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News Media and Public Understanding of Risk: Knowledge, Perception, and Acceptability of Nuclear Energy

LI Yiwei*

Introduction

Development in science and technology has significantly contributed to the progress of human societies. Many technological innovations are playing critical roles in reducing negative impacts of natural disasters, addressing energy crises, improving treatments for diseases, breaking barriers to social changes, and so forth. However, while enjoying the benefits, humans are also facing risks from the inappropriate use and inadequate management of technologies.

Nuclear technology is one of the breakthrough innovations in human history. As a cost-competitive energy source, nuclear power is expected to support a larger share of energy production in many nations to mitigate climate risks and bolster energy security. The development and adoption of nuclear energy is probably among the most important domestic issues of Japan. Dependent on imports for over 90% of primary energy needs, Japan intends to rely on nuclear power to supply 20-22% of the country's electricity by 2030 (The Ministry of Economy, Trade and Industry, 2016). With regard to public attitude toward nuclear energy, Japanese citizens are generally aware of the urgent need for alternative energy source. However, in the aftermath of the Fukushima Daiichi nuclear disaster, people are likely to react unfavorably to attempts the government makes to further develop nuclear energy. A 2016 public opinion survey showed that 57% of Japanese citizens nationwide were opposed to the restarting of nuclear reactors (The Asahi Shimbun, 2016).

Like many other technologically related risks, mainly due to the lack of expertise, it is difficult for most people to anticipate and evaluate the potential consequences of nuclear accidents or nuclear waste leak. Attitudes, policy preferences, and actions among the lay public are likely to be determined by what they have seen, heard, or read via varied sources of information either directly or indirectly (J. X. Kasperson, R. E. Kasperson, Pidgeon, & Slovic, 2003). The media, particularly the news media, could be the most influential one in constructing public

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understanding of nuclear risks. Media messages not only convey facts and make complex issues accessible to lay audiences but also direct public attention and adopt frames to shape public perceptions (Iyengar & Simon, 1993; Scheufele, 1999; Scheufele & Tewksbury, 2007).

Given the importance of public opinion in policy-making, this study explores how Japanese people's understanding and attitude toward nuclear energy are related to their exposure to news media. More specifically, this study investigates the use of print (newspapers and news magazines), broadcast (radio and television), and online media (the Internet) as sources of news and examines the potential influence of these news media on audiences' knowledge, risk perception, and acceptability of nuclear energy. Findings of the present study contribute empirical evidence to the constitutive role of the media in the context of nuclear risk, which may provide governments, industry, experts, and risk managers with practical implications for improving nuclear communication with the general public.

News Media and Perceived Reality of Risk

Through the creation of news, mass media can exert strong influence on audiences' understanding of contemporary life (Tuchman, 1978). Three theoretical models, namely, agenda setting, priming, and framing, help explain how news media produces its effects.

Media agenda setting reflects the impacts of news on public perception of the importance of an issue. Instead of providing an accurate picture of current events, the media may choose to cover certain issues, thereby affecting the level of public concern (Iyengar & Simon, 1993; McCombs & Shaw, 1972). Through such effect, news media can play a major role in determining the degree of thought people put into a particular issue. In addition, known as the *priming effect*, the media can determine the criteria based on which audiences make judgments (Iyengar & Kinder, 2010). For instance, extensive coverage of the aftermath of a nuclear accident highlights the danger and badness of nuclear power, which may subsequently influence audiences' overall evaluation of nuclear energy. Besides, through the *framing effect* the media also sets boundaries for audiences to influence how they make sense of the issue portrayed (Severin & Tankard, 2013). Entman (1993:52) explained that "to frame is to select some aspects of a perceived reality and make them more salient in a communicating context, in such a way as to promote a particular problem definition, causal interpretation, moral evaluation, and/or treatment recommendation for the item described". For instance, in order to make messages more noticeable and memorable to audiences, varied journalistic styles that differ in the set of tones and choice of words are commonly seen in news reporting. As such, media coverage can not only direct public attention to certain aspects of an issue but also facilitate the communication of perspectives,

preferences, and worldviews. Taken together, news media would more likely create a reality for audiences rather than reflect the reality.

In terms of crisis and risk communication, hazards that are catastrophic and new in nature tend to attract great media attention, and risks generated by severe crises or accidents usually receive heavy media coverage (Allan, Adam, & Carter, 2000; Cox & Pezzullo, 2016). Findings of empirical studies have suggested that media coverage of such hazardous events and risks can induce fear in audiences, amplify risk perception, and foster public anxiety (e.g., Ackerson & Viswanath, 2010; Anderson, Brossard, Scheufele, Xenos, & Ladwig, 2014; Eldridge & Reilly, 2003; Frewer, Miles, & Marsh, 2002; Murdock, Petts, & Horlick-Jones, 2003). In particular, concerning issues with low public knowledge, media messages on one hand improve public understanding by conveying facts, on the other hand, frame the issue by emphasizing its dramatic aspects to increase audience size. Consequently, biased information becomes more available and powerful for audiences' judgment and decision making (Lundgren & McMakin, 2013). Nevertheless, news media provides much of people's knowledge of current affairs. In light of the substantial exposure to media information that most people are experiencing nowadays, the lay public would become concerned about risks being covered heavily in the media and be easily attracted to relevant messages that have been craftily designed. Therefore, this study focuses on public reactions to nuclear risk in the post-Fukushima era, attempting to explore whether and how Japanese people's knowledge and risk perception of nuclear energy are related to their daily use of news media. Accordingly, the following two hypotheses are proposed:

Hypothesis 1: Knowledge about nuclear energy will be positively associated with the use of news media.

Hypothesis 2: Perception of nuclear risk will be positively associated with the use of news media.

Knowledge, Judgment, and Attitude toward Risk

The relationship between knowledge and risk perception has been well documented in the literature, particularly quantitative research cast within the psychometric paradigm (Fischhoff, Slovic, Lichtenstein, Read, & Combs, 1978). A majority of previous studies investigated the role of knowledge in the formation of lay people's judgments of risk. For instance, in study of Slovic (1987), nine hypothetical descriptive attributes were grouped into two factors, which were labeled *unknown risk* and *dread risk*, and technologically related risks, including nuclear power, scored particularly high on the *unknown risk* factor. Lai and Tao (2003) also found that knowledge was a major determinant of non-experts' perception of environmental risks. Generally speaking, knowledge can reduce perceived risk because it may decrease feeling of uncertainty and increase sense of

efficacy, leading people to believe that risks may be controlled. It is true that various personal, social, and cultural factors can influence how individual perceives a particular risk. There is consistent understanding in the literature about the importance of knowledge in subjective judgment of risk. Therefore, it is plausible to assume that knowledge is one of the strongest predictors of risk perception, regardless of context. Accordingly, this study proposes the following hypothesis to examine how Japanese people's nuclear risk perception is related to their knowledge about nuclear energy:

Hypothesis 3: Perception of nuclear risk will be negatively associated with knowledge about nuclear energy.

Risk perception can play a central role in the formation of attitudes, which will likely influence individuals' decisions on how to act or behave in response to the risk (Finucane, Alhakami, Slovic, & Johnson, 2000; Kahneman, 2003, 2011). This is mainly due to the affective nature of risk perception, making it the most acute psychological cue for decision-making under an uncertain or risky situation (Peters, McCaul, Stefanek, & Nelson, 2006; Slovic, Peters, & Finucane, 2005; Tversky & Kahneman, 1974). Recent research from psychological perspectives suggests that affect is an essential component in risk perception where positive affect (feelings of "goodness") and negative affect (feelings of "badness") toward a hazard determines the inverse relationship between perceived risk and benefit (Slovic, Finucane, Peters, & MacGregor, 2004). Affective responses occur rapidly and form the basis for attitudes efficiently. Thus, risk perception could be the predictor that has the closest association with attitudinal variables. Regarding public attitude toward nuclear energy, Vainio, Paloniemi, and Varho (2017) found that nuclear risk perception directly contributed to willingness to pay for nuclear energy alternatives. De Groot, Steg, and Poortinga (2013) found that perceived risk was a direct negative predictor of acceptability of nuclear energy. The current investigation also takes into account the role of risk perception in predicting Japanese people's attitude toward the development of nuclear energy in Japan. Hence, the fourth hypothesis is proposed as follows:

Hypothesis 4: Acceptability of nuclear energy will be negatively associated with perception of nuclear risk.

Gender Difference in Reaction to Risk

Previous psychometric studies on environmental and technological risks have demonstrated that men and women tend to worry about the same risks, however, women constantly worry a bit more (Pidgeon, Hood, Jones, Turner, & Gibson, 1992; Slovic, 1987, 1992). Finucane, Slovic, Mertz, Flynn, and Satterfield (2000) also concluded that men tended to perceive a lower level of risk than women. A study on public risk perception of 25 hazardous activities, including nuclear power plants,

found that women had higher risk perception across these hazards, which were considered due to their feeling of vulnerability and perception of a lack of control (Flynn, Slovic, & Mertz, 1994). Moreover, according to a meta-analysis of public reactions to environmental issues (Wachinger, Renn, Begg, & Kuhlicke, 2013), numerous empirical studies have found that gender has an influence on lay people's perceptions of environmental risks, however, there is no consistent understanding about such relationship in the literature.

Sociologists and anthropologists have argued that risks are socially and culturally constructed, and suggested that gender would make a difference in perception of risk (Douglas & Wildavsky, 1983; Gustafson, 1998; Wildavsky & Dake, 1990). Qualitative research from the sociological and cultural perspectives used open-ended questions and revealed that men and women gave priority to different risks. For instance, Fischer, Morgan, Fischhoff, Nair, and Lave (1991) found that women concerned more about environmental risks than men, whereas men showed stronger concerns for health and safety risks than women. This could be attributed to social roles and everyday activities of men and women. More specifically, women are likely to perform the social role of nurturer and care provider and thus worry about environmental risks because environmental problems that are beyond their control would harm the living conditions and well-being of those they care about.

Research about risk and personal factors, such as gender, is important because it would help explain why attempts sometimes failed to improve public acceptance of certain risks. Therefore, in order to provide new insights into the relationships between demographic variables and individual reactions to risk, this study proposes the following research question:

Research Question: How is gender related to risk perception and acceptability of nuclear energy?

Method

Procedures and Participants

An online survey on perceptions and attitudes toward nuclear energy in Japan was conducted in November 2017. The electronic questionnaire was created by *SurveyMonkey* and participants were recruited via the *SurveyMonkey Audience* service. Questionnaire items originally published in English were translated into Japanese by two bilingual doctoral students and back-translated into English. Necessary modifications were made to reconcile differences in translation between the two translators before producing an appropriate Japanese-language questionnaire for use. A total of 341 Japanese adults took part in the survey. Among them, 199 (58.4%) were males and 142 (41.6%) were females. This sample has a mean age of 38.75 (*SD*=12.53), ranging from 20 to 59. With regard to the educational attainment,

5.0% of the respondents were junior high school graduates, 27.8% of the respondents were high school graduates, 20.7% of the respondents received their education in community college or vocational school, 43.8% of the respondents were bachelor's degree holders, and 2.7% of the respondents had a master's degree or higher.

Measures

Use of news media

This study assessed the use of five types of news media, including newspapers, news magazines, radio, television news, and the Internet, to investigate the role of media coverage in influencing public understanding of nuclear energy. On 7-point Likert-type scales, participants were asked to rate how often they used each of the five channels as their source of news where 1=*very rarely* and 7=*very frequently*. There was significant difference in the use of *newspapers* as source of news between male and female participants (males, M=3.95, SD=2.26, females, M=3.20, SD=2.23, $t(339)=3.04$, $p<.01$). However, no significant gender difference was found regarding the use of the other four types of news media (*news magazines*: males, M=2.30, SD=1.82, females, M=1.98, SD=1.56, $t(327.41)=1.76$, $p=.080$; *radio*: males, M=2.73, SD=1.99, females, M=2.37, SD=1.95, $t(339)=1.67$, $p=.095$; *television news*: males, M=5.26, SD=1.76, females, M=5.46, SD=1.70, $t(339)=1.03$, $p=.303$; the Internet: males, M=5.75, SD=1.39, females, M=5.91, SD=1.51, $t(339)=0.98$, $p=.329$).

Subjective and factual knowledge about nuclear energy

This study first assessed subjective knowledge about nuclear energy by asking participants how much they thought they knew about nuclear energy. This item was rated on a 10-point scale with 1=*nothing at all* and 10=*very much* (M=3.91, SD=2.05).

Then, six items were constructed to assess the level of factual knowledge about nuclear energy. Participants were instructed to respond with either a *True* (1) or a *False* (0) to the following statements: (1) The two types of reactions are nuclear fission and nuclear fusion; (2) a nuclear reactor produces heat, which can then be used to generate electricity; (3) nuclear power has a history of being a very safe source of energy, but no technology is perfect; one of the world's worst nuclear accidents occurred in 1986 in Ukraine; (4) nuclear power is cheap, generally safe, and the world's supply of nuclear fuel is plentiful; disposal of radioactive waste is the major factor that has limited the expansion of nuclear power as a source of electricity; (5) nuclear energy produces more energy than fossil fuels; and (6) nuclear energy is one of the lowest polluting energy source today (Trivia Quiz, 2017). Scores were summed to create the index of factual knowledge about nuclear energy (six items, M=4.05, SD=1.54).

Nuclear risk perception

Perceived nuclear risk was measured by four items adopted from Vainio, Paloniemi, and Varho (2017). More specifically, participants were asked to rate to what extent they agreed or disagreed with the following statements: (1) Nuclear waste constitutes a continuous threat for future generations; (2) health risks are associated with living close to nuclear power plants; (3) storage of nuclear waste may lead to wide-ranging environmental effects; and (4) a nuclear power plant accident would cause irreparable damage to large geographical areas and groups of people. All the items were rated on 5-point Likert-type scales (1=*totally disagree* and 5=*totally agree*). Scores were averaged to form the index of nuclear risk perception (four items, Cronbach's α=.90, M=3.80, SD=0.98).

Acceptability of nuclear energy

Four items adopted from De Groot, Steg, and Poortinga (2013) were used to assess acceptability of nuclear energy in the context of Japan. Participants were asked to respond to the following statements on 7-point Likert-type scales (1=*totally disagree* and 7=*totally agree*): (1) Nuclear energy use is acceptable; (2) it is acceptable that we are establishing new nuclear power plants in Japan; (3) it is acceptable that parts of the Japanese energy come from nuclear sources; and (4) it is acceptable that we will use more nuclear energy in Japan in the future. Scores were averaged to form the index of acceptability of nuclear energy (four items, Cronbach's α=.93, M=3.11, SD=1.50).

Results

Correlations between Key Variables

Prior to testing the hypotheses, correlation analysis was conducted to examine the relationships between all key variables involved in the present study. Results in Table 1 first demonstrated that, among the five types of news media, frequency of print news media use had significant positive correlation with subjective knowledge (newspapers: r=.21, p<.001; news magazines: r=.27, p<.001) and risk perception of nuclear energy (newspapers: r=.18, p<.01; news magazines: r=.11, p<.05). Similarly, frequency of watching television news was also significantly and positively correlated with subjective knowledge (r=.12, p<.05) and risk perception (r=.41, p<.001). Different from these three traditional media, the Internet was found to have significant positive correlation with factual knowledge of nuclear energy (r=.15, p<.01) and perceived nuclear risk (r=.23, p<.001). Meanwhile, it is interesting that frequency of radio listening showed no significant relationship with knowledge and risk perception of nuclear energy, but it was significantly and positively correlated with acceptability of nuclear energy (r=.12, p<.05).

Concerning the relationships between knowledge, risk perception, and attitude toward nuclear energy, results (see Table 1) suggested that subjective knowledge had significant positive correlation with perceived risk (r=.19, p<.01), factual knowledge had significant positive correlation with acceptability (r=.15, p<.01), and perceived risk had significant negative correlation with acceptability (r=-.40, p<.001). In addition, this study found that subjective knowledge (r=-.30, p<.001) and acceptability of nuclear energy (r=-.12, p<.05) were significantly and negatively correlated with gender.

Table 1. Correlation Coefficients between Key Variables

Variable	1	2	3	4	5	6	7	8	9
1. Gender	—								
2. Newspapers	-.16**	—							
3. News magazines	-.09	.37***	—						
4. Radio	-.09	.34***	.30***	—					
5. Television	.06	.30***	.22***	.12*	—				
6. The Internet	.05	.01	.05	-.00	.34***	—			
7. Subjective knowledge	-.30***	.21***	.27***	.11	.12*	.09	—		
8. Factual knowledge	.04	.07	-.00	.05	.09	.15**	.12*	—	
9. Nuclear risk perception	.10	.18**	.11*	.05	.41***	.23***	.19**	.08	—
10. Acceptability	-.12*	.01	.07	.12*	-.09	.02	.09	.15**	-.40***

Note. * p<.05; ** p<.01; *** p<.001.

Predicting Knowledge, Risk Perception, and Acceptability of Nuclear Energy

Linear regression was conducted to test the hypotheses proposed in this study. First, regarding the role of news media use in predicting knowledge and risk perception of nuclear energy, results in Table 2 suggested that frequency of print news media use was a significant positive predictor of subjective knowledge (newspapers: β=.12, p<.05; news magazines: β=.22, p<.001). Frequency of watching television news was a significant positive predictor of perceived risk (β=.36, p<.001). Internet use was found to have the potential to contribute to factual knowledge (β=.15, p<.05) and perceived risk (β=.11, p<.05). Frequency of radio listening showed no significant predictive power on knowledge and risk perception. Thus, *Hypothesis 1* is considered being partially supported in the contexts of print media and online media, whereas *Hypothesis 2* is considered being supported in the contexts of televised media and online media.

Table 2. Regression Analysis of Knowledge and Risk Perception on News Media Use

Predictor	Subjective knowledge β	Factual knowledge β	Nuclear risk perception β
Newspapers	.12*	.07	.07
News magazines	.22***	-.05	.00
Radio	-.00	.04	-.02
Television	.01	.03	.36***
The Internet	.08	.15*	.11*
R^2	.09	.03	.18
Adjusted R^2	.08	.02	.17
F	6.95***	2.17*	15.04***

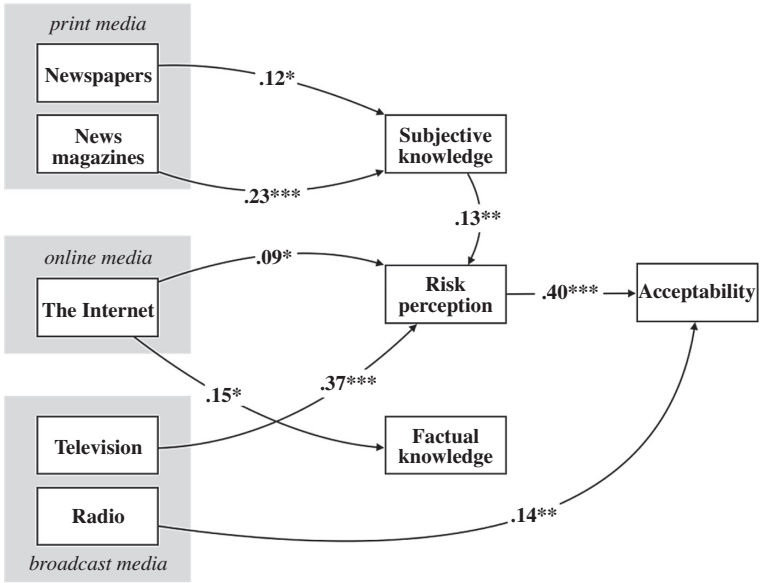
Note. * p<.05; *** p<.001.

With regard to the relationships between knowledge, risk perception, and acceptability of nuclear energy, results of regression analysis indicated that subjective knowledge was a significant positive predictor of nuclear risk perception (β=.18, p<.01), however, factual knowledge showed no predictive power for risk perception (β=.06, p=.269). This finding is inconsistent with *Hypothesis 3*, which posits a negative relationship between knowledge and perceived risk. Concerning the prediction of acceptability, it was found that nuclear risk perception was a significant negative predictor of acceptability of nuclear energy (β=-.40, p<.001), which supports *Hypothesis 4*. In addition, since this study found a positive correlation between radio use and acceptability of nuclear energy (r=.12, p<.05), regression analysis of acceptability on frequency of radio listening was conducted. Results suggested that the use of radio as source of news had the potential to directly contribute to audiences' acceptability of nuclear energy (β=.12, p<.05).

Based on the above results, this study examined a path model (see Figure 1) involving media variables (i.e., frequencies of use of newspapers, news magazines, radio, television, and the Internet as sources of news) and the outcome variables (i.e., subjective knowledge, factual knowledge, risk perception, and acceptability of nuclear energy). Results suggested good model fit: *CMIN*(21)=37.60, *CMIN*/*df*=1.79, p=.014; CFI=.96, TLI=.92, RMSEA=.05, SRMR=.05. The model explained 8.8% of the variance in subjective knowledge, 2.3% of the variance in factual knowledge, 19.1% of the variance in nuclear risk perception, and 17.6% of the variance in acceptability of nuclear energy. To sum up, as demonstrated in Figure 1, print media significantly contributed to audiences' subjective knowledge of nuclear energy, whereas online media significantly contributed to factual knowledge. In the meantime, among the five types of news media, news from the Internet and televised news had the power to increase audiences' nuclear risk perception, which was likely

to be a direct factor impeding the acceptability of nuclear energy. However, radio played a unique role in influencing public reactions to nuclear energy; it had no impact on knowledge and risk perception but was likely to directly promote the acceptability of nuclear energy among audiences.

Figure 1: Pathways from News Media Use to Acceptability of Nuclear Energy.



Note. Estimates are standardized coefficients of regression. * $p<.05$, ** $p<.01$, *** $p<.001$. For parsimony and clarity, covariance between media variables are not shown in the model: newspapers and news magazines, $r=.37$, $p<.001$; newspapers and television, $r=.30$, $p<.001$; newspapers and radio, $r=.34$, $p<.001$; news magazines and television, $r=.20$, $p<.001$; news magazines and radio, $r=.30$, $p<.001$; television and the Internet, $r=.33$, $p<.001$; television and radio, $r=.12$, $p<.05$.

Gender Difference in Judgment of Risk and Attitude

Analysis of differences was designed to answer the research question relating to the role of gender. According to the results of correlation analysis (see Table 1), gender had negative correlation with subjective knowledge ($r=-.30$, $p<.001$) and acceptability of nuclear energy ($r=-.12$, $p<.05$); in the meantime, subjective knowledge had positive correlation with nuclear risk perception ($r=.19$, $p<.01$), which was negatively correlated with acceptability ($r=-.40$, $p<.001$). It is possible that men and women perceive different levels of knowledge they have about nuclear energy, which will consequently lead to different judgments of risk and attitudes between men and women. Therefore, an interaction effect of gender and subjective

knowledge on risk perception and acceptability of nuclear energy was assumed.

Based on the average score of subjective knowledge (M=3.91), participants were divided into two groups: the *high* subjective knowledge group (scored 4 to 10) and the *low* subjective knowledge group (scored 1 to 3). A 2 (male versus female) × 2 (high versus low) analysis of variance was conducted. However, results of univariate analysis of variance failed to confirm the assumption, suggesting no significant interaction effect of gender and subjective knowledge (risk perception: $F_{gender\times group}$ (1,337)=0.48, p=.488; acceptability: $F_{gender\times group}$ (1,337)=0.01, p=.995). The main effect of gender on risk perception (F_{gender} (1,337)=7.13, p<.01, η^2=.02) was significant. Meanwhile, a marginally significant main effect of gender on acceptability (F_{gender} (1,337)=3.61, p=.058, η^2=.01) was also found by the analysis. As such, independent samples t-test was then performed to examine the differences in nuclear risk perception and acceptability of nuclear energy between men and women. Results suggested that women tended to perceive a higher level of nuclear risk than men did (males: M=3.71, SD=0.98; females: M=3.91, SD=0.97; t(339)=1.85, p<.05), and they were less likely than men to support the development of nuclear energy (males: M=3.27, SD=1.57; females: M=2.90, SD=1.38; t(339)=2.26, p<.05).

Discussion

This study investigated how Japanese people's use of news media was associated with their knowledge about nuclear energy, perceived nuclear risk, and attitude toward the development of nuclear energy in Japan. The current investigation has provided additional empirical evidence for the media's constitutive role in public understanding of risks. In general, the Japanese citizens still have a relatively unfavorable view of nuclear energy six years after the Fukushima disaster ($M_{acceptability}$=3.11). Findings of this study suggest important pathways to public attitude toward nuclear energy. More specifically, risk perception is a direct factor impeding public acceptance; television news and news from the Internet can significantly contribute to risk perception, and news from print media, namely newspapers and news magazines, can lead to high risk perception through the mediation of subjective knowledge about nuclear energy. For a majority of the lay public, information about technologically related issues, for instance, nuclear energy, can only be conveniently accessed through the media. As such, their understanding will likely follow the media's pattern of construction.

In the aftermath of the Fukushima disaster, the news media has put a continuous focus on the consequences of the accident. Several topics, including the worrisome radioactive contamination, the potential negative health effects, and details of the accident investigation, have captured so much of public attention these years. Moreover, this communication pattern may have substantially determined Japanese

people's criterion for evaluating nuclear energy. Findings of this study suggest that newspaper and news magazine readers tend to have more confidence in their knowledge about nuclear energy than users of broadcast and online media. The nature of a specific medium affects how a person can extract information from that medium and represent it in memory; in general, print media involves more cognitive effort in information processing than other types of media (Harris & Sanborn, 2014). Therefore, reading newspapers and news magazines can be a way to get deep engagement with an issue, which will consequently generate a feeling of familiarity. Knowledge was originally assumed to reduce fear and uncertainty because it can ensure a comprehensive judgment of the situation. However, given the fact that print media consumption carries a lot of weight in the formation of perceived familiarity, the more people think they know nuclear energy, the more likely they are to have a high risk perception because they know from the media that such technology could be very dangerous.

Comparing to print media, television news and news from the Internet were found to have a more direct power to affect risk perception. This may be not only because Japanese people get more news on television ($M_{television}$=5.34) and online ($M_{Internet}$=5.82) but also associated with the nature of these two mediums. Early experimental study revealed that the pictorial contents presented via television were understood and remembered better (Walma Van Der Molen & Van Der Voort, 1997), making television news stories more easily confused with reality. Internet-based media enables more effective dissemination and exchange of information than other types of media. In addition, the online environment supports a selective way of consuming multimedia materials, for instance, televised programs can be flexibly and repeatedly viewed online, which would likely leverage the social amplification of risk. It is worth noting that men and women seem to have similar patterns of news media use, however, women tend to show higher level of risk perception (M_{males}=3.71<$M_{females}$=3.91, t(339)=1.85, p<.05) and lower level of acceptability regarding nuclear energy (M_{males}=3.27>$M_{females}$=2.90, t(339)=2.26, p<.05) than men. As aforementioned, the same risks may mean different things to men and women due to different experiences they have and different social roles they are playing. Even though men and women are exposed to media coverage of the same issue, for instance, nuclear power, women tend to regard it as primarily an environmental problem, while men tend to consider it as mainly a scientific and technical matter (Davidson & Freudenburg, 1996). The gender difference may be driven by the episodic nature of news framing, televised mews in particular. Episodic framing involves storytelling within which an issue is presented in a specific event or personal case (Iyengar, 1994). News programs after the Fukushima disaster provided extensive coverage about nuclear victims, such as elderly evacuees, mothers of Fukushima who worried about their children's risk of thyroid cancer, and fishermen who longed for restarting their businesses. Such media frame appeals to the social

role of women, and thus women may be more influenced by media messages and feel more sensitive and vulnerable to nuclear risks than men.

Despite the findings and implications, there are several limitations of the current study that should be acknowledged. First, the specificity of the context (i.e., nuclear risk in the post-Fukushima era in Japan) and the sample (i.e., Japanese citizens) may limit the generalizability of the discussed results. Future research should expand to examine how the lay public reacts to different crisis and risk scenarios to achieve a better understanding of media effects. Second, future research should consider conducting content analysis of how the media portrays nuclear energy. Such investigation can demonstrate the characteristics of media messages, such as source, amount, and quality, and detect media frames. Moreover, content analysis can also help further develop the framework for examining media influence on public perceptions, attitudes, and actions toward crises and risks. Third, the role of Internet-based media in crisis and risk communication is worthy of further investigation. Findings of this study supported the power of the Internet as a source of news to increase nuclear risk perception. However, it was also found by this study that the Internet would significantly contribute to factual knowledge, which had a positive correlation with acceptability of nuclear energy (r=.15, p<.01). The nonlinear feature of the Internet allows convenient access to additional information through multiple links, which can contribute to users' better understanding of connections among factual information. Therefore, the online environment may facilitate effective crisis and risk communication in terms of its great potential in grabbing audience attention and increasing public knowledge. Overall, findings of this study are directly applicable to those engaging in the practice of nuclear communications in Japan. Other countries that intend to develop nuclear technology or promote the use of nuclear energy may obtain insights from the present study regarding possible strategies for improving communication with the public and gaining public trust and support.

REFERENCES

ACKERSON Leland K. & VISWANATH Kasisomayajula (2010). "Media Attention and Public Perceptions of Cancer and Eastern Equine Encephalitis". *Journal of Community Health*, 35(4): 409-416.

ALLAN Stuart, ADAM Barbara, & CARTER Cynthia (2000). "Introduction: The Media Politics of Environmental Risk". In ALLAN Stuart, ADAM Barbara, & CARTER Cynthia (eds.), *Environmental Risks and the Media*. New York, NY: Routledge. 1-26.

ANDERSON Ashley A., BROSSARD Dominique, SCHEUFELE Dietram A., XENOS Michael A., & LADWIG Peter (2014). "The 'Nasty Effect': Online Incivility and Risk Perceptions of Emerging Technologies". *Journal of*

Computer-Mediated Communication, 19(3): 373-387.

COX Robert & PEZZULLO Phaedra C. (2016). *Environmental Communication and the Public Sphere*. Thousand Oaks, CA: Sage.

DAVIDSON Debra J. & FREUDENBURG Wiluam R. (1996). "Gender and Environmental Risk Concerns: A Review and Analysis of Available Research". *Environment and Behavior*, 28(3): 302-339.

GROOT Judith I. M., STEG Linda, & POORTINGA Wouter (2013). "Values, Perceived Risks and Benefits, and Acceptability of Nuclear Energy". *Risk Analysis*, 33(2): 307-317.

DOUGLAS Mary & WILDAVSKY Aaron (1983). *Risk and Culture: An Essay on the Selection of Technological and Environmental Dangers*. Berkeley, CA: University of California Press.

ELDRIDGE John & REILLY Jacquie (2003). "Risk and Relativity: BSE and the British Media". In PIDGEON Nick, KASPERSON Roger E., & SLOVIC Paul (eds.), *The Social Amplification of Risk*. Cambridge: Cambridge University Press. 138-155.

ENTMAN Robert M. (1993). "Framing: Toward Clarification of A Fractured Paradigm". *Journal of Communication*, 43(4): 51-58.

FINUCANE Melissa L., ALHAKAMI Ali, SLOVIC Paul, & JOHNSON Stephen M. (2000). "The Affect Heuristic in Judgments of Risks and Benefits". *Journal of Behavioral Decision Making*, 13(1): 1-17.

FINUCANE Melissa L., SLOVIC Paul, MERTZ C. K., FLYNN James, & SATTERFIELD Theresa A. (2000). "Gender, Race, and Perceived Risk: The 'White Male' Effect". *Health, Risk & Society*, 2(2): 159-172.

FISCHHOFF Baruch, SLOVIC Paul, LICHTENSTEIN Sarah, READ Stephen, & COMBS Barbara (1978). "How Safe is Safe Enough? A Psychometric Study of Attitudes towards Technological Risks and Benefits". *Policy Sciences*, 9(2): 127-152.

FISCHER Gregory W., MORGAN M. Granger, FISCHHOFF Baruch, NAIR Indira, & LAVE Lester B. (1991). "What Risks Are People Concerned about". *Risk Analysis*, 11(2): 303-314.

FLYNN James, SLOVIC Paul, & MERTZ C. K. (1994). "Gender, Race, and Perception of Environmental Health Risks". *Risk Analysis*, 14(6): 1101-1108.

GUSTAFSOD Per E. (1998). "Gender Differences in Risk Perception: Theoretical and Methodological Perspectives". *Risk Analysis*, 18(6): 805-811.

HARRIS Richard Jackson & SANBORN Fred W. (2014). *A Cognitive Psychology of Mass Communication, Six Edition*. New York, NY: Routledge.

IYENGAR Shanto (1994). *Is Anyone Responsible?: How Television News Frames*

Political Issues. Chicago, IL: University of Chicago Press.

IYENGAR Shanto & KINDER Donald R. (2010). "The Priming Effect". In IYENGAR Shanto & KINDER Donald R. (eds.), *News That Matters: Television and American Opinion*. Chicago, IL: University of Chicago Press. 63-72.

IYENGAR Shanto & SIMON Adam (1993). "News Coverage of the Gulf Crisis and Public Opinion: A Study of Agenda-Setting, Priming, and Framing". *Communication Research*, 20(3): 365-383.

KAHNEMAN Daniel (2003). "A Perspective on Judgment and Choice: Mapping Bounded Rationality". *American Psychologist*, 58(9): 697-720.

KAHNEMAN Daniel (2011). *Thinking, Fast and Slow*. London: Penguin.

KASPERSON Jeanne X., KASPERSON Roger E., PIDGEON Nick, & SLOVIC Paul (2003). "The Social Amplification of Risk: Assessing Fifteen Years of Research and Theory". In PIDGEON Nick, KASPERSON Roger E., & SLOVIC Paul (eds.), *The Social Amplification of Risk*. Cambridge: Cambridge University Press. 13-46.

LAI Julian Chuk-ling & TAO Julia (2003). "Perception of Environmental Hazards in Hong Kong Chinese". *Risk Analysis*, 23(4): 669-684.

LUNDGREN Regina E. & MCMAKIN Andrea H. (2013). *Risk Communication: A Handbook for Communicating Environmental, Safety, and Health Risks*. Hoboken, NJ: Wiley.

FREWER Lynn J., MILES Susan, & MARSH Roy (2002). "The Media and Genetically Modified Foods: Evidence in Support of Social Amplification of Risk". *Risk Analysis*, 22(4): 701-711.

MCCOMBS Maxwell E. & SHAW Donald L. (1972). "The Agenda-Setting Function of Mass Media". *Public Opinion Quarterly*, 36(2): 176-187.

MURDOCK Graham, PETTS Judith, & HORLICK-JONES Tom (2003). "After Amplification: Rethinking the Role of the Media in Risk Communication". In PIDGEON Nick, KASPERSON Roger E., & SLOVIC Paul (eds.), *The Social Amplification of Risk*. Cambridge: Cambridge University Press. 156-178.

PETERS Ellen, MCCAUL Kevin D., STEFANEK Michael, & NELSON Wendy (2006). "A Heuristics Approach to Understanding Cancer Risk Perception: Contributions from Judgment and Decision-Making Research". *Annals of Behavioral Medicine*, 31(1): 45-52.

PIDGEON Nick, CHRISTOPHER Hood, DAVID Jones, BARRY Turner, & ROSE Gibson (1992). "Risk Perception". In *Risk: Analysis, Perception and Management*. London: The Royal Society. 89-134.

SCHEUFELE Dietram A. (1999). "Framing as A Theory of Media Effects". *Journal of Communication*, 49(1): 103-122.

SCHEUFELE Dietram A. & TEWKSBURY David (2007). “Framing, Agenda Setting, and Priming: The Evolution of Three Media Effects Models”. *Journal of Communication*, 57(1): 9-20.

SEVERIN Werner J. & TANKARD James W. (2013). *Communication Theories: Origins, Methods and Uses in the Mass Media*. Upper Saddle River, NJ: Pearson Education.

SLOVIC Paul (1987). “Perception of Risk”. *Science*, 236(4799): 280-285.

SLOVIC Paul (1992). “Perception of Risk: Reflections on the Psychometric Paradigm.” In SHELDON Krimsky & DOMINIC Golding (eds.), *Social Theories of Risk*. Santa Barbara, CA: Praeger. 117-152.

SLOVIC Paul, FINUCANE Melissa L., PETERS Ellen, & MACGREGOR Donald G. (2004). “Risk as Analysis and Risk as Feelings: Some Thoughts about Affect, Reason, Risk, and Rationality”. *Risk Analysis*, 24(2): 311-322.

SLOVIC Paul, PETERS Ellen, & FINUCANE Melissa L. (2005). “Affect, Risk, and Decision Making”. *Health Psychology*, 24(4): S35-S40.

THE ASAHI SHIMBUN (2016). Survey: 57% Oppose Rebooting Nuclear Reactors, 29% in Favor. Retrieved from http://www.asahi.com/ajw/articles/AJ201610180076.html

THE MINISTRY OF ECONOMY, TRADE AND INDUSTRY (2016). Energy in Japan: Reports of Agency for Natural Resources and Energy, Ministry of Economy, Trade and Industry, Government of Japan. Retrieved from http://www.enecho.meti.go.jp/about/pamphlet/pdf/energy_in_japan2016.pdf

TRIVIA QUIZ (2017). An Introduction to Nuclear Energy. Retrieved from http://www.funtrivia.com/playquiz/quiz3079852342500.html

TUCHMAN Gaye (1978). *Making News: A Study in the Construction of Reality*. New York, NY: Free Press.

TVERSKY Amos & KAHNEMAN Daniel (1974). “Judgment under Uncertainty: Heuristics and Biases”. *Science*, 185(4157): 1124-1131.

VAINIO Annukka, PALONIEMI Riikka, & VARHO Vilja (2017). “Weighing the Risks of Nuclear Energy and Climate Change: Trust in Different Information Sources, Perceived Risks, and Willingness to Pay for Alternatives to Nuclear Power”. *Risk Analysis*, 37(3): 557-569.

WACHINGER Gisela, RENN Ortwin, BEGG Chloe, & KUHLICKE Christian (2013). “The Risk Perception Paradox—Implications for Governance and Communication of Natural Hazards”. *Risk Analysis*, 33(6): 1049-1065.

WALMA VAN DER MOLEN Juliette H. & VAN DER VOORT Tom H. A. (1997). “Children’s Recall of Television and Print News: A Media Comparison Study”. *Journal of Educational Psychology*, 89(1): 82-91.

WILDAVSKY Aaron & DAKE Karl (1990). “Theories of Risk Perception: Who Fears What and Why?” *Daedalus*, 119(4): 41-60.