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ABSTRACT

As Southeast Asia has experienced haze crises in recent years, encouraging Singaporeans to take preventive measures against negative health outcomes during haze is a growing concern. This study examines how communication factors (i.e., attention to traditional media and new media, interpersonal discussion, and knowledge) can inform Singaporeans about haze and influence their risk perceptions and intentions to undertake self-protective measures. The web survey of 410 respondents shows that attention to traditional media, attention to new media, interpersonal discussion, knowledge, and risk perception are positively associated with intention to take preventive measures. However, only interpersonal discussion is related to risk perception. Theoretical as well as practical implications of the findings are discussed.

Introduction

Haze pollution is an annual environmental and health problem among people living in Southeast Asian countries such as Indonesia, Malaysia, and Singapore (Forsyth, 2014). It typically occurs in the dry seasons and is caused by winds bringing in tiny dust and smoke particles from forest fires in neighboring Sumatra and Borneo, Indonesia (Alisjahbana, Anderson, Minnemeyer, Stolle, & Sizer, 2014). Since haze contains harmful air pollutants, its occurrence can cause mild to severe health conditions, including nasal congestion, sore throat, and cough, or serious conditions like asthma attacks, bronchitis, and heart attacks (Raffles Medical Group, 2015). Even though the Association of Southeast Asian Nations agreed to implement measures to prevent the forest fires leading to haze, Indonesia is the only country that still used slash-and-burn for farming and caused the regional haze crisis in 2013 (Forsyth, 2014). Until October 2014, after Indonesia ratified the agreement, the next year, Southeast Asian haze crisis occurred again as a result of its farmers' illegal agricultural fires.

In June 2013, Singapore experienced its worst haze pollution as the Pollutant Standards Index tremendously exceeded the hazardous threshold (Gaurav, 2013). In 2015, the haze lasted longer and became even worse (Chan & Leong, 2015). To mitigate the adverse health impacts and increase public awareness of the haze crisis, the Singapore government utilized various communication channels to disseminate updates and provide preventive advisories to the public during the haze. According to the Theory of Planned Behavior, people's perceptions and behavioral intentions are the critical factors affecting their actual behaviors (Ajzen, 1991). As news media

was found to play an important role in informing and shaping people's opinion on little known environmental issues like climate change and global warming (e.g., Adams & Gynnild, 2013; Bickerstaff & Walker, 2001; Östman, 2014), this study examines its shaping power on people's risk perceptions and intentions to take precautionary measures toward haze. Due to the increased new media use for haze communication, this study also gauges whether Singaporean youths' news attention to traditional media (e.g., TV, newspaper, and radio) and new media (e.g., Internet and mobile media) exerts different influences on their risk perception and behavioral actions. Additionally, as past studies identified interpersonal discussion and knowledge as significant factors in molding people's perceptions and galvanizing their actions toward environmental issues (Ho, Liao, & Rosenthal, 2015; Lee, Ho, Chow, Wu, & Yang, 2013), this study examines how they can influence Singaporean youths' perceived haze risk and intention to take preventive measures as well.

Although several studies have investigated the haze pollution in recent years (Betha, Behera, & Balasubramanian, 2014; Zhou et al., 2015), little relevant scholarly research has tackled this issue through risk and communication perspectives. The findings of this study can enhance the understanding of the risk perception of haze and people's intention to take preventive measures by investigating communication-related factors (i.e., attention to traditional media, attention to new media, interpersonal discussion, and knowledge). In addition, due to rapid economic development, urbanization, and motorization, air pollution has been rampant in many countries such as China, the United States, and Indonesia (Forsyth, 2014; Hand et al., 2014; Wang et al., 2015). This haze study can shed light on the understanding of factors affecting people's risk

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perceptions and behavioral intention to take preventive measurements against health effects of air pollution in other contexts. The findings can also help health authorities develop more useful and effective information dissemination strategies to encourage people to engage in preventive measures during environmental crises like haze.

Literature Review

Behavioral Intention

Singaporeans' behavioral intention to take precautionary measures toward haze is the key dependent variable investigated in the current study. According to the Theory of Planned Behavior, "intentions are the indications of how hard people are willing to try, of how much of an effort they are planning to exert, in order to perform the behavior" (Ajzen, 1991, p. 181). The stronger the intention to engage in the behavior, the more its performance (Ajzen, 1991). Extensive research has provided evidence for the relationship between intentions and action with respect to various behaviors such as game playing (Sheppard, Hartwick, & Warshaw, 1988) and voting (Fishbein & Ajzen, 1981). In the public health communication area, prior research has shown that individuals' actual health-related preventive behavior is greatly predicted by their behavioral intentions (Griva, Anagnostopoulos, & Madoglou, 2009; Jones, Courneya, Fairey, & Mackey, 2005; Katapodi, Dodd, Lee, & Facione, 2009). When haze occurs, taking preventive measures (e.g., minimizing outdoor activities and wearing N95 masks) can reduce negative health-related outcomes (Gaurav, 2013; Raffles Medical Group, 2015). Hence, it is vital to investigate the factors related to Singaporeans' intention to take up these protective behaviors.

Risk Perception

Risk perception, which refers to individuals' subjective perception of their probability of facing health issues caused by the haze pollution, is an independent and a dependent variable in this study. In many of the influential health behavior models such as the Health Belief Model (Janz & Becker, 1984) and the Theory of Reasoned Action (Fishbein & Ajzen, 1981), risk perception is posited as a central construct to understand individuals' behavior change. These models suggest that people who recognize that they are at risk are more likely to embrace protective or less risky behaviors compared with their counterparts (Kowalewski, Henson, & Longshore, 1997). To address the critical role of risk perception in behavior change, a substantial amount of research has been done to examine its influence on several health-protective behaviors such as wearing seatbelts (Stasson & Fishbein, 1990), using condoms (Cochran & Peplau, 1991), and undergoing medical screening (Weinstein, 1999). In particular, previous research has shown that perceived risk positively influences people's intentions to adopt protective measures. For instance, women's perceived risk of breast cancer was found to be linked to their intent to take up mammography screening (Katapodi, Lee, Facione, & Dodd, 2004; Lee et al., 2013). Individuals with a greater risk perception were more likely

to have intentions to engage in healthy behaviors such as exercising and quitting smoking (Chew, Palmer, Slonska, & Subbiah, 2002). Since risk perception was found to be a significant antecedent of individuals' behavioral intentions, this study expects that the greater the risk perception of haze is among Singaporeans, the more likely they will adopt preventive measures. As such, hypothesis 1 is proposed as follows:

H1: Risk perception is positively associated with Singaporeans' behavioral intention to take haze-related preventive measures.

Media Attention

Singaporeans' attention toward haze-related news via traditional and new media platforms is an important factor that may influence their risk perception and behavioral intention. Existing literature suggests that news media plays a vital role in informing and shaping public perceptions on little known health and environmental matters (Adams & Gynnild, 2013; Carvalho, 2010; Ho et al., 2015; Östman, 2014; Zhao, Leiserowitz, Maibach, & Roser-Renouf, 2011). The more individuals depend on media to obtain information, the more attention they will pay to the content produced by these media outlets, and thus the more likely their attitudes and behaviors will be reinforced or changed (DeFleur & Ball-Rokeach, 1989; Lin & Lagoe, 2013).

Risk perception encompasses perceived vulnerability and risk assessment based on exposure to risk information (Millstein & Halpern-Felsher, 2002). One potential source of risk information is the news media. A handful of studies in health and environmental communication have found that attention to media news is positively linked with individuals' level of risk perception (Lee et al., 2013; Tchuenche, Dube, Bhunu, & Bauch, 2011; Zhao et al., 2011). For example, Lee et al. (2013) found that Singapore women who have given more attention to breast cancer news on television, in newspapers, and on the Internet tend to indicate a higher level of risk perception. Besides, Zhao et al.'s (2011) study has demonstrated that attention to science and environment news related to higher risk beliefs about global warming. Collectively, these studies have confirmed a positive relationship between individuals' media attention and risk perception, especially when they perceive risk close to them. In addition, recent studies on environmental and health-related issues have shown a positive relationship between media use and behavioral intention. For example, Lin and Lagoe (2013) found that the frequency of seeing, reading, and hearing news related to the H1N1 influenza (swine flu) outbreak via newspapers, TV, and online sources was positively associated with people's intent to have H1N1 vaccination. Similarly, Ho et al. (2015) found that the attention people paid to pro-environmental messages in television and print newspapers positively predicted their green-buying intention.

As the Singapore government utilized different media platforms to provide abundant haze-related news in July 2013, it is reasonable to expect that Singaporeans' media attention

toward haze-related news will increase their perceived risk of haze pollution and behavioral intention to take self-protective measures. More importantly, this study will specifically investigate whether haze-related news attention on traditional media and new media will exert different influences on Singaporean youths' risk perception and behavioral intention. Singapore is a digital-savvy society, where most people, especially youngsters, tend to rely on the Internet and mobile media to get information. One recent study by Lin and Tan (2014) explored the differences of haze-related information on traditional and new media. Their findings show that traditional media mainly delivers informative news from the government and local authorities, while new media channels provide more diverse topics and alternative perspectives. As different media messages may lead to different perceptions and behavioral intentions, it is extremely worthwhile to separately explore the impacts of haze-related media attention on different media platforms. Based on the aforementioned discussion, we postulate the following two hypotheses:

H2: Attention to haze-related news via traditional media is positively associated with Singaporeans' (a) risk perception and (b) behavioral intention to engage in haze-related preventive measures.

H3: Attention to haze-related news via new media is positively associated with Singaporeans' (a) risk perception and (b) behavioral intention to engage in haze-related preventive measures.

Interpersonal Discussion

In the area of health and environmental communication, studies have shown that interpersonal discussion is a critical source for individuals to obtain related information (Baxter, Egbert, & Ho, 2008; Östman, 2014; Yanovitzky & Blitz, 2000). People's assessments about their own risk go through a process of purposeful information-gathering activities, including interpersonal discussions (Coleman, 1993). Through discussions with different agents (e.g., family members, friends, and classmates/colleagues), people's attitudes, beliefs, and behavior are formed. Specifically, extensive empirical research has demonstrated that interpersonal discussion heightens people's perceptions of personal risk (Dunwoody & Neuwirth, 1991; Morton & Duck, 2001). For example, Morton and Duck (2001) found that the increasing interpersonal discussion with others was significantly associated with individuals' higher level of perceived vulnerability toward skin cancer. Lee et al. (2013) found that women's perceived risk was positively affected by their interpersonal discussion with others. Notably, these studies revealed that interpersonal discussion was an influential factor affecting individuals' risk perception. Hence, it is reasonable to propose that Singaporeans' interpersonal discussion about haze-related issues is a significant predictor of their perceived risk toward haze. Past literature suggests that interpersonal discussion can lead to health-related behavioral change as well (Husaini et al., 2001; Valente & Saba, 2001). Husaini et al. (2001) found that

people who frequently discussed breast cancer with friends had a great tendency to go for mammography. Likewise, Valente and Saba's (2001) study revealed a small but significant relationship between interpersonal discussion and condom use intents among women in Bolivia. Recent environmental communication studies shared similar findings. For instance, Östman (2014) found that adolescents' discussions of environmental issues with parents and peers could influence their everyday lives through motivating pro-environmental behavior. Drawing on existing literature, this study argues that interpersonal discussion about haze-related issues will be another imperative influence on Singaporeans' risk perception and intention to take self-protective measures. Therefore, we propose the following hypothesis:

H4: Interpersonal discussion on haze-related issues with others (e.g., family members, friends, and classmates/colleagues) is positively associated with Singaporeans' (a) risk perception and (b) behavioral intention to engage in haze-related preventive measures.

Knowledge

The last predictor examined in this study is haze-related knowledge. Over the past decades, knowledge about health hazards plays a key role in risk communication research because insufficient knowledge may create unnecessary panic and impair protective behavior adoption (Facione, 2002; Viswanath et al., 2006). Knowledge theory, a framework widely employed in the risk perception literature, suggests that individuals' response to risk is conditioned by the level of knowledge they have (Widavsky & Dake, 1990). The greater risk knowledge people have, the more proper risk judgments they will make (Dillard et al., 2011; Fagerlin, Zikmund-Fisher, & Ubel, 2005; Nisbet et al., 2002). For instance, one study on heart disease revealed that people's perceived risk grew when people obtained more knowledge about the threat of heart attack (Radcliffe & Klein, 2002). Similarly, Dillard et al. (2011) found that people with higher risk perception toward breast cancer were more knowledgeable in regard to this health issue. Furthermore, the increased knowledge of certain risks can lead to the adoption of health-protective behaviors (Hornik, 2002). Studies have shown that women's breast cancer–related knowledge (e.g., its causes and the importance of mammography) is positively associated with their intentions to take and maintain medical screening (Gwarzo, Sabitu, & Idris, 2009; Lee et al., 2013; Muthoni & Miller, 2010). Meanwhile, some found that knowledge of HIV/AIDS is important in preventive health behavior as it is closely associated with people's intention to use condoms (e.g., Chen, Stanton, Chen, & Li, 2013; Krahe & Reiss, 1995). Based on the aforementioned discussion, the following hypothesis is posited:

H5: Knowledge about haze is positively associated with Singaporeans' (a) risk perception and (b) behavioral intention to engage in haze-related preventive measures.

Figure 1 shows the research model that examines how potential factors (i.e., attention to traditional media and new
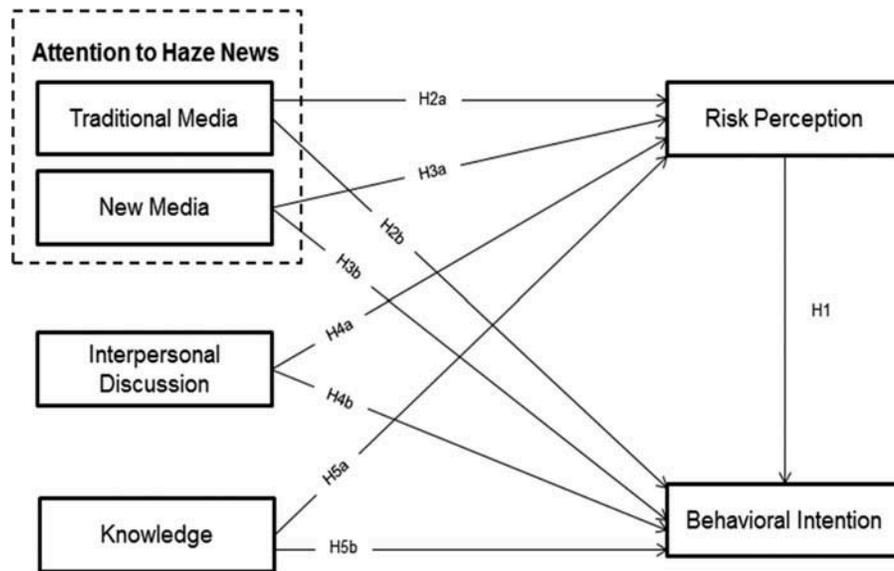
Figure 1. Research model.

media, interpersonal discussion, knowledge) have influences on Singapore youths' haze-related risk perceptions and their intentions to undertake related preventive measures.

Method

Data Collection

This study gathered survey responses from undergraduate students enrolled in a university in Singapore from April to May 2014. A URL link for the English web survey was e-mailed to 2,000 undergraduate students who were selected randomly from a stratified sample based on colleges. To increase the response rate, students who completed the survey with valid answers were given US$8 as an incentive. In total, there were 600 respondents with a response rate of 30%. After data cleaning and filtering out non-smartphone users, the survey yielded 410 valid respondents. Following Westland's (2010) sample size guideline for structural equation modeling (SEM), when a study has at least 88 respondents, it can achieve a statistical power of 80% with a moderate level (0.3) of effect size. Hence, this sample size ($N = 410$) is adequate for data analysis.

In terms of their demographic profile, the average age of the respondents is 22.88 years, and most of them are female (59.3%) and ethnic Chinese (90.3%). With the majority in their third year of study (60.2%), respondents were enrolled mostly in engineering (33.7%), followed by business (21.7%), and humanities and social sciences (20.2%). Using types of housing as an indicator of family economic status (Arias & De Vos, 1996), this study found that 58.9% live in four- to five-room public housing, indicating that most of the respondents were from middle-class families.

Data Analysis

This study utilized partial least squares (PLS) as the main statistical method to test the proposed research model. PLS

is a form of SEM technique originally developed by Wold (1985), which can be used to test multiple variables in a complex research model (Hair, Hult, Ringle, & Sarstedt, 2013). Although popularly used in marketing and business research (Hair, Sarstedt, Ringle, & Mena, 2012), PLS has become a "tool of choice" for multivariate analysis in non-experimental social science studies (Abdi, 2010). PLS is suitable for this study since it adequately handles single-item constructs and survey items measured in 7–10 point scales (Bontis, Booker, & Serenko, 2007). To perform PLS, the data were analyzed using SmartPLS™ 2.0 M3.

Measurements

Measurements for each construct in the study were adapted from previous research and subsequently modified to fit the context of the study (see Appendix 1). To measure the behavioral intention, three items with 10-point Likert scale were adapted from Kahlor (2007). Next, risk perception was measured using five-point Likert scales that were adopted from Krieger and Sarge (2013). Items used to measure attention to haze-related news (traditional and new media sources) were adapted from Lee et al. (2013) and were measured using 10-point Likert scales. For interpersonal discussion, this study utilized items adopted from Ho, Scheufele, and Corley (2010) and was measured using a 10-point Likert scale. To measure the knowledge, we derived five items from the information published by the Singapore Ministry of Health. Respondents were asked to answer each item as either true or false. Each respondent may score between zero and five.

Appendix 1 shows the respective factor loadings of the items. To ensure the fitness of items in the proposed research model, items with factor loadings below 0.70 were removed (Chin, 1998). Consequently, item 6 (*health problems related to the haze would be harmful to my well-being*) of risk perception was removed.

When using PLS for statistical analysis, Henseler, Ringle, and Sinkovics (2009) suggest assessing several validity and

reliability criteria to determine whether the items and constructs used in the study fit the proposed research model. These reference criteria include Cronbach's alpha ($\alpha > 0.70$), composite reliability (CR > 0.70), average variance extracted (AVE > 0.50), and discriminant validity. In addition to mean values, Table 1 shows that all constructs satisfy the recommended values for α, CR, and AVE, thus indicating internal consistency and convergent validity. Moreover, the constructs possess discriminant validity as they fulfill the Fornell–Larcker criterion, where the square root of AVE of each construct was higher than the inter-construct correlations (Hair et al., 2013). Based on the results, the items and constructs fit the proposed model for hypothesis testing.

Results

Figure 2 shows the overall results of the PLS analysis. We found that risk perception was positively associated with behavioral intention ($\beta = 0.17$, $p < 0.001$), indicating that H1 was supported. As for attention to haze-related news via traditional media, we found a positive association with behavioral intention ($\beta = 0.15$, $p < 0.001$), but not with risk perception. Hence, H2b was supported, but H2a was rejected. Attention to haze news via new media was also positively

related to behavioral intention ($\beta = 0.22$, $p < 0.001$), but not to risk perception. The results supported H3b, but rejected H3a. Next, interpersonal discussion of haze was positively associated with risk perception ($\beta = 0.21$, $p < 0.001$) and behavioral intention ($\beta = 0.32$, $p < 0.001$), thus supporting H4a and H4b. Haze-related knowledge was positively associated only with behavioral intention ($\beta = 0.08$, $p < 0.001$), but not with risk perception. As such, the results rejected H5a, but supported H5b. Finally, the factors predicting risk perception and behavioral intention were able to explain 8.4% and 37.4% of the variance respectively.

Discussion

This study found that Singaporean youths' attention toward haze-related news on media platforms (traditional and new media) has a significant association with their behavioral intentions, but not with their perceived risk. Regarding the associations between news attention and behavioral intention, this study found that Singaporean youths' attention toward haze-related news in traditional and new media played crucial roles in shaping their behavioral intentions, similar to prior studies' results (Ho et al., 2015; Östman, 2014). They indicated that disseminating haze-related news information on

Table 1. Mean and validity measures.

					Discriminant validity					
Scale	Mean	α	CR	AVE	1	2	3	4	5	6
1 Knowledge	3.53	—	—	—	—					
2 Traditional media	5.33	0.79	0.87	0.80	—	**0.89**				
3 New media	6.62	0.78	0.90	0.72	—	0.26	**0.85**			
4 Interpersonal	5.68	0.91	0.94	0.64	—	0.36	0.45	**0.80**		
5 Risk perception	3.18	0.85	0.89	0.69	—	0.13	0.20	0.27	**0.83**	
6 Behavioral intention	6.66	0.79	0.88	0.85	—	0.35	0.45	0.52	0.32	**0.92**

Note: α = Cronbach's alpha. CR = composite reliability. AVE = average variance extracted.—= Not applicable. Knowledge and risk perception were measured with 5-point Likert scale, but the rest were measured with 10-point Likert scale. Diagonal elements highlighted in bold are the result of the square root of AVE and should exceed the inter-construct correlations to establish discriminant validity.
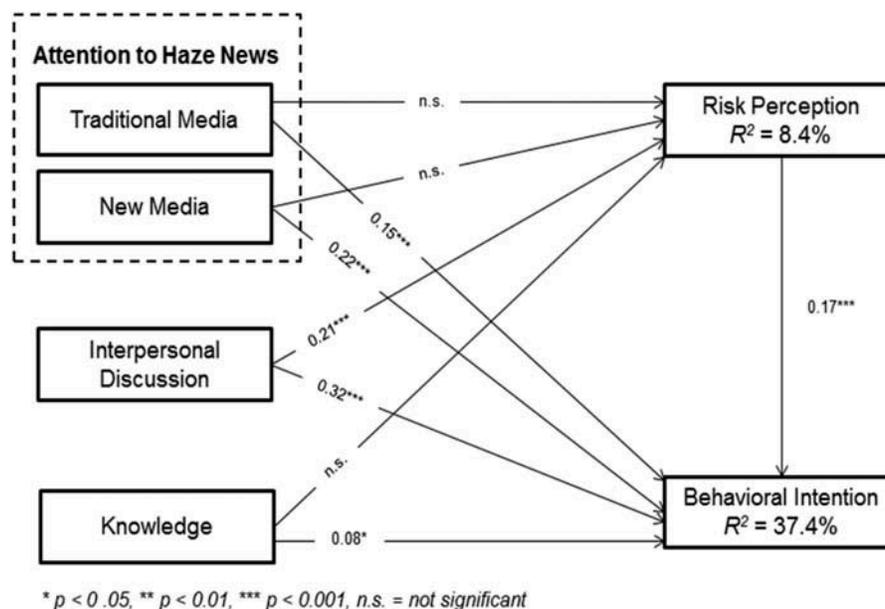

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, n.s. = not significant

Figure 2. PLS analysis results.

mass media (e.g., newspaper, radio, and TV) and on the Internet and mobile platforms could effectively encourage the public to take up protective measures against haze. Importantly, the results also revealed that attention to news on new media platforms exerted greater impacts on behavioral intention than on traditional media. Past studies found that when people perceived greater importance of certain media, that media can have more cognitive, affective, and behavior effects on them (DeFleur & Ball-Rokeach, 1989; Lin & Lagoe, 2013). The result of stronger effects caused by attention to new media's haze-related news can be related to the university student sample, as the younger generation in Singapore consumed more new media content and perceived the information as more important and credible compared with their older counterparts (Lin & Hong, 2015). Hence, this supports why the Internet and mobile news attention exerted greater impact on Singaporean youngsters' behavioral intentions to take preventive measures against haze-related health conditions. It also suggests that, if the Singapore government aims to prompt young people's healthy behaviors toward environmental issues, disseminating relevant news on new media platforms can be effective.

However, contrary to prior studies (Lee et al., 2013; Tchuenche et al., 2011; Zhao et al., 2011), our results did not find significant associations between attention to news on traditional or new media with perceived risk. This is probably because this study measured risk perception of haze at a personal level, namely, the vulnerability felt by the person regarding his or her own risks caused by haze. Haze tends to exert more serious negative impacts on the elderly, pregnant women, children, and patients with chronic diseases. For this study's young and healthy undergraduate students, the haze-related news information they obtained from media was less likely to generate risk perceptions about themselves. Besides, according to the impersonal impact hypothesis, risk perceptions should be divided into social-level and personal-level aspects (Coleman, 1993; Tyler, 1980; Tyler & Cook, 1984). It hypothesizes that mass media influence social risk perceptions predominantly, but tend to have minimal impact on personal risk perceptions. Thus, as we measured risk perception at a personal level, it is unsurprising that we did not find any significant association between old or new media attention to news and personal-level risk perception among young Singaporeans.

Additionally, interpersonal discussion was found to be a key predictor of Singaporeans' risk perception and behavioral intention. This result is consistent with previous studies that found interpersonal discussion having imperative influence on building up risk beliefs and changing intentions (Ho et al., 2015; Morton & Duck, 2001; Nixon & Saphores, 2009; Östman, 2014). When people encounter enormous amounts of health and environmental information each day, it takes time for them to comprehend relevant news and contents as well as their impacts. Interpersonal discussion requires individuals' deeper involvement and effort, compared with paying attention to media news. Discussing with people who are close, such as family, friends, and classmates, about haze issues involves a process of elaboration and reinforcement, which reminds them of and clarifies haze-related problems

and risks as well as preventive measures among Singaporeans. Previous research indicated that the elaboration process can greatly facilitate people's understanding of factual information, which in turn raises issue awareness and promotes desirable behaviors (Ho, Peh, & Soh, 2013; Nenkov, Inman, & Hulland, 2008). Thus, the more Singaporean youths discussed haze-related issues with people close to them, the more likely they felt themselves susceptible to haze-related risks and thus took preventive measures such as wearing masks or staying indoors. Notably, the fact that interpersonal discussion is so effective in raising risk perception and promoting preventive behaviors in Singapore may be related to its unique media ecology as well. Differing from some Western countries, mass media in Singapore are known for strict government control and censorship, and thus people may think that information obtained from interpersonal discussion is more trustworthy and convincing. Hence, for young Singaporeans who tended to be influenced by peers and feel skeptical about media, interpersonal discussion about haze was influential in affecting their risk perceptions.

Next, factual knowledge was found to be positively associated with behavioral intention. This finding is similar to past research, which found that high levels of knowledge about certain health risks increased the intention to take up preventions (Gwarzo et al., 2009; Muthoni & Miller, 2010). As such, if the Singapore government or health authorities aim to encourage Singaporeans to adopt self-protective actions, using different channels to propagate scientific knowledge related to haze might be useful. However, no association was found between knowledge and risk perception. Haze pollution happens almost every year in Singapore in recent years. For most of the residents, they already know a lot about this environmental hazard. Therefore, general knowledge cannot influence their perceived risk of haze.

Lastly, this study found that Singapore residents' perceived risk was significantly related to their behavioral intent to take self-protective measures. This result is in line with most existing health behavior models, such as the Health Belief Model (Janz & Becker, 1984) and the Theory of Reasoned Action (Fishbein & Ajzen, 1981), and research that argue that the more a person believes that he or she is at risk, the greater the likelihood that the person will intend to take preventions (Katapodi et al., 2004; Kowalewski et al., 1997). As such, if health authorities attempt to encourage the public to adopt self-protective behaviors (e.g., wearing N95 masks or reducing outdoor activities) during haze, their health campaigns should focus on increasing people's risk perceptions about haze.

Conclusion

This study found that attention to news in traditional media and new media, interpersonal discussion, and knowledge can play a role in influencing Singaporean youths' intention to take preventive measures toward haze-related health hazards, in addition to validating the influence of interpersonal discussion on the risk perception of haze. There are several theoretical contributions in this study. First, as a pioneering study that examined the haze crisis in Southeast Asia from a risk and health communication perspective, this study contributed to

understanding the haze problem by focusing on how communication factors (e.g., media attention and interpersonal discussion) and knowledge shaped people's perceived risk and behavioral intention to take preventive measures. Second, as haze caused health concerns similar to air pollution issues in other countries like China and India, our findings of the relationships among identified communication, risk, and behavioral intention factors can be utilized to examine similar problems in other contexts. Third, the study expanded traditional media effects research to examine young people's attention to new media (i.e., the Internet and mobile platforms). It found that attention to new media was significantly related to behavioral intention and even more influential than the mass media effect, which emphasizes the importance of examining new media impacts on health or environmental issues in future studies.

As for practical contributions, the findings from this study are especially useful to the Singapore government and its health organizations to understand how potential factors such as attention to traditional and new media news, interpersonal discussion, and knowledge can influence Singaporeans' risk perceptions of haze and their intentions to undertake self-protective measures. This understanding can help health communicators and health authorities to develop effective information dissemination strategies and health campaigns through various channels to engage people to protect themselves more effectively during environmental hazards that cause health problems. For instance, this study found that youths' risk perception and behavioral intention were more likely to be influenced by new media platforms than traditional media. The government and health organizations can utilize new media on the Internet and mobile platforms to disseminate the latest information and knowledge in order to encourage people to take preventive actions to safeguard their health. Also, health message designers should draw lessons from it and design more health messages that are adequate for new media communication in order to obtain more effective outcomes.

However, this study has limitations that should be addressed in future research. First, the model's proposed factors can explain only 8.4% variance in risk perception, indicating a necessity to examine other possible variables such as prior experience with haze pollution or personality traits (e.g., self-efficacy and response efficacy) in future studies to better explain risk perceptions and preventive behavioral intentions toward haze crises or similar health problems. By doing so, the broader scope of research examining behavioral intentions, risk perceptions, and health can be situated within it. Second, the risk perception measurement should include social-level items as haze-like pollution can cause individual and societal health problems. Future studies should improve the measurement so as to get a clear understanding of the relationships between communication factors (e.g., attention to traditional and new media, interpersonal discussion, and knowledge) and perceived risk of haze. Third, when measuring attention to new media, this study asked only two broad questions about the frequency of attention spent on haze-related issues on the Internet and mobile phone. To sort out the influence of various new media (e.g., Facebook and Twitter) and obtain more insights, future studies should improve this measurement by including specific types of new media related to health and environmental communication. Lastly, using a

student sample restricts the result generalizability to other social groups other than young people. Future research can employ a national survey to overcome this limitation.

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References

Abdi, H. (2010). Partial least squares regression and projection on latent structure regression (PLS Regression). *Wiley Interdisciplinary Reviews: Computational Statistics*, 2, 97–106. doi:10.1002/wics.51

Adams, P. C., & Gynnild, A. (2013). Environmental messages in online media: The role of place. *Environmental Communication: A Journal of Nature & Culture*, 7, 113–130. doi:10.1080/17524032.2012.754777

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior & Human Decision Processes*, 50, 179–211. doi:10.1016/0749-5978(91)90020-T

Alisjahbana, A., Anderson, J., Minnemeyer, S., Stolle, F., & Sizer, N. (2014). *Indonesian fires bring more haze to Southeast Asia*. Retrieved from http://www.wri.org/blog/2014/03/indonesian-fires-bring-more-haze-southeast-asia

Arias, E., & De Vos, S. (1996). Using housing items to indicate socioeconomic status: Latin America. *Social Indicators Research*, 38(1), 53–80.

Baxter, L., Egbert, N., & Ho, E. (2008). Everyday health communication experiences of college students. *Journal of American College Health*, 56, 427–436. doi:10.3200/JACH.56.44.427-436

Betha, R., Behera, S. N., & Balasubramanian, R. (2014). 2013 Southeast Asian smoke haze: Fractionation of particulate-bound elements and associated health risk. *Environmental Science & Technology*, 48, 4327–4335. doi:10.1021/es405533d

Bickerstaff, K., & Walker, G. (2001). Public understandings of air pollution: The 'localisation' of environmental risk. *Global Environmental Change*, 11, 133–145. doi:10.1016/S0959-3780(00)00063-7

Bontis, N., Booker, L. D., & Serenko, A. (2007). The mediating effect of organizational reputation on customer loyalty and service recommendation in the banking industry. *Management Decision*, 45, 1426–1445. doi:10.1108/00251740710828681

Carvalho, A. (2010). Media(ted)discourses and climate change: A focus on political subjectivity and (dis)engagement. *Wiley Interdisciplinary Reviews: Climate Change*, 1, 172–179. doi:10.1002/wcc.13

Chan, L., & Leong, W. K. (2015). *Schools to close on Friday due to worsening haze situation: MOE*. Retrieved from http://www.channelnewsasia.com/news/singapore/schools-to-close-on/2147982.html

Chen, X., Stanton, B., Chen, D. G., & Li, X. (2013). Intention to use condom, cusp modeling, and evaluation of an HIV prevention intervention trail. *Nonlinear Dynamics, Psychology, & Life Sciences*, 17, 385–403.

Chew, F., Palmer, S., Slonska, Z., & Subbiah, K. (2002). Enhancing health knowledge, health beliefs, and health behavior in Poland through a health promoting television program series. *Journal of Health Communication*, 7, 179–196. doi:10.1080/10810730290088076

Chin, W. W. (1998). The partial least squares approach to structural equation modeling. *Modern Methods for Business Research*, 295, 295–336.

Cochran, S. D., & Peplau, L. A. (1991). Sexual risk reduction behaviors among young heterosexual adults. *Social Science & Medicine*, 33, 25–36. doi:10.1016/0277-9536(91)90447-K

Coleman, C.-L. (1993). The influence of mass media and interpersonal communication on societal and personal risk judgments. *Communication Research*, 20, 611–628. doi:10.1177/009365093020004006

DeFleur, M., & Ball-Rokeach, S. (1989). Media system dependency theory. In M. DeFleur & S. Ball-Rokeach (Eds.), *Theories of mass communication* (pp. 292–327). New York, NY: Longman.

Dillard, A. J., Ubel, P. A., Smith, D. M., Zikmund-Fisher, B. J., Nair, V., Derry, H. A. … Fagerlin, A. (2011). The distinct role of comparative risk perceptions in a breast cancer prevention program. *Annals of Behavioral Medicine*, 42, 262–268. doi:10.1007/s12160-011-9287-8

Dunwoody, S., & Neuwirth, K. (1991). Coming to terms with the impact of communication of scientific and technological risk judgments. In L. Wilkins & P. Patterson (Eds.), *Risky business: Communicating issues of science, risk and public policy* (pp. 11–30). Westport, CT: Greenwood.

Facione, N. C. (2002). Perceived risk of breast cancer. *Cancer Practice*, 10, 256–261. doi:10.1046/j.1523-5394.2002.105005.x

Fagerlin, A., Zikmund-Fisher, B. J., & Ubel, P. A. (2005). How making a risk estimate can change the feel of that risk: Shifting attitudes toward breast cancer risk in a general public survey. *Patient Education & Counseling*, 57, 294–299. doi:10.1016/j.pec.2004.08.007

Fishbein, M., & Ajzen, I. (1981). Attitudes and voting behavior: An application of the theory of reasoned action. In G. M. Stephenson & J. M. Davis (Eds.), *Progress in applied social psychology* (Vol. 1, pp. 253–313). London, UK: Wiley.

Forsyth, T. (2014). Public concerns about transboundary haze: A comparison of Indonesia, Singapore, and Malaysia. *Global Environmental Change*, 25, 76–86. doi:10.1016/j.gloenvcha.2014.01.013

Gaurav, R. (2013). *Singapore haze bad news for the elderly, people with weak immunity.* Retrieved from http://blogs.wsj.com/searealtime/2013/06/20/singapore-haze-bad-news-for-the-elderly-people-with-weak-immunity/

Griva, F., Anagnostopoulos, F., & Madoglou, S. (2009). Mammography screening and the theory of planned behavior: Suggestions toward an extended model of prediction. *Women & Health*, 49, 662–681. doi:10.1080/03630240903496010

Gwarzo, U. M. D., Sabitu, K., & Idris, S. H. (2009). Knowledge and practice of breast self-examination among female undergraduate students . *Annals of African Medicine*, 8, 8–55. doi:10.4103/1596-3519.55766

Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2013). *A primer on partial least squares structural equation modeling (PLS-SEM).* Thousand Oaks, CA: Sage.

Hair, J. F., Sarstedt, M., Ringle, C. M., & Mena, J. A. (2012). An assessment of the use of partial least squares structural equation modeling in marketing research. *Journal of the Academy of Marketing Science*, 40, 414–433. doi:10.1007/s11747-011-0261-6

Hand, J. L., Schichtel, B. A., Malm, W. C., Copeland, S., Molenar, J. V., Frank, N., & Pitchford, M. (2014). Widespread reductions in haze across the United States from the early 1990s through 2011. *Atmospheric Environment*, 94, 671–679. doi:10.1016/j.atmosenv.2014.05.062

Henseler, J., Ringle, C. M., & Sinkovics, R. R. (2009). The use of partial least squares path modeling in international marketing. *Advances in International Marketing*, 20, 277–319.

Ho, S. S., Liao, Y., & Rosenthal, S. (2015). Applying the Theory of Planned Behavior and media dependency theory: Predictors of public pro-environmental behavioral intentions in Singapore. *Environmental Communication*, 9, 77–99. doi:10.1080/17524032.2014.932819

Ho, S. S., Peh, X., & Soh, V. (2013). The cognitive mediation model: Factors influencing public knowledge of the H1N1 pandemic and intention to take precautionary behaviors. *Journal of Health Communication*, 18, 773–794. doi:10.1080/10810730.2012.743624

Ho, S. S., Scheufele, D. A., & Corley, E. A. (2010). Making sense of policy choices: Understanding the roles of value predispositions, mass media, and cognitive processing in public attitudes toward nanotechnology. *Journal of Nanoparticle Research*, 12, 2703–2715. doi:10.1007/s11051-010-0038-8

Hornik, R. (2002). *Public health communication: Evidence for behavior change.* New York, NY: Lawrence Erlbaum.

Husaini, B. A., Sherkat, D. E., Bragg, R., Levine, R., Emerson, J. S., Mentes, C. M., & Cain, V. A. (2001). Predictors of breast cancer screening in a panel study of African American women. *Women & Health*, 34, 35–51. doi:10.1300/J013v34n03_03

Janz, N. K., & Becker, M. H. (1984). The health belief model: A decade later. *Health Education & Behavior*, 11, 1–47. doi:10.1177/109019818401100101

Jones, L. W., Courneya, K. S., Fairey, A. S., & Mackey, J. R. (2005). Does the theory of planned behavior mediate the effects of an oncologist's recommendation to exercise in newly diagnosed breast cancer survivors? Results from a randomized controlled trial. *Health Psychology*, 24, 189–197. doi:10.1037/0278-6133.24.2.189

Kahlor, L. A. (2007). An augmented risk information seeking model: The case of global warming. *Media Psychology*, 10, 414–435. doi:10.1080/15213260701532971

Katapodi, M. C., Dodd, M. J., Lee, K. A., & Facione, N. C. (2009). Underestimation of breast cancer risk: Influence on screening behavior. *Oncology Nursing Forum*, 36, 306–314. doi:10.1188/09.ONF.306-314

Katapodi, M. C., Lee, K. A., Facione, N. C., & Dodd, M. J. (2004). Predictors of perceived breast cancer risk and the relation between perceived risk and breast cancer screening: A meta-analytic review. *Preventive Medicine*, 38, 388–402. doi:10.1016/j.ypmed.2003.11.012

Kowalewski, M. R., Henson, K. D., & Longshore, D. (1997). Rethinking perceived risk and health behavior: A critical review of HIV prevention research. *Health Education & Behavior*, 24, 313–325. doi:10.1177/109019819702400305

Krahe, B., & Reiss, C. (1995). Predicting intentions of AIDS-preventive behavior among adolescents. *Journal of Applied Social Psychology*, 25, 2118–2140. doi:10.1111/j.1559-1816.1995.tb02391.x

Krieger, J. L., & Sarge, M. A. (2013). A serial mediation model of message framing on intentions to receive the human papillomavirus (HPV) vaccine: Revisiting the role of threat and efficacy perceptions. *Health Communication*, 28, 5–19. doi:10.1080/10410236.2012.734914

Lee, E. W. J., Ho, S. S., Chow, J. K., Wu, Y. Y., & Yang, Z. (2013). Communication and knowledge as motivators: Understanding Singaporean women's perceived risks of breast cancer and intentions to engage in preventive measures. *Journal of Risk Research*, 16, 879–902. doi:10.1080/13669877.2012.761264

Lin, C. A., & Lagoe, C. (2013). Effects of news media and interpersonal interactions on H1N1 risk perception and vaccination intent. *Communication Research Reports*, 30, 127–136. doi:10.1080/08824096.2012.762907

Lin, T. T. C., & Hong, A. H. (2015). Different but not that different: New media's impact on young voters' political participation. In T. H. Tan, A. Mahizhnan, & P. H. Ang (Eds.), *Battle for hearts and minds: New media and elections in Singapore* (pp. 121–142). Toh Tuck Link, Singapore: World Scientific Publishing..

Lin, T. T. C., & Tan, H. J. S. (2014, March). *Public opinions about haze crisis in Singapore: Traditional media news vs. new media voices.* Paper presented at the International Conference on Media Impact and Public Opinion Representation, Taipei, Taiwan.

Millstein, S. G., & Halpern-Felsher, B. L. (2002). Judgments about risk and perceived invulnerability in adolescents and young adults. *Journal of Research on Adolescence*, 12, 399–422. doi:10.1111/1532-7795.00039

Morton, T. A., & Duck, J. M. (2001). Communication and health beliefs: Mass and interpersonal influences on perceptions of risk to self and others. *Communication Research*, 28, 602–626. doi:10.1177/009365001028005002

Muthoni, A., & Miller, A. N. (2010). An exploration of rural and urban Kenyan women's knowledge and attitudes regarding breast cancer and breast cancer early detection measures. *Health Care for Women International*, 31, 801–816. doi:10.1080/07399331003628453

Nenkov, G. Y., Inman, J. J., & Hulland, J. (2008). Considering the future: The conceptualization and measurement of elaboration on potential outcomes. *Journal of Consumer Research*, 35, 126–141. doi:10.1086/525504

Nisbet, M. C., Scheufele, D. A., Shanahan, J., Moy, P., Brossard, D., & Lewenstein, B. V. (2002). Knowledge, reservations, or promise?: A media effects model for public perceptions of science and technology. *Communication Research*, 29, 584–608. doi:10.1177/009365002236196

Nixon, H., & Saphores, J.-D. M. (2009). Information and the decision to recycle: Results from a survey of US households. *Journal of Environmental Planning & Management*, 52, 257–277. doi:10.1080/09640560802666610

Östman, J. (2014). The influence of media use on environmental engagement: A political socialization approach. *Environmental Communication, 8*, 92–109. doi:10.1080/17524032.2013.846271

Radcliffe, N. M., & Klein, W. M. (2002). Dispositional, unrealistic, and comparative optimism: Differential relations with the knowledge and processing of risk information and beliefs about personal risk. *Personality & Social Psychology Bulletin, 28*, 836–846. doi:10.1177/0146167202289012

Raffles Medical Group. (2015). *Health advisory on haze.* Retrieved from https://www.rafflesmedicalgroup.com/docs/default-source/health-advisories/rmg-haze-advisory-v1-0915web.pdf?sfvrsn=2

Sheppard, B. H., Hartwick, J., & Warshaw, P. R. (1988). The theory of reasoned action: A meta-analysis of past research with recommendations for modifications and future research. *Journal of Consumer Research, 15*, 325–343. doi:10.1086/jcr.1988.15.issue-3

Stasson, M., & Fishbein, M. (1990). The relation between perceived risk and preventive action: A within-subject analysis of perceived driving risk and intentions to wear seatbelts. *Journal of Applied Social Psychology, 20*, 1541–1557. doi:10.1111/j.1559-1816.1990.tb01492.x

Tchuenche, J. M., Dube, N., Bhunu, C. P., & Bauch, C. T. (2011). The impact of media coverage on the transmission dynamics of human influenza. *BMC Public Health, 11*, S5. doi:10.1186/1471-2458-11-S1-S5

Tyler, T. R. (1980). Impact of directly and indirectly experienced events: The origin of crime-related judgments and behaviors. *Journal of Personality & Social Psychology, 39*, 13–28. doi:10.1037/0022-3514.39.1.13

Tyler, T. R., & Cook, F. L. (1984). The mass media and judgments of risk: Distinguishing impact on personal and societal level judgments. *Journal of Personality & Social Psychology, 47*, 693–708. doi:10.1037/0022-3514.47.4.693

Valente, T. W., & Saba, W. P. (2001). Campaign exposure and interpersonal communication as factors in contraceptive use in Bolivia. *Journal of Health Communication, 6*, 303–322. doi:10.1080/108107301317140805

Viswanath, K., Breen, N., Meissner, H., Moser, R. P., Hesse, B., Steele, W. R., & Rakowski, W. (2006). Cancer knowledge and disparities in the information age. *Journal of Health Communication, 11*, 1–17. doi:10.1080/10810730600637426

Wang, Q., Zhuang, G., Huang, K., Liu, T., Deng, C., Xu, J. … Chen, J. (2015). Probing the severe haze pollution in three typical regions of China: Characteristics, sources and regional impacts. *Atmospheric Environment, 120*, 76–88. doi:10.1016/j.atmosenv.2015.08.076

Weinstein, N. D. (1999). What does it mean to understand a risk? Evaluating risk comprehension. *JNCI Monographs, 1999*, 15–20. doi:10.1093/oxfordjournals.jncimonographs.a024192

Westland, J. C. (2010). Lower bounds on sample size in structural equation modeling. *Electronic Commerce Research & Applications, 9*, 476–487. doi:10.1016/j.elerap.2010.07.003

Widavsky, A., & Dake, K. (1990). Theories of risk perception: Who fears what and why? *Daedalus, 119*, 41–50.

Wold, H. (1985). Partial Least Squares. In S. Kotz & N. L. Johnson (Eds.), *Encyclopedia of statistical sciences* (pp. 581–591). New York, NY: Wiley.

Yanovitzky, I., & Blitz, C. L. (2000). Effect of media coverage and physician advice on utilization of breast cancer screening by women 40 years and older. *Journal of Health Communication, 5*, 117–134. doi:10.1080/108107300406857

Zhao, X., Leiserowitz, A. A., Maibach, E. W., & Roser-Renouf, C. (2011). Attention to science/environment news positively predicts and attention to political news negatively predicts global warming risk perceptions and policy support. *Journal of Communication, 61*, 713–731. doi:10.1111/j.1460-2466.2011.01563.x

Zhou, J., Chen, A., Cao, Q., Yang, B., Chang, V. W.-C., & Nazaroff, W. W. (2015). Particle exposure during the 2013 haze in Singapore: Importance of the built environment. *Building and Environment, 93*, 14–23. doi:10.1016/j.buildenv.2015.04.029

Appendix 1.
Survey items

	Factor Loadings
Knowledge (1 = true, 0 = false)	
1 The Pollutant Standards Index of 101 and above is deemed unhealthy. (TRUE)	-
2 Haze particles may cause healthy people's irritation of the eyes, nose, or throat, which can't be resolved on its own. (FALSE)	-
3 N95 masks do not provide good protection against the haze. (FALSE)	-
4 Drinking plenty of water is one way to protect you being affected by haze. (TRUE)	-
5 There may be up to 1–3 day time lag between exposure to haze and health effects/symptoms. (TRUE)	-
Haze News Sources—Traditional Media (1 = no attention at all, 10 = very close attention)	
1 How much attention do you pay to news stories related to haze on TV?	0.90
2 How much attention do you pay to news stories related to haze on newspaper?	0.87
3 How much attention do you pay to news stories related to haze on radio?	0.74
Haze News Sources—New Media (1 = no attention at all, 10 = very close attention)	
1 How much attention you pay to news stories related to haze on Internet via desktop/laptop?	0.92
2 How much attention you pay to news stories related to haze on mobile phone?	0.89
Interpersonal Discussion (1 = least frequent, 10 = most frequent)	
1 How frequently do you discuss issues related to haze with family members?	0.92
2 How frequently do you discuss issues related to haze with friends?	0.94
3 How frequently do you discuss issues related to haze with classmates/colleagues?	0.91
Risk Perception (1 = strongly disagree, 5 = strongly agree)	
1 I am at high risk for getting health problems from haze.	0.77
2 It is likely that I will get health problems from haze.	0.82
3 There is a high chance that I will get health problems from haze.	0.83
4 If I were to get health problems related to the haze, it would be a very serious threat to my quality of life.	0.75
5 If I were to get health problems related to the haze, it would be a very severe threat to my health.	0.77
6 Health problems related to the haze would be harmful to my well-being.	Dropped
Behavioral Intention (1 = least likely, 10 = most likely)	
1 I intend to limit heavy outdoor activities in future during haze.	0.78
2 I intend to wear a face mask outside in future during haze.	0.87
3 I intend to seek more health information related to the haze in future.	0.87