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Effects of Incidental Brief Exposure to News on News Knowledge While Scrolling Through Videos

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ABSTRACT Increasing media choices due to online media diversification ensure that people without any interest in news avoid news media. This obstructs the construction of a shared social reality given the presence of politics news seekers and news avoiders. For mitigating these issues using media, incidental exposure to news on the Internet can be a powerful tool because it can bring news to the awareness of people who are politically disinterested. We studied the effects of the glimpsing a news screen for less than a few seconds while watching online television news, termed incidental brief exposure, on news knowledge. For evaluating the effects, we combined the logs of news-watching behavior on an online television (for incidental brief exposure) and the results of a questionnaire survey (for news knowledge and media repertoires). We found that this incidental brief exposure mitigated the negative effect of social media usage on news knowledge. Although people with heavy social media usage have low news knowledge, heavy social media users with high frequently incidental brief exposure have more news knowledge than heavy social media users. As a possible scenario, memorizing news keywords due to incidental brief exposure may facilitate reading news related to these keywords when users incidentally encounter news on social media. On the other hand, the exposure did not moderate the effects of news media usage, such as mass media, curation sites, and online news sites. These findings suggest that incidental brief exposure while scrolling through videos, which is hardly noticed by users, enhances passive exposure effects in non-news media, such as social media.

INDEX TERMS Incidental brief exposure, online television news, news-watching behavior logs, news knowledge.

I. INTRODUCTION

Before the development and popularization of the Internet, there were more opportunities for incidental exposure to political news because of limited media choices for news and entertainment information, such as television and newspapers. Such incidental exposure contributed towards the acquisition of political information by people who are politically disinterested [1], [2].

After the arrival of the Internet, and particularly smartphones, the opportunities for incidental and unintentional exposure have decreased because of increased selectivity due to an increase in accessible media, such as numerous online news sites, curation sites, weblogs, video media, and social media. Increasing media has increased the costs of exposure

to political information because the exposure requires that people voluntarily access political news [3]–[6]. In other words, people who are disinterested in politics can easily avoid political news if they wish to access only entertainment information [6], [7], and this is called preference-based selective exposure. Additionally, information filtering using algorithms has accelerated biased information access (filter bubble) [8]. Therefore, people who are disinterested in news have decreased encountering news with decreasing mass media users [9], e.g. in the U.S. [10], Europe [11], Sweden [12], and Japan [13], [14]. This is an important issue in the era of internet media because the reduced opportunities for news exposure may negatively impact citizens' political knowledge and voting behavior [6], [7].

Additionally, media diversification obstructs the construction of a shared social reality of politics because the choice of media, and consequently, knowledge varies across people.

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For example, although traditional media provides covers various news topics [15], online news site users may be more interested in niche political issues than television news users [16]. This makes it difficult to engage in productive political discussions [17], [18].

For media that consciously aims to mitigate these issues, incidentally exposing viewers to news on the Internet can be a powerful tool because it can help such media reach people who do not have an active interest in politics and news [19]–[25].

Previous studies [21], [25] demonstrated that people who are disinterested in the news acquire political knowledge by watching titles of news articles even if they do not read the body texts on a portal site. Such people prefer entertainment although they tend not to avoid sites including the news, i.e., they use a portal site including news information for seeking entertainment information [25]. Consequently, they incidentally learn news in mixed environment of entertainment and news [25]. In other words, mixed environments of news and entertainment information are effective for incidental exposure of people who are disinterested in the news. In addition, incidental exposure to online news facilitates the online participation of people who are disinterested in the news [20]. Incidental exposure to political news through social media also increases political knowledge [23] and online participation in politics [22], [26].

Incidental exposure can change people's behavior relating news in the longer term. Incidental exposure on a portal site seems to facilitate news seeking behavior of people who are disinterested in the news [25]. News-related posts on social media can motivate users to access the complete news article on news media [27].

Additionally, although exposure to news depicting contrary attitudes to the user's attitude has a null effect or an opposite effect [18], [28], this effect is reduced in the case of incidental exposure [23]. Such incidental exposure can complement selective news exposure [24], [29] because incidental exposure provides random access to news in contrast to selective exposure which reinforces biased news access [30].

On the other hand, incidental exposure without reading contents can facilitate that people believe and spread misinformation. Several online media tend to use titles and/or thumbnails that are designed to attract attention, typically sensationalized or misleading [31], [32]. Many people do not read news articles which are found at incidental exposure in social media, and they do not read most articles [33] and share these articles without reading [34]. Consequently, incidental exposure to problematic/biased media can negatively affect people's knowledge and belief [35], [36].

In this paper, we study how incidental exposure for a few seconds to news topics on an internet television called "ABEMA"¹ affects news knowledge. ABEMA users can sequentially flick through the channels when searching for a channel to watch (Fig. 1). They are incidentally exposed

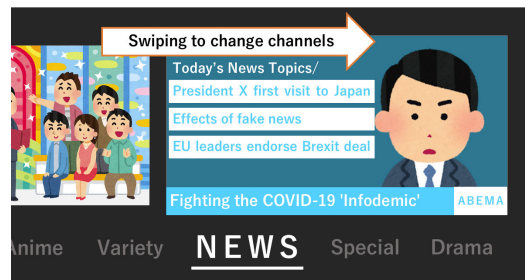


FIGURE 1. Incidental brief exposure while changing channels on ABEMA.

to news programs when flicking over a news channel even if they do not pause to watch the news program. News programs tend to display summaries of news topics [19]. This would lead to a few seconds incidental exposure to news topics, as “incidental brief exposure.”

Note that this understanding of incidental brief exposure excludes those who watch the news program after being exposed to it. Therefore, the effects of incidental brief exposure in this paper may be weaker than incidental exposure in previous studies (one study has explored a portal site [21], [25] and others have explored social media [23]) because the duration of incidental brief exposure is shorter than in previous studies. Additionally, it can be argued that this study focuses more on people who are disinterested in politics than the previous studies because it excludes news watching behavior after incidental exposure. Therefore, incidental brief exposure as defined in this paper includes a wide range of users even though the duration itself may be small.

We also consider combination effects between the incidental brief exposure and the usage of news media (interactions) for investigating the reinforcement effects of incidental brief exposure on news media usage. Diversifying media have also increased the number of accessible media. As a result, people may be exposed several times to the same news in diverse media repertoires [12], [27], [37]–[40]. Similarly, we can assume that involuntarily memorizing keywords related to political news by incidental brief exposure on ABEMA facilitates delving into political news when exposed to the news in news media.

We analyze the effects of the incidental brief exposure on ABEMA and the interactions between this exposure and news media usage on news knowledge by combining the logs of news-watching behavior on ABEMA and the results of a questionnaire survey provided to the audience (Fig. 2). This enables us to evaluate the effects of incognizable behavior, such as the effects of a few seconds of incidental brief exposure, on knowledge that cannot be measured through user behavior logs.

This study can contribute to understand the incidental exposure to news screens on other platforms, such as broadcast televisions, video hosting services [41], [42], and social media (news thumbnails on social media [43]).

¹<https://abema.tv/>

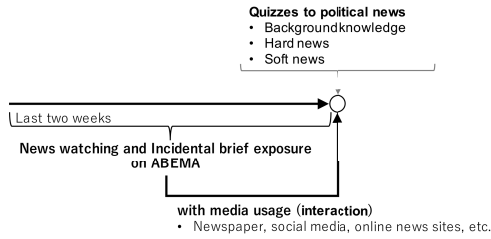


FIGURE 2. Structure of our analysis.

II. DATASET

ABEMA’s news programs and user experiences resemble mass media television news. ABEMA offers news contents created by the Japanese mass media “TV Asahi.” It has some channels (around 20) that specialize in some genres (e.g., news, sports, dramas, and anime), and each channel broadcasts programs according to certain time schedules. As a result, the user experience is also similar to television, with users often engaging in channel surfing. This is one of the popular streaming video distribution platforms in Japan, particularly among young people (active users account for 12 million per month [44]). These similarities with television news and detailed audience behavior logs available from Internet applications are useful for media communication studies [45], [46].

We used ABEMA user behavior logs (watching programs and changing channels) on a news channel and non-news channels. We recruited participants, who have an identifier for connecting ABEMA behavior logs, in this study from panelists registered with Macromill Incorporation. A total of 1031 participants were selected randomly according to their age and gender (642 males, 389 females; see Table 3 for details). We provided a questionnaire survey in Japanese to the participants (March 25 to 29, 2019). We describe the examples of English questionnaire items in the next section. These English items were translated by the authors excluding “entertainment/news preference” [47]. The responses to the questionnaires were obtained on five-point Likert-type scales by default unless otherwise noted. In our analysis, we used the responses to the questionnaire that included data on knowledge of political news and its background, media usage frequencies, political interest, entertainment/news preference, usage motivation of ABEMA, critical thinking disposition, subjective media literacy and suspicion of media, feelings towards information seeking, feelings towards news exposure, ideology, political communication, and demographic information (age, gender, jobs, married or not, and having children or not).

This study was approved by an ethics committee of a private university in Japan (Ritsumeikan University). All procedures were conducted in accordance with the guidelines for studies involving human participants, the ethical standards of the institutional research committee, and the revised 1964 Helsinki declaration and its later amendments or comparable ethical standards.

III. STATISTICAL MODELLING

We aim to evaluate the effects of incidental brief exposure z and its interaction with media usage frequencies (news watching time in ABEMA w and other media usage frequencies \bar{m}) on objective variables y (background knowledge of news, hard news/soft news knowledge).

The frequency of incidental brief exposure z not only reflects “knowledge obtained by the exposure,” but also reflects “audiences’ disposition towards news knowledge,” e.g. disinterest.

Capturing disinterest in news programs and media choices is important because audiences without interest in news programs would move from a news channel to other channels, immediately. Therefore, we controlled for the effect of the disinterest in news programs (and media choice behavior due to disinterest) immanent in the frequencies of incidental brief exposure. For controlling, we used several control variables \bar{c} related to participants’ attitudes and feelings pertaining to politics and news information, participants’ watching durations for non-news channels on ABEMA, and demographic information (see Table 3 for details). We did not analyze these control variables.

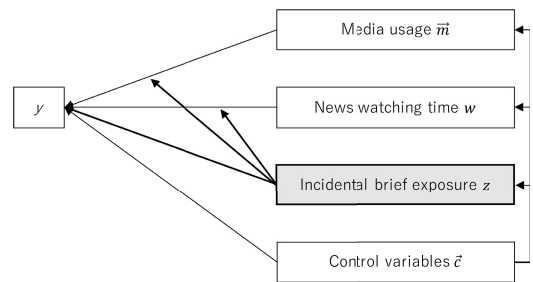


FIGURE 3. Path diagram of our model.

Fig. 3 shows a path diagram of our statistical model, including paths from \bar{c} to not only z but \bar{m} and w because \bar{c} should be expected to affect them.

We describe objective variables, explanatory variables (incidental brief exposure, media usage, and interaction between them), and control variables in the following sections. Unless otherwise noted, we conducted confirmatory factor analysis by maximum likelihood estimation and exploratory factor analysis by maximum likelihood estimation and Promax rotation where we selected the number of factors by Bayesian information criterion (BIC).

A. OBJECTIVE VARIABLES

We constructed our objective variables (background knowledge of news, hard news knowledge, and soft news knowledge) by applying item response theory (two-parameter model) [48] to the answers of each category quiz (background of news, hard news, and soft news). Each category was constructed by four quizzes that had five choices including “I don’t know.”

Hard news and soft news quizzes measured knowledge of recent political news topics. Hard news quizzes examined

knowledge of political and international news, excluding scandals, such as “Where was the US-North Korea summit meeting held on at Feb 28, 2019?” Soft news quizzes were political scandals, such as “Which politician was criticized because he claimed that the problems of declining birth rate were due to young people not having children?” Background knowledge quizzes measured background knowledge of political news topics, which did not depend highly on current affairs, such as “Which article of the Constitution of Japan renounces war?” All items in Japanese and correct answer ratios are shown in Table S1 in Supplementary Information.

B. EXPLANATORY VARIABLES

1) ABEMA USAGE AND INCIDENTAL EXPOSURE FREQUENCIES

We defined glimpsing a news screen for less than four seconds (the median of the watching time of each news program) as incidental brief exposure while searching for channels. The frequency of incidental brief exposure is described as z . On the contrary, we defined the duration of watching news programs that exceeded four seconds or more as news watching time w . We used the data from the last two weeks before our survey (March 12, 2019 to March 25, 2019) for z and w .

2) MEDIA USAGE FREQUENCY

We acquired four factors by exploratory factor analysis for twelve offline and online media usage frequencies through our survey (Table 1). These are social media, curation sites, traditional media, and online news sites. We describe these four factors as \bar{m} . In this factor analysis, we used the minimum residual method instead of the maximum likelihood method to avoid factor loading greater than one.

The social media factor included popular social media in Japan (LINE News is an online news media on online messenger LINE). The articles of curation sites in Japan tend to be very sensational and have tabloid-like characteristics; these summarize Twitter, 2-channel, and 5-channel (like 4chan) for getting advertising revenue. Japanese Yahoo! news which was included the traditional media factor, the most popular portal site [51], offers articles from various media including newspapers. Yahoo! news tends to place hard news on the top page for the public’s benefit. Online news sites, that also offer articles from various media, tend to place soft news on the top page.

This factor analysis result shows that participants’ media repertoires tended to be sets of similar media, such as a set of social media, curation sites, traditional media, and online news sites, similar to [38], [39]. Additionally, the correlations between these factors also show that internet media (social media, curation sites, and online news sites) tended to be used in combination.

On the other hand, traditional media users also used online news sites, as with [37].

C. CONTROL VARIABLES

As we mentioned above, we used several control variables \bar{c} for controlling disinterest in news programs and politics. These control variables can be used without problems because participants’ frequency of incidental brief exposure z (the number of channel changes) does not affect these variables. In the same manner, media usage frequencies within a short period (the audience behavior logs for the data period, i.e. the last two weeks) also do not seem to affect the variables. The questionnaire items in Japanese and their factor analyses are shown in Table S2-S6 in Supplementary Information.

1) POLITICAL INTEREST

This variable reinforces political knowledge [52], [53]. We asked the participants about their degree of awareness of politics.

2) ENTERTAINMENT/NEWS PREFERENCE

We used the entertainment/news preference scale [47], which explains news choice behavior (we used a Japanese version translated by Dr. Tetsuro Kobayashi). Typical question items were “I enjoy spending an entire evening watching movies and TV shows” (entertainment preference) and “I prefer detailed news coverage to news headlines even if it requires more time” (news preference).

We conducted a confirmatory factor analysis for this scale (CFI: 0.978, RMSEA: 0.058 [0.044, 0.074]). Cronbach’s α of entertainment and that of News were 0.807 and 0.731, respectively. Note that we excluded two items² that decreased Cronbach’s α from the original scale [47].

3) ABEMA USAGE MOTIVATION

For creating the ABEMA usage motivation scale, we merged some questions on YouTube usage motivation [54] to evaluate the features of internet media on televisions and web usage motivation [55], extending [56]’s survey for Japan. This scale that captures the motivation of media usages such as information seeking and leisure entertainment, is relevant to the interests of news programs and politics. We conducted exploratory factor analysis for this scale (CFI: 0.986, RMSEA: 0.048 [0.037, 0.060]).

We acquired four factors, namely, convenience (information for own hobbies and diversions), relaxation, reproducibility, and news seeking. The convenient factor shows that users aim to obtain useful information for themselves and have fun, as indicated in “It gives useful information for hobbies/leisure” and “It’s exciting.” The relaxation factor shows that users aim to relax by watching ABEMA programs, as indicated in “It allows me to unwind.” The reproducibility factor shows that users find on-demand broadcasting functions useful, as indicated in “I can watch past programs again.” The news seeking factor shows that users aim to

²“Watching movies or prime time shows on television is unsatisfying. (reversed)” (entertainment preference) and “Following the news is not my idea of fun. (reversed)” (news preference).

TABLE 1. The exploratory factor analysis results of media usage frequencies (comparative fit index (CFI): 0.972 [49], root mean square error of approximation (RMSEA): 0.048 [0.037, 0.060] [50]). The square brackets show 90% confidence intervals. We regard Factors 3, 1, 2, and 4 as social media, curation sites, traditional media, and online news sites, respectively.

Item	Factor 3	Factor 1	Factor 2	Factor 4
Instagram	0.90	-0.08	-0.07	-0.12
Twitter	0.53	0.24	-0.04	-0.09
Facebook	0.48	-0.06	0.10	0.03
LINE News	0.35	-0.04	0.00	0.18
Twitter curation sites and curation sites of 2chan/5chan	-0.04	0.96	0.10	0.00
Other curation sites, e.g. NAVER matome	0.01	0.47	-0.07	0.36
Online news sites by traditional media	0.00	-0.08	0.59	0.29
Newspapers	-0.01	-0.04	0.57	-0.01
Television	0.04	0.03	0.45	-0.12
Yahoo! News	-0.02	0.07	0.38	0.00
Livedoor News	0.03	0.01	-0.12	0.64
Other online news sites	-0.05	0.03	0.11	0.42
Factor correlations	Factor 3	0.36	0.18	0.38
	Factor 1		0.15	0.49
	Factor 2			0.38

know the news, as indicated in “I can know the situation of the world.” The correlations between these factors excluding news seeking were high. In contrast, the correlations between the news seeking factor and the other factors were low.

Although the previous studies (on television [55] and YouTube [54]) indicated that people sought both news and entertainment through these media, the results of the present study indicate that a separation exists between news seekers (the news seeking factor) and entertainment seekers (the convenient factor) among ABEMA users. This and the low correlations between the news seeking factor and the other factors suggest that there is preference-based selective exposure to news programs or entertainment programs in ABEMA as well.

4) CRITICAL THINKING DISPOSITION

We used the simplified scale by [57] of the original critical thinking disposition scale (awareness for logical thinking, inquiry-mind, objectiveness, and evidence) [58]. Critical thinking disposition increases political interest [57]. On the other hand, this decreases the probability of voting due to interaction with soft news [57]. Typical question items were “I am able to summarize my thinking” (awareness for logical thinking), “I wish to continue learning new things life-long” (inquiry-mind), “I take care to avoid biased thinking” (objectiveness), and “I attach importance to evidence when I decide” (evidence).

We conducted confirmatory factor analysis for this scale (CFI: 0.982, RMSEA: 0.043 [0.034, 0.053]). Cronbach’s α of awareness for logical thinking, inquiry-mind, objectiveness, and evidence-based judgment were 0.788, 0.772, 0.679, and 0.713, respectively. Note that we excluded an item³ that decreased Cronbach’s α from the original simplified scale [57].

³“When I look at things, I only think from my perspective.” (objectiveness)

5) SUBJECTIVE MEDIA LITERACY AND SKEPTICISM AGAINST MASS MEDIA

We used the scale of subjective media literacy and skepticism against mass media [51] that explain how high/low political interest affects media exposure. We conducted exploratory factor analysis for this scale (CFI: 0.994, RMSEA: 0.044 [0.028, 0.060]).

We acquired two factors, namely subjective media literacy and skepticism against mass media. Typical question items were “I can detect misinformation in mass media” (subjective media literacy) and “Mass media can stir up a great fuss for disguising important things” (skepticism against mass media).

6) FEELINGS TOWARDS INFORMATION SEEKING

We constructed this scale by using the questionnaire items from [59]’s survey. This scale is expected to clarify the motivation for information seeking. We conducted exploratory factor analysis for this scale (CFI: 1.000, RMSEA: 0.000 [0.000, 0.045]).

We acquired two factors, namely, limited information seeking and information overload. Typical question items were “I think that I only have to know about the thing one wants to know” (limited information seeking) and “I think that there is information overload in current society” (information overload).

7) FEELINGS TOWARDS NEWS EXPOSURE

We used a question from [59]’s survey. This scale shows participants’ activeness in being exposed to news. This scale was expected to explain their media choices.

8) IDEOLOGY

Ideology affects media choice behavior [40], [60] and political knowledge [61]. We asked seven-point Likert-type scales with “I don’t know my ideology.” We made three variables from this. That is, a right-wing tendency (if an answer indicated a more right-wing orientation than a neutral one,

the score ranged from one to three; else, it was zero), a left-wing tendency (if an answer indicated a more left-wing orientation than neutral, then the score ranged from one to three; else, it was zero), and non-self-avowed (“I don’t know my ideology” was 1, else 0).

9) POLITICAL COMMUNICATION

We asked about the frequency of political communication with close people (family, friends, co-workers, and neighbors) and on social media, which we termed as offline political communication and online political communication, respectively. Offline [52] and online [62] political communication reinforce political knowledge.

10) BEHAVIOR ON ABEMA NON-NEWS CHANNELS

We used the watching time of non-news programs w' and incidental brief exposure to non-news programs z' . These indicate participants’ preference for non-news programs and participants’ behavior traits in terms of channel changes, respectively.

11) DEMOGRAPHIC INFORMATION

We used demographic information, such as age ranges (five-year groups), sex (male/female), jobs, married or not (married: 584 (56.6%)), and having children or not (having children: 508 (49.3%)). The frequencies of participants’ age and sex are shown in Table 3. Job categories were civil-service worker, management executive and board member, office worker (clerk), office worker (engineer), office worker (other), self-owned business, liberal profession, full-time homemaker, part-timer, student, others, and unemployed. The frequencies of the job categories are shown in Table 4.

D. MODEL

We constructed the following statistical model based on Fig. 3 to evaluate the effects of incidental brief exposure z on the background knowledge of news, hard news knowledge, and soft news knowledge.

$$\begin{aligned}
 y &\sim \text{Normal}(\mu, \sigma) \\
 \mu &= \bar{\alpha} \cdot \bar{m} + \beta_1 \log_{10}(w + 1) + \beta_2 \log_{10}(z + 1) \\
 &\quad + \bar{\gamma} \cdot \bar{m} \log_{10}(z + 1) + \gamma' \log_{10}(w + 1) \log_{10}(z + 1) \\
 &\quad + \zeta \cdot \bar{c} + \gamma_0
 \end{aligned} \tag{1}$$

, where we conducted logarithmic transformation of w , z , w' , and z' because these variables have skew distributions. “+1” in the transformations was included because the ranges of these variables include zero. $\bar{m} \log_{10}(z + 1)$ shows the interactions between media usage frequencies and incidental brief exposure. $\log_{10}(w + 1) \log_{10}(z + 1)$ shows the interactions between ABEMA news watching time and incidental brief exposure. All variables excluding categorical variables were standardized (mean: 0, standard deviation: 1).

We estimated the parameters of this model by Stan [63]; while the number of chains was 4, the number of iterations

was 3,000, and the first 1,000 iterations were discarded as burn-in iterations. We used a normal distribution (mean: 0.0, standard deviation: 100.0) as non-informative prior distributions of all parameters. As a result of estimation, the model was converged (R hat [64] of all parameters were less than 1.005).

IV. RESULTS

Table 2 shows the results of the evaluation of our model.

A. MAIN EFFECTS

The main effects of incidental brief exposure did not show significant effects on any type of knowledge, i.e. 95% credible interval of their distributions included zero. The incidental brief exposure in our study showed weaker effects than the incidental exposure in portal sites [21], as expected. Similarly, mere incidental exposure on social media also does not contribute to news recall [23].

The ABEMA news watching times, curation sites, and online news sites also did not show significant effects on any of the types of knowledge. Reference [38] has indicated that soft news, which curation sites and online news sites tend to publish, does not contribute to increasing users’ news knowledge.

Social media usage frequencies showed a significant negative effect only on hard news knowledge.

Traditional media usage frequencies contributed to all types of knowledge, consistent with [38], [65].

B. INTERACTIONS BETWEEN INCIDENTAL EXPOSURE AND MEDIA USAGE

The interactions between incidental brief exposure and social media usage frequencies had significant positive associations with only background knowledge and hard news knowledge. Other interactions were not significant. This implies that social media users’ knowledge was reinforced by incidental brief exposure.

To provide a more intuitive understanding of the interaction of incidental brief exposure and media usage frequencies, predicted values (y) based on the statistical model are shown in Fig. 4, holding all the other continuous variables at their means and categorical variables at zero (i.e. male, no married, no children, and civil-service worker). This figure also shows the differences between with/without incidental brief exposure based on the predicted values (Δy).

Participants with high social media usage and frequent incidental brief exposure increased their background knowledge and hard news knowledge more than did participants with low incidental brief exposure frequencies (Fig. 4a and f). Additionally, for soft news, the interaction showed a similar trend in soft news knowledge, although the trend was not significant (Fig. 4k).

There were no effects of the interaction between incidental brief exposure and other media usage.

TABLE 2. The coefficients of regression analyses (median, 2.5 percentile, and 97.5 percentile). Medians are indicated in bold face when the 95% credible interval of the coefficients did not include zero. Control variables are not listed here as they are not essential to the analysis.

Category	Variable	Background knowledge		Hard news knowledge		Soft news knowledge	
		Med.	[2.5%ile, 97.5%ile]	Med.	[2.5%ile, 97.5%ile]	Med.	[2.5%ile, 97.5%ile]
ABEMA News	Watching time	-0.042	[-0.108, 0.023]	0.001	[-0.067, 0.068]	-0.021	[-0.087, 0.043]
	Incidental brief exposure	0.020	[-0.055, 0.098]	0.003	[-0.080, 0.083]	0.008	[-0.070, 0.086]
Media usage	Social media	-0.027	[-0.092, 0.038]	-0.075	[-0.141, -0.010]	-0.025	[-0.090, 0.040]
	Curation site	0.014	[-0.057, 0.084]	-0.003	[-0.074, 0.070]	0.033	[-0.034, 0.104]
	Traditional media	0.082	[0.007, 0.156]	0.108	[0.037, 0.180]	0.193	[0.124, 0.266]
	Online news site	0.001	[-0.081, 0.085]	0.026	[-0.058, 0.109]	0.037	[-0.044, 0.117]
Interaction with incidental exposure	Social media	0.075	[0.014, 0.135]	0.111	[0.050, 0.171]	0.053	[-0.006, 0.112]
	Curation site	-0.004	[-0.079, 0.071]	-0.012	[-0.086, 0.059]	0.012	[-0.059, 0.084]
	Traditional media	0.012	[-0.051, 0.075]	0.006	[-0.058, 0.071]	-0.003	[-0.063, 0.059]
	Online news site	-0.024	[-0.105, 0.060]	-0.035	[-0.121, 0.049]	0.009	[-0.071, 0.092]
	ABEMA watching time	0.033	[-0.025, 0.090]	0.003	[-0.057, 0.063]	0.010	[-0.046, 0.068]
Coefficient of determination	R ²	0.288	[0.272, 0.300]	0.272	[0.257, 0.284]	0.329	[0.315, 0.341]
	Adj. R ²	0.252	[0.235, 0.264]	0.234	[0.219, 0.248]	0.295	[0.280, 0.307]

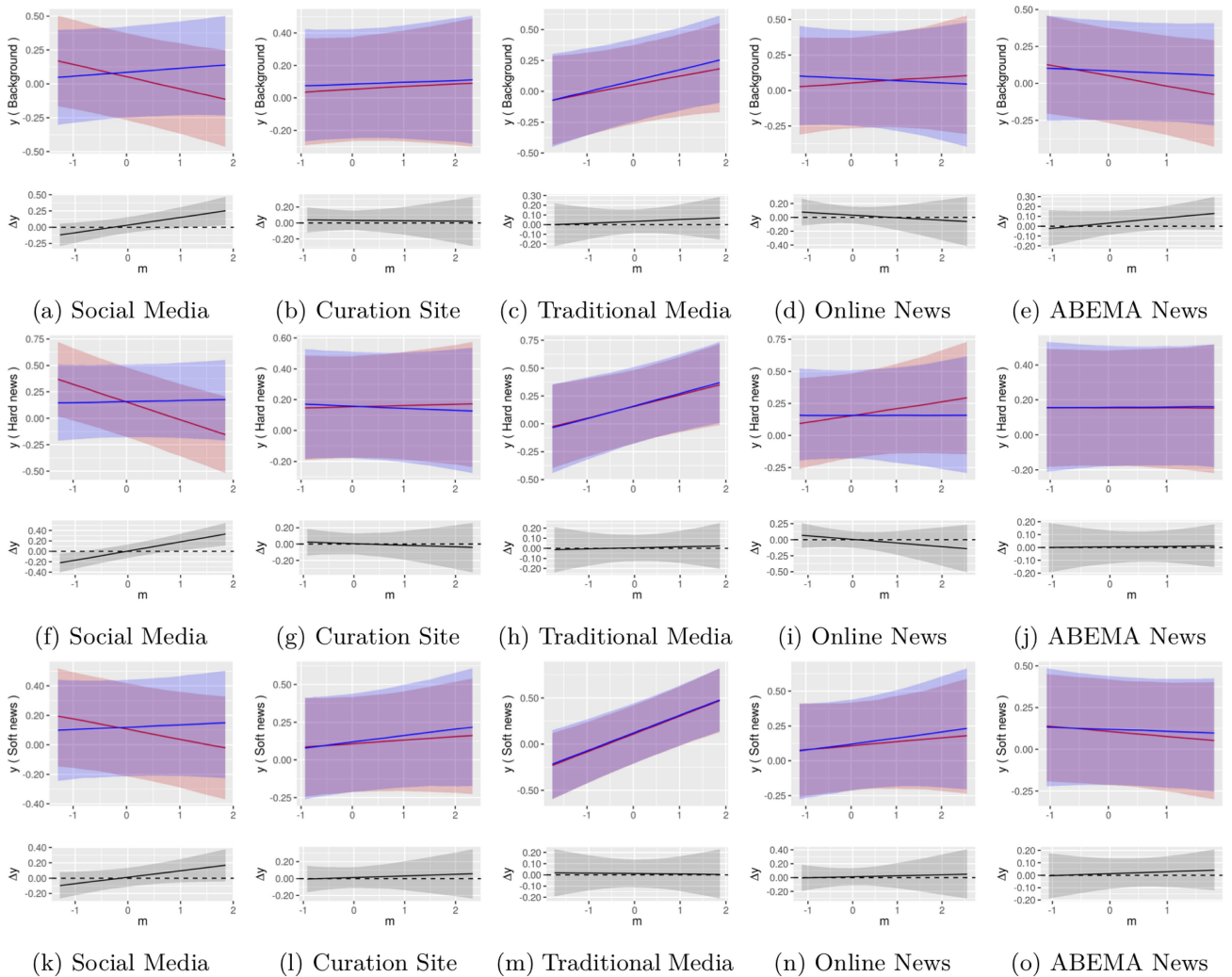


FIGURE 4. Interactions between incidental brief exposure and media usage frequencies including ABEMA's news program watching time. The red lines show all the types of knowledge of the participants with the low incidental brief exposure frequencies (25 percentile). The blue lines show all the types of knowledge of the participants with high incidental brief exposure frequencies (75 percentile). The black lines show the differences between both. The positive values of the black lines indicate that the high incidental brief exposure frequencies positively affect each objective value y . The horizontal axes range is from 2.5 percentile to 97.5 percentile for each media usage frequency. The semi-transparent ribbons represent the 95 percent credible interval.

V. DISCUSSION

In this paper, we analyzed the effects of incidental brief exposure on news knowledge while changing channels on Internet

television by combining the findings from user behavior logs and a questionnaire survey completed by the users. We found that incidental brief exposure can mitigate the negative effects

of social media usage due to the significant interaction between the exposure and social media usage, although its main effects were not significant. This finding shed light on incidental brief exposure while scrolling videos which has barely received any attention because of the difficulty of measuring it in the field studies, although most people have experienced such incidental brief exposure on television.

As expected, the incidental brief exposure while scrolling through news videos did not significant main effects on political knowledge. In contrast, the incidental exposure on a portal site [21], [25] and social media [23] increases people's news knowledge. This difference may suggest that incidental exposure requires more time than incidental brief exposure (less than four seconds), even on portal sites and social media.

Our analysis showed the negative association between social media usage and hard news knowledge. Also, background and soft news knowledge did not show significant associations. Previous works [38], [66] pointed out that social media usage does not contribute political knowledge. In addition, social media usage would reduce time and attention for other media usage among the users. Highly frequent social media users do not tend to use traditional media [38], [39] which is effective for obtaining news knowledge. Consequently, the positive association between the heavy usage of social media and news knowledge may not have been observed in this study, even if social media provides opportunities for incidental exposure to news [22], [23].

As a possible scenario for explaining our study findings, we can consider that memorizing news keywords by incidental brief exposure may facilitate reading news related to these keywords when users incidentally encounter the same news on social media. This may increase background knowledge and hard news knowledge. The reason for this effect may be that people learn news by repeatedly encountering the same or similar news stories [19], [25]. Additionally, incidental exposure facilitate news seeking of people who are disinterested in news [25]. As a result, the effect of incidental exposure of social media [22], [23], [27] can be reinforced by incidental brief exposure while scrolling through videos. Increasing political interest increases political knowledge via more frequent usage of news media [52]. Incidental brief exposure may increase news knowledge by increasing the political interests of people who heavily use social media.

Increasing social media users' political knowledge is important for mitigating the gap of political knowledge because people who encounter news items on social media have some problems with news/political knowledge, such as insufficient news knowledge [38], [66], [67] and overconfidence about their political knowledge [67]. We can expect that incidental brief exposure mitigates these issues by facilitating social media users' news knowledge because incidental exposure is effective even if people have less news knowledge [21].

Our findings may also mitigate the problem of non-representative political communication by social media users. Social media can be used to visualize the political

TABLE 3. Demographic information.

Gender	Age	Number of participants
Male	15–19	16
Male	20–29	37
Male	30–39	109
Male	40–49	181
Male	50–59	170
Male	60–69	129
Female	15–19	19
Female	20–29	73
Female	30–39	103
Female	40–49	88
Female	50–59	88
Female	60–69	18

TABLE 4. Job categories.

Categories	Number of participants
Civil-service worker	28
Management executive and board member	33
Office worker (clerk)	116
Office worker (engineer)	106
Office worker (other)	197
Self-owned business	70
Liberal profession	30
Full-time homemaker	116
Part-timer	131
Student	156
Others	45
Unemployed	103

opinions of users because they post their feelings and opinions related to news on social media [68], [69]. However, those who expose news items on social media tend to have strong attitudes due to overconfidence about their political knowledge [67]. Consequently, the visualization of opinions on social media seems to be constructed by such people with less news knowledge and a strong attitude, e.g. hate speech [70], [71]. The increasing political knowledge of social media users by incidental brief exposure might address this issue because incidental exposure is not reliant on people's attitudes [23].

It is also interesting that incidental brief exposure on online television did not moderate media usage effects, except for social media. This could be because of the difference in media usage motivations. Other media (traditional media, curation sites, online news sites, and ABEMA news programs) are news media though they have the differences in news quality and topics (hard news/soft news). In contrast, people use social media for checking friends' recent posts and feelings rather than news, i.e. much of news exposure seems to be incidental [22], [23], [27]. In other words, very weak incidental exposure, such as incidental brief exposure while scrolling through videos, can only reinforce incidental exposure, as in the above scenario.

People may be affected by incidental brief exposure on not only ABEMA but also other platforms, such as other internet televisions, non-internet televisions, video hosting services (e.g., YouTube and TikTok), and online video ads. This is because they also provide opportunities for incidental brief exposure. On non-internet televisions, people incidentally

TABLE 5. The coefficients of control variables in regression analyses (median, 2.5 percentile, and 97.5 percentile). Medians are indicated in bold face when the 95% credible interval of the coefficients did not include zero.

Category	Variable	Background		Hard news		Soft news	
		Med.	[2.5%ile, 97.5%ile]	Med.	[2.5%ile, 97.5%ile]	Med.	[2.5%ile, 97.5%ile]
Political interest	Political interest	0.115	[0.041, 0.189]	0.174	[0.098, 0.249]	0.156	[0.083, 0.228]
	News	0.014	[-0.059, 0.086]	0.025	[-0.047, 0.096]	0.041	[-0.026, 0.110]
Preference	Entertainment	-0.035	[-0.101, 0.032]	-0.012	[-0.078, 0.054]	-0.059	[-0.122, 0.004]
	Convenient	-0.139	[-0.219, -0.057]	-0.156	[-0.242, -0.074]	-0.228	[-0.306, -0.150]
ABEMA usage Motivation	Relaxation	0.151	[0.046, 0.260]	0.027	[-0.084, 0.139]	0.110	[0.002, 0.218]
	Reproducibility	-0.023	[-0.118, 0.073]	0.039	[-0.058, 0.137]	0.037	[-0.058, 0.131]
News seeking	News seeking	0.032	[-0.023, 0.089]	0.038	[-0.018, 0.094]	0.030	[-0.024, 0.083]
	Awareness for logical thinking	-0.022	[-0.114, 0.072]	-0.080	[-0.176, 0.015]	-0.055	[-0.149, 0.036]
Critical Thinking Disposition	Inquiry-mind	-0.010	[-0.106, 0.087]	0.029	[-0.068, 0.123]	-0.065	[-0.156, 0.029]
	Objectiveness	0.156	[-0.043, 0.365]	-0.085	[-0.289, 0.121]	-0.087	[-0.282, 0.109]
Evidence based judgment	Evidence based judgment	-0.093	[-0.265, 0.078]	0.053	[-0.123, 0.228]	0.113	[-0.056, 0.285]
	Subjective media literacy	-0.049	[-0.132, 0.032]	-0.011	[-0.093, 0.071]	0.017	[-0.062, 0.093]
and suspicion of media	Suspicion of media	0.092	[0.018, 0.167]	0.067	[-0.007, 0.142]	0.080	[-0.006, 0.151]
	Feelings towards information seeking	0.081	[0.011, 0.153]	0.118	[0.043, 0.192]	0.082	[0.011, 0.153]
Feelings towards news exposure	Limited information seeking	-0.153	[-0.220, -0.086]	-0.090	[-0.158, -0.024]	-0.075	[-0.139, -0.008]
	Information overload	0.029	[-0.035, 0.093]	0.023	[-0.042, 0.088]	0.011	[-0.052, 0.074]
Ideology	Right-wing tendency	0.116	[0.057, 0.175]	0.044	[-0.016, 0.104]	0.153	[0.095, 0.209]
	Left-wing tendency	0.045	[-0.013, 0.104]	0.029	[-0.030, 0.088]	0.020	[-0.037, 0.075]
Political communication	Non-self-avowed	-0.090	[-0.149, -0.033]	-0.029	[-0.088, 0.030]	-0.008	[-0.064, 0.050]
	Online	-0.043	[-0.109, 0.023]	-0.065	[-0.132, 0.002]	0.056	[-0.005, 0.119]
ABEMA (non-news)	Offline	0.020	[-0.045, 0.082]	0.020	[-0.044, 0.084]	-0.079	[-0.143, -0.016]
	Watching time	0.066	[-0.043, 0.174]	-0.015	[-0.123, 0.094]	-0.029	[-0.134, 0.072]
Demographics	Incidental brief exposure	-0.042	[-0.154, 0.073]	0.008	[-0.106, 0.125]	0.023	[-0.086, 0.133]
	Age	0.073	[-0.003, 0.147]	0.061	[-0.017, 0.137]	0.002	[-0.070, 0.077]
Job	Sex (Male: 0, Female: 1)	-0.443	[-0.587, -0.298]	-0.345	[-0.492, -0.195]	-0.369	[-0.504, -0.228]
	Married:1, else: 0	-0.038	[-0.185, 0.107]	0.003	[-0.147, 0.147]	0.043	[-0.100, 0.180]
Job	Having children:1, else: 0	0.136	[-0.002, 0.280]	0.064	[-0.076, 0.204]	0.123	[-0.012, 0.259]
	Executive	0.120	[-0.323, 0.550]	0.287	[-0.154, 0.725]	-0.044	[-0.463, 0.370]
Demographics	Office worker (clerk)	0.100	[-0.255, 0.442]	0.081	[-0.288, 0.437]	0.031	[-0.307, 0.375]
	Office worker (engineer)	-0.126	[-0.484, 0.234]	-0.211	[-0.588, 0.153]	-0.247	[-0.594, 0.109]
Job	Office worker (others)	-0.025	[-0.369, 0.308]	-0.133	[-0.483, 0.219]	-0.103	[-0.428, 0.234]
	Self-owned business	0.095	[-0.286, 0.468]	0.045	[-0.351, 0.427]	0.213	[-0.145, 0.578]
Demographics	Liberal profession	0.061	[-0.389, 0.498]	0.152	[-0.301, 0.620]	0.201	[-0.234, 0.641]
	Full-time homemaker	0.014	[-0.362, 0.375]	-0.132	[-0.507, 0.238]	-0.003	[-0.366, 0.357]
Job	Part-timer	-0.073	[-0.426, 0.281]	-0.123	[-0.495, 0.238]	-0.104	[-0.448, 0.250]
	Student	0.332	[-0.081, 0.739]	-0.168	[-0.595, 0.256]	-0.333	[-0.740, 0.069]
Demographics	Others	0.071	[-0.329, 0.472]	0.014	[-0.405, 0.420]	-0.272	[-0.671, 0.118]
	Unemployed	0.096	[-0.273, 0.460]	0.041	[-0.349, 0.416]	0.098	[-0.257, 0.466]
Intercept	Intercept	0.070	[-0.252, 0.393]	0.155	[-0.176, 0.492]	0.114	[-0.208, 0.422]

encounter news while changing channel, as with ABEMA. We can also regard glimpsing video screens on video hosting services and online video ads as incidental (brief) exposure, not through change channels. Internet televisions and video hosting services show a recommended video list and automatically run the next video. Online video ads, which can include political news, are displayed in many web sites. Therefore, we can expect the positive effects of incidental brief exposure, such as increasing social media users' political knowledge because many people tend to use some news media with social media [72].

This also suggests the risk of incidental brief exposure to biased video contents. People, particularly social media users, may be affected by such biased content even if they watch these contents for only a few seconds. Particularly, video hosting services and online video ads can increase this risk because they are available to everyone, including evil organizations and individuals, unlike in non-internet televisions and ABEMA. Actually, problematic/biased media using video hosting services and online video ads tends to use sensationalized and misleading titles and/or thumbnails for attracting attention [31], [32]. Incidental exposure to such media can badly affect people's knowledge and belief [35], [36]. Additionally, in video hosting services and online video ads, displaying news video contents controlled by algorithms fitting in audience preference (personalization) [73] may amplify the biased incidental brief exposure in contrast with randomly incidental brief exposure on non-internet television and ABEMA. Many people experience such personalization without the detail knowledge of algorithmic personalization [72].

Therefore, future studies on such exposure can extend the scope of the present study to other platforms.

Although there may be the risk of incidental exposure for spreading misinformation due to exposure sensationalized titles and/or thumbnails without reading in social media [31], [32], [34], at least, our result did not indicate negative association between incidental brief exposure and news knowledge. This may be because ABEMA offers mass media contents which tend not to show biased titles. Testing the effect of incidental brief exposure to mass media contents on misinformation knowledge is required.

One study limitation is that the frequency of incidental brief exposure reflects knowledge obtained by the exposure and audiences' disinterest. In this study, we controlled it to the extent possible by using several control variables. Another study limitation is that the study focuses only on people who are disinterested in politics and excludes those who engage in news watching behavior after incidental brief exposure to news screens on Internet television. Experimental studies on incidental brief exposure would provide more definitive insight.

APPENDIX

See Tables 3–5.

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