water. Specifically, participants' intention to take preventive measures against infectious diseases, $M = 5.59, SD = 1.45, t(270) = 18.08, p < 0.001, Cohen's d = 1.10$, intention to mitigate climate change, $M = 4.76, SD = 1.49, t(263) = 8.25, p < 0.001, Cohen's d = 0.51$, and intention to conserve water, $M = 5.07, SD = 1.44, t(267) = 12.29, p < 0.001, Cohen's d = 0.75$, were all greater than the mid-point of the behavioral intention scale. At the bivariate level, the results indicated descriptive norms and injunctive norms were significantly correlated with behavioral intention, and the extent to which participants were uncertain about the health or environmental threats and the severity of the threat were associated with behavioral intention (see Table 2).

Prior to hypothesis testing, a confirmatory factor analysis was performed to determine whether uncertainty about susceptibility, uncertainty about severity, perceived susceptibility, and perceived severity constituted separate factors.

¹ We also conducted hypotheses testing and answered the research questions within each topic, and similar patterns emerged. Detailed results are reported in the online Supporting Information.

TABLE 3 Three-way interactions between descriptive norms, perceived susceptibility, and perceived severity.

		<i>B</i> (<i>SE</i>)	<i>t</i>	95% <i>CI</i>
Main effects	DN	0.01 (0.02)	5.40***	[0.006, 0.03]
	PER-SUSC	0.07 (0.03)	2.09*	[0.004, 0.13]
	PER-SEV	0.49 (0.04)	10.67***	[0.40, 0.58]
Two-way interactions	DN × PER-SUSC	−0.003 (0.003)	−0.56	[−0.01, 0.003]
	DN × PER-SEV	0.001 (0.002)	0.58	[−0.004, 0.005]
	PER-SUSC × PER-SEV	−0.01 (0.03)	−0.76	[−0.07, 0.05]
Three-way interaction	DN × PER-SUSC × PER-SEV	0.0002 (0.0005)	0.23	[−0.001, 0.001]

Abbreviations: DN, descriptive norms; PER-SEV = perceived severity; PER-SUSC = perceived susceptibility * $p < 0.05$, *** $p < 0.001$.

TABLE 4 Interactions between descriptive norms, uncertainty about susceptibility, and uncertainty about severity.

		<i>B</i> (<i>SE</i>)	<i>t</i>	95% <i>CI</i>
Main effects	DN	−0.01 (0.002)	5.39***	[0.01, 0.02]
	UNC-SUSC	0.06 (0.04)	1.46	[−0.02, 0.15]
	UNC-SEV	−0.04 (0.04)	−0.95	[−0.13, 0.04]
Two-way interactions	DN × UNC-SUSC	0.001 (0.001)	1.01	[−0.01, 0.004]
	DN × UNC-SEV	−0.007 (0.003)	0.46	[−0.002, 0.003]
	UNC-SUSC × UNC-SEV	−0.03 (0.02)	−1.24	[−0.07, 0.02]
Three-way interaction	DN × UNC-SUSC × UNC-SEV	0.002 (0.001)	3.03**	[0.001, 0.003]

Abbreviations: DN, descriptive norms; UNC-SEV, uncertainty about severity; UNC-SUSC, uncertainty about susceptibility.

** $p < 0.01$, *** $p < 0.001$.

It was found that a four-factor solution fit the data well, $\chi^2(59) = 188.57$, $p < 0.001$, CFI = 0.98, RMSEA = 0.052 (90% CI = 0.0440–0.061), SRMR = 0.036. Additionally, we performed an alternate two-factor confirmatory factor analysis by grouping (1) perceived susceptibility with uncertainty about susceptibility and (2) perceived severity with uncertainty about severity. The two-factor solution fit the data poorly $\chi^2(57) = 2733.45$, $p < 0.001$, CFI = 0.68, RMSEA = 0.28 (90% CI = 0.30–0.32), SRMR = 0.33. Given these findings, we proceeded to test hypotheses and answer research questions following the forementioned procedures.

4.2 | Hypotheses testing

4.2.1 | Interactions between social norms, perceived susceptibility, and perceived severity

To answer *RQ1* and *RQ2*, which asked whether social norms interact with perceived severity and susceptibility to influence behavioral intention. The Johnson-Neyman (1936) output in the PROCESS macro was selected with 5,000 bootstrap resamples. The results indicated that neither two-way interaction probed in *RQ1*, nor the three-way interaction asked in *RQ2* was significant. The results were detailed in Tables 3 and 5.

4.2.2 | Interactions between social norms and uncertainty about susceptibility and severity

H1 predicted two-way interactions between social norms and uncertainty about susceptibility (H1a) and severity (H1b) and H2 hypothesized a three-way interaction between social norms, uncertainty about susceptibility, and uncertainty about severity. We employed the same analytic procedures as in the data analyses to answer *RQ1-2*. The results revealed a significant three-way interaction between descriptive norms, uncertainty about susceptibility, and uncertainty about severity emerged, $\beta = 0.002$, $SE = 0.001$, $t = 3.03$, $p < 0.01$ (see Table 4). However, no such interaction was detected for injunctive norms, lending partial support to our hypothesis *H2*. Moreover, injunctive norms were found to interact with uncertainty about susceptibility ($\beta = -0.11$, $SE = 0.04$, $t = -2.53$, $p < 0.05$), and uncertainty about susceptibility interacted with uncertainty about severity ($\beta = -0.13$, $SE = 0.06$, $t = -2.07$, $p < 0.05$) to influence behavioral intention (see Table 6).

Significance in the interaction between descriptive norms and uncertainty about susceptibility was contingent upon uncertainty about severity surpassing a threshold, as indicated by our analysis. For the three-way interaction, the results suggested that the interaction between descriptive norms and uncertainty about susceptibility was not significant when respondents' uncertainty about severity was below 4.98 and the interaction became statistically significant when

TABLE 5 Interactions between injunctive norms, perceived susceptibility, and perceived severity.

		<i>B</i> (<i>SE</i>)	<i>t</i>	95% <i>CI</i>
Main effects	IN	0.51 (0.04)	12.47***	[0.42, 0.59]
	PER-SUSC	0.04 (0.03)	1.29	[-0.02, 0.10]
	PER-SEV	0.34 (0.04)	7.75***	[0.25, 0.42]
Two-way interactions	IN × PER-SUSC	0.005 (0.02)	0.22	[-0.04, 0.05]
	IN × PER-SEV	-0.03 (0.03)	-1.20	[-0.09, 0.02]
	PER-SUSC × PER-SEV	0.003 (0.02)	0.15	[-0.03, 0.04]
Three-way interaction	IN × PER-SUSC × PER-SEV	-0.001 (0.01)	-0.14	[-0.02, 0.02]

Notes: IN = injunctive norms; PER-SEV = perceived severity; PER-SUSC = perceived susceptibility.
*** $p < 0.001$.

TABLE 6 Interactions between injunctive norms, uncertainty about susceptibility, and uncertainty about severity.

		<i>B</i> (<i>SE</i>)	<i>T</i>	95% <i>CI</i>
Main effects	IN	0.85 (0.16)	5.27***	[0.57, 0.98]
	UNC-SUSC	0.80 (0.25)	3.12**	[0.30, 0.87]
	UNC-SEV	0.05 (0.27)	0.20	[-0.48, 0.59]
Two-way interactions	IN × UNC-SUSC	-0.11 (0.04)	-2.53*	[-0.08, 0.03]
	IN × UNC-SEV	0.003 (0.05)	0.06	[-0.09, 0.10]
	UNC-SUSC × UNC-SEV	-0.13 (0.06)	-2.07*	[-0.25, -0.01]
Three-way interaction	IN × UNC-SUSC × UNC-SEV	0.02 (0.01)	1.63	[-0.003, 0.04]

Abbreviations: IN, injunctive norms; UNC-SEV, uncertainty about severity; UNC-SUSC, uncertainty about susceptibility.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

participants reported 4.98 or greater on uncertainty about perceived severity. Moreover, as shown in Figure 1a-c, uncertainty about susceptibility attenuated the effect of descriptive norms on behavioral intention when uncertainty about severity was low, whereas as uncertainty about severity enhanced, uncertainty about susceptibility strengthened the impact of descriptive norms. On the other hand, uncertainty about susceptibility weakened the effect of injunctive norms on behavioral intention (see Figure 2) such that as uncertainty about susceptibility increased, the effect of injunctive norms on behavior reduced.

RQ3 asked whether the interactions hypothesized in *H1-2* and asked in *RQ1-2* varied depending on the types of social norms. The findings yielded from the testing of *H1-2* and *RQ1-2* indicated that neither descriptive norms nor injunctive norms interacted with perceived severity or susceptibility to affect behavioral intention. Uncertainty about susceptibility and severity moderated the relationship between social norms and behavioral intention, but the natures of these interactions differed. Specifically, results showed that uncertainty about perceived risks enhanced the impact of descriptive norms on behavioral intention, whereas uncertainty about risks, in particular susceptibility, attenuated the effect of injunctive norms on behavioral intention.

5 | DISCUSSION

To bring greater clarity to the literature regarding how social norms shape behaviors to mitigate health and environmen-

tal risks, this research strived to achieve two goals. First, this study re-introduced the concept of uncertainty to bridge the two separate corpora of research on social norms and risk perceptions. Second, through a cross-sectional survey, this study gathered empirical evidence to test the interactions between social norms, risk perceptions, and uncertainty about risk perceptions on risk-mitigating behavioral intention. Informative findings are yielded and warrant in-depth discussion.

The most noteworthy finding pertains to the interaction between uncertainty about risk perceptions and social norms on behavioral intention (*H1-H2*). The results indicate that uncertainty about susceptibility strengthens the effect of descriptive norms, which is further amplified among participants who were also uncertain about the seriousness of the risk. Put differently, the intention to comply with descriptive norms to mitigate a risk is intensified when individuals are not sure about the extent to which they could be affected by the risk (i.e., uncertainty about perceived susceptibility), and the intention becomes even stronger among individuals who were also uncertain (vs. certain) about how serious the risk was (i.e., uncertainty about perceived severity). On the other hand, perceived susceptibility and severity did not affect the magnitude of the impact of social norms on behavioral intention, indicating that individual tendencies to comply with social norms to engage in risk-mitigating behaviors are independent from their risk assessments (*RQ1-2*). These findings shed light on the extant literature in two ways.

FIGURE 1 (a) Three-way interaction between descriptive norms (DN), uncertainty about severity, and uncertainty about susceptibility (SUSC) under low uncertainty about severity. (b) Three-way interaction between descriptive norms (DN), uncertainty about severity, and uncertainty about susceptibility (SUSC) under medium uncertainty about severity. (c) Three-way interaction between descriptive norms (DN), uncertainty about severity, and uncertainty about susceptibility (SUSC) under high uncertainty about severity.

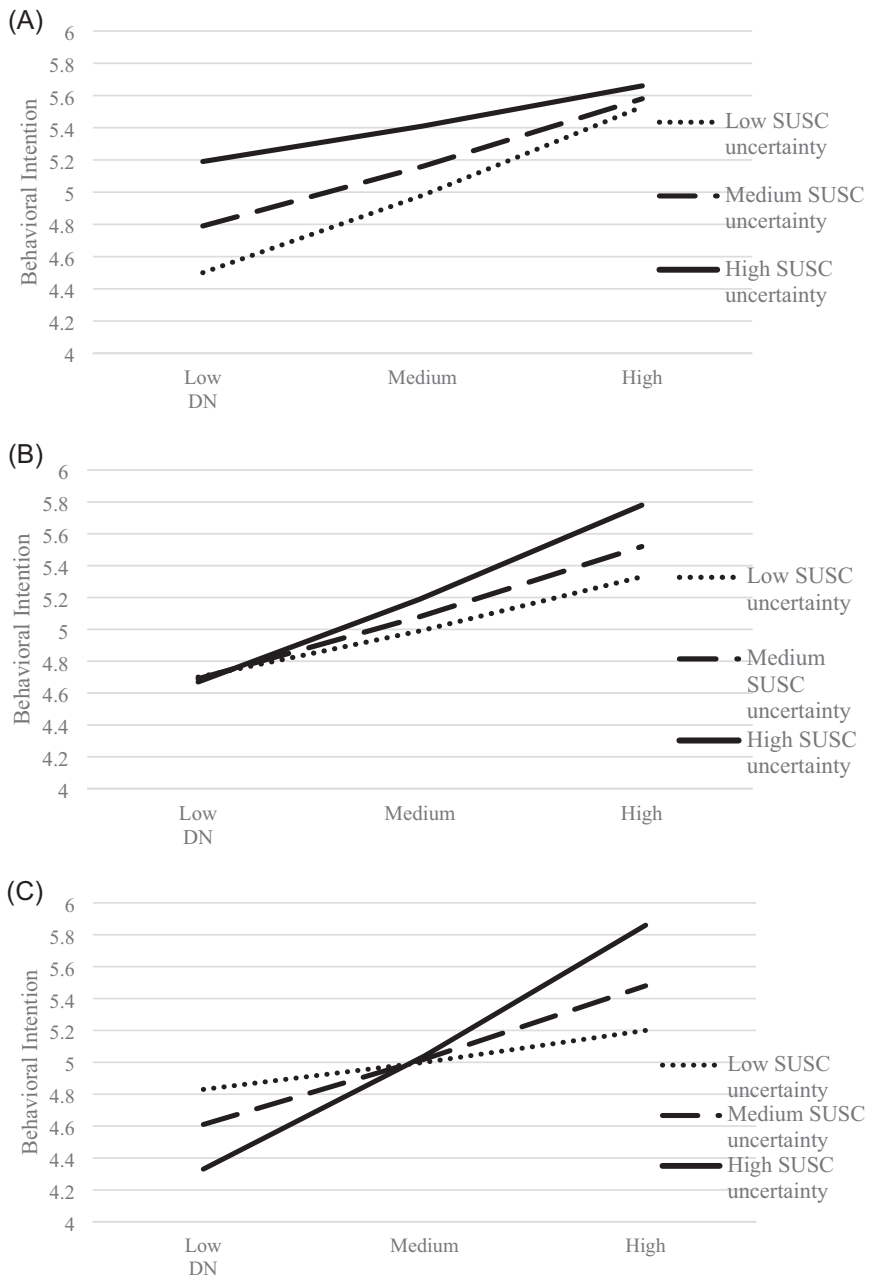
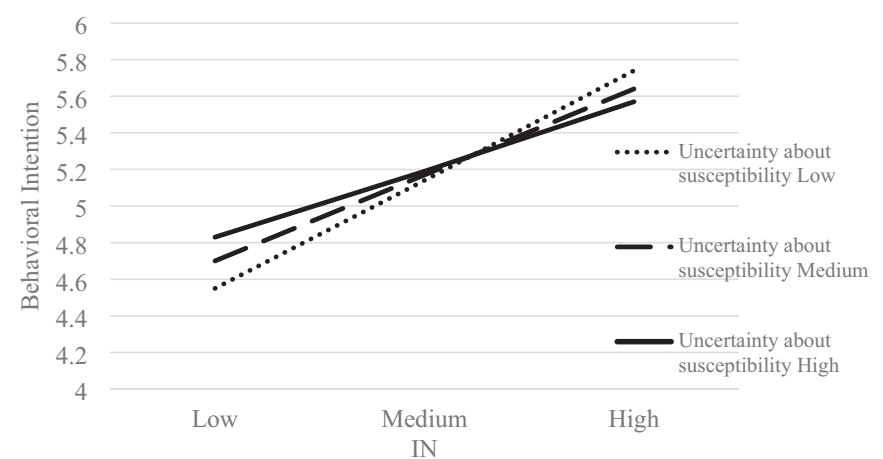


FIGURE 2 Behavioral intention as a function of injunctive norms (IN) and uncertainty about susceptibility.



First, these findings highlight the critical role played by uncertainty in compliance with social norms to mitigate health and environmental risks and its potential to delineate the nuances of social normative influence. Prior research, at least in the context of vaccination, has indicated that social norms is double-sided sword in promoting vaccination. Ibuka and colleagues (2014), for example, found that observations of high influenza vaccination coverage within a social group decreased the observer's vaccination acceptance. In a similar vein, Galizzi et al. (2022) incrementally increased the percentage of vaccination rates, and found individual vaccination intention increased up to a point when they were told that 75% of people outside their households were vaccinated, but began to decline when the coverage rates continued to rise. In other contexts (e.g., climate change, water conservation), albeit empirical evidence yet to be gathered, researchers caution the counterproductive effects of social norms (Bechtel et al., 2019; Janssen, 2017). Beyond climate change and other environmental crises, Constantino et al. (2022) extended the warning of using social norms to trigger desired behavioral changes to other social issues whose solutions demand collective and interdependent efforts and argued that an overemphasis on strong social norms can lead to freeriding and other unintended consequences.

Contrary to the well-documented freeriding momentum produced by prevailing social norms, it is not clear what circumstances cause compliance with social norms to decline. Additionally, what factors can boost the effect of social norms on risk-mitigating behaviors and avoid freeriding are largely unknown. The notion of uncertainty is uniquely positioned in the intersection between normative compliance and risk judgment. Findings yielded from this study suggest that priming or highlighting the uncertainty about risk assessment can be of use in curtailing the freeriding effect and serve as a plausible tool to complement and sustain the constructive role of social norms.

Second, the effect of either type of social norms on behavioral intention was not altered by individual risk perceptions (*RQ1-2*). That is, people comply with social norms to decide whether they will take preventive measures regardless of how they perceive the risk. However, it would be premature to conclude that risk perceptions and social norms are unrelated to one another in affecting behavior. To the authors' best knowledge, this study is one of a few empirical studies that tested the interaction between social norms and risk perceptions, and these studies have produced inconsistent findings. One study (Zhuang, 2021) experimentally manipulated social norms and risk intensity and found that increasing risk weakened the tendency to comply with social norms on intention to begin taking preventive measures against infectious diseases. In another study, researchers (Zhuang, Schrodt, & Guan, 2024) discovered that increasing perceived risks attenuated the effect of social norms on COVID-19 vaccination intentions only among individuals who held strong efficacy beliefs. Griskevicius et al. (2006), on the contrary, found that people were more motivated to follow social norms when

primed to believe they were in danger than not. Although the findings yielded from the present study appear to be at odds with previous research, they collectively suggest the necessity for greater attention paid to disentangle the complex relationship between social norms, risk perceptions, and risk-mitigating behaviors.

The second set of illuminating findings reveal that depending on the type of social norms, the patterns of the interaction between uncertainty about risk assessments and social norms vary, indicating that these two types of social norms shape risk-mitigating behaviors in different manners. Unlike descriptive norms, the effects of injunctive norms on risk-mitigating behaviors have only received limited attention, and findings yielded from this research fill this void. The results show that the effect of social group members' approval (i.e., injunctive norms) on behavioral intention decreased as individuals reported increasing uncertainty about their likelihood of being affected by a risk. In other words, participants were more susceptible to injunctive normative influence when they are more confident about their assessment regarding their personal vulnerability to the risk, whereas they were less likely to comply with injunctive norms when they felt uncertain about their assessment. This finding can be interpreted through the lens of risk and information processing (Trumbo, 1999). Scholars have argued that when individuals are uncertain about their risk judgment, they are likely to engage in systematic information processing and heavily rely on heuristic decisional cues (Steginga & Occhipinti, 2004; Tversky & Kahneman, 1974; Walker & Sorrentino, 2000). Injunctive norms, which are theorized to motivate systematic information seeking (Cialdini & Trost, 1998), are therefore ineffective in motivating behavioral changes. For a risk that entails minimal uncertainty about one's susceptibility to the risk and the seriousness of the risk, making injunctive norms salient can be an effective strategy to induce behavioral change. However, since scientific inquiries into the relationship between injunctive norms and risk-mitigating behaviors have only begun to evolve, more evidence is needed to make a definite conclusion.

6 | LIMITATIONS, IMPLICATIONS, AND CONCLUSIONS

While our study offers valuable insights into the interplay between social norms and risk perceptions, this research has several limitations that warrant acknowledgement. First, although all measures were adopted from the existing literature, the scales used to measure uncertainty about susceptibility and severity (Huang & Yang, 2020) fell short in reliability and validity indices. Specifically, after one item was removed, the uncertainty about susceptibility scale consisted of two items, and similarly, the uncertainty about severity was comprised of three items after one item was removed, which disabled us to assess the scale reliability and validity, respectively. Although the confirmatory factor

analysis indicated that uncertainty about susceptibility and severity loaded onto separate factors than perceived susceptibility and severity, future research is needed to develop valid measures for uncertainty about risk perceptions. Second, it should be noted that the cross-sectional nature of the study design did not allow us to claim the causal relationship between social norms and behavioral intention moderated by uncertainty judgment, which would be a direction for future research to pursue. Third, information processing, as mentioned in several theoretical perspectives that guided this research, may serve as an underlying mechanism for why social norms and uncertainty about risk interact to influence risk-mitigating behaviors. However, given the primary goal of this research, we did not measure or model information processing, which can be a viable direction for future research. Last, the three health and environmental risks in which the study was contextualized all featured risk interdependence (Dickinson et al., 2020; Murray et al., 2008), meaning that one's risk would increase because of increasing risks posed to close others. Future research can bring greater insights by situating the relationships in health and environmental topics which observe risk interdependence to a lesser extent (e.g., cancer screening).

To conclude, it is not an understatement to say that social norms play a powerful role in shaping health and environmental behaviors. In the meantime, theorists also noted the complex role played by social norms (Rimal & Real, 2005; Schultz et al., 2007) both prior and after the recent global pandemic (Geber, 2023). In the context of health and environmental risks, it is particularly imperative to consider how risks are intertwined with social norms to influence risk-mitigating behaviors. Recently, Rimal and Lapinski (2021) proposed attribute-centered theorizing to address behavioral changes, in which they posited that three behavioral attributes (i.e., receptiveness, cost, and public visibility) are important considerations in developing effective health interventions. Other researchers (e.g., Manning, 2011) delineated other behavioral attributes (e.g., social motivation, social approval, utility, and interpersonal-ness) that make certain behavior more susceptible to normative influence than others. However, despite the wide applications of social norm-based efforts to intervene health- and environmental behaviors, our understanding regarding the role played by uncertainty about risk perceptions in social norm-based efforts to elicit behavior changes to mitigate risks is limited. Based on the findings generated in this study, one way to advance our knowledge is to locate and identify groups of populations who are uncertain about their judgments of a given risk and apply social norms interventions targeting these groups. Alternatively, researchers and practitioners can categorize risk behaviors based on the public's uncertainty about their perceived risks and implement social norm-based interventions to behaviors towards which the public lack confidence in their risk perceptions. Both approaches can enhance the effectiveness of social norm-based interventions in eliciting desired behavior changes. Overall, a re-introduction of uncertainty about

risk perceptions into the scholarship of social norms in health and risk environment provides a new and more precise way to examine the relationship between social norms, risks, and behaviors, and identify the right timing to highlight social norms when the public face health and environmental risks.

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CONFLICT OF INTEREST STATEMENT

The authors have declared no conflict of interest.

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SUPPORTING INFORMATION

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