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Is Processing COVID-19 Information Effective for Wearing Masks? The Effect of Information Processing on Preventive Intention

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This study explores the effects of coronavirus disease 2019 (COVID-19) risk perception and negative affective responses on related information processing and preventive intention using an extended risk information seeking and processing (RISP) model. A nationwide online survey was conducted in South Korea. The results revealed that a stronger perceived risk of COVID-19 was associated with more negative affective responses, such as fear or nervousness, which acted as a driving force for seeking information. Negative affective responses were not only antecedents of information insufficiency but also mediators of the relationship between risk perception, information insufficiency, and information processing. Supplementary systematic processing was used as the perceived need for risk information intensified, which increased preventive intention. However, a higher perception of having sufficient risk-related information was associated with a more pronounced tendency toward heuristic information processing. The theoretical and practical implications are discussed.

Keywords: extended RISP model, heuristic information processing, COVID-19, South Korea

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When a new infectious disease emerges, governments, researchers, and pharmaceutical companies endeavor to develop and distribute vaccines or treatments. However, developing a new drug requires a minimum of one year of clinical testing, with mandatory procedures, such as the Food and Drug Administration (FDA) approval. Until vaccines and treatments become available, people can take simple precautions, such as washing their hands after going out in public, minimizing contact with others, and wearing masks. Such actions seem trivial but are effective in preventing the spread of viruses. For example, the effectiveness of wearing a mask has been proven in Asian countries, where wearing one at the onset of the coronavirus disease 2019 (COVID-19), Middle East respiratory syndrome (MERS), and severe acute respiratory syndrome (SARS) outbreaks were mandatory. Given the effectiveness of wearing a mask in the early and middle stages of the COVID-19 pandemic, the United States and other Western countries emphasized its usefulness and implemented mandatory mask-wearing policies. This study aims to explore the cognitive structure of individuals that increases their preventive behavioral intentions, such as wearing a mask or washing their hands properly, to protect themselves when a completely new infectious disease, such as COVID-19, surfaces.

In the early stages of an infectious disease, people tend to rely on government agencies or experts for crucial information due to a lack of relevant knowledge (Ahn, 2022; Hallgrimsdottir & Benner, 2014). Therefore, confusion is inevitable when experts present conflicting opinions. Understanding how the individuals perceive risk and process information in the early stages of an epidemic when information uncertainty can contribute to future risk response strategies is crucial. Consequently, this study aimed to investigate the cognitive processes that contribute to risk perception and subsequent risk-prevention behavior during the initial phases of the COVID-19 pandemic. This study was conducted, and data were collected between late August and early September 2020, during the second wave of COVID-19 (Kim, 2020; Kim et al., 2021).

The risk information seeking and processing (RISP) model explains how people perceive and handle risks. The RISP model describes how people perceive risk and explore risk-related information (Griffin, Dunwoody, & Neuwirth, 1999). According to this model, risk perception evokes negative affective responses, with risk-related information systematically or heuristically processed to resolve these affective responses (Yang, Aloe, & Feeley, 2014).

Many RISP model studies have focused on the approaches from risk recognition to information processing (Lu, APPC 2018-2019 ASK Group, Winneg, Jamieson, & Albarracín, 2020; Rose, Toman, & Olsen, 2017; Yang, Dong, & Liu, 2022); however, Griffin et al. (1999), who proposed the model, emphasized that information seeking and processing from the time of the model presentation should ultimately lead to behaviors in response to actual risks. This signifies that the comprehensiveness of the model increases only when behavioral factors are included as a result of RISP. Considering that risk information processing aims to avoid or resolve a risk situation (Seo, 2016), the need for a model extension has been constantly raised. Therefore, risk-preventive behavior, such as one's intention to wear a mask, must be theoretically examined in the model.

The present study used the RISP model for information processing. Yang et al. (2014) reported that, compared with other variables, heuristic processing demonstrated a low correlation with the major

variables of the RISP model. As the model is based on the elaboration of risk information, such as cognition and affective responses to potential risks and information insufficiency, the explanatory power of heuristic processing was evaluated to be low.

However, in some instances, elaborating on risk is difficult due to a lack of credible information, such as when a new crisis emerges. This was reflected in the initial stages of COVID-19, where people lacked cognitive resources. Because COVID-19 was a new infectious disease, information about it was limited, with experts having conflicting opinions and various countries proclaiming different policies to combat the viruses. In a situation where the risk-related cognitive resources are insufficient, individuals' heuristic processing modes may be activated. When individuals have insufficient motivation or lack cognitive resources to process information, they process information superficially (Todorov, Chaiken, & Henderson, 2002). Thus, the outcome of the heuristic information processing mode must be considered.

It is helpful to determine how people were exposed to a particular risk-related information in the initial stages of COVID-19, as well as how they processed that information and the consequences of their actions. Researchers have analyzed the different behavioral intentions individuals reveal after processing information on their own (Huh & Kim, 2015; Kim, 2019; Seo, 2016). However, while many studies focused on the results of systematic processing, with limited discussion of heuristic processing, this study thoroughly explored the information processing used in the risk perception of COVID-19 according to an individual's propensity and how different processing styles affect preventive behaviors.

In summary, this study aims to investigate the extended RISP model by adding preventive behavioral intentions to the basic model, including risk perception, negative affective responses, and risk information processing in the context of COVID-19. In addition, we examine the effect of information processing by analyzing the relationship between the two types of information processing (systematic and heuristic) and preventive intention.

Theoretical Foundation

Model of Risk Information Seeking and Processing (RISP)

The RISP model provides a framework for how individuals process risk-related information (Yang et al., 2014). Griffin et al. (1999) argued that direct and indirect factors, such as individual characteristics, perceived risk perceptions, negative affective responses, information-related subjective norms, information insufficiency, differences in individual ability to learn, and belief in channels, influenced how risk information was sought. Each variable in the RISP model was constructed by integrating the elaboration likelihood model, heuristic-systematic processing model, and theory of planned behavior.

Individual characteristics comprise risk-related experiences and demographic attributes (Yang et al., 2014). In RISP research, they are mainly analyzed as control variables (Seo, 2016). Perceived hazard characteristics are a concept that involves the effects of personal and environmental factors, such as perceived risk perception, risk management, trust in institutions, and self-efficacy. Considering that the early RISP model by Griffin et al. (1999) was presented in a conceptual form, the model has been developed

with specific variables in subsequent studies. Perceived risk personality has been measured as the perception of risk severity and the likelihood that this risk will occur to the person, that is, the perceived susceptibility (Seo, 2016). In the present study, risk perception was set as the starting point of the model to explore the severity and vulnerability of COVID-19.

Affective responses refer to negative emotions, such as anxiety, worry, and anger, caused by risk perception. In the RISP model, risk perception leads to information seeking and processing through motivations, such as negative affective responses or information insufficiency. The model proposed in our study particularly emphasizes the role of the negative affective response by accepting that the components of risk perception, namely cognitive and emotional factors, as claimed by Slovic (1987), act complexly. The role of negative affective response has also been consistently demonstrated in RISP studies conducted in South Korea (Kim, 2019; Ku, Ahn, & Noh, 2020; Seo, 2016). For example, Ku et al. (2020) confirmed that the risk perception of particulate matter led to preventive intention through information seeking and processing, where the negative affective response played an effective mediating role in risk perception, leading to information insufficiency, information seeking, information processing, and behavioral intention.

According to the original RISP model, risk perception and negative affective responses lead to information insufficiency, which implies the level of knowledge that is considered necessary to handle a specific issue. Information insufficiency corresponds to the motivation to seek or process information. This concept refers to the difference between the level of knowledge an individual perceives subjectively of a risk and the level of knowledge deemed necessary to deal with that risk (Griffin et al., 1999). Thus, the perception of information insufficiency increases as one perceives that the amount of risk information he or she currently has is insufficient to manage the risk. Information insufficiency is considered a key variable in the RISP model, as it directly evokes the motivation for information processing. Hypotheses 1 and 2 are about the relationship between these three variables. We propose H1a and H1b based on the results of previous studies (Huh & Kim, 2015; Seo, 2016) that demonstrate an increase in negative affective responses and information insufficiency with strong risk perception.

H1a: Risk perception of COVID-19 is positively related to negative affective responses.

H1b: Risk perception of COVID-19 is positively related to information insufficiency.

Past studies have investigated the positive relationship between negative affective responses and information insufficiency (Seo, 2016; Yang et al., 2014). Therefore, it is probable that the stronger the negative affective responses to risk, the more likely individuals would feel the need for information to address the risk (H2a).

H2a: Negative affective response is positively related to information insufficiency.

In a follow-up study, Griffin et al. (2008) suggested a modified model that included direct effects, stating that risk perception and affective response acted as direct antecedents of information processing, although through information insufficiency. The revised model postulated that negative

affective responses mediated information insufficiency and directly affected not only the path acting on information processing but also the motivation for information seeking and processing (Seo, 2016; Yang & Kahlor, 2013). Therefore, we present H2b and H2c as follows:

H2b: Negative affective response is positively related to systematic information processing.

H2c: Negative affective response is negatively related to heuristic information processing.

Systematic Processing and Heuristic Processing

Griffin et al. (1999) argued that individuals tended to seek and process information when they perceived a lack of information on risk issues. Information seeking is classified into seeking and avoidance. Information search not only uses various traditional and new media channels to examine risk-related information but also relies on interpersonal communication channels, such as family and friends. Meanwhile, information avoidance occurs when people receive unsettling information and do not process it further (Yang & Kahlor, 2013).

Information processing can be divided into systematic and heuristic processing. Systematic processing is placing more cognitive effort into digesting information, such as pondering the information and linking it with other data, or communicating the acquired information with others. Conversely, heuristic processing is processing information superficially, such as not focusing on it or being biased when exposed to it.

Put differently, systematic processing involves scrutinizing information thoroughly and diligently. Contrastingly, heuristic processing involves scrutinizing information effortlessly to process information superficially (Huang & Yang, 2018). Because this study focuses on the effect of information processing on behavioral intention during the early stages of COVID-19, information search, which reflects the strong influence of media/channels, was not considered in this study.

Kahlor, Dunwoody, Griffin, Neuwirth, and Giese (2003) reported that the more the risk information was perceived as insufficient, the greater the willingness to search for information, which led to systematic processing. Contrarily, when the risk information was perceived as sufficient, the tendency to perform heuristic processing intensified. If the risk perception was high, evoking strong negative affective responses, it could be inferred that an active cognitive effort would be made to resolve the negative affective responses. The results of a meta-analysis of 15 RISP model studies by Yang et al. (2014), reporting that the explanatory power of systematic processing was higher than that of heuristic processing, also confirmed the relationship between risk perception and systematic processing.

Huh and Kim (2015) indicated that information processing was systematically performed with high perceived information insufficiency, and heuristic processing was performed with low information insufficiency. Thus, if individuals perceive that they have insufficient risk information, they tend to perform systematic processing with cognitive efforts to solve it. However, if they perceive that they have sufficient risk information, they tend to perform heuristic processing to superficially process the information they are

exposed to. Thus, we propose H3a and H3b based on previous studies about the relationship between information insufficiency and information processing (Huh & Kim, 2015; Kahlor et al., 2003):

H3a: Information insufficiency is positively related to systematic information processing.

H3b: Information insufficiency is negatively related to heuristic information processing.

Information Processing and Extended Model

The RISP model is a schematization of a cognitive structure that begins with risk perception and ends with information seeking and processing. In many RISP studies, information seeking and processing are regarded as dependent variables (Lu et al., 2020). Recent efforts have been made to expand the RISP model, formerly founded solely on information seeking and processing. When Griffin et al. (1999) first proposed the model, they highlighted that communication behavior must lead to risk-preventive behavior. This signified that the explanatory power of the model increased when the behavioral elements explained in planned behavior theory were included, rather than ending at information seeking and processing. Seo (2016) also indicated that verifying this part was necessary because personal processing of risk information aimed to avoid or escape risk.

Even before the RISP model, the effects of risk perception on preventive intention have been consistently tested in the theory of planned behavior and health belief models (Chang & Shim, 2013; Didarloo, Nabilou, & Khalkhali, 2017; Jo, Kim, Lee, & Jeong, 2004; Tuma, Smith, Kirk, Hagmann, & Zemel, 2002). For example, Jo et al. (2004) conducted a meta-analysis of health belief model studies published in South Korea for roughly 20 years, reporting that perceived vulnerability and severity constituting risk perception were major variables explaining health behavior intention. Chang and Shim (2013) also identified that the risk perception of foot-and-mouth disease, mad cow disease, and H1N1 influenza affected the intention of preventive action. Considering this flow, adding preventive intention to the RISP model that examines risk perception and information processing seems reasonable. Regarding the relationship between information processing and preventive behavioral intention, Kim (2019) and Seo (2016) revealed that systematic processing led to risk-related information sharing and risk-preventive behavior. Fischer and Glenk (2011) also found that those who systematically processed risk information demonstrated greater preventive intentions.

The current study also expects to unveil the significant effect of systematic processing. Thus, we propose the fourth hypothesis.

H4: Systematic processing is positively related to risk-preventive intention.

Studies using information seeking and processing as the dependent variables indicated that systematic processing was more effective than heuristic processing. In a meta-analysis of RISP studies, Yang et al. (2014) also suggested that researchers should focus on systematic rather than heuristic processing when analyzing this model. Cho and Kim (2021) also confirmed the significant effect of systematic processing on public evaluation of the government's response to COVID-19. However, they

did not explain the path between heuristic processing and preventive behavior. Thus, only a few studies examine how attitudes or intentions for preventive behavior are formed with no elaborate information processing. Ku et al. (2020) examined the effects of heuristic processing in South Korea. The study revealed that heuristic processing of particulate matter-related information negatively affected the intention of prevention behavior. Accordingly, the present study intends to examine any possible difference in the preventive behavioral intention caused by the heuristic processing of given information.

The path between heuristic processing and preventive behavior must also be explored. Especially when there exists a lack of information on new infectious diseases or the prevalence of unverified information about the diseases, systematic processing may have negative consequences. Griffin et al. (1999) explained that people do not pay much attention to risk-related information that they cannot decipher on their own. Individuals also tend to take information critically when they are uncertain about it (Ahn, 2022; Han, Moser, & Klein, 2007). During the study period, that is, in August 2020, South Korea was experiencing the second wave of COVID-19 (Kim et al., 2021), during which quarantine policies were frequently altered, and various expert opinions emerged. In this situation, considering the heuristic processing of information is crucial.

Lu, Chu, and Ma (2021) also confirmed that heuristic information processing should be considered when examining the RISP model. Their study focused on the type of information rather than the information processing mode. However, the results demonstrated that all four types of information in their study served as a heuristic cue. Thus, the RISP model should pay special attention to heuristic information processing. Researchers believe that individuals can make reasonable judgments after encountering various information without exerting much effort to process the information. Therefore, not all information is necessarily processed systematically, and some do not need to be. For example, statistical information demonstrating an increase in COVID-19-confirmed cases can serve as a heuristic cue.

Thus, how attitudes or intentions for preventive actions will be formed when people do not elaborately process information must be explored. The pathway corresponding to the RQ is one of the key pathways to be explored in this study. Considering that only a few studies have been conducted on the relationship between heuristic treatment and preventive behavioral intentions (Ku et al., 2020), it was included as the following RQ.

RQ: Is heuristic processing related to risk-preventive intention?

Application of the RISP Model to New Infectious Diseases

Since the RISP model was introduced by Griffin et al. (1999), it has been applied to various risk situations, such as the environment (Griffin et al., 2008; Kahlor, 2007; Yang et al., 2014) and health (Clarke & McComas, 2012; Link, 2021; Lu et al., 2020; Park & Chai, 2020; Seo, 2016). A steady number of studies have applied the RISP model to examine individual information processing for new infectious diseases, such as MERS (Seo, 2016) and COVID-19 (Ahn, Ku, & Noh, 2021; Li & Zheng, 2022; Yang et al., 2022).

Li and Zheng (2022) applied the RISP model to examine the effect of COVID-19 risk perception. They uncovered that affective responses, informational subjective norms, and information insufficiency had positive effects on online information seeking. They further reported that information seeking was related to prevention intention. In South Korea, Park and Chai (2020) explored the effects of seeking and processing COVID-19-related risk information on preventive behavior and information sharing, where the pathways of existing models leading to risk perception, information insufficiency, and online information seeking and processing were identified. They unveiled how online information processing led to practical actions of information sharing and preventive behaviors. Based on the RISP model, Ahn et al. (2021) examined the relationships among trust in government, negative and positive affective, information insufficiency, and multichannel information seeking in the context of COVID-19. The data demonstrated that trust in government enhanced positive affect and information seeking from governmental websites/SNSs, the Internet, and television.

Before COVID-19, continuous research was conducted on infectious disease risk perception using the RISP model. For example, Lu et al. (2020) studied one's intention to seek information on the influenza vaccine using the RISP model. They revealed that information-related subjective norms, information insufficiency, and various types of affective responses were strong predictors of information-seeking intention. Seo (2016) confirmed that active MERS-related information seeking and systematic processing positively affected MERS preventive behavior. Seo's (2016) study was significant in that it examined actual risk behavior by surveying the same respondents twice during the 2015 MERS crisis in South Korea and confirmed the initially proposed effect of the RISP model on actual behavior.

Meanwhile, Yang et al. (2022) examined the effect of COVID-19 risk perception in China, focusing on the cognitive structure of systematic information processing in the RISP model. However, the basic structure of the model was not fully supported. They concluded that the RISP model was sensitive to operationalization, sample, cultural context, and topic of study. Thus, our research question reflects the need to consider the characteristics of new infectious diseases (i.e., insufficient information, inaccurate information, and conflicting information among experts). Overall, the current study examines the effect of COVID-19 risk perception in Korea and attempts to increase the RISP model's explanatory power, focusing on the role of heuristic information processing in the early stages of new infectious diseases, which remains underexplored.

Research Model

Our model aimed to examine the process from risk perception and affective response through information insufficiency, to systematic processing and heuristic processing, as well as the preventive behavioral intention induced along the way. Thus, we excluded the information-related subjective norms, media reliability, information seeking, and information collection ability included in the early model. Figure 1 presents the research model based on the proposed hypotheses and research question.

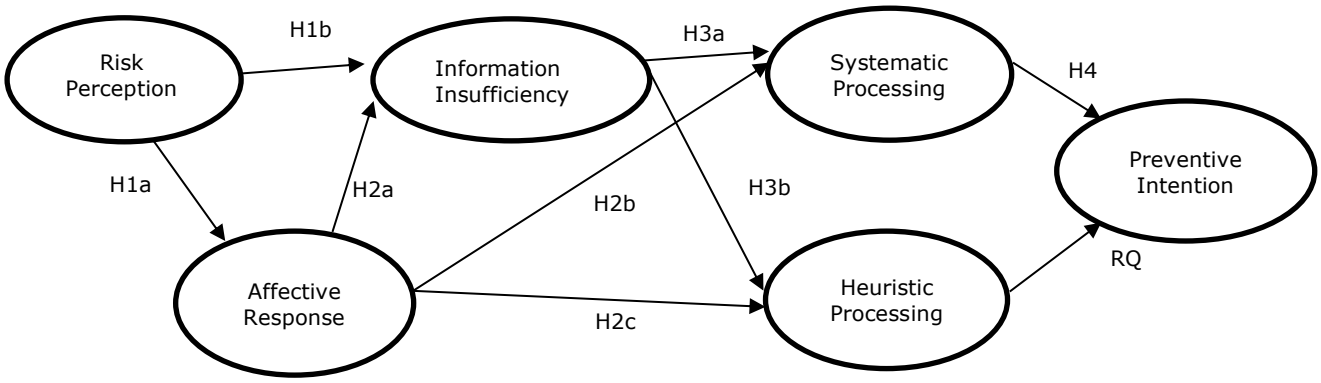

Figure 1. Theoretical model with hypothesized relationships.

Method

Data Collection

Data were collected from August 31 to September 2, 2020, to understand the risk perception and information processing methods about COVID-19. An online panel registered with a nationwide research company that specialized in online surveys expressed their intention to participate in the national panel held by the institution. They were sampled based on the proportion of the population. Of the 2,371 people who participated in this online survey, 1,500 completed it (response rate = 63.3%). The sample comprised 51.3% males and 48.7% females. In terms of age group, 23.6% were in their 20s, 22.2% in their 30s, 26.6% in their 40s, and 27.6% in their 50s. As for the education level, 65.9% (988 people) were college or university graduates, with the largest number of people, 17.9% (269 people).

Measures

The participants read and answered items on the seven variables, such as COVID-19 risk perception, negative affective responses, information insufficiency, systematic processing, heuristic processing, and health behavior intentions, as well as the control variable, namely, the individual COVID-19 experience level. The items were revised and supplemented based on previous studies, and the remaining items were measured on a five-point Likert scale from 1 to 5 points (1 = strongly disagree, 5 = strongly agree), except for information insufficiency, which measured the perceived level of information. In addition, demographic variables, such as age, gender, education level, and average monthly income, were measured.

Based on previous studies on risk information search and processing models (Hovick, Kahlor, & Liang, 2014; Seo, 2016), *COVID-19 risk perception* was assessed through two items of perceived risk severity and two items of perceived risk susceptibility. On a five-point scale, the participants' perceptions of the severity of the impact of COVID-19 on them, their families, and their communities were evaluated. Perceived risk susceptibility was measured on a five-point scale for how likely it was that COVID-19 would

become a risk to them, their families, and their communities. The internal consistency of the items was reliable (M = 4.09, SD = 0.68, α = 0.86).

Negative affective responses about COVID-19 were measured on a five-point scale based on the participants' agreement with items such as "when I think of COVID-19, I'm afraid," "annoyed," "worried," and "nervous," referring to the measurement method of appraisal theory (Shen & Dillard, 2007). The internal consistency of the items was found to be reliable (M = 3.92, SD = 0.75, α = 0.81).

Information insufficiency was defined as "the amount of information that was considered necessary to cope with risk" with reference to an existing study (Griffin et al., 1999). In this study, a method of measuring the amount of information the individuals thought they needed alone (Seo, 2016) was used. Based on the information the participants had, they were asked to rate how much more information they required on an 11-point scale (0 = I know all about COVID-19, I need no more information; 11 = I need a lot of information about COVID-19; M = 7.86, SD = 1.89).

Among the methods of processing risk information, *systematic processing* was defined as the level of processing COVID-19 information with cognitive effort based on the RISP model studies (Huh & Kim, 2015; Yang et al., 2014). The participants were asked to answer the four items regarding their attitude on receiving COVID-19 information, such as "I found myself making connections between the story and what I've read or heard about elsewhere," on a five-point Likert scale (M = 3.89, SD = 0.62, α = 0.80).

Heuristic processing was defined as the level at which information was processed limitlessly, with little cognitive effort (Kim, 2019; Yang et al., 2014). The participants were asked to answer three items regarding their attitude on receiving COVID-19 information, such as "I skimmed through the story," on a five-point Likert scale. The reliability of the items was adequate (M = 2.61, SD = 0.96, α = 0.86).

Preventive intention was defined as the degree to which one intended to take action to prevent COVID-19. By referring to the action guidelines provided by the Korea Centers for Disease Control and Prevention, three items, such as "I wear a mask when going out," were scored on a five-point Likert scale. The reliability of the items was adequate (M = 4.36, SD = 0.64, α = 0.77).

As the control variable, the individual *COVID-19 experience level* was measured by using a single item, "Have you ever been diagnosed with COVID-19?" Few people had received a COVID-19 diagnosis, accounting for 0.8% (n = 12). During the survey period, the cumulative number of confirmed cases in South Korea was 19,947 (as of August 31, 2020), which was a relatively small number.

Measurement Model Analysis

The statistical package AMOS 20.0 was used to examine the structural equation, and the maximum likelihood estimation method was used for estimation. Specifically, the two-step approach of Anderson and Gerbing (1988) was employed to investigate the suitability of concept composition by verifying the measurement model and then identifying the relationship between all variables through structural model analysis. To determine the multivariate normal distribution, the skewness and kurtosis of the variables

included in the model were assessed, indicating that the distribution was normal as it did not exceed the general criteria: skewness = 2.0 and kurtosis = 3.0 (Kline, 2011).

Next, the discriminant validity of each variable was examined. In Table 1, the bold numbers show the average variance extracted (AVE) value for each variable, and the rest of the column shows the square value of the correlation coefficient between the variables. The AVE value of each variable was higher than the square value of the correlation coefficient with other variables, ensuring discriminant validity.

Table 1. Results of Discriminant Validity (N = 1,500).

		1	2	3	4	5	C.R.
1.	Risk Perception	**0.70**					0.9
2.	Affective Response	0.26	**0.57**				0.83
3.	Systematic Processing	0.12	0.12	**0.62**			0.87
4.	Heuristic Processing	0.04	0.02	0.11	**0.64**		0.84
5.	Preventive Intention	0.14	0.11	0.18	0.12	**0.66**	0.85

Note. Each cell is the squared value of the correlation, and the bold numbers are the AVE values.

For an accurate model analysis, confirmatory factor analysis (CFA) was first performed to confirm factor loading, model validity, and reliability. Indices for measuring the fit of the structural equation model include absolute fit measures, such as the chi-square statistic and root mean square error of approximation (*RMSEA*), and incremental fit measures, such as normed fit index (*NFI*) and comparative fit index (*CFI*). As for chi-square, the model is considered suitable when the *p* value is 0.05 or greater, but it is used as a reference for research results, as it is highly sensitive to the degree of freedom (Bentler & Bonett, 1980; Huh & Kim, 2015). It is considered suitable when *RMSEA* is between 0.05 and 0.08, and *NFI* and *CFI* are closer to 1 (Huh, 2013). After the CFA, $\chi^2[138] = 712.68$, $p < 0.001$, *CFI* = 0.95, *NFI* = 0.94, and *RMSEA* = 0.05, indicating that the model was acceptable to be used for the analysis. Table 2 exhibits correlations between variables.

Table 2. Correlations Between Key Variables (N = 1,500).

		1	2	3	4	5
1.	Risk Perception	1				
2.	Affective Response	0.51^{**}	1			
3.	Information Insufficiency	0.31^{**}	0.30^{**}	1		
4.	Systematic Processing	0.35^{**}	0.34^{**}	0.31^{**}	1	
5.	Heuristic Processing	0.20^{**}	-0.14^{**}	-0.15^{**}	-0.33^{**}	1
6.	Preventive Intention	0.37^{**}	0.33^{**}	0.24^{**}	0.43^{**}	-0.35^{**}

$^{**}p < 0.01$

Results

Hypotheses Testing

Verification using a structural equation model was performed on the proposed model to test the hypotheses. The fit of the research model was found to be satisfactory ($\chi^2[224] = 1202.63$, $p < 0.001$, *CFI* = 0.92, *NFI* = 0.91, *IFI* = 0.92, *RMSEA* = 0.05). Table 3 and Figure 2 summarize the analysis results of the model.

Table 3. Results of Path Analysis (N = 1,500).

	Path	*B*	*S.E.*	*t*
H1a	Risk Perception → Affective Response	0.60***	0.03	14.8
H1b	Risk Perception → Insufficiency	0.22***	0.10	6.1
H2a	Affective Response → Insufficiency	0.20***	0.15	5.4
H2b	Affective Response → Systematic Processing	0.38***	0.04	10.4
H2c	Affective Response → Heuristic Processing	−0.18***	0.06	−5.4
H3a	Insufficiency → Systematic Processing	0.22***	0.01	7.7
H3b	Insufficiency → Heuristic Processing	−0.10***	0.06	−5.4
H4	Systematic Processing → Preventive Intention	0.45***	0.03	13.5
RQ	Heuristic Processing → Preventive Intention	−0.27***	0.02	−9.1

***$p < 0.001$

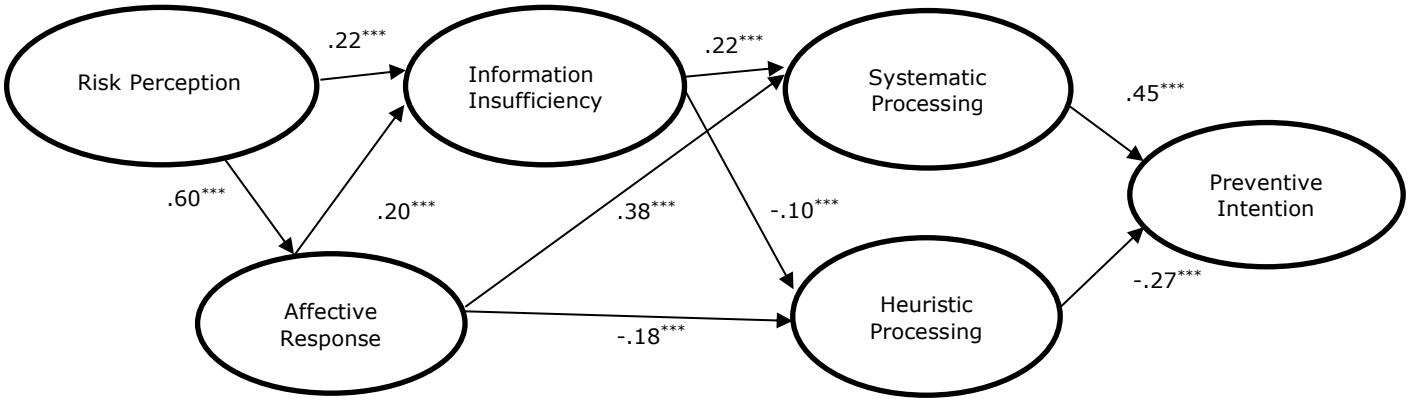

Figure 2. Results of structural equation model.

Note. ***p < 0.001.

The analysis demonstrates that the research model proposed for the risk perception of COVID-19 was generally suitable, as shown in Table 3 and Figure 2. For each hypothesis, the COVID-19 risk perception significantly affected negative affective responses, which corresponded to the psychological motives of feeling information insufficiency ($\beta = 0.60$, $p < 0.001$). Thus, the more the participants perceived COVID-

19 as dangerous, the stronger the negative affective responses, such as anxiety and nervousness, appeared, thereby supporting H1a. Moreover, the participants discerned greater information insufficiency when their perceived COVID-19 risk was higher ($\beta = 0.22$, $p < 0.001$), thus supporting H1b.

The negative affective response acted as a crucial variable in the model. First, negative affective responses affected information insufficiency ($\beta = 0.20$, $p < 0.001$). The same pattern was observed in most RISP studies. Negative affective responses also had a significantly positive effect on systematic processing ($\beta = 0.38$, $p < 0.001$). As the participants felt more anxious or nervous about the risk, they tended to invest more focus and cognitive effort into processing the information. Conversely, negative affective responses negatively affected heuristic processing, which involved processing information superficially ($\beta = -0.18$, $p < 0.001$). This indicated a negative correlation between resolving negative affective responses and heuristic processing. Therefore, H2a, H2b, and H2c on the role of negative affective response were supported.

Information insufficiency positively affected systematic information processing ($\beta = 0.22$, $p < 0.001$) and negatively affected heuristic information processing ($\beta = -0.10$, $p < 0.001$). This finding is in line with the results of previous studies indicating that a higher perceived risk information insufficiency led to an increase in the tendency to perform systematic processing. Similar to the results of the previous studies, a higher perceived information insufficiency for the risk led to an increased tendency to perform systematic processing. Therefore, H3a and Hb were supported.

As a result of examining the preventive intention of the expanded RISP model, a positive correlation between systematic processing and preventive behavioral intention was identified ($\beta = 0.45$, $p < 0.001$). The more elaborately the risk-related information is processed with cognitive effort, the greater the willingness to act on addressing the risk, thus supporting H4. For the RQ, the effect of heuristic processing on behavioral intention was examined. The results indicated that heuristic processing negatively affected risk-prevention behavior ($\beta = -0.27$, $p < 0.001$). Thus, when risk-related information was processed carelessly or without much attention, it negatively influenced active preventive behavioral intention.

Indirect Effect Testing

In this study, the final dependent variable was an individual's behavior, such as the health screening intention. To specifically examine the relationship between the added behavioral intention and the existing variables, we also investigated the indirect effects. Using a bootstrapping analysis to estimate the indirect effect (bootstrapping $N = 5{,}000$), we found that each variable significantly affected behavioral intention, as shown in Table 4. All the indirect effect paths (mediating effect paths) were statistically significant.

Table 4. Results of Indirect Effects (N = 1,500).

Path			Direct	Indirect	Total
Risk Perception	→	Insufficiency	0.22^{***}	0.12^{***}	0.34^{***}
		Systematic Processing	-	0.30^{***}	0.30^{***}
		Heuristic Processing	-	-0.14^{***}	-0.14^{***}
		Preventive Intention	-	0.17^{***}	0.17^{***}
Affective Response	→	Systematic Processing	0.38^{***}	0.04^{***}	0.42^{***}
		Heuristic Processing	-0.18^{***}	-0.02^{**}	-20^{***}
		Preventive Intention	-	0.24^{***}	0.24^{***}
Insufficiency	→	Preventive Intention	-	0.13^{***}	0.13^{***}

$^{**}p < 0.01$, $^{***}p < 0.001$

Discussion

This study aimed to examine how the risk perception of COVID-19 led to the intention to take preventive actions. Specifically, the study intended to separate the information processing mode into systematic and heuristic processing and examine their roles amid COVID-19. The initial situation of COVID-19 coincides with the objective of this study, which is to investigate information processing in the absence of reliable information.

The results suggested that the RISP model could be applied to the new infectious disease, COVID-19. Given that the model fit was acceptable, the verification of the overall model was significant. Specifically, the risk perception of COVID-19 evoked negative affective responses, such as fear and nervousness. In addition, the higher the risk perception, the higher the perception that the relevant information was insufficient. Negative affective responses led to information insufficiency, a psychological motivating factor for information processing. The negative affective responses thus had a direct positive effect on systematic processing while yielding a negative influence on heuristic processing.

With increasing awareness of information insufficiency, the tendency for systematic processing intensified. With a decrease in the awareness of information insufficiency, the tendency for heuristic processing increased. In our study, an extended model that included risk-preventive intentions as a result of information processing was adopted. The results revealed that a high level of preventive behavioral intention was observed when systematic processing, which involved cognitive effort into information processing, was performed. Contrarily, an increase in heuristic processing led to an increase in the tendency to refrain from taking preventive behaviors against COVID-19, such as refraining from visiting multiple places or wearing a mask in public.

The key implications of our findings are as follows. First, in this study, the effect of heuristic information processing on risk-preventive intention was examined. The results showed that systematic processing increased risk-prevention intention. Contrastingly, heuristic information processing lowered risk-prevention intent. As noted by Todorov et al. (2002), heuristic information processing minimizes individuals' cognitive efforts and leads them to process information superficially. Such mode of processing is activated

when there is low motivation or when an environment for processing information is insufficient. As witnessed in the initial stages of COVID-19, when a new infectious disease emerges, people tend to engage in heuristic processing mode due to the environment where lack of risk information exists and inaccurate or fake information overflows. Finding the negative relationship between heuristic information processing and preventive intent is alarming, given that the early stages of new infectious diseases by nature create an environment in which heuristic processing is likely to occur for people.

In this regard, Trumbo (1999) explained that heuristic processing of risk information would lead to lowered risk perception. As less cognitive effort is taken to superficially process information, the risk is not taken seriously, and the willingness to take preventive action is reduced. As we found the negative effect of heuristic information processing on preventive action, future studies about COVID-19 should investigate and confirm such an effect. Ku et al. (2020) reported the negative relationship between heuristic information processing and behavioral intention in previous studies on risk perception of particulate matters. Given that the negative relationship between heuristic processing and behavioral intention was repeated even when the research topic was different, this reaffirms the need to carefully examine this pathway.

The negative relationship between heuristic processing and behavioral intention is more noteworthy when referring to the research results of Kim, Ahn, Atkinson, and Kahlor (2020). According to this study, when individuals perceive that they know enough about COVID-19, they tend to process information heuristically rather than systematically. Although this study investigated exposure to COVID-19-related misinformation, it confirmed the correlation between information insufficiency and heuristic processing. Based on this and the results of this study, which found the adverse effects of heuristic processing, avoiding heuristic processing when processing COVID-19-related information appears necessary.

This result holds theoretical and practical implications in that it confirms the negative relationship between heuristic processing and behavioral intentions. As suggested by our findings, systematic processing must be induced, as going through heuristic processing can lower one's intention to prevent COVID-19. To foster an environment that activates systematic information processing even in the early stages of new infectious diseases, governments and health institutions should preemptively provide information. Preventing fake news overload and presenting consistent and concise information from experts are imperative.

Second, this study holds theoretical significance in that it analyzed an extended model in which a behavioral variable termed risk-preventive intention was added to the original RISP model. The RISP model could not be free from the "so what" question due to the absence of further explanations after information processing transpires (Lu et al., 2020). To resolve this, studies investigating the consequences of information processing are being conducted (Fischer & Glenk, 2011; Seo, 2016; Yang et al., 2014; Yang, Seo, Rickard, & Harrison, 2015). For example, Seo (2016) identified the relationship between MERS-related information processing and risk-preventive intentions and thoroughly examined how individual behavior changes after processing risk information. The current study is meaningful in that it explored the effect of information processing on preventive intention. Risk-preventive intention showed a significant correlation with all variables constituting the RISP model. Thus, recognizing the severity or vulnerability of COVID-19 results in a positive awareness of actions to prevent COVID-19. Griffin et al. (1999), who initially advocated the RISP model, suggested that the model should ultimately include actual preventive behaviors. This means

that the communication behaviors from risk perception to information processing must have eventually led to the preventive behavioral component described in the theory of planned behavior. Numerous studies underway are applying this in South Korea (Kim, 2019; Ku et al., 2020; Seo, 2016), and this study has revalidated the extended model, including the preventive behavioral intention. Future studies must explore any changes in actual preventive behavior through repeated measures (Lu et al., 2021).

Considering that the COVID-19 preventive behavioral intention was applied to the RISP model, there are practical implications. Although health-related organizations, such as the Ministry of Health and Welfare, are continuing campaigns on individual behaviors to prevent COVID-19, most of the messages focus on information appeals, such as guidance on preventive behaviors. For a more effective campaign, the motivation for systematic processing, such as risk perception and negative affective responses, must be reinforced. Particularly, given that negative emotional responses and heuristic processing demonstrated a negative relationship, utilizing negative emotional responses seems necessary. Thus, this study can serve as a theoretical basis for utilizing the effects of risk perception and negative affective responses in producing messages or contents.

Finally, the direct and indirect effects of negative affective responses among the major variables of the RISP model were identified. In early RISP models, negative responses were mentioned as antecedent variables explaining information insufficiency. Subsequent studies have consistently confirmed that negative affective responses acted as psychological motivators that induced an individual's desire to seek and process information (Griffin et al., 2008; Seo, 2016; Willoughby & Myrick, 2016). Although negative responses, such as anxiety, nervousness, and fear, are considered natural phenomena on recognizing a dangerous situation, these responses must be noted as the key drivers that steer individuals away from danger. Kim (2019) also focused on the emotional effect. Although risk communication research has revealed that affective reactions play a role in increasing engagement, such as arousing attention, researchers have explained that affective responses also directly contribute to increasing behavioral intentions.

Ku et al. (2020) reported that the amplified negative affect regarding particulate matter led to information search and processing without the need to recognize information insufficiency. Similar trends are found in COVID-19 studies (Coifman et al., 2021; Kim, 2022; Li & Zheng, 2022). For instance, Li and Zheng (2022) found that negative affective responses toward COVID-19 led to preventive intention through information search. However, information insufficiency did not mediate the relationship between affective response and information search. Thus, affective responses can instinctively be considered irrational affective reactions or hindrances to making correct judgments, thereby playing a positive role among individuals.

Despite its significant implications, this study has a few limitations. First, although this study was intended to extend the model to risk-preventive behavior, we measured behavioral intentions rather than actual behaviors. To confirm that the preventive behavior was a result of risk perception, negative affective responses, and information processing, performing repeated measures on the same participants was necessary. However, because we used a survey method, we only measured the preventive intention and included it in the model. In the same logical manner, affirming that the intention of preventive action is the result of information processing was difficult. Our research model was formed and tested based on the

models in the previous studies. Our model fit was acceptable after adding new variables. Nonetheless, conducting an experimental study would strengthen the causal relationship suggested in our model.

This study was conducted in South Korea, which is one of the countries that has enforced strict regulations, such as wearing masks indoors and outdoors, limiting the number of people in gatherings, and limiting business hours for restaurants and bars. Thus, some individuals might have developed reactance toward the preventive action. However, we failed to control the participants' existing attitudes toward preventive action, which is a limitation of the study.

Furthermore, this study considered merely one type of risk in testing the extension of the model. For a three-dimensional examination of whether the risk-preventive intention is an appropriate variable for the RISP model, future researchers should explore diverse risks, such as the environment or natural disasters. We focused on examining individual information processing motives, processing behaviors, and preventive behaviors, we did not analyze the variables, such as the subjective bias of information, information source (channel) reliability, and information collection ability recognition. To improve the explanatory power of the extended model, future studies should include all variables proposed by the RISP model.

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