

The key factors impacting on science communication effects in the WeChat official accounts: A theoretical framework of risk-benefit perceptions

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Abstract

By adopting the theoretical framework of Risk-Benefit perceptions, this study takes the popularization of Artificial Intelligence (AI) knowledge as an empirical object to test the key factors impacting on science communication effects in the WeChat official accounts. Results showed that science communication uncertainty produced both direct and indirect effects on science communication effects. The indirect effect was mainly mediated by perceived risk. Public trust negatively moderated the association between perceived uncertainty and perceived risk at a low trust level. Perceived entertainment had a positive effect on science communication effects in the benefit-perception perspective.

Keywords: key factors, science communication effects, communication uncertainty, WeChat official accounts, Artificial Intelligence

INTRODUCTION

Science communication plays a crucial role in science activities and has received great attention in both developed and developing countries (Jin et al., 2018). Studies that aim to examine science communication effects shall merit scholarly attention because findings will provide scientists with insights on how to communicate

science effectively in diverse contexts (Varner, 2014). In recent years, many scientists prefer to use social media to communicate scientific knowledge, which greatly facilitates popular science communication among the public (Jia et al., 2017). Compared with scientists and professionals, the public are more influenced by the scientific information on social media (Cao and Li, 2015). However, questions arise regarding what factors may contribute to the effective public communication of science and technology through social media (Fontaine et al., 2019).

Artificial intelligence (AI), a branch of computer science and one of the most cutting-edge technologies, refers to technologies or machines that can think on their own like human beings (Patrick, 1992). AI knowledge have been integrated across people's daily life. People activate personal digital assistants such as Siri to enhance hands-free communication (Campolo et al., 2017). Public health organizations have used AI in screening, analyzing, predicting, and tracking both current patients and potential patients during COVID-19 (Vaishya et al., 2020). However, a public opinion survey with more than 20,000 respondents from 27 countries conducted by the Davos Forum revealed that around 41 percent of the respondents expressed concerns about the applications of AI (Yang, 2019). As the most popular social media platform in China, WeChat official accounts of popular science has become an ideal arena for communicating AI knowledge (Jia et al., 2017; Chinese Science Communication, 2017). Therefore, exploring the key factors effecting science communication effects may facilitate effective public communication of AI knowledge through WeChat official accounts and address public concerns.

This study first starts with a conceptualization of science communication effects and then tests the associations among perceived uncertainty, perceived risk, public trust and science communication effects from the perspective of Risk perceptions, as well as the associations among perceived entertainment and factors in the Technology Acceptance Model (TAM) from the perspective of Benefit perceptions. At last, hypothesized model of Risk-Benefit perceptions is provided.

LITERATURE REVIEW

Science communication effects and Risk-Benefit perceptions

There was some research on science communication effects in the prior literatures. When investigating the topics of Iran, H1N1 Swine and Michael Jackson on Twitter, Cha et al. (2010) derived three dimensions of science communication effects: in-degree (the number of followers), retweets (the number of sharing or forwarding), and mentions (the number of a Twitter user being mentioned). Kuang and Wu (2019) examined health communication topics and embraced individuals' awareness, cognition, attitude, and emotion in science communication effects. Science communication has three development stages and three models. The three stages were traditional popular science, public understanding of science, and reflective science communication in science communication effects, and the three models were the central broadcast model, deficient model, and democratic model of science communication (Liu, 2009). Based on three stages and three models of science communication, Niu (2020) identified four dimensions (i.e., public popularity of science, public understanding of science, public reflection of science, and public participation of science) in science communication effects of AI topics. The four dimensions calculated by entropy, a quantitative method, were 34.3%, 27.5%, 22.4% and 15.8% in science communication effects. This study will follow Niu's (2020) approach to examine the science communication effects of AI knowledge in the WeChat official accounts.

Some scholars have adopted the framework of Risk-Benefit perceptions in empirical studies to examine science communication effects (Connor and Siegrist, 2010; Hallman et al., 2003). The perspective of risk perceptions generally emphasizes the negative outcomes associated with innovative technologies. Hallman et al. (2003) examined the science communication of Genetically Modified Foods from risk perceptions. The perspective of benefit perceptions instead describes the positive outcomes associated with science technologies. Connor and Siegrist (2010) analyzed people's acceptance of gene technology from the perspective of perceived benefits. This study aims to develop this theoretical framework of the benefit-perception perspective.

Science communication uncertainty, perceived risk, and science communication effects

Uncertainty, rooted in science communication, refers to the possibility of encountering unpredictable or alternative outcomes beyond expectations (Berger and Calabrese, 1975). Hou (2018) argued that science communication uncertainty includes two parts. One is the uncertainty of science. The competitive, iterative, and eternal nature of scientific progress will inevitably generate conflicting theories and competing hypotheses (Shanteau, 2000). In terms of the uncertainty of AI knowledge, the deviation of training data or the setting of algorithm parameters will trigger unexpected results and make its performance unpredictable (Gao, 2020). The other is the uncertainty embedded in the science communication process. The interaction between AI knowledge and people is complicated and such complexity of interaction between humans and AI generates high uncertainty. Science communication uncertainty is relatively subjective in terms of public perceptions. Due to cultural diversity and ideological differences, the public may perceive and process scientific information in different ways and get selective exposure to scientific information in the communication process, which altogether contribute to the varying levels of cognitive understanding and science literacy of AI knowledge (Cheng et al., 2020; Fontaine et al., 2019). Different individuals may perceive different degrees of science communication uncertainty.

Perceived uncertainty is related to perceived risk (Mitchell, 1999). Cunningham (1967) defined perceived risk as the uncertainty of loss and severity of consequences expected by consumers. Scholars have evidenced the impact of science communication uncertainty on the public perceived risk (Majid et al., 2020; Sjoberg, 2001). Chen (2014) suggested that the uncertainty about genetically modified organisms (GMOs) incurs questioning and early warning and predicts the public perceived risk of GMOs. Wu (2019) pointed out that the uncertainty of genetically modified technology predicts the public perceived risk of the technology.

The uncertainty in the development of AI knowledge will spawn many risks. AI knowledge will encounter technical problems such as algorithm inexplicability, strong data dependence, and artificial malicious applications, which lead to risks in the fields of economy, society, and national politics and consequently affect economic security, ideological security, and national security (Zhang and Li, 2019). Thus, we proposed this hypothesis.

H1: The public perceived uncertainty of AI knowledge is positively associated with the public perceived risk.

Uncertainty is often incomprehensible and ambiguous and results in confusion and negative consequences (Han et al., 2007). Some scholars have argued that it is important to convey uncertainty to the public in science communication so that the public is not misled and science communication effects can be improved (Campbell, 2011). Empirical research has shown that the perceived uncertainty about scientists is negatively related to people's supportive attitudes toward scientific content (Ding et al., 2011). We therefore propose that perceived uncertainty about AI knowledge and science communication effects may be negatively related.

H2: The perceived uncertainty of AI knowledge is negatively associated with science communication effects.

Previous scholars have examined the relationship between perceived risk and technology acceptance attitudes or behaviors. Shi (2017) and Wu (2018) found that perceived risk mitigates consumers' willingness to use smartphones and mobile Apps. It can be expected that the public perceived uncertainty will have a negative impact on the science communication effects in understanding and accepting AI knowledge. Based on the above analyses, we proposed the following hypotheses.

H3: The perceived risk of AI knowledge is negatively associated with the science communication effects.

According the H1, H2, and H3, the hypothesis of mediating effect can be proposed.

H4: The public perceived risk of AI knowledge mediates the association between perceived uncertainty and science communication effects.

Public trust, perceived uncertainty, and perceived risk

Previous empirical studies have identified trust as an important factor in the science communication process (Brewer and Ley, 2011; Dijkstr and Gutteling, 2012). Public trust may moderate the relationship between perceived uncertainty and perceived risk. Some research suggested that trust serves as an important mechanism to

reduce users' uncertainty (Gefen, 2000). Bellaby (2010) pointed out that partial "trust" might play a moderating role between uncertainties and risks in transitions to use sustainable energy. Wu et al. (2019) argued that trust can moderate the association between treatment effect and medical risk awareness. The treatment effect is uncertain before the patient is treated, therefore, trust moderates the relationship between the uncertainty of medical effect and risk awareness. The higher the patient's trust, the less the impact of uncertainty affects risk awareness. The lower the patient's trust, the greater the impact of uncertainty on risk awareness. When public trust in the WeChat official accounts of popular science is high, it can be expected that the association between perceived uncertainty of science communication and the public perceived risk gets weak. On the contrary, when public trust is low, the association between perceived uncertainty of science communication and public perceived risk becomes strong. We therefore propose the following hypothesis.

H5: Public trust moderates the association between perceived uncertainty and perceived risk.

Perceived benefits and science communication effects

The TAM, one of the most commonly used theories to explain the public acceptance of new technologies or products, suggests that perceived ease of use affects perceived usefulness and perceived ease of use and perceived usefulness jointly influence attitude toward use, which consequently predicts intention to use and subsequent use behavior (Davis, 1986). Previous studies adopted the TAM to examine Facebook and WeChat use and found that perceived usefulness and perceived ease of use have positive impacts on attitudes toward social media platforms and subsequent use behaviors (e.g., Rauniar et al., 2014; Zheng and Zhang, 2020). Perceived ease of use has a significant impact on perceived usefulness of WeChat shopping (Li and Li, 2016). This study utilizes the TAM to examine the mechanism of use of WeChat official accounts of AI knowledge. The perceived usefulness of WeChat official accounts is affected by the perceived ease of use. The perceived usefulness and perceived ease of use will altogether influence the public to use the WeChat official accounts to read articles about AI knowledge. Perceived ease of use and perceived usefulness will directly and indirectly influence users' behavioral intentions to adopt WeChat services (Yang, 2020). Based on the above ideas, we propose the following hypotheses.

H6a: The public perceived ease of use is positively associated with science communication effects.

H6b: Perceived usefulness is positively associated with science communication effects.

H7: Perceived ease of use is positively associated with perceived usefulness.

H8: The public perceived usefulness mediates the association between perceived ease of use and science communication effects.

Scholars have expanded the TAM by adding emotional factors. Value-based adoption model (VAM) is an expanded model on technology acceptance (Kim et al., 2007). Perceived entertainment is one of the perceived benefits in VAM. Chinese users often read articles on WeChat Moments and official accounts or play WeChat mini-program games for entertainment and leisure purposes.

Perceived entertainment will enhance social media users' willingness to use WeChat official accounts because it relieves cognitive loadings and arouses positive emotions. The association between perceived entertainment and intention to use new technologies has been well addressed in previous studies. Moon and Kim (2001) pointed out that perceived entertainment online has a positive impact on users' intention to use for a World-Wide-Web context. Ouyang (2015) found that perceived entertainment is a strong predictor of WeChat Moments use.

Similar to perceived ease of use, perceived entertainment will also have a positive impact on perceived usefulness. Hong and Tam (2006) found that perceived entertainment has a direct and positive impact on users' perceived usefulness and behavioral intention to use mobile data services. The impact of perceived usefulness on both intention and actual behavior in science communication further affects the overall science communication effects. The perceived usefulness of Weibo vlogs has affected the audiences' attitudes toward vlogs and their actual use behavior (Lv, 2021). Among perceived entertainment, perceived usefulness, intention and behavior, perceived entertainment indirectly affects user behavioral intention through perceived usefulness (Sun et al., 2016). Perceived entertainment indirectly affects college students' attitudes toward using mobile live broadcasting

through the mediation of perceived usefulness (Du, 2018). Science communication effects includes public popularity of science, public understanding of science, public reflection of science and public participation in science in this paper, so the attitudes, intentions and behaviors of the public formed through using social media in the above studies reflect science communication effects. For WeChat users, reading, sharing and forwarding AI-related information of WeChat official accounts is part of the science communication effects. We therefore raise the following hypotheses.

H9: Perceived entertainment is positively associated with science communication effects.

H10: Perceived entertainment is positively associated with perceived usefulness.

H11: Perceived usefulness mediates the association between perceived entertainment and science communication effects.

METHOD

Respondents

Of the 558 respondents who participated in the study, 531 (95.16%) finally completed the survey. In the final sample, the gender ratio was about even, with 51.22% men and 48.73% women. Respondents aged from 18 to 50 accounted for 90% of the total sample. In terms of education, 53.1% were undergraduates, 25.0% were postgraduates, and 21.9% were below secondary school. Media usage refers to previous exposure to popular science on WeChat official accounts. Most respondents used WeChat official accounts of popular science from 2 to 3 years (45.6%), followed by respondents who used the accounts from 1 to 2 years (30.9%).

Measures

The dependent variable of this study is science communication effects of WeChat official accounts of popular science. The independent variables (i.e. perceived uncertainty of science communication, perceived ease of use and perceived entertainment), the mediating variables (i.e. perceived usefulness and perceived risk), and the moderating variable (i.e. public trust) were also measured. The control variables included age, education, job and media usage. Table 1 summarizes the key variables and their measures.

Table 1. Key variables and measures

Variable	Measurement item	Reference	M (SD) Cronbach α
Perceived usefulness	(1) WeChat official accounts of popular science enables me to access a lot of information about AI technologies.	Davis (1986) Bhattacharjee (2001)	3.875 (1.141) .872
	(2) WeChat official accounts of popular science can provide me with practical knowledge about AI technologies.		
	(3) WeChat official accounts of popular science are efficient for me to know about AI technologies.		
Perceived ease of use	(1) WeChat official accounts of popular science are easy to use.	Davis (1986)	3.930 (1.130) .859
	(2) Reading or sharing articles about AI technologies through WeChat official accounts is not limited by time and place.		
	(3) It is easy to understand AI technology articles on WeChat official accounts of popular science.		

Perceived entertainment	(1) WeChat official accounts for popular science enable me to see interesting AI content. (2) Reading articles about AI on WeChat official accounts can make me feel better. (3) Forwarding or sharing AI articles on WeChat official accounts makes me feel happy.	Davis (1986) Moon and Kim (2001)	3.696 (1.221) .873
Public trust	(1) I think the WeChat official accounts are authoritative. (2) I don't think the WeChat official accounts will release my privacy. (3) I think the information provided on the WeChat official accounts is reliable.	McKnight et al. (2002)	3.874 (1.100) .850
Perceived uncertainty in science communication	(1) The development of AI scientific regulations in the future is uncertain. (2) The application of AI technologies in the future is uncertain. (3) The process of AI communication is uncertain.	Friedman et al. (1999) Gao (2020)	3.042 (1.023) .787
Perceived risk	(1) I am concerned about the future of AI technologies. (2) I am concerned about the author's expertise in AI technologies. (3) I am concerned that the authors may produce the articles by exaggerating or belittling AI technologies for practical purposes.	Pan et al. (2010) Wu (2019)	3.687 (1.238) .872
Public popularity	(1) Have you heard about topics of AI? (2) Have you read articles about AI? (3) Have you learned anything related to AI?		2.343 (.953) .742
Public understanding	(1) How much do you understand the main ideas of this article? (2) How much do you understand the phenomena mentioned in this article. (3) How much do you understand the principle of this article?	Chang and Yang (2009) Hu (2019) Gao (2020)	3.735 (1.136) .868
Public reflection	(1) How much do you identify with the AI technologies mentioned in this article. (2) You will think about the impact of AI technologies on your work or life. (3) You will think of the impact of AI technologies on the country or the society.	Wan et al. (2011) Xing (2011)	3.766 (1.149) .868
Behavioral participation	(1) I will share or forward this article. (2) The knowledge in this article will guide my work and life. (3) I will try to buy AI products.		3.641 (1.250) .880

Science communication effects	The Public popularity, public understanding, public reflection and Behavioral participation are weighted to form a composite measure of science communication effects.	Niu (2020)
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Procedures

A survey with convenient sampling was used to collect data. This article entrusts a consulting service company to select respondents to fill in the questionnaires. Respondents were first asked to report whether they had read AI knowledge articles on WeChat official accounts of popular science (“Yes” or “No”). If respondents reported “No”, they were excluded from the study. Only those who reported “Yes” were asked to answer the questions based on their experiences of reading AI articles on WeChat official accounts of popular science.

DATA ANALYSIS

We performed structural equation modeling analyses to test the hypotheses using AMOS. The model fit was good (Chi-square/ df = 1.212, RMSEA = .029, GFI = .97, NFI = .97, IFI = .99, TLI = .99, CFI = .99).

Results of path of structural equation model analyses showed that perceived uncertainty of science communication was positively associated with perceived risk ($\beta = 0.26, p < .001$; H1) and the science communication effects ($\beta = 0.136, p < .001$; H2), and the perceived risk was positively associated with the science communication effects ($\beta = 0.066, p < .01$; H3).

H4 proposed the mediating effect of perceived risk in the association between perceived uncertainty and science communication effects. To test the hypothesis, this paper followed three-step regression method (Baron and Kenny, 1986). The approach first constructs three multiple regression equation models and then compares these models to analyze whether the mediating effect is statistically significant. Analyzing the simple linear regression of perceived uncertainty on science communication effects in the first step, Results showed that the impact of perceived uncertainty on science communication effects was significant ($\beta = 0.12, p < .01$), and running the simple linear regression of perceived uncertainty on perceived risk, the results found that the impact of perceived uncertainty on mediating variable “perceived risk” was also significant in the second step ($\beta = 0.096, p < .05$). At last, after adding the mediating variable “perceived risk” in the first regression, the impact of perceived uncertainty ($\beta = 0.109, p < .05$) and perceived risk on science communication effects is also significant ($\beta = 0.114, p < .05$). Therefore, H4 was supported. Perceived risk partially mediated the association between perceived uncertainty of science communication and science communication effects according to three-step regression method (Baron and Kenny, 1986).

H5 proposed the moderating role of public trust in the association between perceived uncertainty of science communication and perceived risk. In the multiple regression model, perceived uncertainty, perceived trust and the interaction between perceived uncertainty and public trust were entered as independent variables and perceived risk was entered as the dependent variable. Results showed that the interaction between perceived uncertainty and public trust was significantly negative ($\beta = -0.134, p < .05$), and the R-square changed significantly after the interaction variable was added ($R^2 = 0.088, R^2_{\text{change}} = 0.1, p < .05$). PROCESS Macro (model 1) was adopted to test the moderating effect of public trust at the different levels (Hayes, 2018). Results showed that confidence interval did not include 0 between LLCI (0.100) and ULCI (0.402) at the low-level group of public trust, whereas confidence interval contained 0 between LLCI (-0.162) and ULCI (-0.148) at the high-level group of public trust. Therefore, public trust moderated the association between perceived uncertainty of science communication and perceived risk and such moderating effect was significant when public trust was low.

An additional model was performed to test the moderated mediation effect, using Model 7 of PROCESS in SPSS. Results showed that the confidence interval was between LLCI (-0.021) and ULCI (-0.002). Therefore, the moderated mediation effect was significantly negative ($\beta = -0.01$).

The testing results of H6a, H6b, and H7 are as follows. The results of structural equation modelling indicated that the association was not significant between perceived ease of use ($\beta = -0.022, p > .05$; H6a), perceived usefulness ($\beta = 0.015, p > .05$; H6b) and science communication effects. Three-step regression method was adopted to test the mediating effect of perceived usefulness between perceived ease of use on science communication effects. Results showed that the impact of perceived ease of use on science communication effects was not significant in the first step ($\beta = -0.014, p > .05$). Perceived usefulness did not mediate the association between perceived ease of use and science communication effects. H8 was not supported. Results also indicated that perceived entertainment was positively associated with science communication effects ($\beta = 0.058, p < .05$; H9), but was not significantly associated with perceived usefulness ($\beta = 0.043, p > .05$; H10). The association between perceived entertainment and perceived usefulness was not significant in the second step ($\beta = 0.032, p > .05$). No mediation of perceived usefulness was found in the association between perceived entertainment and science communication effects. Therefore, H11 was not supported.

RESULT AND DISCUSSION

The findings revealed that the public perceived uncertainty of AI knowledge had a positive impact on science communication effects. It makes sense that when the public are uncertain about an emerging technology, the motivation of uncertainty reduction will drive them to know more about the technology, reflect more on the technology, and engage in more tech-related sharing or forwarding activities on social media. In China, AI knowledge remain unfathomable in the public eyes and the perceived uncertainty of AI is still high. Driven by curiosity and interests, the public want to know more about such high-tech. The findings also suggested a positive association between the public perceived risk of AI knowledge and science communication effects. Another possible explanation is that the positive impact of perceived uncertainty and perceived risk on science communication effects is likely to be related to the life cycle of scientific and technological development. According to the diminishing marginal utility, in the initial phase of a new technology, such an impact is positive. When the public become more familiar with the technology, the utility of perceived uncertainty and perceived risk will diminish marginally. In addition, we speculate that the association between perceived risk and science communication effects may be contingent on the content of science communication in terms of the frames or valence of media coverage (Gong et al., 2015; Schuck and De Vreese, 2006).

What was unexpected, the two factors (i.e. perceived usefulness and perceived ease of use) proposed in the TAM, exerted no significant influence on science communication effects of AI knowledge in WeChat official accounts. One possible explanation is that the TAM mainly examines people's willingness to accept new technologies and products. This study regards science communication effects as a comprehensive concept with multiple dimensions. It goes beyond the public willingness to accept technologies and includes public understanding, reflection and even behavioral participation. The multi-dimension of science communication effects may lead to non-significance. Moreover, the public have got used to WeChat and WeChat official accounts and they are no longer new products in China, so the impact of perceived usefulness and perceived ease of use wanes. However, perceived entertainment in using WeChat official accounts showed a positive impact on the public understanding of AI knowledge. People use WeChat for leisure and entertainment, given the eye-catching content production on WeChat official accounts, vivid interface and sophisticatedly built entertainment features. The content of popular science produced on WeChat official accounts caters to the public needs for entertainment. It enlightens scientists and educators regarding how to design science communication campaigns when they aim to promote new technologies.

The findings also revealed a negative moderating role of public trust in the association between perceived uncertainty and perceived risk and the moderating effect of public trust was found significant only at a low-trust level. The public were more concerned about the uncertainty and risks of AI knowledge when they had low trust in the information sources.

Although the current study provides insights on how to reduce public concerns and misunderstanding

through the science communication process, some caveats need to be addressed. First, taking science communication effects as a comprehensive variable was a black box. This study did not examine the impact of science communication uncertainty on each dimension of science communication effects, which provided limited information regarding how such uncertainty contributed to the public popularity, public understanding, public reflection of AI knowledge and AI-related social media participation. Second, science communication uncertainty and science communication effects were operationalized as respondents' subjective perceptions. Objective measures, such as the number of views, likes and retweets on social media shall also be included. Other methods such as Bayesian probability can also be employed to capture science communication uncertainty (Morgan et al., 1992).

Declaration of Conflicting Interest

The authors declare that there is no conflict of interest.

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