



How uncertainty affects information search among consumers: a curvilinear perspective

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Abstract

Uncertainty is an inherent part of consumers' environment. A large literature in marketing and related disciplines has found a positive relationship between uncertainty and information search: as consumers' uncertainty about a brand, product, or service increases, so does their inclination to seek out and engage with information. In contrast to this conventional view, the present research proposes and demonstrates a curvilinear (inverted-U) relationship between uncertainty and information search. Conceptually, we put forth theoretical insight for this relationship: uncertainty increases both accuracy and efficiency considerations, presenting an inherent tradeoff. This tradeoff is perceived to be more favorable at moderate levels of uncertainty relative to low and high levels. Empirically, we observe an inverted-U relationship between uncertainty and information search across three experiments and find evidence consistent with our theorizing. This research suggests that the conventional view is incomplete and points to the importance of exploring uncertainty at multiple levels.

Keywords Uncertainty · Information search · Accuracy · Efficiency · Curvilinear relationship

1 Introduction

Uncertainty is an inherent part of consumers' environment. Consumers experience uncertainty about many things, including products and services, topical issues, and other people. One adaptive function of uncertainty is to provide a signal that one should search for more information. For example, uncertainty about a product may

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encourage consumers to obtain more information via online reviews, websites, or friends.

A substantial literature has documented that as consumers' uncertainty about a stimulus increases, so does their tendency to search for and process information pertaining to that stimulus, i.e., a positive relationship (e.g., Grant & Tybout, 2008; Heslin et al., 1972; Lanzetta & Driscoll, 1968; Maheswaran & Chaiken, 1991). Indeed, this relationship has been found in the domains of marketing (e.g., Murray, 1991; Sun et al., 2012), economics (e.g., Kohn & Shavell, 1974; Mele & Sangiorgi 2010), communications (e.g., Bradac, 2001; Kuhlthau, 1993; Wilson, 1999), and psychology (Pelham & Wachsmuth, 1995; Weary & Jacobson, 1997).

We suggest the conventional view—uncertainty exerts a positive effect on consumers' information search—reflects a useful but incomplete representation of how consumers respond to uncertainty. We advance the hypothesis that the relationship between uncertainty and information search can be curvilinear—specifically, an inverted-U form.

2 Conceptual development

2.1 Conventional view: uncertainty increases information seeking

The experience of uncertainty has been defined as the subjective assessment of a gap in one's information or understanding of a stimulus (Clore & Parrott, 1994; Kagan, 1972; Milliken, 1987). The reduction of uncertainty is viewed as a critical driver of human behavior (Berlyne, 1960; Inglis, 2000; Kagan, 1972). Since uncertainty arises from a perceived gap in information or understanding, acquiring information is a natural means to reduce uncertainty.

For example, in past research, consumers who were more uncertain about whether they could predict another person's behavior sought more information about that person (Weary & Jacobson, 1997). Similarly, consumers who were more uncertain about a disease were more inclined to seek information (Rosen & Knäuper, 2009). Indeed, the idea that uncertainty increases consumers' desire to seek out or engage with information has been used to explain diverse phenomena from how people evaluate new products (Grant & Tybout, 2008) to how emotions affect information processing (Tiedens & Linton, 2001).

Based on these and other findings (e.g., Desender et al., 2018; Heslin et al., 1972; Maheswaran & Chaiken, 1991; Pelham & Wachsmuth, 1995; Sun et al., 2012; Tormala et al., 2012), one might conclude that uncertainty governs consumers' information search in a simple fashion: consumers are more prone to engage in search as uncertainty increases. This positive relationship can be explained by the idea that consumers' uncertainty provides an internal signal that additional information will be useful (Chaiken et al., 1989; Weary & Jacobson, 1997).

2.2 Unexplained findings

The idea of a positive relationship is parsimonious, intuitive, and consistent with the vast majority of prior findings in the literature. Yet, such a conclusion overlooks a handful of findings that suggest uncertainty can reduce information search—i.e., a negative relationship. For example, Urbany et al. (1989) found that consumers with greater uncertainty about product offerings were less inclined to seek information. Elsewhere, for decision problems high in uncertainty, further uncertainty appeared to negatively correlate with information search (Driscoll & Lanzetta, 1964). While intriguing, prior research has not put forth an integrative solution for these findings against the larger literature documenting a positive relationship between uncertainty and information search.

Existing research is also marked by a critical empirical limitation. Namely, experimental manipulations of uncertainty have usually focused on two levels of uncertainty—lower versus higher (e.g., Grant & Tybout, 2008; Heslin et al., 1972; Maheswaran & Chaiken, 1991; Rosen & Knäuper, 2009; Sun et al., 2012; Tormala et al., 2012; Weary & Jacobson, 1997). With two levels of uncertainty, it was only possible to test for a linear effect of uncertainty on participants' desire for information (i.e., positive, negative, or null). Theorizing and findings of the conventional positive relationship may thus be predicated on this empirical limitation.

Of interest, some prior research has found evidence of an inverted-U relationship between a related construct—prior knowledge—and the extent of information search or processing (Bettman & Park, 1980; Johnson & Russo, 1984; Moorthy et al., 1997; but see Brucks, 1985; Punj & Staelin, 1983). While this finding provides initial reason to believe that uncertainty may exert an inverted-U effect on search, the present research is distinct in two important respects. First, uncertainty is distinct from knowledge (Alba & Hutchinson, 1987; Rheingold, 1985). A consumer with low knowledge may nevertheless feel highly certain (Dunning, 2011; Fischhoff et al., 1977). Second, and equally important, we put forth a novel theoretical account. The intuition for the curvilinear effect of knowledge is that knowledge increases both the ability to process more information (increasing search) and the ability to search in a more effective manner (decreasing search). In contrast to the ability-centric explanation for knowledge, our theoretical account for the effect of uncertainty involves judgment goals. We present this theorizing next.

2.3 Conceptual framework

We propose that the relationship between uncertainty and information search may often be curvilinear across the uncertainty continuum. Our proposition rests on the assumption that consumers strive to strike a balance between two common judgment goals—accuracy and efficiency (e.g., Bettman, Luce, and Payne 1998; Forster et al., 2003; Payne et al., 1988). An accuracy goal refers to a desire to reach a judgment or decision that is valid and correct. An efficiency goal refers to a desire to be economical with one's time and energy in

making the judgment or decision. Consumers often seek to allocate their time and energy in a manner that offers the greatest value (Fiske & Taylor, 1991; Higgins & Bargh, 1987; Sherman et al., 1989)—that is, to balance acceptable accuracy with reasonable efficiency.

We propose that uncertainty itself impacts consumers' perceptions of accuracy versus efficiency considerations in information search. Because uncertainty arises from a perceived gap in information or understanding, higher uncertainty about a stimulus implies to the consumer that more information is needed to achieve accuracy in their judgment about the stimulus. At the same time, seeking and processing this additional information would require further time and effort, thus hindering efficiency. In other words, rising uncertainty increases both the accuracy and efficiency considerations of information search, presenting an inherent tradeoff—accuracy considerations create a driving force for search while efficiency considerations create a deterring force (e.g., Bettman, 1979; Schmidt & Spreng, 1996). The tradeoff between these competing forces shapes and helps to explain the relationship between uncertainty and information search.

We hypothesize that as uncertainty rises from lower to moderate levels, the driving force predominates. At lower levels of uncertainty, the tradeoff favors accuracy because additional information is perceived to substantially increase accuracy while efficiency concerns remain tolerable. Thus, initially, a rise in uncertainty causes information search to increase. However, as uncertainty rises further from moderate to higher levels, the deterring force predominates. At higher levels of uncertainty, the tradeoff favors efficiency because additional gains in accuracy are perceived to come at the cost of substantial decrements in efficiency. Thus, a further rise in uncertainty causes information search to decrease. This theorizing predicts that search peaks at moderate levels of uncertainty. Put simply, moderate uncertainty signals a favorable balance between accuracy and efficiency, increasing the value of search.

If our hypotheses are true, then the relationship between uncertainty and information search would take on an inverted-U form. Or, put differently, the conventional positive relationship between uncertainty and information search would emerge from low to moderate uncertainty, but turn negative at higher levels of uncertainty, ultimately producing a curvilinear relationship across the uncertainty continuum.

3 Empirical overview

We report three experiments which investigate the inverted-U relationship in different domains of judgment. Study 1 provides an initial demonstration of this relationship in a product purchase context. Study 2 assesses natural variation in consumers' uncertainty towards mask-wearing during the COVID-19 pandemic and examines their information search behavior. Lastly, study 3 examines the proposed mechanism by testing whether a perceived accuracy-efficiency tradeoff mediates the inverted-U relationship.

Sample sizes were determined prior to data collection and were based on a consideration of study design, collection method, and participant availability.

Data from each study were analyzed only once data collection was complete. Any additional measures and analyses are reported in the Supplemental Appendix. Data are available at https://osf.io/xpbj2/?view_only=003050cdf25247f4a993ab3b9ca5db98.

4 Study 1

Prior research, which usually operationalized uncertainty at only two levels, could not test a curvilinear relationship. As such, study 1 manipulated uncertainty at three levels to test whether an inverted-U relationship would emerge.

4.1 Method

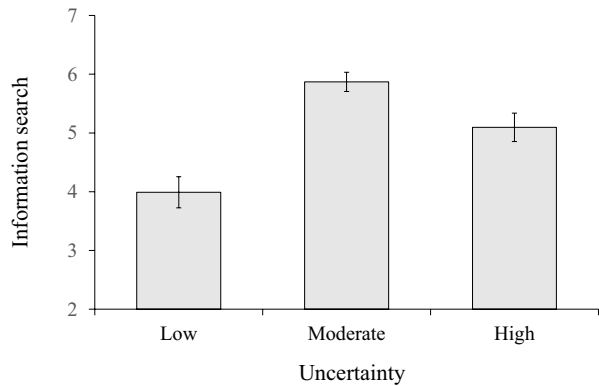
One hundred fifty participants on Amazon Mechanical Turk completed this study (97 females, $M_{\text{age}} = 35.35$). Participants were randomly assigned to one of three between-participant conditions: low, moderate, or high uncertainty.

We manipulated participants' sense of uncertainty about a product or service based on a procedure adapted from past research (Cheatham & Tormala, 2017). This task involved participants writing about a potential gift (a product or service) about which they felt "very certain" (low uncertainty), "somewhat, but not totally, certain" (moderate uncertainty), or "very uncertain" (high uncertainty) (see Supplemental Appendix for the complete verbatim instructions).

Next, participants read a scenario in which they were deciding among gift options. Participants were further informed that they had some time, but not a lot of time, to purchase a gift. Thus, the scenario was designed to encourage participants to allocate their resources strategically, as they often would in everyday life. Participants then completed two measures assessing their intention to search for information about the product or service they had described in the writing task: the extent to which they would want to find out more information about the option they described (1 = *not at all*; 7 = *very much so*), and how likely they were to seek more information about the option (1 = *not likely at all*; 7 = *very likely*), $r = 0.86$. The expectation was that participants' uncertainty regarding the product or service they described should affect the extent to which they were willing to search for information about this option.

Next, as a manipulation check, four items assessed participants' uncertainty about the product or service they described (1 = *very uncertain*, 7 = *very certain*; see Supplemental Appendix for items), $\alpha = 0.88$. Lastly, two items assessed participants' evaluation of the product or service (1 = *very negative*; 7 = *very positive*; 1 = *very unfavorable*, 7 = *very favorable*), $r = 0.76$.

Fig. 1 The curvilinear effect of uncertainty on information search (study 1). Note: The error bars represent the standard error of each mean



4.2 Results and discussion

We analyzed the data using one-way ANOVA.

4.2.1 Manipulation check

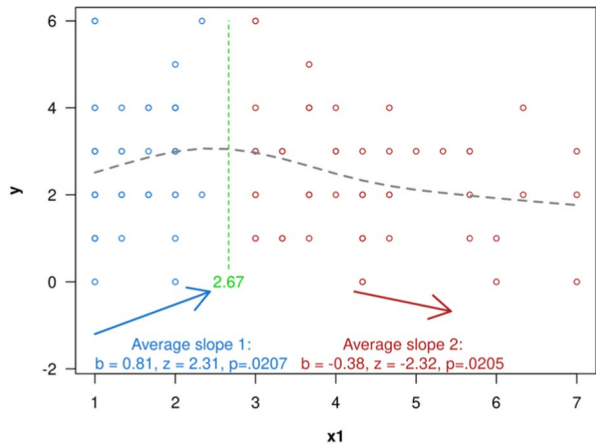
The manipulation had a significant overall effect, $F(2, 147) = 76.68$, $p < 0.0001$, $\eta^2 = 0.51$. With lower values representing higher uncertainty, participants were more uncertain in the moderate uncertainty condition ($M = 4.81$, $SD = 1.18$) compared to the low uncertainty condition ($M = 6.22$, $SD = 0.75$), $t(101) = 6.60$, $p < 0.001$, $d = 1.43$, and more uncertain in the high uncertainty condition ($M = 3.54$, $SD = 1.28$) than in the moderate uncertainty condition, $t(95) = 5.78$, $p < 0.001$, $d = 1.04$.

4.2.2 Information search

A trend analysis testing for an inverted-U effect was significant, $F(1, 147) = 22.44$, $p < 0.0001$. Individual contrasts revealed that intentions to search increased from low ($M = 3.99$, $SD = 1.92$) to moderate levels of uncertainty ($M = 5.87$, $SD = 1.16$; $t(101) = 5.90$, $p < 0.001$, $d = 1.18$), then declined from moderate to high uncertainty ($M = 5.10$, $SD = 1.65$; $t(95) = 2.36$, $p = 0.02$, $d = 0.55$) (see Fig. 1). For robustness, we also ran an ANCOVA in which participants' evaluation of the product or service was included as a covariate. The effect of this covariate was nonsignificant, $F(1, 146) = 0.04$, $p = 0.844$, $\eta_p^2 = 0$, and did not affect the significance of the trend analysis or the individual contrasts.

Study 1 offered evidence that uncertainty can have a curvilinear effect on information search. While the established positive effect was observed from low to moderate levels of uncertainty, the relationship reversed and became negative at a higher level of uncertainty.

Fig. 2 Uncertainty about mask-wearing had a curvilinear effect on information search (study 2)



5 Study 2

Study 2 measured natural variation in consumers' uncertainty towards wearing a mask during the COVID-19 pandemic and examined its effect on the search for information about mask-wearing.

5.1 Method

One hundred forty-one undergraduate participants at a large Canadian university completed this study as part of online lab sessions in June 2020 (83 females, $M_{age} = 22.58$).

Participants responded to three items assessing their uncertainty about wearing a mask, specifically how uncertain they were about (1) the effect of wearing a mask for COVID-19 prevention, (2) public health recommendations for wearing a mask during the COVID-19 pandemic, and (3) whether they were going to wear a mask during the COVID-19 pandemic (1 = *not uncertain at all*; 7 = *very uncertain*), $\alpha = 0.92$.

Next, participants were allowed to select up to six pieces of information to read about different aspects of mask-wearing, including the science of masks, the impact of masks, the appropriate use of masks, and when to wear a mask. The number of items selected served as the dependent variable. Participants then viewed their chosen information items on the next screens. Finally, participants completed measures of their attitude towards mask-wearing and behavioral intentions to wear a mask.

5.2 Results

Twenty-five participants failed the attention check for the online lab session (see Supplemental Appendix), and their responses were excluded from the analysis.

To test for an inverted-U relationship between uncertainty and information seeking, we analyzed the data using the two-line test recommended by Simonsohn (2018). This method estimates two regression lines, one for lower values of uncertainty and one for higher values of uncertainty, and tests whether the slopes of the two lines are opposite in sign. An inverted-U relationship would be indicated by a positive slope for the first line (lower values of uncertainty positively predict information seeking) and a negative slope for the second line (higher values of uncertainty negatively predict information seeking). We found a positive effect of uncertainty for the first line ($b=0.81$, $z=2.31$, $p=0.021$) and a negative effect for the second line ($b=-0.38$, $z=2.32$, $p=0.021$). Thus, an inverted-U relationship emerged (see Fig. 2).

Increased information seeking had a positive effect on attitudes and behavioral intentions to wear a mask. These results are reported in the Supplemental Appendix.

Study 2 offered additional evidence for a curvilinear relationship between uncertainty and information search.

6 Study 3

Our theoretical account proposes that, as uncertainty increases, more information search should be perceived to help enhance accuracy but also to hinder efficiency. The tradeoff between these two competing considerations should be viewed as relatively optimal at a moderate level of uncertainty, where acquiring information offers a satisfactory gain in accuracy for an acceptable amount of efficiency. To test this mechanism, this experiment presented participants with three alternatives that varied in uncertainty (low, moderate, and high). For each alternative (i.e., each level of uncertainty), we measured participants' perceptions of the tradeoff between accuracy and efficiency and tested whether this perceived tradeoff mediated the curvilinear effect of uncertainty on information search.

6.1 Method

This pre-registered experiment manipulated uncertainty within participants (preregistration available at <https://aspredicted.org/bb6q3.pdf>). All participants were presented with three alternatives, each associated with a different level of uncertainty (low, moderate, and high). One hundred twenty participants completed this study online through the Prolific panel (75 females, mean age = 32.67).

Participants read a scenario involving buying a vacuum cleaner. They were shown a set of three alternatives, each accompanied by a photo, the average consumer rating, and some text. The average rating was the same for all three alternatives (4 stars), thus holding evaluative information constant. The degree of

uncertainty associated with each alternative was varied based on the amount and source (first- or second-hand) of participants' existing information about the alternative (Fazio & Zanna, 1981). Specifically, for the *low uncertainty* alternative, participants were told that it was made by a brand whose vacuum cleaners they had used in the past. For the *moderate uncertainty* alternative, participants were told that they had not used the brand before but their friend owned this vacuum cleaner. Lastly, for the *high uncertainty* alternative, participants were told that they had not used the brand before and their friends could not tell them much about it either. This manipulation was pretested and found to vary uncertainty as expected¹ (see Supplementary Appendix for stimuli and pretest results).

To assess information search, participants rated how likely they would be to learn more about each alternative (1 = *very unlikely*, 7 = *very likely*). Next, to assess participants' tradeoff between efficiency and accuracy, they rated the extent to which it would be worthwhile to spend time getting a more accurate impression of each alternative (1 = *not at all*, 7 = *very much so*). Lastly, as a manipulation check, participants rated how certain they were about how the product would perform (1 = *very uncertain*, 7 = *very certain*).

6.2 Results and discussion

The data were analyzed using repeated measures ANOVA.

6.2.1 Manipulation check

The uncertainty manipulation had a significant overall effect, $F(2, 238) = 279.64$, $p < 0.0001$, $\eta_p^2 = 0.70$. With lower values indicating higher uncertainty, participants were more uncertain about the moderate uncertainty alternative ($M = 4.92$, $SD = 1.06$) than the low uncertainty alternative ($M = 6.11$, $SD = 0.86$), $t(119) = 8.68$, $p < 0.001$, $d = 1.24$. They were also more uncertain about the high uncertainty ($M = 2.88$, $SD = 1.47$) relative to the moderate uncertainty alternative, $t(119) = 14.71$, $p < 0.001$, $d = 1.59$.

6.2.2 Information search

A trend analysis to test for an inverted-U effect was significant, $F(1, 238) = 34.54$, $p < 0.0001$. Individual contrasts revealed that participants were more likely to engage in information search for the alternative they were moderately uncertain about ($M = 5.46$, $SD = 1.28$) than the one they had low uncertainty about ($M = 4.88$, $SD = 1.96$), $t(119) = 2.66$, $p < 0.001$, $d = 0.35$. By contrast, they were less likely to seek information

¹ A potential limitation of this manipulation, as pointed out by an anonymous reviewer, is that it contains social information. As a result, while clearly varying uncertainty, it is possible that the manipulation may have also varied additional factors.

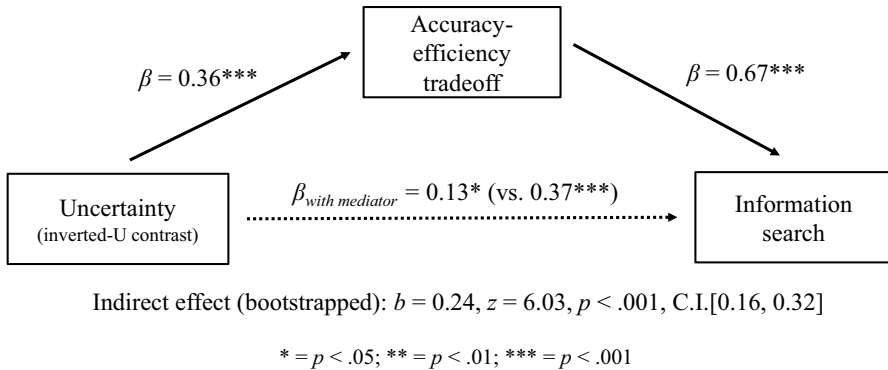


Fig. 3 Perceptions of an accuracy-efficiency tradeoff mediated the inverted-U effect of uncertainty on information search (study 3)

for the alternative they were highly uncertain about ($M=3.81, SD=1.83$) compared to the one they were moderately uncertain about ($M=5.46$), $t(119)=7.52, p < 0.001, d=1.05$.

6.2.3 Mediation analysis

Participants' tradeoff perceptions were more favorable for the moderate-uncertainty alternative ($M=5.49, SD=1.35$) than for the low-uncertainty ($M=4.51, SD=2.05$; $t(119)=4.67, p < 0.001, d=.57$) and high-uncertainty alternatives ($M=4.31, SD=1.68$; $t(119)=5.58, p < 0.001, d=.77$).

We performed a multilevel mediation analysis with the tradeoff measure as a mediator of the inverted-U effect. Uncertainty (coded as a quadratic contrast term) positively predicted tradeoff perceptions, and tradeoff perceptions positively predicted search (see Fig. 3). The indirect effect was significant (bootstrapped: $b=0.24, z=6.03, p < .001, C.I.[0.16, 0.32]$). The inverted-U effect of uncertainty on search decreased in magnitude when the mediator was included ($\beta=0.13, z=2.54, p=.011$) compared to when the mediator was not included ($\beta=0.37, z=5.66, p < .001$). Conditional on the assumptions of our mediation model, our statistical test showed that tradeoff perceptions can account for a significant portion of variance.

7 General discussion

Substantial prior research has found that uncertainty increases information search. The present work builds on this foundation by offering an alternative perspective. While a positive relationship is observed when examining low to moderate levels of uncertainty, the relationship can become negative between moderate to high levels of uncertainty, thus producing a curvilinear relationship across the uncertainty continuum. We suggest the relationship between uncertainty and search is

shaped by a tradeoff between accuracy and efficiency, which varies across different levels of uncertainty.

This research can offer insight about why consumers may not seek information in some situations involving uncertainty. For example, marketers may want consumers to seek information about new products, and policy makers may often want consumers to be well-informed in domains such as health (e.g., a new vaccine) or personal finance (e.g., investing for retirement). The present work suggests consumers may search less if they are highly uncertain about the product or issue at hand. Rather, an “optimal” level of uncertainty—determined based on the relative importance of accuracy and efficiency considerations in a given situation—may be most effective in motivating search.

This research also highlights the importance of operationalizing uncertainty at multiple levels. If researchers only operationalize uncertainty at two levels, its effects may depend on whether “low uncertainty” in the study is actually low or moderate and whether “high uncertainty” is actually moderate or high. Indeed, the present findings suggest that much of prior research may have unknowingly operationalized low and moderate certainty, respectively. This reveals the importance of examining multiple levels of uncertainty to understand its effects more fully.

This work contributes to a broader literature on the antecedents of consumer information search, which include factors such as involvement, need for justification, and product characteristics, among others (Beatty & Smith, 1987; Moore & Lehmann, 1980; Punj & Staelin, 1983; Schmidt & Spreng, 1996; Srinivasan & Ratchford, 1991). In fact, some of these factors may shape the relationship between uncertainty and information search by affecting the perceived accuracy–efficiency tradeoff. For example, high involvement may increase the importance of accuracy in the tradeoff, which may lead the inflection point of the curvilinear effect to occur at a higher level of uncertainty. We also note the proposed accuracy–efficiency tradeoff mechanism has theoretical roots in the benefit–cost perspective of search (e.g., Bettman, 1979). A novel insight of the present research is this tradeoff varies across different levels of uncertainty, which helps to explain why uncertainty has a curvilinear effect on search.

Although this work focused on efficiency concerns as a driver of the downturn in search at high uncertainty, we recognize other factors might drive this downturn. For example, high uncertainty may be associated with stronger negative emotions (Bar-Anan et al., 2009), which could discourage search in some situations. A fruitful avenue for future research is to explore additional mechanisms that may underlie the relationship between uncertainty and search.

In sum, while a great deal of research has found that uncertainty increases information search, the present research suggests that the effect of uncertainty on search is more complex than previously understood. We hope this research challenges scholars to engage in greater exploration of the important link between uncertainty and information search.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s11002-022-09657-0>.

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Declarations

This research was conducted in accordance with the APA's guidelines on the ethical treatment of human subjects. The data in this manuscript have not been published elsewhere, and the manuscript is not under consideration for publication elsewhere. All authors have seen and approved the manuscript.

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