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An analysis of literacy differences related to the identification and dissemination of misinformation in Japan

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Abstract

Purpose – This study aims to examine the relationship between various types of literacy on one hand and identification of misinformation and dissemination of such information on the other, in search for better countermeasures against misinformation.

Design/methodology/approach – Based on data from a large-scale survey, models are constructed and analyzed to assess the relationships of literacy with both the identification of inaccuracies and dissemination behavior.

Findings – Regarding the identification of misinformation, individuals with high critical thinking attitudes (subjective literacy) are less likely to recognize misinformation, while other objective literacies do not have a significant relationship. Regarding dissemination behavior, individuals with high information literacy, media literacy and critical thinking scores tend not to disseminate misinformation, whereas those with high critical thinking attitudes are more likely to disseminate such information.

Originality/value – First, it quantitatively elucidates the relationships various literacies have with the accuracy judgment and dissemination behavior of misinformation. This highlights the effectiveness of objective indicators of

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literacies and the need for caution regarding subjective literacy – i.e. self-confidence in their own literacy. Second, it provides a cross-disciplinary analysis of the relationships, covering not only oft-studied politics and health care but also various other fields, thereby identifying comprehensive literacy strategies against misinformation. Third, it addresses differences in dissemination methods and offers insights into more practical countermeasures.

Keywords Misinformation, False information, Literacy, True/false judgment, Dissemination behavior, Disinformation

Paper type Research paper

Introduction

Background

The purpose of this study is to quantitatively analyze the relationship between literacy and both the identification and dissemination of widely spread misinformation in Japan, identifying commonalities and differences in the effective literacies for each. This aims to develop more effective countermeasures against misinformation.

Misinformation's social impact has become increasingly severe. During the 2016 US presidential election, misinformation favoring Trump was shared about 30 million times, while that favoring Clinton was shared about 7.6 million times, totaling approximately 37.6 million shares (Allcott and Gentzkow, 2017). Political content dissemination bots used in this election were also used in the 2017 French election (Lazer *et al.*, 2018). In the 2017 German federal election, one-fifth of the news shared on Twitter contained misinformation (Neudert *et al.*, 2017).

Corporate stock prices and brand images are also affected by misinformation. For instance, when false news about United Airlines filing for bankruptcy was posted in September 2008, its stock price plummeted by 76% (Carvalho *et al.*, 2011). Conversely, companies benefiting from positive misinformation experienced unusually high returns and trading volumes (Ullah *et al.*, 2014). Flostrand *et al.* (2019) revealed through surveys of brand managers that the increase in misinformation, particularly in the service industry, is perceived as a significant risk.

In the medical field, misinformation has had substantial effects, especially related to COVID-19. Numerous misinformation posted about COVID-19 has not only hindered proper treatment but also potentially facilitated the virus's spread (Pennycook *et al.*, 2020). Despite social media companies' efforts to curb this, COVID-19 misinformation has spread globally, across multiple languages and media formats, including videos and photos (Frenkel *et al.*, 2020). In addition, research on misinformation in beauty and healthcare has also been conducted (De Regt *et al.*, 2020). Misinformation issues have also been identified in other fields, including sexual minorities and diversity (Strand and Svensson, 2019; Lelo and Caminhas, 2021; Carratalá, 2023).

Furthermore, the increasing global prevalence of generative artificial intelligence (AI) has exacerbated the issue of misinformation. For instance, during the 2024 US presidential election, the use of AI-generated deepfakes became a significant concern.

Literature review and research gaps

Identification of misinformation

Research on the detection of misinformation has accumulated findings related to cognitive and demographic factors. Extreme misinformation does not convince people, but repeated exposure to plausible misinformation significantly increases its impact (Pennycook *et al.*, 2018). Higher analytical thinking scores correlate with better identification of misinformation, while lower scores correlate with poorer identification (Pennycook and

Rand, 2019). Younger individuals, especially those aged 15–20 who are highly active on social media, are more susceptible to misinformation (Manalu *et al.*, 2018).

Studies in the context of literacy have also accumulated. An online survey of US citizens revealed that information literacy significantly enhances the ability to identify misinformation, whereas other forms of literacy (media, digital and news) do not have significant effects (Jones-Jang *et al.*, 2021). Information literacy involves the ability to assess the reliability of sources, detect biases and identify the presence of the author's opinions (Boh Podgornik *et al.*, 2016). On the other hand, media literacy pertains to interactions with mass media, news literacy to understanding the influence and creation of news and digital literacy to computer usage skills. Training in these literacies can improve understanding and recognition of misinformation, as well as the tendency to share accurate news (Apuke *et al.*, 2023). In addition, conspiratorial thinking and patriotism positively correlate with belief in political misinformation, while media literacy and concern about misinformation negatively correlate with such belief (Daunt *et al.*, 2023).

Research on COVID-19 misinformation is notable, showing a significant correlation between accuracy of judgment on the veracity of information and e-health literacy. A one-unit increase in e-health literacy scores corresponds to a 6% decrease in the likelihood of remaining unvaccinated (Nazari *et al.*, 2023). Tanihara and Yamaguchi (2023) examined the effectiveness of fact-checking and its relationship with literacy and media types used for dissemination. They found that information literacy is crucial for correctly receiving fact-checking information, especially for COVID-19 misinformation, where government websites are more effective than social media. They warn that indiscriminate sharing of fact-check information on social media can be counterproductive depending on the recipient's literacy. On the other hand, it is important to note that some accounts exhibit behavior typically associated with media literacy, yet as a result, appear to have come to believe COVID-19 misinformation (Toriumi, 2024).

Beyond analytical thinking and literacy, research also explores the role of belief strength in judgment. Politically extreme individuals are more likely to accept misinformation aligned with their values and resist corrections (Kahan, 2017). In Zambia, individuals with higher education are confident in identifying misinformation but are less flexible in their beliefs, often accepting misinformation that aligns with their views (Gondwe, 2023).

Dissemination behavior

There is also extensive research on dissemination behavior. Misinformation spreads more widely than true news because people tend to share novel information, which misinformation often represents (Vosoughi *et al.*, 2018). On Facebook, the frequency of misinformation shares can match or even exceed that of true news (Fletcher *et al.*, 2018). Information with strong timeliness or novelty tends to spread more easily, and information that includes images, such as screenshots of television screens or news, is also more likely to be disseminated (Inoue and Yamamoto, 2024).

Some studied the relationships between various types of literacies and dissemination behavior. Yamaguchi *et al.* (2022) revealed that low levels of news literacy, digital literacy and information literacy are associated with a higher tendency to unknowingly spread misinformation. Yamaguchi and Tanihara (2023) found that individuals who believe misinformation to be true are more likely to spread it compared to those who do not. In addition, individuals with low media and information literacy are more likely to disseminate misinformation than those with high media and information literacy. Khan and Idris (2019) explored the relationship between information sharing on social media without verifying the accuracy of the said information and what they termed information literacy skills. They

found that some skills (learning advanced skills via YouTube) negatively correlate with one's tendency to share information without verifying its accuracy, while other skills (making valuable contributions to online communities and using online tool to verify information) showed positive correlation.

Other studies indicated other relevant factors, though not necessarily consistently. Talwar *et al.* (2019) indicated that trust in online articles, the degree of self-disclosure online, fear of missing out (FoMO) and social media fatigue positively correlate with the sharing and dissemination of misinformation. Additional factors include the alignment of information with personal beliefs, lack of time to verify information (Valencia-Arias *et al.*, 2023), political extremism (Van Bavel and Pereira, 2018) and the entertainment value of misinformation, which serves as an extrinsic motivator along with self-promotion, conspiracy beliefs and political ideology (Melchior and Oliveira, 2024). Fake news sharing was found to be correlated with negative affective orientation toward social media (Chadwick *et al.*, 2022), altruism and ignorance, but not FoMO, pass time or entertainment-seeking (Balakrishnan *et al.*, 2021). Yet another study suggested that altruism is a strong predictor and socialization, information seeking and passing time are relevant, but not entertainment (Apuke and Omar, 2021). Information sharing via social media without verifying its accuracy is found to be correlated with general belief in reliability of online information and negatively correlated to with attitude to verify information (Khan and Idris, 2019). Sharing of unverified COVID-19-related information was found to be correlated positively with self-promotion, entertainment value of the information and deficient self-regulation but negatively with exploration and religiosity in one study (Islam *et al.*, 2021), whereas it was found to be correlated with trust in online information and perceived online overload in another study (Laato *et al.*, 2020).

Research focusing on social media usage and dissemination behavior has also been prominent. Individuals who frequently use social media and have strong online connections are more likely to spread misinformation (Shen *et al.*, 2019). Longer social media usage increases exposure to misinformation, raising the likelihood of sharing it without distinguishing it from true news (Li, 2019). On Twitter, users who frequently retweet are more likely to spread misinformation (Iwahashi and Yabuki, 2018). Conversely, those with high information literacy are less likely to accept and spread misinformation (Pennycook and Rand, 2020).

Fields of misinformation

Research on misinformation can be categorized by field. In politics, misinformation has been widely studied, especially during the 2016 US presidential election (Allcott and Gentzkow, 2017; Lazer *et al.*, 2018) and the 2017 German federal election (Neudert *et al.*, 2017).

In healthcare, COVID-19-related studies are prominent (Frenkel *et al.*, 2020; Pennycook *et al.*, 2020; Tanihara and Yamaguchi, 2023; Nazari *et al.*, 2023), along with misinformation in the health and beauty industry (De Regt *et al.*, 2020). In Japan, as exposure to uncertain health-related information increases, the ability to acquire accurate knowledge when needed has become crucial. The importance of health information literacy for critically evaluating, judging and selecting health information has been emphasized (Mori, 2024).

Recent research also addresses misinformation about sexual minorities and diversity. Lelo and Caminhas (2021) examined gender-related misinformation in Brazil, highlighting issues in moral discourse. Carratalá (2023) noted that much of the fake news circulating on social networks target vulnerable groups like the lesbian, gay, bisexual, transgender, queer or questioning, intersex, and others (LGBTQI+) community with hate speech, often being perceived as true information.

Research gaps and hypotheses

As demonstrated, various studies have been conducted on the identification and dissemination of misinformation. However, there are still areas that need clarification to develop effective countermeasures.

The first point is the lack of research on the literacies related to both the identification and dissemination of misinformation. Effective literacies may differ between these two behaviors. For example, recognizing the problem of spreading uncertain information might prevent dissemination even if one cannot identify misinformation. Additionally, individuals with high subjective literacy but low objective literacy scores might have poor judgment capabilities. Few studies, such as Yamaguchi *et al.* (2022), have addressed these aspects but did not include subjective literacy.

The second point is the scarcity of cross-disciplinary analyses. While existing literature has focused on politics and healthcare, there is a lack of cross-disciplinary research, especially involving Japanese misinformation. Comprehensive countermeasures require analyses that transcend specific fields of misinformation.

Clarifying these issues will identify effective literacies for combating misinformation in today's information environment, guiding policy and organizational actions. Therefore, this study tests the following hypotheses:

H1. Individuals with low literacy related to misinformation are less likely to identify it than those with high literacy.

H2. Individuals with low literacy related to misinformation are more likely to disseminate it than those with high literacy.

H3. Effective literacies for combating misinformation differ between judging the truth or false and dissemination prevention.

The novelty of this study lies in two aspects. First, it quantitatively elucidates the relationships between judging the truth or false, dissemination behavior of misinformation and various literacies. Second, it provides a cross-disciplinary analysis of these relationships, highlighting literacies as comprehensive countermeasures against misinformation.

Methods

Questionnaire data

Based on the results of the literature review, we developed questionnaire items and conducted a survey. The survey targeted registered monitors aged 15–69, maintained by the Internet research company My Voice.com, Inc. The survey was conducted from February 1 to February 5, 2024, and collected 33,487 responses for the preliminary survey and 6,214 responses for the main survey. After data cleaning, including trap questions, 20,000 valid responses were retained for the preliminary survey and 5,000 for the main survey. Respondents were presented with actual misinformation (without labeling it as such), and all survey participants, including those who discontinued the survey midway, were informed after the survey was completed that the presented cases were false or misinformation.

The primary purposes of the preliminary survey were to determine the percentage of individuals who have encountered misinformation and to screen those individuals to obtain a prioritized sample. The preliminary survey targeted a population residing throughout Japan, with allocations based on population estimates by sex and age group.

As the screening stage included a higher proportion of individuals exposed to misinformation, the sample distribution in this study is skewed compared to the real-world

population. In other words, analyzing the data from this study as is would lead to discrepancies in analyzing the rate of exposure to misinformation and the characteristics of the media through which it is encountered. Therefore, in the analysis using this study's data, the rate of exposure was calculated to misinformation by five-year age and gender groups based on preliminary survey data and performed weighting adjustments accordingly. The sample sizes by age and gender groups used in both the preliminary and main surveys are shown in Table 1 below.

A total of 15 pieces of misinformation were presented across five areas:

(1) domestic politics (favoring conservatives);
(2) domestic politics (favoring liberals);
(3) medicine/health;
(4) war/conflict; and
(5) diversity (foreign nationals, sexual minorities, etc.) (see Appendix Table A1. for details).

To select these pieces of misinformation, we first comprehensively collected those that were widely disseminated in Japan in 2023 and had corresponding fact-check articles from fact-checking organizations. Referring to fields covered in previous studies, the information was categorized into five areas and selected the three most widely spread pieces of information in each field.

The obtained data includes the following literacy indicators, as well as interest in news in each field, usage time for various media, political inclination (conservatism), political extremity and demographic attributes. Interest in news was surveyed on a five-point scale ranging from "1: Not at all interested" to "5: Very interested" for each news field, with higher scores indicating greater interest. For political inclination, we referred to Inamasu and Miura (2015) and conducted a survey on a seven-point scale of conservative-liberal ideology to create an indicator of how conservative the respondents are. We also created a variable indicating political extremity by taking the absolute value of the deviation from the median.

Table 1. Sample size by gender and age

	Preliminary			Main		
Age	Male	Female	Total	Male	Female	Total
15–19	697	660	1,357	174	183	357
20–24	788	744	1,532	173	196	369
25–29	820	776	1,596	216	236	452
30–34	803	761	1,564	155	96	251
35–39	882	847	1,729	249	143	392
40–44	965	938	1,903	166	188	354
45–49	1,130	1,101	2,231	269	227	496
50–54	1,204	1,182	2,386	341	346	687
55–59	1,024	1,024	2,048	273	254	527
60–64	916	933	1,849	286	234	520
65–69	879	926	1,805	301	294	595
Total	10,108	9,892	20,000	2,603	2,397	5,000

Source: Table by authors

Literacy data

Details on the literacy collected within the questionnaire are as follows. First, information literacy was surveyed using five items based on Jones-Jang *et al.* (2021) information literacy framework, modified to emphasize Japanese people's ability to read and understand information. The number of correct answers was scored from 0 to 5 points.

Next, media literacy was assessed. Referring to Kotera (2017) and Sakamoto (2022), questions were designed covering the following six areas:

(1) constructiveness of media messages;
(2) media's ability to construct "social reality";
(3) commercial nature of media;
(4) ideology and value transmission of media;
(5) media style and language; and
(6) nonuniform interpretability by receivers.

Specifically, we selected questions with high item-total correlation coefficients in Kotera's (2017) analysis and those applicable to online media. Media literacy was defined as "the ability to read and understand media or media messages." All questions were surveyed using a four-point scale from "strongly agree" to "strongly disagree," with the average score used as the media literacy score.

Next, critical thinking was examined. Critical thinking is defined as "recursive thinking that consciously examines one's reasoning process" (Ennis, 1989) and involves logical and unbiased thinking. This construct is divided into attitudes and dispositions, and abilities and skills (Hirooka *et al.*, 2001). To measure critical thinking, it is important to assess both the ability and the disposition to demonstrate it (Hirayama and Kusumi, 2004; Nakanishi *et al.*, 2006; Isowa and Minami, 2015). Therefore, this study investigated both critical thinking attitudes and abilities.

For critical thinking attitudes, we referred to the social critical thinking disposition scale by Nakanishi *et al.* (2006) and prepared 27 questions. Respondents rated their abilities on a seven-point scale ranging from "very capable" to "not capable at all." The average score across all items (with "very capable" scoring 7 points) was calculated to derive the critical thinking attitude score (1–7 points). In the original paper, this scale is defined as measuring the degree of an individual's critical thinking from three perspectives:

(1) disposition;
(2) experience; and
(3) self-recognition of ability.

This indicator is the only one that measures self-reported attitudes.

Additionally, to assess critical thinking skills, we referred to Kuhara *et al.* (1983) critical thinking skills test, a Japanese translation of the Watson–Glaser critical thinking appraisal, commonly used to measure critical thinking ability. This test measures the ability to evaluate the degree of certainty from 20 textual reasoning questions. However, to avoid confusion among respondents, the names of characters and nouns in the questions were updated to reflect the context of 2024, when this study was conducted, rather than 1985, when the original paper was published. The number of correct answers to these 20 questions was used as the score (0–20).

Analysis

Because many factors are thought to influence the judgment on misinformation, regression analysis is used to clarify the influence of these factors. Regarding the tendency to engage in dissemination behavior, it is considered appropriate to conduct an analysis to identify related

factors using a logit model, as referenced in Yamaguchi and Tanihara (2023). The model of determinants for the judgment can be written as in equation (1) below, where i is the individual and t is each piece of misinformation:

$$log_{it}[P(Correct_{it}=1)] = log\left(\frac{P[Correct_{it}]}{1-P[Correct_{it}]}\right) = \alpha + \beta_1 Literacy_i + \beta_2 Media\_usage_i + \beta_3 Characteristics_i + \gamma_1 FN_t \quad (1)$$

Where $Correct_{it}$ is a dummy variable set to 1 if individual i believes that misinformation t is false, $P(Correct_{it} = 1)$ is the probability that $Correct_{it}$ is 1. $Literacy_i$ is a vector of literacy measures, including media literacy, information literacy, critical thinking attitude and critical thinking score. $Characteristics_i$ is an attribute vector for individual i, including interest in information and news, political leanings (conservatism and extremism), internet usage history (years), gender (female), age and education (college degree or higher). FN_t is a vector of dummy variables set to 1 if the information is about misinformation t. α, β_1, β_2, β_3 and γ_1 are parameters associated with each variable or vector. The model is a logit model with t as a fixed effect. Note that the analysis is limited to those who are exposed to each misinformation.

Similarly, many factors are believed to influence the dissemination behavior of misinformation, so regression analysis will be used to clarify these influences. The determinant model of misinformation dissemination behavior can be written as in equation (2) below:

$$log_{it}[P(Spread_{it}=1)] = log\left(\frac{P[Spread_{it}]}{1-P[Spread_{it}]}\right) = \alpha + \beta_1 Correct_{it} + \beta_2 Literacy_i + \beta_3 Media\_usage_i + \beta_4 Characteristics_i + \gamma_1 FN_t \quad (2)$$

Where $Spread_{it}$ is a dummy variable set to 1 if individual i diffuses misinformation t, $P(Spread_{it} = 1)$ is the probability that $Spread_{it} = 1$, $Correct_{it}$ is a vector of dummy variables set to 1 if individual i considers misinformation t to be correct information, and 1 if individual i considers misinformation t to be misinformation, α, β_1, β_2, β_3, β_4 and γ_1 are parameters associated with each variable or vector. The model is a logit model with t as a fixed effect. Note that the analysis is limited to those who are exposed to each misinformation.

Basic statistics

The model used in this analysis adopts a panel data structure for both the accuracy judgment and dissemination behavior. This means that if individual i encounters misinformation t, it constitutes one sample, and if individual i encounters three instances of misinformation, it constitutes three samples. If the individual is unaware of misinformation t, they are not included in the analysis. Additionally, as previously mentioned, the variable FN_t is used to control for the fixed effects of misinformation.

The basic statistics for this panel data are shown in Table 2 below.

Results

Main results

The results of estimating equation (1) are shown in Table 3. The marginal effects column lists the average marginal effects. The p-values are calculated using robust standard errors clustered by information category.

Table 2. Basic statistics of the panel data

Variable category	Variable	Mean	SD	Min.	Max.
Dissemination	Disseminated information	0.174	0.379	0.000	1.000
Identification	Believing the information is correct	0.514	0.500	0.000	1.000
	Believing the information is incorrect	0.144	0.351	0.000	1.000
Literacy	Media literacy (1–4)	2.806	0.366	1.667	4.000
	Information literacy (0–5)	3.428	1.348	0.000	5.000
	Critical thinking attributes (self-reported) (1–7)	4.878	0.838	1.000	7.000
	Critical thinking score (0–20)	6.181	2.551	0.000	18.000
Media usage	Social media (min/day)	67.107	102.532	0.000	450.000
	Video-sharing service (min/day)	98.303	119.151	0.000	450.000
	TV and newspaper (min/day)	92.624	119.363	0.000	450.000
	Mass media other than TV and newspapers (min/day)	31.115	75.528	0.000	450.000
	Online news (min/day)	33.335	61.128	0.000	450.000
	Message app (min/day)	27.733	60.830	0.000	450.000
	Personal website or blog (min/day)	17.328	56.575	0.000	450.000
	Factchecking site (browsing or not)	0.173	0.378	0.000	1.000
Attributes	Interest in information and news (1–7)	4.744	1.532	1.000	7.000
	Political orientation: conservatism (1–7)	4.300	0.931	1.000	7.000
	Political orientation: extreme degree (0–3)	0.721	0.661	0.000	3.000
	Internet history (years)	18.075	5.890	1.500	22.500
	Gender (female)	0.437	0.496	0.000	1.000
	Age	43.580	16.414	15.000	69.000
	Education (graduate or above)	0.503	0.500	0.000	1.000
n			8,405		

Source: Table by authors

First, examining the literacy variables, only critical thinking attitudes are significantly negative. This indicates that individuals with higher self-reported critical thinking attitudes are less likely to recognize misinformation. However, other literacies do not yield significant results, suggesting no strong correlation between objective literacy levels and the ability to judge the accuracy of misinformation.

Next, other variables are considered. Regarding media usage time, only video-sharing services is significantly negative. For attributes, interest in information and news is significantly positive, while being female is significantly negative.

The results of estimating equation (2) are shown in Table 4. The *p*-values are calculated using robust standard errors clustered by information category.

First, the relationship between the judgment of misinformation and dissemination behavior is examined. Both variables, "believing the information is correct" and "believing the information is incorrect," are significantly positive, indicating that making a judgment leads to higher dissemination compared to withholding judgment.

Next, the literacy variables related to dissemination behavior are examined. Media literacy, information literacy and critical thinking scores all show significantly negative results, indicating that individuals with higher levels of these literacies are less likely to disseminate information. Conversely, self-reported critical thinking attitudes show significantly positive results, indicating a tendency to disseminate information more readily.

Moreover, other variables are considered. Regarding media usage time, social media, online news, personal websites or blogs sites are significantly positive. In contrast, TV and

Table 3. Estimation results of identification behavior

Variable category	Variable	Marginal effect	*p*-value	
Literacy	Media literacy (1–4)	−0.001	0.941	
	Information literacy (0–5)	0.004	0.196	
	Critical thinking attributes (self-reported) (1–7)	−0.011	0.006	**
	Critical thinking score (0–20)	−0.002	0.078	
Media usage	Social media (min/day)	0.000	0.461	
	Video-sharing service (min/day)	−0.000	0.012	*
	TV and newspaper (min/day)	0.000	0.700	
	Mass media other than TV and newspapers (min/day)	0.000	0.379	
	Online news (min/day)	0.000	0.904	
	Message app (min/day)	0.000	0.601	
	Personal website or blog (min/day)	−0.000	0.245	
Attributes	Interest in information and news (1–7)	0.009	0.000	**
	Political orientation: conservatism (1–7)	−0.010	0.199	
	Political orientation: extreme degree (0–3)	0.011	0.086	
	Internet history (years)	0.000	0.725	
	Gender (female)	−0.018	0.006	**
	Age	0.000	0.862	
	Education (graduate or above)	0.011	0.115	
Information	Omitted			
	n	8,405		
	Pseudo R^2	0.0189		

Notes: $^{**}p < 0.01$; $^{*}p < 0.05$
Source: Table by authors

newspapers show significantly negative results. Regarding attributes, high interest in information and news and political orientation: extreme degree, are significantly positive, while being female is significantly negative.

Results by dissemination behavior

The results of dissemination behavior are presented in Table 5. These results are based on the estimation of equation (2). For social media and message apps, only those who indicated that they use each medium were included in the analysis.

First, the results for sharing on social media are examined. Regarding true or false judgment, only "believing the information is correct" is significantly positive, indicating a higher likelihood of dissemination when the information is judged as truth, which differs from the overall results where both variables were significant.

Next, regarding literacy, information literacy and critical thinking scores are significantly negative, indicating that individuals with higher levels of these literacies are less likely to disseminate information. Media literacy and critical thinking attitudes (self-reported) do not reach significance, which is a difference from the overall results.

Moreover, other variables are examined. For media usage time, social media, mass media other than TV and newspapers and personal website or blog are significantly positive, while TV and newspaper and message app are significantly negative. Regarding attributes, interest in information and news and political orientation: extreme degree, are significantly positive, while being female and age significantly negative.

The second column shows the results for message apps. Regarding true or false judgment, only "believing the information is incorrect" is significantly positive, indicating a higher

Table 4. Estimation results of diffusion behavior

Variable Category	Variable	Marginal effect	*p*-value	
Identification	Believing the information is correct	0.105	0.000	**
	Believing the information is incorrect	0.059	0.000	**
Literacy	Media literacy (1–4)	−0.094	0.000	**
	Information literacy (0–5)	−0.021	0.000	**
	Critical thinking attributes (self-reported) (1–7)	0.022	0.000	**
	Critical thinking score (0–20)	−0.004	0.036	*
Media usage	Social media (min/day)	0.000	0.000	**
	Video-sharing service (min/day)	0.000	0.162	
	TV and newspaper (min/day)	−0.000	0.000	**
	Mass media other than TV and newspapers (min/day)	0.000	0.070	
	Online news (min/day)	0.000	0.005	**
	Message app (min/day)	0.000	0.051	
	Personal website or blog (min/day)	0.000	0.000	**
Attributes	Interest in information and news (1–7)	0.024	0.000	**
	Political orientation: conservatism (1–7)	0.009	0.131	
	Political orientation: extreme degree (0–3)	0.014	0.003	**
	Internet history (years)	−0.001	0.469	
	Gender (female)	−0.031	0.000	**
	Age	−0.001	0.070	
	Education (graduate or above)	−0.022	0.018	*
Information	Omitted			
	n		8,405	
	Pseudo R^2		0.0128	

Notes: $^{**}p < 0.01$; $^{*}p < 0.05$
Source: Table by authors

likelihood of dissemination when the information is judged as false, which differs from the overall results where both variables were significant.

Regarding the literacy variables, media literacy, information literacy and critical thinking scores are significantly negative, indicating that individuals with higher levels of these literacies are less likely to disseminate information. Self-reported critical thinking attitudes are significantly positive, aligning with the overall trend that higher self-reported critical thinking attitudes increase dissemination.

Moreover, other variables are considered. Media usage time for online news and message apps are significantly positive, while TV and newspapers are significantly negative. Regarding attributes, interest in information and news and internet history are significantly positive, while being female and age are significantly negative.

The third column shows the results for verbal dissemination. Regarding true or false judgment, only "believing the information is incorrect" is significantly positive, indicating a higher likelihood of dissemination when the information is judged as false, which differs from the overall results where both variables were significant.

Regarding the literacy variables, aligning with the overall trend, media literacy, information literacy and critical thinking scores are significantly negative indicating that individuals with higher levels of these literacies are less likely to disseminate information. In contrast, self-reported critical thinking attitudes are significantly positive, aligning with the overall trend as well.

Table 5. Estimated results of dissemination behavior

Variable Category	Variable	Social media Marginal effect	*p*-value		Message app Marginal effect	*p*-value		Verbal Marginal effect	*p*-value	
True/false judgement	Believing the information is correct	0.059	0.000	**	0.006	0.177		0.008	0.103	
	Believing the information is incorrect	0.020	0.071		0.015	0.001	**	0.019	0.001	**
Literacy	Media literacy (1–4)	−0.015	0.249		−0.031	0.000	**	−0.039	0.000	**
	Information literacy (0–5)	−0.012	0.000	**	−0.004	0.000	**	−0.005	0.000	**
	Critical thinking attributes (self-reported) (1–7)	−0.003	0.269		0.010	0.000	**	0.012	0.000	**
	Critical thinking score (0–20)	−0.008	0.000	**	−0.002	0.000	**	−0.002	0.001	**
Media usage	Social media (min/day)	0.000	0.000	**	−0.000	0.539		−0.000	0.694	
	Video-sharing service (min/day)	0.000	0.079		−0.000	0.364		−0.000	0.387	
	TV and newspaper (min/day)	−0.000	0.004	**	−0.000	0.002	**	−0.000	0.001	**
	Mass media other than TV and newspapers (min/day)	0.000	0.000	**	0.000	0.355		0.000	0.272	
	Online news (min/day)	0.000	0.004	**	0.000	0.000	**	0.000	0.000	**
	Message app (min/day)	−0.000	0.000	**	0.000	0.000	**	0.000	0.000	**
	Personal website or blog (min/day)	0.000	0.000	**	0.000	0.673		0.000	0.895	
Attributes	Interest in information and news (1–7)	0.014	0.000	**	0.003	0.006	**	0.004	0.001	**
	Political orientation: conservatism (1–7)	0.000	0.830		−0.002	0.396		−0.003	0.144	
	Political orientation: extreme degree (0–3)	0.015	0.000	**	0.003	0.205		0.006	0.016	*
	Internet history (years)	−0.001	0.164		0.001	0.008	**	0.001	0.004	**
	Gender (female)	−0.050	0.000	**	−0.012	0.000	**	−0.016	0.000	**
	Age	−0.001	0.000	**	0.000	0.010	*	−0.001	0.005	**
	Education (graduate or above)	−0.002	0.472		−0.002	0.305		−0.004	0.200	
Information			Omitted							
n			6,658			7,007			8,405	
Pseudo R^2			0.254			0.299			0.073	

Notes: $^{**}p < 0.01$; $^{*}p < 0.05$
Source: Table by authors

For other variables, regarding media usage time, online news and message apps are significantly positive, while TV and newspapers are significantly negative. Regarding attributes, interest in information and news, political orientation: extreme degree and internet history are significantly positive, while being female and age are significantly negative.

Discussion

First, the results of variables related to various literacies and their relationship with the true/false judgment of misinformation are examined. Among the literacy variables, only critical thinking attitudes were significantly negative, indicating that individuals with higher subjective literacy are more likely to misjudge the accuracy of misinformation. If subjective literacy is interpreted as a score reflecting confidence in one's information discernment ability, this aligns with Gondwe (2023).

Unlike studies that found objective information literacy and media literacy to be related to the true/false judgment of misinformation (Daunt *et al.*, 2023; Jones-Jang *et al.*, 2021; Pennycook and Rand, 2019), other literacies did not yield significant results. This difference may be due to our integrated analysis of subjective and objective indicators. For instance, Jones-Jang *et al.* (2021) used quiz-based measures of four types of literacy, but apart from digital literacy, which asked about PC skills, but did not consider subjective literacy regarding information. Daunt *et al.* (2023) found a positive relationship between subjective media literacy and true/false judgment but did not include quiz-based measures of objective literacy. Our analysis included both subjective and objective literacy indicators, resulting in these differences. It is said that measuring critical thinking from both attitudinal and skill-based perspectives is essential (Nakanishi *et al.*, 2006; Hirayama and Kusumi, 2004; Isowa and Minami, 2015), and this difference highlights the importance of this approach. Future research should include both attitudes and scores when assessing critical thinking.

Other variables are also interpreted. Regarding media usage, longer usage of video-sharing services made individuals less likely to recognize misinformation. Video-sharing services provide a mix of credible and misinformation, making it harder for users to differentiate between them, which aligns with findings that repeated exposure to information can lead to accepting misinformation as true (Pennycook *et al.*, 2018). On the other hand, the significantly positive result of interest in information and news suggests that individuals with a strong interest in information are more likely to engage in verification behaviors. This active engagement likely enhances their ability to identify misinformation.

Next, the relationships between dissemination behavior and literacy are discussed. Overall, individuals with higher media literacy, information literacy and critical thinking scores are less likely to disseminate misinformation, whereas those with higher critical thinking attitudes are more likely to do so. These findings regarding media literacy and information literacy are consistent with Yamaguchi and Tanihara (2023), Yamaguchi *et al.* (2022) and Pennycook and Rand (2020). Notably, individuals with the highest media literacy are 25.2 percentage points less likely to disseminate misinformation compared to those with the lowest media literacy. This highlights the importance of enhancing objective literacy as a countermeasure against the spread of misinformation.

The two critical thinking indicators showed opposite results: critical thinking attitudes (subjective) were positively significant, while critical thinking scores (objective) were negatively significant. This emphasizes the need to measure both dimensions (Nakanishi *et al.*, 2006; Hirayama and Kusumi, 2004; Isowa and Minami, 2015). Enhancing critical thinking skills can prevent misinformation dissemination but increasing confidence without ability can be counterproductive. Considering the results of true/false judgment, high

self-reported critical thinking attitudes make individuals less likely to recognize misinformation and more likely to disseminate it.

Regarding the relationship between true/false judgment and dissemination behavior, both "believing the information is correct" and "believing the information is incorrect" are significantly positive, indicating that making a judgment leads to higher dissemination compared to withholding judgment. However, the marginal effect is 0.046 higher for those who believe the information is correct, indicating they are 4.6 percentage points more likely to disseminate it than those who believe it is incorrect.

Furthermore, the results by dissemination method are analyzed. For social media sharing, information literacy and critical thinking scores show negative relationships with dissemination behavior. A notable difference from the overall results is that media literacy and subjective critical thinking attitudes were not significant. For dissemination on social media, enhancing objective literacies, such as the ability to interpret information and evaluate its credibility, may effectively prevent the spread of information. Additionally, because information believed to be correct is significantly more likely to be disseminated, posting fact-check results on social media may help prevent the spread. However, this could backfire depending on the recipient's information literacy (Tanihara and Yamaguchi, 2023), so caution is needed.

For message apps and verbal communication, similar trends were observed. Aligning with the overall trend, higher media literacy, information literacy and critical thinking score (objective literacy) decrease dissemination, while higher critical thinking attributes (subjective literacy) increase it. Thus, enhancing objective literacy can prevent misinformation dissemination through message apps and verbal communication. Unlike the overall trend, for message apps and verbal communication, there is a stronger tendency to disseminate information only when it is believed to be incorrect. This contrasts with the dissemination of misinformation on social media. However, even if the initial disseminators share misinformation to raise awareness, this could backfire if recipients believe it to be true, depending on their literacy. This is similar to the effects observed with fact-checking sites (Tanihara and Yamaguchi, 2023). Therefore, it is essential to conduct awareness campaigns with this caution in mind.

Conclusions

In this study, online survey data was used to analyze models related to the identification and dissemination of false and misleading information, using widely spread information in Japan, and testing the three research questions.

For *H1*, it is found that individuals with high subjective confidence in their ability to judge accuracy are more likely to misjudge misinformation. For *H2*, individuals with low objective literacy but high subjective literacy are more likely to spread misinformation. These differences support *H3*.

These results have several implications. First, the government should promote awareness and educational activities to improve literacy. Enhancing media literacy, information literacy and critical thinking scores can effectively counter the spread of misinformation. However, regarding critical thinking attitudes, there was a notable tendency to unknowingly spread misinformation, for individuals who, at least subjectively, felt confident and considered themselves to have high literacy. Therefore, when raising awareness, care must be taken not to increase confidence without improving actual ability. Second, tailored misinformation countermeasures should be considered for different media. For example, on social media, only information believed to be true is significantly disseminated, suggesting that displaying the accuracy of information efficiently on social media could prevent the spread of misinformation. On the other hand, for message apps and verbal dissemination, only

information believed to be incorrect is significantly spread. However, even if the intent is to raise awareness, it is necessary to educate people about the potential for this to backfire depending on the recipient's literacy. In addition, long usage times of video-sharing services correlate with a tendency to spread misinformation. Taking advantage of this, educational initiatives could include using platform-based measures, such as video ad slots or collaborations with influencers.

This study has some limitations. First, the cross-sectional survey design means we can only analyze trends, not causality. Second, the selection of the three most widely spread pieces of information in each field means our analysis is not exhaustive. Third, this study is limited to misinformation in Japan. While the findings may offer generally applicable insights, the same results may not necessarily apply in all countries. Fourth, this study does not consider literacies that may be particularly effective against misinformation in specific fields, such as health literacy for information in the health domain.

Despite these limitations, this study contributes to the field in three ways. First, it quantitatively elucidates the relationships various literacies have with the accuracy judgment and dissemination behavior of misinformation. This highlights the effectiveness of objective literacy and the need for caution regarding subjective confidence in their own literacy. Second, it provides a cross-disciplinary analysis of the relationship between misinformation and literacy, covering not only politics and healthcare but various fields, thereby identifying comprehensive literacy strategies against misinformation. Third, it addresses differences in dissemination methods and offers insights into more practical countermeasures.

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Appendix. Misinformation used in the survey

The misinformation used in the survey is shown in Table A1.

Table A1. Misinformation used in the analysis

Information category	Information details
Domestic politics (favoring conservatives)	Eiko Kimura and Yasuhiko Funago from the Reiwa Shinsengumi have not attended the diet for a single day
	Nine trillion yen from the gender equality budget is flowing to leftist activists
	During the democratic party administration, Japan was in a state of diplomatic isolation from the world
Domestic politics (favoring liberals)	The Kishida administration is taxing scholarships and unemployment benefits
	The Japanese government announced plans to make my number card registration mandatory for using YouTube, X, etc
	Rui Matsukawa from the Liberal Democratic Party, criticized for her visit to France, stated, "I found out that the consumption tax in France is 19.6%."
Medicine and health	Due to a surge in vaccine-related deaths, a Philippine court issued an international arrest warrant for bill gates on suspicion of murder
	Ingredients derived from crickets are labeled only as "amino acids" when added to food
	17,000 people die annually in saunas
War and conflict	In the Israel-Palestine conflict, there have been no airstrikes on evacuation areas in Southern Gaza
	Russia has deployed missiles in the Kuril Islands that can reach the prime minister's office in one minute
	In Eastern Ukraine, controlled by pro-Russian forces, the world's largest pipeline for Europe exploded due to a Ukrainian military attack
Diversity	Legal gender changes are now possible without surgery, based only on self-identification
	A former male swimmer who won a women's competition declared he wants to revert to being male
	Musashino city promoted an ordinance granting Chinese citizens voting rights after three months of residence

Source: Table by authors

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