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Communication, Cognitive Processing, and Public Knowledge About Climate Change

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Abstract

This study advances the cognitive mediation model (CMM) by examining the factors behind acquiring knowledge about climate change. Based on a nationally representative survey of Singaporeans (N = 1,083), this study supported the original CMM. The extended CMM showed that surveillance gratification was positively associated with traditional and online media attention, while social utility was positively associated with online media attention. While attentions to traditional and online media were positively associated with elaboration, online media attention was positively associated with selective scanning. Elaboration was positively associated with knowledge. Implications for theory and practice were discussed.

Keywords: Cognitive mediation model; traditional media; online media; information processing; motivation

Communication, Cognitive Processing, and Public Knowledge About Climate Change

Climate change is a major, overriding environmental issue of our time, with far-reaching consequences for global health, the food supply, and the ecosystem (Intergovernmental Panel on Climate Change [IPCC], 2014). Evidence showed that human activities such as deforestation and destruction of fossil fuels caused an increase in concentrations of greenhouse gases in the atmosphere and a rise in temperature (Rubenstein, 2010). Singapore, a city-state in Southeast Asia, is highly vulnerable to the effects of climate change. As the island nation has almost zero elevation, it faces the danger of rising sea levels (National Climate Change Secretariat [NCCS], 2013). The Singapore government has publicly attributed the unusual and repeated episodes of flash floods and heavy rains to climate change (Ismail, 2011). Other dangers of climate change in Singapore include the loss of water resources, higher rate of recurrence of the annual haze, and resurgence of tropical diseases (NCCS, 2013).

The media plays an important role in disseminating information and shaping beliefs about climate change (Eveland & Cooper, 2013). Due to an emphasis on balanced reporting in countries such as the U.S., competing views of climate change are often highlighted, regardless of whether or not they have equal scientific weight (Casper, 2010). This gives rise to an informational bias that diverges from scientific consensus (Boykoff & Boykoff, 2004). Climate change deniers therefore receive a good deal of airtime in the news media, despite the scientific weaknesses of their claims (Hoffman, 2011). This has resulted in widespread confusion and uncertainty among the public in the U.S. regarding the nature of climate change.

Unlike the U.S. that is characterized by partizan and polarized news mediums, the government largely controls the media in Singapore (Starr, 2010; Wong, 2004). Economic concerns of businesses that thrive on carbon use are paramount to the considerations of the

Singapore government, and any climate change policy cannot be allowed to threaten the economy (Choon, 2011). Singapore therefore does not have the numerous diverse, dissenting voices in the media that is prevalent in the U.S. What people know about climate change can influence their own behavior (Chew, Palmer, Slonska, & Subbioh, 2002), as well as the support they give to public policies that address the issue, such as mandatory industry standards against emissions (Leiserowitz, 2005). Given the unique cultural setting and media landscape, it is worthwhile to assess how factors such as Singaporeans' media attention and cognitive processes can be associated with their knowledge about climate change.

The original CMM was tested in the traditional media environment (Eveland, 2001). With the expansion in online media information sources, people are increasingly turning to online media platforms for information. In particular, online media is becoming an important information source for the public to get information about science topics (Runge et al., 2013). Meanwhile, scientists are increasingly producing and disseminating their research findings to the lay audience on social media (Brossard & Scheufele, 2013).

Moreover, the governments and relevant authorities are employing online media to disseminate information on science topics. For example, the National Climate Change Secretariat (NCCS) in Singapore has established a dedicated website to cultivate public understanding of climate change. Additionally, the non-governmental environmental groups in Singapore are increasingly turning to online media to voice their concerns of climate change and encourage public engagement with climate change. For example, ECO Singapore, which is a non-governmental youth environmental social enterprise, has launched its own Facebook webpage to promote youth engagement in sustainability, and to educate youth to engage with key environmental issues, such as climate change. Furthermore, those online campaigns and activities initiated by the non-governmental green groups were found to be effective in promoting public engagement with environmental issues (Cukier & Middleton,

2003; Shirky, 2008). A study that explored the web presence of environmental non-profit organizations reported that the adaptation of new media had enabled the green groups to expand their grassroots mobilization, and provided the non-governmental organizations with opportunities to directly reach out to the prospective members (Greenberg & MacAulay, 2009). Thus, this study proposes to examine the effects of online media, in addition to traditional media, in informing public understanding of climate change.

This study applies the cognitive mediation model (Eveland, 2001) to examine how communication and cognitive processes can potentially mediate the relationships between various motivations and public levels of factual knowledge with regard to climate change. Researchers have tested the CMM in the contexts of personal risks (e.g. health issues; Ho, Peh, & Soh, 2013), but not in the contexts of impersonal risks such as climate change. Theoretically, we aim to advance the cognitive mediation model (CMM) in three ways: (1) by replicating the original model to examine the extent to which it can be generalized to the impersonal risk context of climate change; (2) by examining the role of attention to online media, in addition to attention to traditional media in the model; and (3) by testing selective scanning as a new mediating information processing strategy into the model. Practically, our findings could be used to understand how knowledge about climate change is learnt and inform policymakers on ways to facilitate this learning. We will first discuss the original CMM and its various hypotheses, followed by the rationale behind the extended CMM.

The Cognitive Mediation Model

The CMM (Eveland, 2001) posits that learning from the news takes place when individuals are motivated to do so, starting from a process in which self-imposed learning motivations encourage individuals to process news information, which in turn determines the amount of knowledge that individuals will acquire. Experiments have shown that people's motivations drive knowledge gain, and those who pay attention to and engage in elaborative

processing of media messages tend to acquire knowledge (Cowan, 1993).

In Eveland's (2001) original model, surveillance gratification was the strongest motivation of news media use in determining individuals' learning from the news. Surveillance gratification refers to individuals' desire to gain information about their environment (Payne, 1988). This knowledge about individuals' environment can add to their sense of security, provide advice about practical matters, and satisfy their curiosity and interest in world events (McQuail, 1983). Those who view news with a surveillance gratification objective learn more than those who do so for entertainment (McLeod & McDonald, 1985). Notably, surveillance motives have been shown to be associated with attention to news across various mediums (Vincent & Basil, 1997).

Media attention is defined as the focus of mental effort on a subject matter in the media (Chaffee & Schleuder, 1986). In the original CMM, media attention shapes knowledge by making information available for processing in individuals' mind (Eveland, 2001). It is reasonable to assume that if something escapes individuals' attention, then no conscious elaborative processing and learning can take place, and therefore, attention is an important condition for learning (Rigney, 1978). News attention can enhance public learning in various contexts (Chaffee & Schleuder, 1986).

Engaging in elaboration is the next step after having attended to new information. Eveland (2001) defined elaboration as 'the process of connecting new information with other pieces of information store in memory, including prior knowledge, personal experiences, or the connection of two new bits of information together in new ways' (p. 573). Individuals can compare mediated information with their past experiences, place the information in an organizational structure, and find ways to apply the information (Eveland, 2002). Studies have shown that elaboration is positively associated with knowledge level (e.g. Ho, Scheufele, & Corley, 2013).

In CMM, Eveland (2001) found that surveillance gratifications motivation is associated with attention and elaboration, resulting in learning. Likewise, other studies provided empirical support for the CMM in the context of political communication (Beaudoin & Thorson, 2004; Lo & Chang, 2006). In this study, the original CMM that comprises the relationships among surveillance gratifications, media attention, elaboration, and knowledge will be examined, to test the applicability of the model to the context of climate change in Singapore. We posit the following research question:

RQ1: To what extent is the CMM applicable to the context of climate change?

Extending the CMM

Linking motivations with attention to traditional media and online media

The uses and gratifications paradigm point to a number of motivations that can drive media use, including diversion or entertainment, personal identity affirmation, the need for cognition, guidance, and self-efficacy (Beaudoin & Thorson, 2004; McQuail, 1983). Many scholars who have examined gratifications for the use of news media in information seeking have found that surveillance gratification motivation and social utility function are the most relevant in explaining variations in learning (David, 2009; Rubin & Perse, 1987). Moreover, Eveland (2001) noted that the CMM would benefit from the testing of additional motivational variables beyond surveillance gratification that would further extend the applicability of the model. Thus, in addition to surveillance gratifications motivation, social utility motivation will be examined in our study.

Social utility motivation refers to the purpose of gaining information for use in conversations with others, so as to connect interpersonally with family and friends (Eveland, 2004). Social utility was positively associated with news attention and news elaboration (Beaudoin & Thorson, 2004). Levine and Russo (1995) found that subjects preparing to defend their stance on a controversial issue among a group of people tend to acquire more

information to support their viewpoint. In the process of carefully attending to news about current affairs, individuals might put in mental effort to consider which points they would want to raise for discussion, or marshal arguments to support their position. The expected conversation need not take place, for the learning has already occurred in anticipation.

In the last decade, online media in general and social media in particular, have risen in popularity (Pew Research Center, 2011). Generally, online media has become an important provider of daily information to the general public in addition to traditional media. The effects of traditional media (e.g. newspaper, television) have been extensively examined in past studies on CMM, whereas few studies have shed lights on online media. Moreover, Eveland (2001) suggested that future studies should be extended to examine how attention to different news mediums can influence information processing and knowledge gain. Thus, in extending the CMM model, we will examine how traditional and online media will mediate the relationships between motivation, information processing, and knowledge.

In particular, the uses and gratifications studies have highlighted that the specific function of online media could largely gratify users' surveillance needs and social utility needs (Kaye & Johnson, 2002; Whiting & Williams, 2013). Unlike traditional media, online media increase individuals' access to a large volume of information in an active manner. Online media users are more goal-directed and more aware of the needs that they are attempting to satisfy (Lin & Jeffres, 1998). For example, while individuals can gratify television needs by simply switching on the program and clicking the remote control, the search engines in online media platforms enable individuals to actively search for information. Moreover, the wide range of information available on online media has made it easier for people to find information about the world around them and gain information for use in conversations with others. Additionally, the interactive feature of online media does not only enable users to engage in online discussions, but also increase individuals'

opportunities to engage in offline discussions. For example, people can first learn about hot topics from online discussions, and subsequently initiate offline discussions on these topics.

Despite its distinctiveness from traditional media, online media play an important role in satisfying individuals' surveillance gratification and social utility needs. Hence, we propose that surveillance gratification and social utility motivation may encourage attention to news not only on traditional media, but also on online media:

H1: Surveillance gratification motivation is positively associated with attention to news on (a) traditional media and (b) online media.

H2: Social utility motivation is positively associated with attention to news on (a) traditional media and (b) online media.

Linking motivations with information processing strategies

Information processing may be more analytic and effortful, or heuristic and less elaborate in nature (Sotirovic & McLeod, 2001). One such heuristic information-processing strategy is selective scanning, which refers to the process of ignoring items that are not of interest or use to the audience (Kosicki & McLeod, 1990). This is often a response to the sheer volume of mediated information people receive, and the limited resources of time and energy they possess to sift through the information.

The heuristic-systematic information processing model (Chaiken, 1980; Eagly & Chaiken, 1984) puts forth that people employ both systematic and heuristic processing strategies to process information. In other words, the two modes of information processing – elaboration and selective scanning – can co-occur. Moreover, the cognitive miser model proposed by Fiske and Taylor (1991) posits that people are cognitive misers who will use a minimal amount of energy and effort to make judgment. To be efficient, people tend to use easily accessible heuristics to process information. Besides, time pressure constrains the amount of effort that people devote to systematic information processing, but promote

selective scanning which require less energy (Eagly & Chaiken, 1993). Hence, both elaboration and selective scanning may come into play when people process information.

Prior studies have demonstrated that people with higher levels of motivation are more likely to involve themselves in audience activities, including information processing (Eveland, 2001; Rubin & Perse, 1987). Thus, we expect that individuals' motivation would encourage both elaboration and selective scanning. We hypothesize:

H3: Surveillance gratifications motivation is positively associated with (a) elaboration and (b) selective scanning.

H4: Social utility motivation is positively associated with (a) elaboration and (b) selective scanning.

Linking attention to traditional media and online media with knowledge

Traditional news media plays an important role in cultivating people's learning about public issues. Empirical evidence has shown that newspapers play a major role in informing the public about current affairs, as they usually communicate a large amount of information and carry detailed analysis (Chaffee & Kanihan, 1997; Eveland, Seo, & Marton, 2002). In addition, studies have shown that people have the ability to learn from television programs (Atkin, 1982; Miller, Augenbraun, Schulhof, & Kimmel, 2006). Adults are able to retain information after watching news related to science and health on television (Miller et al., 2006). Moreover, seven in 10 of the adult population in Singapore read newspapers, 75.2% of adults watch terrestrial television regularly, and 45.1% view cable television, which also attests to the importance of traditional news media in disseminating information (Nielsen Singapore, 2011).

With the popularity of online media, a growing body of research has examined their roles in the process of learning. Internet news articles are similar to print news in terms of format, length, and style (Eveland, Marton, & Seo, 2004). Previous studies have

demonstrated that attention to Internet news could lead to an increase in individuals' knowledge (Eveland et al., 2004; Ho, Yang, Thanwarani, & Chan, 2017). A recent study has found that news attention to the H1N1 pandemic on the Internet is positively associated with public knowledge on this topic (Ho et al., 2013). Moreover, the rise of social media allows consumers to create, modify and share Internet content and communicate with one another, which facilitate information exchange and acquisition (Kietzmann, Hermkens, McCarthy, & Silvestre, 2011). Social media can also function as a source of public news (Gil de Zúñiga, Jung, & Valenzuela, 2012).

Overall, there is much evidence to show that attention to news can be associated with knowledge. Indeed, a number of studies have demonstrated that news attention can enhance learning, especially in science and health contexts (Ho, 2012; Ho, Detenber, Rosenthal, & Lee, 2014). Therefore, the following hypotheses are put forth:

H5: Attention to news on traditional media is positively associated with knowledge of climate change.

H6: Attention to news on online media is positively associated with knowledge of climate change.

Linking news attention with information processing

Media effects on knowledge can be attributed to information processing strategies that people apply when they are exposed to news. According to the CMM (Eveland, 2001), people engage in information processing after they pay attention to media messages. People usually employ more cognitive skills to process news on newspapers (Eveland & Scheufele, 2000). The information presented on newspapers is somewhat in-depth (Ho, 2012), and therefore requires readers to pay more attention when they read stories on newspapers (Grabe, Kamhawi, & Yegiyan, 2009). Moreover, Petty, Cacioppo, and Goldman (1981) argued that messages in print give more opportunity for elaboration. With respect to attention

to news on television, people also need high cognitive involvement to process information. As the pace, sequence, and content are controlled by the TV station, television news is low in user control (Eveland, 2003). Besides, television news is highly linear and tends to take a narrative format (Beaudoin, 2008). To understand the stories presented on television news, people have to stay focused and get elaborately involved. Thus, we expect that people are more likely to elaborate than selectively scan when they pay attention to news on traditional media. Hence, we posit:

H7: Attention to news on traditional media is positively associated with (a) elaboration, and negatively associated with (b) selective scanning.

As online media is becoming an important information source, a growing body of research has examined the effect of online media on the process of learning. One defining characteristic of online media is that audiences have a great deal of control in choosing what they want to learn about at their own pace, which can be beneficial for learning (Shin, Schallert, & Savenye, 1994; Young, 1996). User control theory states that there are individual differences in learning and each person has his/her own particular knowledge structure (Jonassen, 1988). Hence, giving people control over their own learning is thought to be beneficial for learning as they can organize and dictate their own learning based on the connections they make in their minds (Shin et al., 1994). Moreover, Eveland and Dunwoody (2002) found that Internet news use encouraged elaboration, as the presentation of hypermedia with links to related information may help audiences make mental connections between their knowledge and the information that they have just read. As such, elaboration may be increased through attention to news on online media.

While online media give users a great deal of control over what they learn, they encourage them to skip over much content (Astleitner & Leutner, 1995). Reading out of order and skipping sections that are of less interest is a structural norm in online news, and it is

often difficult to determine when all of the content has been covered unlike the linear format in traditional newspaper and television news (Eveland & Dunwoody, 2002). Unsurprisingly, news readers find it easy to scan online news, because the homepage contains most of the major headlines, making it easy to choose subjects of interest and skip over others (Li, 2006). Additionally, as people are generally not good with navigating and processing large amounts of information online, the overwhelming data may propel users to engage in selective scanning (Eveland & Cortese, 2004). Therefore, people can employ selective scanning as an information processing strategy when they pay attention to news online (Eveland, 2005; Eveland & Dunwoody, 2002). As such, the following hypothesis is proposed:

H8: Attention to online news is positively associated with (a) elaboration and (b) selective scanning.

Linking information processing strategies with knowledge

The importance of information processing strategies, whether effortful or heuristic, is therefore brought into focus – individuals who actively process the news media they use and compare the new information to what they already know would be able to form a more complete picture of the climate change situation and reduce their uncertainties. Conversely, individuals who selectively scan for information that interests them would be more likely to learn less about climate change. A substantial number of studies have confirmed that elaboration is beneficial to the learning process (Eveland, 2001; Yang, Chuah, Lee, & Ho, 2017), and in contrast, selective learning is detrimental to knowledge acquisition (Tewksbury & Althaus, 2000). Therefore, the following hypotheses are proposed:

H9: Elaboration is positively associated with the level of factual knowledge of climate change.

H10: Selective scanning is negatively associated with the level of factual knowledge of climate change.

Method

A nationally representative Computer Assisted Telephone Interview (CATI) survey of 1,093 adult Singaporeans was conducted during February 2012 at a large public university in Singapore. To maximize the response rate, interviews were conducted in either English or Mandarin. This survey used the youngest male or oldest female technique to randomize individuals within households, which have been demonstrated to be effective in obtaining randomly representative samples (Kennedy, 1993). Respondents aged between 21 and 81 years (*Mdn* = 42, *M* = 42.60, *SD* = 14.22). For gender, 45% of the respondents were female. The median education level was 'Diploma,' which is equivalent with the associate degree in the United States. The median monthly household income ranged from S$3,001 to S$4,000. The response rate was 42.7% based on APPOR formula 3. The margin of error was approximately ±3% at the 95% confidence level. The age, gender distribution, and education, and household income of our sample were comparable to that of the general population[1].

Measures

Table 1 shows the factors loadings, means, and standard deviations for the measurement items. Factor loadings reflect the measurement model and most loadings were above .40, indicating acceptable measurement validity.

[Insert Table 1 about here.]

Surveillance Gratification Motivation. Adapted from Eveland's (2001) study, five 10-point items (1 = 'strongly disagree,' 10 = 'strongly agree') asked respondents to indicate their agreement with the following reasons behind paying attention to news: (a) 'To stay in touch

[1] Our sample demographics are similar in terms of age and gender distribution to the characteristics of the 2010 Singapore population census (Singapore Department of Statistics, 2011). The median age in our sample was 42 years as compared to 37.4 years in the census. 45% of the respondents in our sample were female while 50.6% were female in the census. There were some differences in the variables of education and household income. The median education level attained in the census was secondary education while the media education level of our respondents was 'Diploma'. The median household income reported in the Singapore census was $5000, but '$3001–4000' among our respondents. These differences are not of major concern, as we treat them s control variables in our study.

with the world;' (b) 'To find out about the main events of the day;' (c) 'To find out what is happening to the environmental policies I support;' (d) 'The news gives me more facts to back up my opinions;' and (e) 'The news helps me make up my mind about things' (*Cronbach's* α = .84).

Social Utility Motivation. Adapted from Beaudoin and Thorson (2004), four 10-point items (1 = 'strongly disagree,' 10 = 'strongly agree') measured respondents' motivation to gain information to connect interpersonally with others using the following questions: (a) 'To find out interesting things to talk about;' (b) 'To pass on information to others;' (c) 'To prepare for discussions;' and (d) 'To get ammunition for arguments' (*Cronbach's* α = .85).

Attention to News on Traditional Media. Two 10-point items adapted from previous studies (|Eveland, 2001, 2002) were used to ask respondents to indicate how much attention they paid to climate change issue on (a) television and (b) print newspapers (1 = 'very little attention,' 10 = 'very close attention') (r = .47, p < .01).

Attention to Online News. Two 10-point items adapted from previous studies (O'Neill & Boykoff, 2011) were used to ask respondents to indicate how much attention they paid to climate change issue on (a) Internet news and (b) social media (1 = 'very little attention,' 10 = 'very close attention') (r = .63, p < .01).

Elaboration. Modified from Eveland et al.'s (2004) study, six 10-point items were employed to measure respondents' elaboration of information on climate change. Respondents were asked to indicate their agreement with the following statements: 'After I encounter information on environmental issues … (a) "I am likely to stop and think about it," (b) "I will try to read between the lines to understand it better," and (c) "I will try to figure out what the real story is that the news has not reported." In addition, (d) 'When I come across environmental information, I find myself linking it to ideas I already have,' (e) 'I often relate what I learnt from the media about environmental issues to my past experiences,' (f) 'I

try to mentally piece the stories together like a puzzle to gain a thorough understanding of environmental issues' (*Cronbach's* α = .9 0).

Selective Scanning. Adapted from previous studies on CMM (Eveland & Cortese, 2004; Eveland & Dunwoody, 2002), three items were employed to measure selective scanning of information on climate change. On a 10-point scale (1 = 'strongly disagree,' 10 = 'strongly agree'), respondents were asked to state their agreement with the following statements: (a) 'I only pay attention to environmental information that looks interesting;' (b) 'I only pay attention to environmental news that looks important;' and (c) 'I usually skim through environmental information that I receive' (*Cronbach's* α = .70).

Knowledge. In this study, knowledge was operationalized as the level of factual knowledge of climate change. To evaluate respondents' knowledge level on climate change issue, five questions were adapted from a number of sources to fit the Singapore context (Tan, Lee, & Goh, 1998). For each of the statements, respondents were to answer if the following statements are 'true' or 'false': (a) 'Climate change is caused mostly by human activities;' (b) 'Most scientists do not think that climate change is happening;' (c) 'The earth's climate has changed naturally in the past, and therefore humans are not the cause of climate change;' (d) 'Melting of the polar ice caps can result in low-lying areas being flooded;' and (e) 'Burning coal and oil does not change the amount of carbon dioxide in the atmosphere' (*KR-20* = .61).

Analytical approach

The hypothesized model was tested using structural equation modeling (SEM), with maximum likelihood estimation in *Mplus 6* (Muthén & Muthén, 2012). We replicated the original CMM proposed by Eveland (2001) and tested it using SEM in this study. SEM controls for possible measurement error and provides estimation of model fit (Kaplan, 2009). Following Anderson and Gerbing (1988), a two-step analytic approach was employed in this

study. We first estimated measurement models using confirmatory factor analysis (CFA) and then tested structural model. Specifically, the CFA was conducted first to validate the measurement components, which provided foundation for structural model testing. Following this, we tested the hypothesized relationships between latent variables in the structure model.

The aim of the analysis was to test whether the hypothesized model fit the data well based on goodness of fit indices: the maximum likelihood chi-square (χ^2), normed chi-square (χ^2/ df), Comparative Fit Index (CFI), TLI (Tucker-Lewis Index), and the Root Mean Square Error of Approximation (RMSEA). Specifically, the normed chi-square between 1 and 5 is acceptable (Wheaton, Muthen, Alwin, & Summers, 1977). TLI and CFI over .95 are considered acceptable, and RMSEA value less than .05 indicates good fit (Hu & Bentler, 1999).

Results

In the measurement model, seven latent variables were specified. Freely estimating paths among latent variables, all measurement model fit statistics fell within acceptable ranges, demonstrating a good fit to the data (Table 2). All factor loadings were over .40, and most exceeded .70 (Table 1). Factor loading for all latent variables were significant ($p <$ .001). Results indicated that both the replicated and the extended CMM had good fit (Table 2).

[Insert Table 2 about here.]

Replicated CMM

The result indicated that the relationships among the factors in the replicated CMM was consistent with those of Eveland's CMM (2001). Specifically, surveillance motivation was positively associated with traditional media attention ($\beta = .75$, $p < .001$) and elaboration ($\beta = .64$, $p < .001$). Traditional media attention was significantly associated with elaboration ($\beta = .13$, $p < .05$) and knowledge ($\beta = .22$, $p < .01$). Finally, elaboration was positively

associated with knowledge (β = .12, p < .05). The original CMM model was supported by the data. Figure 1 summarizes the results.

[Insert Figure 1 about here.]

Extended CMM

Surveillance gratifications motivation was positively associated with traditional media attention (β = .68, p < .001) and online media attention (β = .24, p < .001), supporting H1a, and H1b. Social utility motivation was positively associated with online media attention (β = .13, p < .05), which supported H2b. However, H2a was not supported as no significant relationship was found between social utility motivation and traditional media attention.

Surveillance gratifications motivation was positively associated with elaboration (β = .33, p < .001) and selective scanning (β = .27, p < .01), supporting H3a and H3b. Meanwhile, social utility motivation was positively associated with elaboration (β = .33, p < .001) and selective scanning (β = .45, p < .001), supporting H4a and H4b.

H5 posited a relationship between traditional media attention and knowledge about climate change, and the hypothesis was supported (β = .21, p < .01). However, H6, which held that online media attention had a positive association with knowledge, was not supported, as no significant relationship was found. Traditional media attention was positively associated with elaboration (β = .10, p < .05) and negatively associated with selective scanning (β = −.27, p < .01) supporting H7a and H7b. Online media attention was found to be positively associated with elaboration (β = .13, p < .001) and selective scanning (β = .18, p < .001), which supported H8a and H8b.

Finally, H9a and H9b contended that the information processing variables are significantly and positively associated with knowledge. H9 was supported, as elaboration was significantly associated with knowledge about climate change (β = .14, p < .05). However, H10 was not supported as no relationship was found between selective scanning and

knowledge. Figure 2 summarizes these results.

[Insert Figure 2 about here.]

Discussion

This study has demonstrated some important findings by extending the CMM to the context of climate change. The original CMM model was supported in the current data. Results showed that surveillance gratifications motivation regarding climate change is associated with attention to news media and elaboration, and this information processing is in turn, related to climate change knowledge. This demonstrates that the CMM can be applied to the area of environmental communication.

Surveillance gratifications motivation was associated with attention to traditional and online news, consistent with previous studies (Eveland, 2002). This is unsurprising as news media provide much information about the environment, and is often our only avenue to events happening outside of our direct experiences. People often use media to satisfy their need for information about the world around them (Blumler & Katz, 1974). Social utility motivation predicted attention to online media, but had no significant relationship with attention to traditional media. A potential explanation could be the different attributes of those two kinds of media. With a high level of interactivity, online media promote discussion with others (Beaudoin, 2008). Social utility refers to the purpose of gaining information to connect interpersonally with family and friends (Eveland, 2004). Accordingly, online media, compared with traditional media is a better platform for them to get information that can be used in discussion with others.

Surveillance gratifications and social utility function were associated with elaboration, consistent with previous studies (Beaudoin & Thorson, 2004; Eveland, 2002). It is plausible that the same motivations that steered respondents to pay attention to environmental news would also spur them to consciously process this news to acquire knowledge. This is

supported by the literature, as surveillance gratifications and social utility motivations are the most commonly cited motivations for news media attention and elaboration (David, 2009; Eveland, 2002). Besides, both surveillance gratifications and social utility were positively associated with selective scanning, consistent with previous research on motivational determinant of processing mode (Chaiken, 1987). People are 'economy-minded soul,' as they tend to satisfy their needs in the most efficient ways (Chaiken & Eagly, 1989). The least effort principle asserts that people prefer less effortful to more effortful modes of information processing. Thus, it is within our expectation that individuals' motivation promoted selective scanning.

With regard to the effect of traditional media attention on knowledge, respondents who paid more attention to traditional media news were found to have higher levels of knowledge about environmental issues, which are consistent with previous studies (Jensen, 2011; Lo & Chang, 2006). Attention to online news was found to have no significant association with knowledge about climate change. One possible explanation could be the attributes of online media. Tewksbury and Althaus (2000) suggest that this could be due to the manner in which Internet news is structured – it can be difficult to tell which news have greater news value and which are merely the latest news. Without such editorial cues, Internet news readers may need to invest information processing effort to generate significant learning, hence the path to knowledge is an indirect one. Besides, the quality of user-generated contents on social media varies drastically from excellent to abuse (Agichtein, Castillo, Donato, Gionis, & Mishne, 2008). As a result, the increase of such contents on social media makes it difficult for people to identify useful and high-quality information from which they can gain knowledge.

Attention to news on traditional and online media had different relationships with elaboration and selective scanning. Specifically, attention to traditional media was found to

be positively associated with elaboration, and negatively associated with selective scanning. Consistent with previous studies, this could be ascribed to the attributes of traditional media. People tend to spend more cognitive effort when they process in-depth information on newspaper, and highly linear but less controlled information on television. Comparatively, attention to online media was found to be both positively associated with elaboration and selective scanning, consistent with past research. This could be explained by the nature of the Internet that allows for hyperlinks to other related information, mimicking the associative network in one's brain (Easley & Kleinberg, 2010). However, the Internet also encourages readers to selectively scan for information by reading out of order and skipping content that is of less interest (Astleitner & Leutner, 1995).

Elaboration had a significant influence on knowledge, which is consistent with previous studies (Beaudoin & Thorson, 2004; |Eveland, 2002, 2004; Lo & Chang, 2006). People who actively process the information they receive and associate it with knowledge they already have are more likely to learn. Selective scanning, however, had no relationship with knowledge. One possible explanation may be that selective scanning is a limited mode of information processing which receives less in-depth processing as compared to elaboration. As less in-depth processing produces weaker memory (Craik & Tulving, 1975) which is essential for promoting knowledge (Kornell, Rhodes, Castel, & Tauber, 2011), it is not surprising that selecting scanning had no significant association with knowledge in our study.

The present study has several limitations that should be addressed in future research. With the popularity of social media, future studies should take a closer look at the role of social media use in CMM, which will enhance our understanding of the underlying processed behind how the specific features of social media may alter the way in which individuals obtain knowledge. For example, this study examined information on social media in a general

manner. We asked the respondents to indicate how much attention they pay to news of climate change on social media. However, different from other media platforms, people do not only pay attention to news on social media, but also scrutinize or browse information shared by their friends on social media. It is possible that people would process news on social media and information shared by friends on social media in different ways. Moreover, people may process information shared by friends with different social distances distinctively. Thus, future studies could make an in-depth examination of how people process information shared by friends on social media, and how it may affect their knowledge acquisition.

Another potential limitation is that we employed five items to measure factual knowledge. To enhance the reliability of the measurement, future studies could employ more items to measure factual knowledge of climate change. Moreover, this study merely assessed individuals' factual knowledge at one point in time. Future research could conduct longitudinal studies to examine the amount of factual knowledge acquisition over time. Besides, we have not examined other types of knowledge, such as perceived familiarity. Thus, future studies could make further examination of different types of knowledge in CMM research. Additionally, the study was conducted in Singapore, which may limit the generalizability of our findings. Due to the cross-sectional survey used in this study, we cannot infer causality within the model.

Nevertheless, this study has made a number of theoretical and practical contributions. Attention to both traditional and online media was integrated into the CMM, which highlighted the ways in which these mediums affected information processing. Selective scanning was added to the model as a second information-processing variable, providing a useful contrast to elaboration. Social utility motivation was added as a salient variable. Overall, these additions expanded the CMM and offered a more nuanced explanation of the

processes behind knowledge acquisition.

In terms of practical contributions, communication practitioners may use the model to understand how audiences may learn about news in the media and to develop strategies to meet campaign goals. Environmental groups can have a better understanding of the factors behind learning from the news. Traditional media have a direct impact on knowledge gaining. Considering the important role of traditional media in disseminating information, government should make better use of them in cultivating public understanding of climate change. Moreover, the importance of elaboration also comes into play when reading news online. Communication practitioners should develop strategies to encourage audience to elaborate on online information about climate change and to discourage them from skipping important information via selective scanning. Like Singapore, the coastlines of several other countries in Southeast Asia are highly vulnerable to climate change (Yuen & Kong, 2009). Considering the fact that citizens in these countries are increasingly turning to online (and in particular social media) to acquire information (We Are Social, 2015), communication practitioners should put in more effort into differentiating the different media platforms when designing communication messages to mitigate climate change.

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Tables and Figures

Table 1. Summary of Measurement Items.

Variable	Factor loading	*M*	*SD*
Traditional media attention			
tma1	.70	5.22	2.53
tma2	.69	5.02	2.58
Online media attention			
oma1	.82	4.23	2.91
oma2	.77	3.44	2.70
Surveillance gratification			
gratification1	.74	5.81	2.61
gratification2	.67	6.02	2.62
gratification3	.73	5.14	2.65
gratification4	.75	5.50	2.55
gratification5	.73	5.51	2.53
Social utility			
utility1	.74	5.25	2.58
utility2	.79	5.47	2.58
utility3	.74	4.52	2.52
utility4	.69	4.11	2.49
Elaboration			
ela1	.74	5.47	2.58
ela2	.83	5.43	2.64
ela3	.76	4.88	2.68
ela4	.80	5.08	2.50
ela5	.77	5.48	2.53
ela6	.78	5.04	2.61
Selective scanning			
ss1	.67	6.06	2.46
ss2	.63	6.71	2.33
ss3	.61	5.44	2.40
Knowledge of climate change			
know1	.44	0.86	0.35
know2	.55	0.75	0.43
know3	.49	0.70	0.46
know4	.54	0.85	0.35
know5	.52	0.68	0.47

Note: For reference, items appear in this table in the same order as in the Method section.

Table 2. Measurement and Structural Model Fit Indices.

Model	χ^2	*df*	χ^2/df	CFI	TLI	RMSEA (*p* close)
Measurement	614.08	280	2.19	.97	.97	.03 (1.00)
CMM	292.58	153	1.91	.98	.98	.03 (1.00)
Extended CMM	748.67	349	2.15	.97	.96	.03 (1.00)

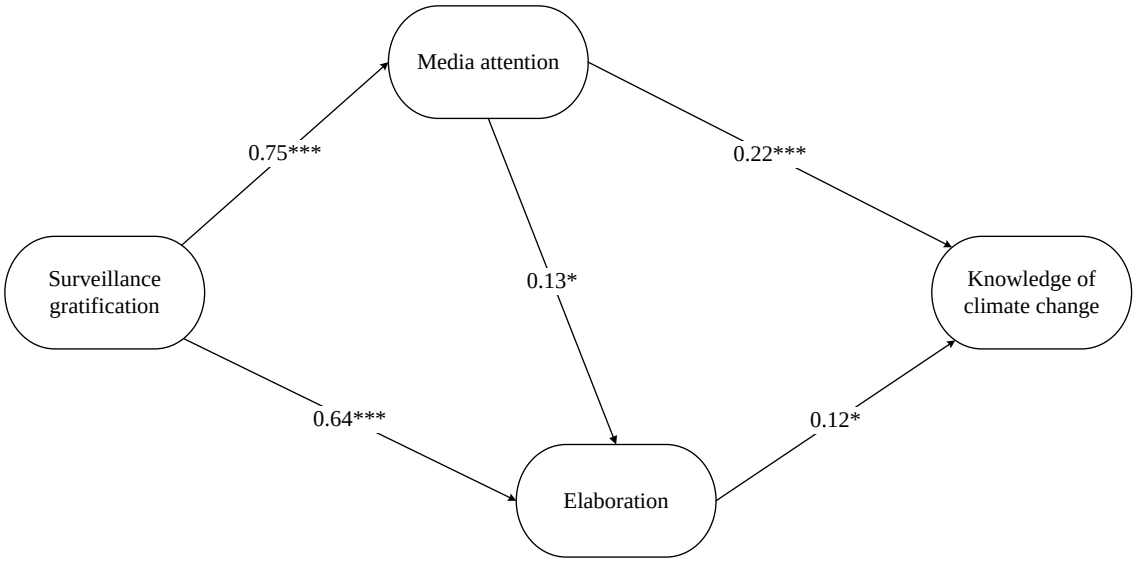

Figure 1. Replicated CMM.
*p < .05, **p < .01, ***p < .001.

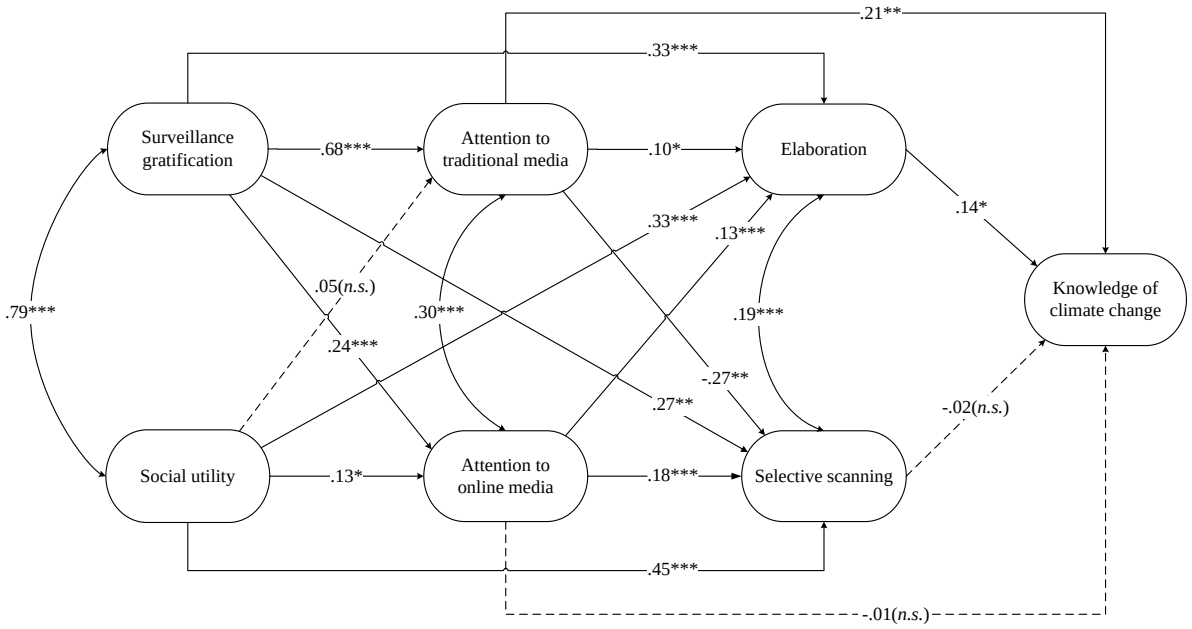

Figure 2. Extended CMM.
Note: Dotted lines denote hypothesized non-significant paths. *$p < .05$, **$p < .01$, ***$p < .001$.