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RUNNING HEAD: Scientific Uncertainty, Norms, and Intentions

Scientific Uncertainty as a Moderator of the Relationship between
Descriptive Norm and Intentions to Engage in Cancer Risk-Reducing Behaviors

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Abstract

This study examined motivational factors underlying six behaviors with varying levels of scientific uncertainty with regard to their effectiveness in reducing cancer risk. Making use of considerable within-subjects variation, we examined the moderating role of the degree of scientific uncertainty about the effectiveness of cancer risk-reducing behaviors in shaping relationships between constructs in the Integrative Model of Behavioral Prediction (Fishbein & Yzer, 2003). Using cross-sectional data ($n = 601$), the descriptive norm-intention relationship was stronger for scientifically uncertain behaviors like avoiding BPA plastics and using a hands-free mobile phone headset than established behaviors (e.g., avoid smoking, fruit and vegetable intake, exercise, and apply sunscreen). This pattern was partially explained by the mediating role of injunctive norms between descriptive norm and intentions, as predicted by the extended Theory of Normative Social Behavior (Rimal, 2008). For behaviors more clearly established as an effective means to reduce the risk of cancer, self-efficacy was significantly more predictive of intentions to perform such behaviors. We discuss practical implications of these findings and theoretical insights into better understanding the role of normative components in the adaptation of risk reduction behaviors.

Keywords: cancer prevention, descriptive norms, integrative model of behavioral prediction, theory of normative social behavior, health communication

Scientific Uncertainty as a Moderator of the Relationship between
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Risk for the most common cancers can be halved through behavior, but many people do not engage in evidence-based behaviors to reduce cancer risk (American Institute for Cancer Research (AICR), 2009). The relative importance of motivational factors underlying human behavior varies by the nature of the behaviors themselves. Thus, theory-based formative research would be informative to design effective health campaigns that address different types of cancer risk-reducing behaviors. Utilizing the Integrative Model of Behavioral Prediction (IMBP; Fishbein & Yzer, 2003) as a framework, we examined psychological factors predictive of intentions to engage in six cancer risk-reducing behaviors characterized by different levels of scientific uncertainty regarding their effectiveness in reducing cancer risk.

Overview of the Study's Rationale

The IMBP is an extension of the Theory of Reasoned Action (TRA; Ajzen & Fishbein, 1980) and Theory of Planned Behavior (TPB; Ajzen, 1991), which state that a stronger intention to perform a behavior leads to an increased likelihood of performing that behavior. Among theoretical constructs in the IMBP, this study focused on the distinctive roles of injunctive and descriptive norms in predicting intentions to perform cancer risk-reducing behaviors. Injunctive (beliefs about what others think we should do) and descriptive norms (beliefs about what others actually do) are based on different sources of motivation (Deutsch & Gerard, 1955; Cialdini, Reno, & Kallgren, 1990), and the most recent version of the IMBP includes both types of norms (Fishbein & Ajzen, 2010). Researchers have also investigated ways to effectively utilize different types of norms in promoting risk reduction behaviors (Lapinski & Rimal, 2005; Mollen, Rimal, & Lapinski, 2010; Rimal & Real, 2005; Rimal, 2008).

The nature of the behavior of interest is likely an important determinant of the relative

importance of normative influence, among other IMBP components, in predicting intentions (Ajzen & Fishbein, 1980; Robin et al., 2010; Godin & Kok, 1996). Researchers have argued for the need to understand the nature of similarities and differences amongst behaviors by grouping them into higher-level categories (e.g., Johnston & Dixon, 2008). Mollen et al. (2010), for example, notes that research has yet failed to specify underlying attributes that make behaviors more or less susceptible to normative influence. Although the TRA, TPB and IMBP have been applied to many health issues, few studies have examined variability across categories of behaviors, particularly within the same respondents. For example, Smith-McLallen and Fishbein (2008) used the IMBP to predict intentions to engage in three cancer screening behaviors and three healthy life style behaviors. However, this study did not examine underlying behavioral attributes, which would require them to account for correlations between measurements within the same subject. This study examines how the role of the IMBP's psychological factors differs by behavior by holding individual characteristics constant and categorizing cancer risk-reducing behaviors in terms of their level of scientific uncertainty in effectively reducing cancer risk.

Theories of Reasoned Action and Planned Behavior

According to the TRA and TPB, behavior is guided by three psychological predictors which include personal factors as well as social influences: (1) attitudes toward the behavior, (2) injunctive norms related to the behavior, and (3) self-efficacy beliefs, similar to the concept of perceived behavioral control (PBC) (Fishbein & Ajzen, 2010). These factors determine intentions to perform a behavior, which in turn is a strong predictor of performing that behavior.

Attitude toward a behavior refers to the overall evaluation of the behavior. People tend to act in consistency with their beliefs and attitudes; as a result, higher levels of positive attitudes lead to higher intentions to perform a behavior (Fishbein & Ajzen, 1975). Positive attitudes toward cancer risk-reducing behaviors are likely to increase intentions to engage in such actions.

Injunctive norms are social pressures that an individual believes that significant others (e.g., family, friends) have for performing a behavior. Individuals fear being alienated from or rejected by their social group (Prentice & Miller, 1993), so more supportive injunctive norms lead to higher intentions to perform a behavior. However, a meta-analysis found that injunctive norms were the weakest predictor of intentions in the TPB (Armitage & Conner, 2001).

Self-efficacy and PBC have been used interchangeably by some researchers (e.g., Ajzen, 1991; Armitage & Conner, 2001). We adopted self-efficacy to conceptualize the control component of the TPB. Compared to PBC, self-efficacy explains more of the variance in intentions in a meta-analysis (Armitage & Conner, 2001) and is more clearly defined and operationalized in the literature (Bandura, 1997). Self-efficacy is defined as beliefs about one's own capabilities to exercise control in performing a behavior (Bandura, 1997). Self-efficacy beliefs affect an individual's behavior by determining whether the behavior is attainable or not. The higher a person's self-efficacy to perform a behavior, the more likely it is that the person will engage in that behavior (Crowell & Emmers-Sommer, 2001).

Social Influence in the TRA and TPB

Meta-analyses show that attitudes, injunctive norms, and PBC/self-efficacy explain between 27 and 39 percent of the variance in behavioral intentions (Armitage & Conner, 2001; Ravis & Sheeran, 2003). Nevertheless, a large proportion of the variance in intentions typically remains unexplained, and injunctive norms usually explain the smallest amount of variance (Armitage & Conner, 2001; Sheppard, Hartwick, & Warshaw, 1988). Several researchers suggest that a narrow conceptualization of normative influence in the model explains this predictive weakness (Ravis & Sheeran, 2003; Conner & Armitage, 1998).

A parallel literature on social influence emphasizes the need to distinguish between injunctive and descriptive norms because they are based on different sources of human

motivation (Cialdini et al., 1990). Injunctive norms describe beliefs about what others morally approve or disapprove, while descriptive norms address what is typical or normal among others. Descriptive norms enable people to make decisions about behavior by providing information about what is effective and adaptive in a given situation (Cialdini, 1988). While conceptually distinct, descriptive and injunctive norms are consistent in many cases because people often infer what is required to them by observing what others' do (Rimal & Real, 2005).

Injunctive and descriptive norms can also have different implications for behavioral decision-making in some contexts (Cialdini et al., 1990). A meta-analysis found that descriptive norms increased the variance explained in intention by 5 percent over and above the other TPB components, including injunctive norms (Rivis & Sheeran, 2003). Other research suggests that injunctive norms play a stronger role than descriptive norms in forming intentions to engage in cancer screening behaviors (Smith-McLallen & Fishbein, 2008). Still other studies have found that manipulating the salience of descriptive norm can change injunctive normative beliefs about whether or not a behavior is appropriate or not in a given situation (Cialdini et al., 1990; Cialdini, Kallgren, & Reno, 1991). Combined, these observations led the original TRB/TRA theorists to include descriptive norms in their most recent IMBP and emphasize the need to understand conditions under which descriptive and injunctive norms matter most in predicting behavior (Fishbein & Ajzen, 2010). We test whether the influence of normative pressure on intentions to engage in risk-reducing behaviors varies by the type of cancer risk-reducing behaviors.

Scientific Uncertainty as a Moderator of the Descriptive Norm-Intention Relationship

Although there are multiple ways to classify behaviors, we distinguish cancer risk reducing behaviors along the dimension of scientific uncertainty. While we recognize that individuals may differ in their beliefs about the level of scientific certainty in support of a particular behavior, we characterize scientific uncertainty as an aggregate behavioral attribute

largely dependent upon the strength of scientific evidence and history of public dissemination about the behavior's effectiveness in reducing cancer risk. This behavioral attribute is not fixed and may change over time in response to new evidence and its widespread and consistent public dissemination, but changes in the aggregate level of scientific uncertainty tend to occur slowly across a long time period. This approach is practical for the topic of cancer prevention for which there is variability in scientific uncertainty about the efficacy of behaviors to reduce cancer risk, as well as the amount of time that has passed since these behaviors were first introduced as risk-reducing. Classifying behaviors based on their current level of scientific uncertainty may help us to better understanding factors that influence whether people adopt new risk-reducing behaviors.

Established behaviors. Some behaviors are widely accepted as effective in reducing the likelihood of developing a cancer. These behaviors (1) have a long history of scientific study that demonstrates their ability to reduce cancer risk, and (2) are advocated for by health professionals, receiving media attention, and generating widespread public awareness. For example, cigarette smoking has been associated with lung cancer from the 1950s (Hammond & Horn, 1954). Reports of the Surgeon General (1979) have recommended eating fruits and vegetables and exercising regularly to reduce the risk of colon cancer as well as avoiding cigarette smoking to reduce the risk of lung cancer. Skin cancer has long been linked to excessive solar ultraviolet (UV) exposure (Setlow, 1974). Both the Centers for Disease Control and Prevention (CDC, 2011) and American Cancer Society (ACS, 2003) have long recommended applying sunscreen as an important cancer risk-reducing behavior. A national survey (AICR, 2009) reported a very high level of awareness about cancer risk associated with tobacco use and excessive exposure to sunlight (94%, 87%, respectively). About half of Americans were also aware of the cancer risk associated with diets low in fruits and vegetables (52%) and a lack of physical activity (46%).

Scientifically uncertain behaviors. There is an emerging evidence base for two behaviors with potential to reduce cancer risk: avoiding BPA plastics and using hands-free mobile phone headsets. BPA has recently been linked to increased risk for breast and prostate cancer (Briskin, 2008, Ho et al., 2006). While researchers have suggested a possible link between mobile phone radiation and cancer risk for several years, studies testing the relationship between mobile phone use and brain cancer/tumors have reported inconsistent results (Schüz et al., 2006). The ACS categorizes these two behaviors as “uncertain causes” due to inconsistent findings among researchers. As a result, there is insufficient evidence to conclude that hands-free headsets or avoiding BPA plastics are effective at reducing cancer risk. In light of the recency of their emergence as possible cancer risks and the preliminary nature of the science linking them to increased rates of cancer, we classify these two behaviors as scientifically uncertain.

Study hypotheses. Researchers have addressed the complexity of descriptive norm-intention relationship, which may be conditional on many psychological factors such as outcome expectancy beliefs, group identity, and injunctive norms (Rimal & Real, 2005, Rimal, 2008; Park & Smith, 2007, Park, Klein, Smith, & Martell, 2009). We offer scientific uncertainty as another potential moderator of this relationship. Descriptive norms gauge perceptions of whether or not a behavior is appropriate in a given situation because it offers “social proof as information toward right living” (Cialdini & Trost, 1998, p. 156). Researchers have suggested that descriptive norms become a most useful heuristic in novel, ambiguous, or uncertain situations (Cialdini & Trost, 1998; Deutsch & Gerard, 1955; Tesser, Campbell, & Mickler, 1983). For uncertain cancer-related behaviors, for which the appropriate course of action is unclear, people are likely to use the evidence of others’ behaviors to decide whether they should also perform the behavior.

Hypothesis 1 (H1): The association between descriptive norms and intentions will be stronger for scientifically uncertain behaviors than established behaviors.

The extended Theory of Normative Social Behavior (TNSB; Rimal, 2008) suggests that injunctive norms also mediate the descriptive norm-intention relationship. According to this theory, beliefs about what others do can result in the perception that one has to conform to group behavior because failure to do so will result in social sanctions. In line with this prediction, those who perceived high prevalence of alcohol consumption also believed that they are expected to consume it, which in turn enhanced their intentions to consume alcohol (Rimal, 2008). Likewise, those who perceive that most others perform an uncertain cancer risk-reducing behavior may also believe that it is expected of them to perform it, making them more likely to engage in the behavior. One unanswered question, offered by Rimal (2008), is whether the prediction of the extended TNSB would hold up in a context characterized by different levels of ambiguity. We sought to address this question by examining whether scientific uncertainty changes the predicted relationships in the extended TNSB (i.e., the mediating role of injunctive norms). If the relationship between descriptive and injunctive norms changes depending on the degree of scientific uncertainty about a risk-reducing behavior, this would help to explain any observed moderating role of scientific uncertainty in the descriptive norm-intention relationship.

Research Question 1 (RQ1): Do differences in the relationship between descriptive and injunctive norms by scientific uncertainty explain the overall moderating effect of scientific uncertainty on the relationship between descriptive norms and intentions?

Method

We collected data as a part of a larger project to test the effects of cancer news story components on cultivating a sense of information overload and fatalistic beliefs about cancer causes and prevention (author own). We randomly assigned participants to read one of fifteen in-text news story conditions that included different combinations of story elements: (1) the type and the number of potential cancer causes presented (either mobile phone usage or exposure to

BPA, or both), (2) the presence of efficacy information about how to reduce the risk associated with the cancer causes (e.g., avoid using BPA plastic), and (3) the inclusion of a story about the effectiveness of risk-reducing behaviors (emphasizing established behaviors like regular exercise, eating fruits and vegetables, using sunscreen and avoiding smoking, or a contradictory behavior, drinking coffee to prevent brain cancer). A control story focused on topics unrelated to cancer. Effects of randomized treatment on overloaded and fatalistic beliefs about overall cancer risk are presented in a separate paper (author own). We did not expect the manipulations to directly influence behavioral intentions, but the questionnaire included IMBP variables for several cancer-related behaviors to permit testing of the theoretical hypotheses outlined here.

Procedure and Participants

We recruited participants ($n = 601$) in a public location (a shopping mall in a small northeastern city) in exchange for a payment of \$10 between August 20th and September 4th, 2011. After providing informed consent, we seated participants at one of ten laptop computers and asked them to read one or two news stories. Participants then reported their responses to the stories, beliefs about cancer causes and prevention, IMBP constructs, and socio-demographics.

Fifty-two percent were female, ranging in age from 18 to 95 years ($M = 28.6$, $SD = 14.0$; 4 cases missing). Among those who reported their race/ethnicity ($n = 558$), more than half identified as White (57%), 34 percent as Asian, 10 percent as Black, and 9 percent as Hispanic or Latino. Forty three percent reported attending some college, 40 percent had a college degree, and the rest had less formal education (17%; 13 missing).

Measurement Instrument

Following procedures commonly adopted by studies on the IMBP, we measured attitudes, injunctive norms, descriptive norms, and self-efficacy in relation to six cancer-related behaviors¹: in the next year, (1) applying sunscreen most times when they go outside, (2)

avoiding smoking completely, (3) avoiding the use of BPA plastics completely, (4) having five or more servings of fruits and vegetables most days, (5) exercising at least three times in most weeks, and (6) using a hands-free headset most times when taking on a mobile phone (Table 1).

Behavioral intentions. We assessed behavioral intentions with a single item for each behavior. On a 5-point Likert scale ranging from 1 (very unlikely) to 5 (very likely), participants indicated the likelihood that they would perform each of the six behaviors in the next year (e.g., “How likely is it that you will exercise at least three times in most weeks over the next year?”).

Attitudes. Using 5-point semantic differential scales, we asked whether performing each behavior would be (1) extremely bad – extremely good, and (2) extremely unpleasant – extremely pleasant. The items were moderately to strongly correlated for each behavior ($r_{\text{range}} = .33$ to $.72$; $r_{\text{avg}} = .48$). We averaged responses for each behavior into a 2-item index.

Normative pressure. We assessed injunctive norms by asking participants to indicate the extent to which they believe most people who are important to them think they should or should not perform each behavior (1 = definitely should not, 5 = definitely should). We assessed descriptive norms by asking how many of the people who are important to the participant had engaged in each behavior, to the best of their knowledge (1 = none, 2 = a few, 3 = some, 4 = most, 5 = all or almost all). The correlation between injunctive and descriptive norms for each behavior ranged from $.28$ (exercise) to $.40$ (avoid BPA; $r_{\text{avg}} = .33$).

Self-efficacy. Participants rated their confidence in their ability to perform each behavior (1 = very unsure, 5 = very sure; e.g., “If you wanted to, how sure are you that you can exercise at least three times in the most weeks over the next year?”).

Results

Ruling Out Experimental Condition Effects

We first examined whether experimental conditions influenced (1) behavioral intentions, (2) IMBP predictors, and (3) relationships between IMBP constructs (none of which were a focus of the other paper). The inclusion of efficacy information in news reports did increase self-efficacy to engage in risk-reducing behaviors ($b = .18, t = 2.76, p = .006$) but did not influence intentions or any other IMBP predictors. The covariance between four IMBP predictors and intentions did not change with or without experimental conditions (including the presence of efficacy information) in hierarchical regression models. Experimental condition did not influence the amount of variance added by descriptive norm in predicting each behavioral intention. Having confirmed that the experimental inductions did not influence the results relevant to our study objective, we excluded these variables in our subsequent analyses.

Predictive Utility of the IMBP and the Role of Descriptive Norm

Next, we examined the predictive validity of the IMBP for each behavior using a series of stepwise ordinary least squares (OLS) regressions. Specifically, we predicted each behavior as a function of the original TRA/TPB constructs (attitude, injunctive norms, and self-efficacy in step 1) and both original TRA/TPB constructs and descriptive norms (in step 2). We examined the degree of variability in the additional amount of variance explained by descriptive norms between uncertain and established behaviors in order to justify subsequent testing of H1.

As presented in Table 2, higher levels of positive attitudes and self-efficacy beliefs were positively associated with intentions to perform all 6 behaviors. The relationship between injunctive norms and intention was significant across all behaviors except avoiding smoking ($p = .06$). The TPB model explained 46 (using hands-free headsets) to 59 (avoid smoking) percent of the variance in intentions; injunctive norms was the weakest predictor of intentions. Adding descriptive norms to the model reduced the β coefficient for injunctive norms (e.g., for sunscreen use, β coefficient reduced from .16 to .10). Over and above the three primary TRA/TPB

predictors, descriptive norms contributed an additional .5 (avoiding smoking) to 7.6 (avoiding BPA plastics) percent of the variance in intentions to engage in cancer-related behaviors.

Scientific Uncertainty as a Moderator in the IMBP

Having confirmed variance in the amount of variance explained by descriptive norms across behaviors, we formally tested the moderating role of scientific uncertainty in the descriptive norm-intention relationship (H1) using a hierarchical linear model (HLM) with restricted maximum likelihood estimation (REML). Because each participant reported their responses for 6 behaviors, HLM allowed us to account for correlations between measurements within the same subject in comparing the strength of coefficients across behavior types.

Table 3 presents parameters of the fixed and random effects of models that explain behavioral intentions. All predictors were grand mean-centered and subject factor was treated as a random effect. A one-way random effect model found significant variation in intentions between participants (Model 1; variance = .27). Fourteen percent of the total variance in intentions was accounted for by differences between respondents. The grand mean of intention responses of the respondents was 3.60 ($p < .001$). Behaviors were categorized either as established or uncertain behaviors. Established behaviors were used as the reference category. Three TRA/TPB constructs, descriptive norms, and behavior type were entered as fixed factors in Model 2. All fixed factors except behavior type positively predicted behavioral intentions. Attitudes ($b = .39, t(3464) = 20.9, p < .001$) and self-efficacy ($b = .39, t(3467) = 29.6, p < .001$) were most predictive of behavioral intentions. Descriptive norm ($b = .23, p < .001$) was a stronger predictor of intentions than injunctive norm ($b = .13, p < .001$).

In Model 3, interaction terms between behavior type and 4 IMBP predictors were entered to examine possible moderating effects of scientific uncertainty. All of the predictors entered in Model 3 had a tolerance above .20 and a variance inflation factor (VIF) below 10, indicating that

the model does not have significant multicollinearity². Scientific uncertainty was a significant moderator of the effects of descriptive norms and self-efficacy on behavioral intentions. Figure 1 graphically shows patterns of significant interactions. We plotted predictive margins of the relationship between descriptive norm/self-efficacy and intentions by scientific uncertainty (with 95% confidence intervals) at one standard deviation above and below the mean of descriptive norm/self-efficacy. Supporting H1, the descriptive norm-intention relationship was stronger for the uncertain ($b = .34$) than established behaviors ($b = .18$), $t(3176) = 5.75$, $p < .001$. Although not hypothesized, the relationship between self-efficacy and intentions was stronger for the established ($b = .44$) than the uncertain behaviors ($b = .31$), $t(3218) = -5.09$, $p < .001$. Respondents had greater intentions to perform uncertain behaviors than established ones when they had higher descriptive norms (+1SD) and lower self-efficacy (-1SD).

To examine whether the mediating role of injunctive norms between descriptive norm and intentions explains the pattern of H1, we tested the mediated moderation of the scientific uncertainty effect on behavioral intentions using HLM (RQ1; Muller, Judd, & Yzerbyt, 2005; see Figure 2 notes for explanation). The effect of descriptive norm on injunctive norm (a mediator) was moderated by scientific uncertainty ($b = .07$, $SE = .02$, $t = 3.04$, $p = .002$); the simple effect of descriptive norm on injunctive norm was stronger for uncertain behaviors than for established behaviors. Regardless of scientific uncertainty, supportive injunctive norm increased behavioral intentions ($b = .38$, $SE = .03$, $t = 14.63$, $p < .001$). Compared to the overall moderation of the descriptive norms effect ($b = .09$, $SE = .03$, $t = 3.09$, $p = .002$), the residual direct effect of descriptive norms on behavioral intentions was *less* moderated by scientific uncertainty ($b = .08$, $SE = .03$, $t = 2.45$, $p = .01$), once we controlled for the mediator (injunctive norm) and allowed the indirect effect via the mediator to be moderated³. We thus conclude that the moderating

effect of scientific uncertainty on the relationship between descriptive norms and intentions is partially, but not fully, explained by an increase in supportive injunctive norms.

Discussion

Study findings offer theoretical insights into the role of normative components in cognitive health models and practical implications for communicating about cancer prevention.

Theoretical Implications

Normative pressure. Researchers have critiqued the weakness of TRA/TPB models in incorporating normative influence in behavior prediction (Armitage & Conner, 2001). Some authors suggest that descriptive norms may provide more useful information in risk decision-making because they help people understand whether or not a behavior is adaptive in a given situation (e.g., Cialdini et al., 1990). Our findings are consistent with these theoretical claims; in deciding whether to intend to engage in cancer risk-reducing behaviors, individuals appear to use information about what others are doing, not necessarily what they believe others expect them to do. We found only a modest correlation between descriptive and injunctive norms ($r = .33$) and different patterns of interaction with scientific uncertainty about the behavior's effectiveness in reducing cancer risk, providing further evidence that the constructs are conceptually distinct.

The descriptive norm-intention relationship was stronger for uncertain behaviors than for established behaviors. Social influence theorists have argued that people use the evidence of others' behaviors to make decisions when the situation is ambiguous or uncertain (Cialdini & Trost, 1998; Deutsch & Gerard, 1955; Tesser et al., 1983). Behaviors like avoiding BPA plastics and using a hands-free mobile phone headset have only recently been associated with reducing cancer risk, and there is considerable uncertainty about whether performing these behaviors reduces cancer risk. We also found evidence, consistent with predictions of the extended TNSB (Rimal, 2008), that beliefs about what others do became a more useful heuristic in making

judgments about whether a (relatively new and scientifically uncertain) behavior is subject to social pressures to conform. This suggests a need to further refine the conceptualization of relationships between normative constructs in the IMBP. There appears to be predictive value to examining the temporal ordering of these variables (descriptive norms shaping injunctive ones), rather than treating them at the same level within the model.

Self-efficacy. Compared to uncertain behaviors, the self-efficacy-intention relationship was stronger for established cancer risk-reducing behaviors. Ajzen (1991) has previously argued that the strength of the PBC–intention relationship differs by the type of behavior and the nature of the situation. Although we can only speculate, the comparatively weak efficacy–intention association for uncertain behaviors may be attributable to a parallel lack of efficacy information about the ease of performing those behaviors, perhaps because people have not yet tried them. To address this possibility, future research should examine the extent to which individuals perform both uncertain and established risk-reducing behaviors, and the influence of this prior behavior on perceived capability to perform those behaviors. For novel and uncertain behaviors, it may be important to *first* believe a behavior is an effective way to reduce cancer risk before it matters whether or not a person believes that behavior is something that s/he can achieve.

Implications for Health Communication Practice

Different intervention approaches may be more or less effective depending on the level of scientific uncertainty associated with the behavior. For behaviors that are scientifically uncertain, descriptive normative information may be an important criterion from which to decide whether or not to perform it. People tend to underestimate the prevalence of health promotion behaviors like condom use (Scholly, Katz, Gascoigne, & Holck, 2005), but overestimate the incidence of other's risk-taking behaviors like drug use (Perkins & Craig, 2003). Misperceptions about descriptive norms have behavioral consequences (Carey, Borsari, Carey, & Maisto, 2006), and

there is some evidence that normative restructuring strategies are effective at correcting misperceived prevalence of others' behaviors (Rimal, 2008; Priebe & Spink, 2012). As a result, providing individuals with accurate information about others' behavior may be important for communicating cancer risk-reducing behaviors that are promising yet scientifically uncertain and relatively unknown to the general public. From an ethical standpoint, this information should be accompanied by a clear acknowledgement of the level of scientific uncertainty that underlies a particular preventive behavior, and the need to monitor further scientific developments.

It also appears particularly important for campaigns to increase self-efficacy to perform cancer risk-reducing behaviors. Across all six behaviors, self-efficacy was the strongest predictor of intentions, and its influence was heightened for established behaviors. Motivational interventions rooted in Social Learning Theory (Bandura, 1977) have been successfully implemented in campaigns endorsing physical activity (Milne, Orbell, & Sheeran, 1999) and avoiding smoking (Martin, Froelicher, & Miller, 2000). Addressing specific contexts in which these behaviors are engaged (e.g., applying sunscreen every morning after washing one's face) may offer a useful strategy to enhance the achievability of these behaviors (Milne et al., 1999).

Limitations and Future Research

People may have somewhat different perceptions on the efficacy of the behaviors studied here than those assumed by their dichotomous (established vs. uncertain) classification. Literature is sparse regarding the level of public awareness or perceived effectiveness of the scientifically uncertain cancer-related behaviors studied here. We thus used objective characteristics rather than public perception to operationalize scientific uncertainty. Objective characteristics of a particular behavior should be closely related to people's perception about the behavior, but this is an empirical question. Future studies should measure perceived scientific certainty across a variety of behaviors and use HLM to compare the extent to which scientific

uncertainty varies within (suggesting uncertainty as a behavioral attribute) and between individuals (suggesting it as an individual difference variable).

Participants read cancer news articles with variations of story features (as part of a larger project) and such elements did not affect the relationships between IMBP constructs relevant to our study objective. We thus utilized cross-sectional and convenience sample data in testing our theoretical predictions. While convenience samples are often used to test behavior prediction models, the patterns observed in the present study should be confirmed in future research with representative, population-based samples. Future work should also address the effects of interpersonal or mediated messages in changing beliefs about cancer risk-reducing behaviors.

Although some study constructs were measured with a single item, we adopted standard measures that had been extensively used and examined in studies of the reasoned action approach. Because each participant reported on the same single item measure repeatedly for six behaviors, measurement errors are likely to be at similar range across behaviors within the respondent. It should also be noted that the effect sizes of the observed interactions were small. This is not unprecedented in studies that have tested moderators of the descriptive norm-intention relationship (less than 1% of variance explained; Rimal & Real, 2003, 2005), but future research should attempt to replicate these patterns in different health contexts and samples.

Conclusion

This study offers theoretical insights into conditions under which normative and efficacy components are stronger or weaker predictors of behavior. People appear more likely to rely on perceptions of others' behavior in developing intentions to engage in scientifically uncertain cancer risk-reducing behaviors. When behaviors are strongly established as effective means to reduce cancer risk, self-efficacy (already a strong predictor) becomes even more important in shaping intentions to engage in them.

Endnotes

1. Measures relevant to coffee drinking were also assessed but excluded in this paper due to its unique nature. While coffee drinking involves uncertainty in regard to whether they change cancer risk, it differs from other uncertain behaviors in that it has been associated with *increased* cancer risk as early as the 1980s, and has been associated with both *increasing* and *reducing* the risk of various cancers over time. No studies suggest that avoiding BPA plastics or using hands-free mobile headsets *increase* cancer risk. We thus excluded coffee drinking to separate it from the other behaviors.
2. A tolerance of less than .20 and/or a VIF of 10 and above indicates a multicollinearity problem.
3. According to Muller et al. (2005), the reduction in the magnitude of interaction coefficients is taken as evidence that a mediator (partially) mediates the effect of the treatment*moderator interaction on outcomes. Only when the moderation of the residual treatment effect is nonsignificant, it is considered “full” mediated moderation.

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Table 1. *Descriptive Statistics of Cancer Prevention Behaviors*

	<i>Established Behaviors</i>				<i>Uncertain Behaviors</i>	
	Avoid smoking	Fruit and vegetable intake	Exercise	Apply sunscreen	Use hands-free headset	Avoid BPA plastics
Intention	4.54 (1.10)	4.03 (1.04)	4.08 (1.06)	3.24 (1.35)	2.69 (1.39)	3.38 (1.26)
Attitude	4.70 (.77)	4.55 (.62)	4.38 (.73)	3.76 (.94)	3.46 (1.10)	3.87 (.92)
Injunctive norm	4.62 (.95)	4.41 (.72)	4.43 (.73)	3.97 (.93)	3.42 (.97)	3.70 (.98)
Descriptive norm	4.00 (1.18)	3.25 (1.02)	3.13 (.97)	2.79 (1.15)	2.14 (1.04)	2.57 (1.23)
Self-efficacy	4.54 (1.10)	3.74 (1.15)	3.91 (1.16)	3.32 (1.38)	2.72 (1.44)	3.08 (1.29)

Note. All measures are based on a 5-point scale. Cells present the mean value and standard deviation.

Table 2. *Hierarchical Regressions to Predict Cancer Prevention Intentions*

Predictor (beta)	<i>Established Behaviors</i>				<i>Uncertain Behaviors</i>	
	Avoid smoking	Fruits and vegetable intake	Exercise	Apply sunscreen	Use hands-free headset	Avoid BPA plastics
Step 1						
Attitude	.198	.228	.294	.307	.332	.266
Injunctive norm	.054 (.06)	.123	.109	.159	.150	.159
Self-efficacy	.614	.533	.488	.473	.357	.452
Step 2						
Attitude	.187	.202	.276	.278	.290	.209
Injunctive norm	.041 (.15)	.089 (.005)	.072 (.016)	.102 (.001)	.093 (.006)	.094 (.003)
Self-efficacy	.587	.482	.438	.408	.303	.341
Descriptive norm	.083 (.007)	.188	.183	.240	.269	.332
Step 1 R^2	.585	.501	.504	.575	.455	.500
Step 2 ΔR^2	.005	.028	.027	.043	.058	.076

Notes. All Model F and F change significant at $p < .001$ level (except avoid smoking, F change at $p = .007$); All individual regression coefficients significant at $p < .001$ level otherwise p value noted in parenthesis.

Table 3. *Hierarchical Linear Model of Cancer Prevention Intentions*

	<i>Coefficient (SE)</i>		
	Model 1	Model 2	Model 3
Fixed effects			
Intercept	3.60 (.03)	3.57 (.02)	3.57(.11)
Attitude	-	.39 (.02)	.41 (.02)
Injunctive norm	-	.13 (.02)	.13 (.02)
Self-efficacy	-	.39 (.01)	.44 (.02)
Descriptive norm	-	.23 (.01)	.18 (.02)
Behavior (established) ^a	-	Reference	Reference
Behavior (uncertain) ^b	-	.04 (.03) <i>ns</i>	.05 (.03) <i>ns</i>
Behavior (uncertain) × attitude	-	-	-.05 (.04) <i>ns</i>
Behavior (uncertain) × injunctive norm	-	-	.02 (.03) <i>ns</i>
Behavior (uncertain) × self-efficacy	-	-	-.13 (.03)
Behavior (uncertain) × descriptive norm	-	-	.16 (.03)
Random effect			
Variance	.27	.13	.12
Random error	1.69	.55	.54

Notes. All coefficients significant at $p < .001$ level otherwise noted. ^a established behaviors (fruits and vegetable intake, exercise, avoid smoking, and apply sunscreen) were used as the reference category; ^b uncertain behaviors refer to avoiding BPA and using hands-free headsets. All of the predictors were grand-mean centered.

Figure 1. *Model-Predicted Relationships by Scientific Uncertainty*

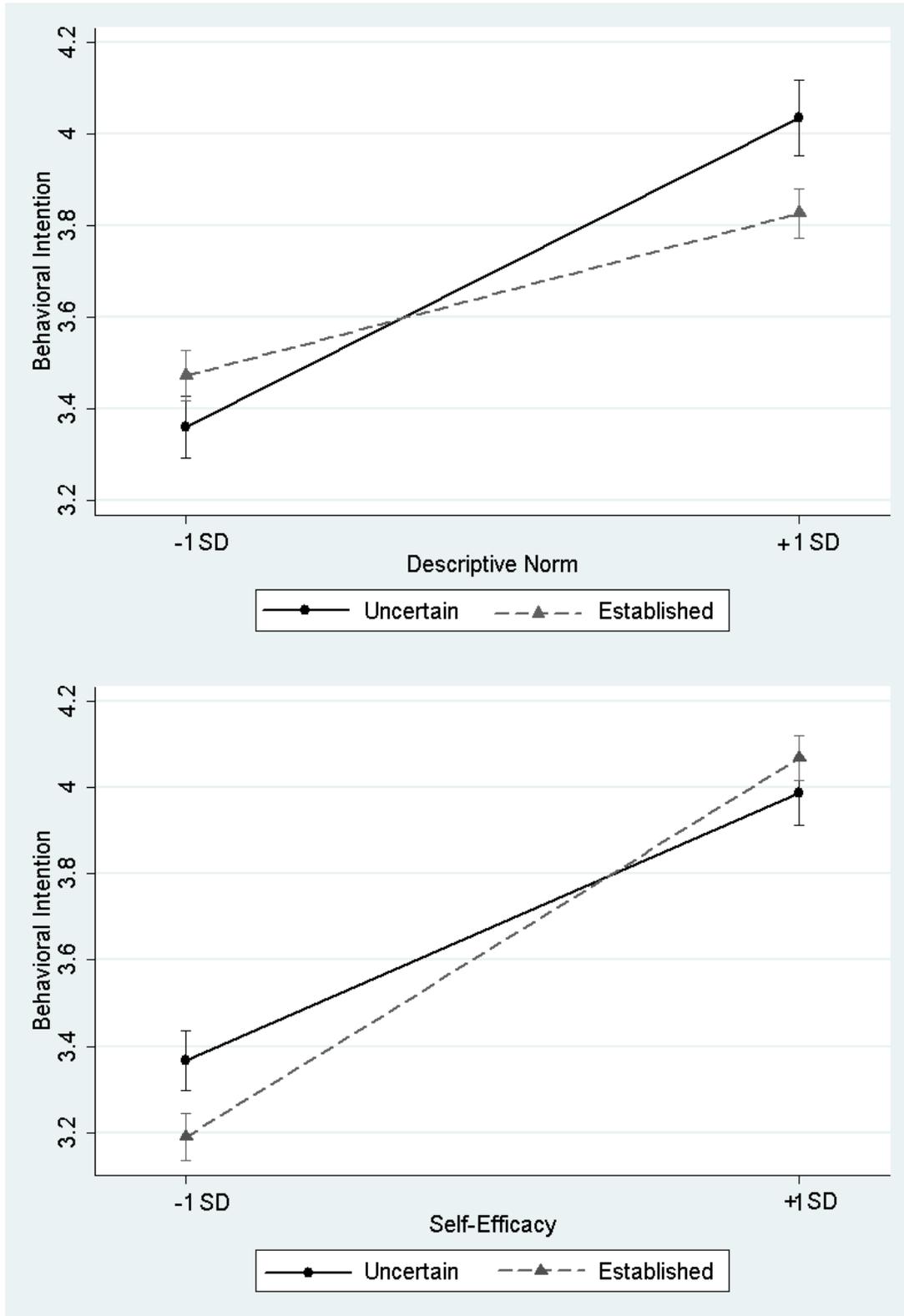
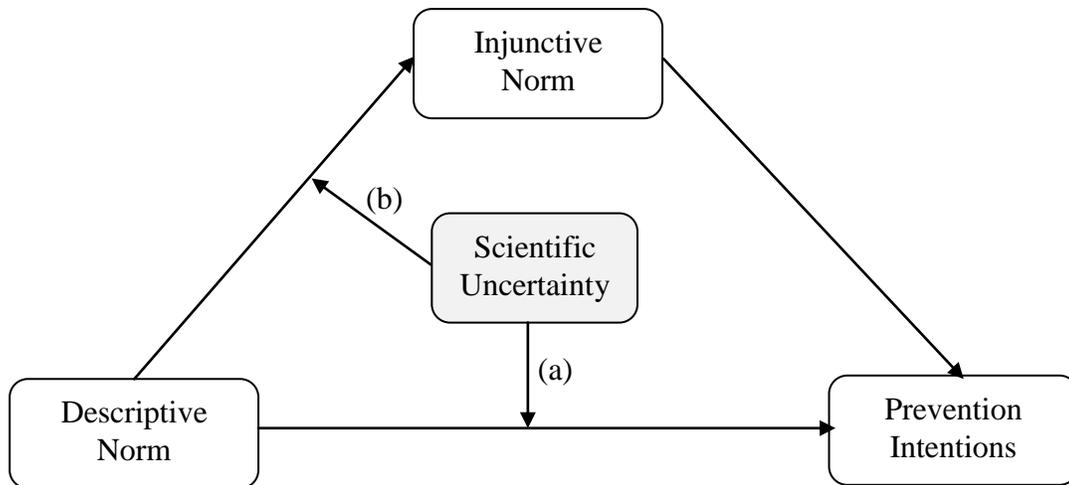


Figure 2. *Test of Mediated Moderation*



Notes. To establish the mediated moderation (Muller et al., 2005), there should be (a) an overall moderation of the treatment effect on outcome variable ($b = .09, p = .002$), and (b) either the effect of treatment on mediator depends on the moderator ($b = .07, p = .002$) and/or the partial effect of mediator on outcome depends on the moderator ($b = -.02, p = ns$). Lastly, compared to the moderation of the overall treatment effect, the moderation of the residual direct effect of the treatment ($b = .08, p = .01$) should be reduced.