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The Agenda-Setting Function of Twitter and Its User's Characteristics on COVID-19: An Empirical Research Using Log Data and Survey Data in Japan

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Abstract

This study investigates the functions of Twitter as a medium during COVID-19. Specifically, we analyze the agenda-setting function of Twitter (Study 1) and characteristics of information disseminators on Twitter (Study 2) related to the COVID-19 pandemic. In Study 1, we examined rank correlations between the media agendas on COVID-19 identified from two months of two newspapers and Twitter content data, and public agendas identified from an internet survey (n = 903). The results indicated that Twitter has a shorter-term agenda-setting function compared with the newspapers and resonates with those who have liberal tendencies. In Study 2, we used data from the internet survey to identify political attitudes of people who tweet or retweet on COVID-19. The descriptive statistics indicated that 2.1% of users generated 54.3% of COVID-19-related tweets, and 3.0% generated 62.3% of the retweets. This means that more than half of the COVID-19-related discourses on Twitter were generated by a small number of users. Results of the logit model analyses revealed that those who tweeted regarding COVID-19 tend to be liberal, and those who retweeted tend to have the "flaming orientation". Based on these results and the nature of retweeting that is less psychologically demanding than tweeting, it is possible to see that people with liberal tendencies, motivated by their political attitude, create original tweets, and some of those tweets are then retweeted by flaming-oriented people driven by a sense of justice. This seems to be how information about COVID-19 spreads on Twitter.

Keywords

COVID-19, Twitter, Agenda-setting function, Public opinion, Analysis on Twitter users,
Tweet and Retweet

要旨

本稿の目的は、新型コロナウイルス感染症の流行下（以下、COVID-19）における Twitter のメディアとしての機能を明らかにすることである。具体的には、Twitter の議題設定機能（研究 1）及び、Twitter 上の情報発信者の特徴（研究 2）を分析する。

研究 1 では、約 2 ヶ月分の新聞及び Twitter の内容データから特定した COVID-19 に関するメディアアジェンダと、サーベイ調査（n = 903）から特定した公衆アジェンダの順位相関を検証した。その結果、Twitter は新聞と比べて短期間の議題設定機能を有すること及び、リベラル傾向のある層と共振していることが明らかとなった。研究 2 では、サーベイ調査のデータを用いて、COVID-19 についてツイート／リツイートする人の特徴を明らかにした。COVID-19 関連のツイート／リツイートを投稿数ベースで見てみると、2.1%のユーザーが 54.3%のツイートを生成し、3.0%のユーザーが 62.3%のリツイートを生成していた。これは、我々が Twitter 上で目にする COVID-19 関連言説の半数以上がごく少数のユーザーによって生成されていることを意味する。モデル分析の結果、COVID-19 についてツイートした人にのみリベラル傾向が見出され、リツイートした人にのみ炎上を志向する傾向が見出された。こうした結果と、リツイートはオリジナルツイートの生成に比べて心理的負担が少ないことを合わせて考えると、COVID-19 に関する Twitter 上の情報拡散に次のような構造が見出せる。すなわち、リベラル傾向のある人が、政治的志向に動機づけられて負担を伴うオリジナルのツイートを作成し、それを炎上志向の人が正義感からリツイートしているということである。

1. Introduction

The aim of this paper is to clarify the function of Twitter as an information medium during the COVID-19 pandemic. Specifically, we clarify the agenda-setting function of Twitter and characteristics of information disseminators and spreaders on Twitter.

Over a year since the outbreak COVID-19 hit Japan, varying information has been spread through social media, as well as mass media such as newspapers and television. According to a survey conducted by Japan's Ministry of Internal Affairs and Communications (n = 2,000), 22.6% of respondents said that Twitter was the information medium through which they had seen news about COVID-19, which is the highest percentage among social media outlets surveyed. Among those in their teens and twenties, the percentage is approximately 50%, which is higher than the percentage of those who consumed news online, though not as high as that of those who had seen news on television (Ministry of Internal Affairs & Communications, 2020). In addition, given that information on Twitter has sometimes been discussed in the Diet, it can influence public policy. Thus, the presence of Twitter as a news medium on COVID-19 is not small. Therefore, the biases found on Twitter are important factors for the decision-making of people and governments. This paper provides insights into Twitter's biases through analyses of its agenda-setting function and characteristics of its users.

Agenda-setting research in the field of media studies has accumulated more than 400 empirical studies, demonstrating that the agendas reported in mass media can influence the public agendas (McCombs, 2014). Agenda-setting research has developed by examining the rank correlation between agendas in mass media, such as newspapers and television, and public agendas. Since the 2010s, social media has also come into the scope of agenda-setting research. Researchers have examined the relationship between information from mass media accounts on Twitter and tweets of the general public (McGregor & Vargo, 2017; Vargo et al., 2014) and the intermedia agenda-setting function between newspapers and Twitter (Ceron, 2014). In the background of such research, there is a view that sees Twitter as public opinion (Vargo, 2011). However, there are limitations in viewing Twitter as public opinion. It has been pointed out that content data on Twitter cannot be used as an accurate representative sample. (Salganik, 2017). Some empirical studies in Japan have also

demonstrated that online political discourses do not always reflect public opinions (Toriumi, 2020; Tanaka & Hamaya, 2019). On the other hand, information disseminated on Twitter can influence people, as seen with Twitter's use in the 2016 U.S. Presidential Election (Morris, 2017). In addition, it has been pointed out that Twitter is used by journalists to build agendas (Parmelee, 2014). With regard to political communications in Japan, Kobayashi & Ichifuji (2015) demonstrated that the increased exposure to politician's tweets has a positive impact on the overall favorability of that politician. Thus, in Study 1, we consider Twitter as a kind of medium and examine the relationship between agendas on Twitter and actual public agendas regarding the COVID-19 pandemic.

Information on Twitter is generated and diffused by ordinary users, unlike that of mass media which is systematically edited. In other words, it can be considered that ordinary users are the generators of Twitter agendas. In Study 2, we use survey data to analyze characteristics of people who tweet and retweet about COVID-19. Research on social media and COVID-19 has not yet addressed the issue of the medium's bias, which renders this study timely and necessary. In addition, methodologically, the analysis of Twitter log data has been the main research focus in COVID-19 (Li et al., 2020; Lwin et al., 2020), and there has not been much research focusing on the information sender. Therefore, we provide evidence about characteristics of people who tweet or retweet about COVID-19 using survey data.

2. Study 1

2.1 Agenda-setting functions of media

Research on the agenda-setting function of media has evolved from a first-level function that focuses on the relative importance among major issues (e.g., diplomacy, economy, and other large topics) to a second-level function that focuses on the attributes of specific issues and to a third-level function that focuses on the people's cognition of network among major issues. In 2020, COVID-19 has been particularly important as a major issue, so this study focuses on the second-level agenda-setting function, attributes of COVID-19. There are debates regarding the scope of the second-level agenda-setting function (Takeshita, 2006). One of them limits the agenda-setting function to the analysis of relative importance among sub-issues of a particular issue (Takeshita &

Mikami, 1995), and another extends the agenda-setting function to the framing function of "how to think" about a particular issue (McCombs et al., 2000). While assuming that there is a continuum between these two positions, we based our study on the former debate.

As described later, we divided issues related to COVID-19 into 20 categories using content analysis of two newspapers (*Yomiuri Shimbun* and *Asahi Shimbun*) and Twitter. Of these, the majority of the categories merely point out the situation, such as "The number of infected people" and "The impact on corporate profits (such as bankruptcy or closure of businesses)". Judging the importance of these agendas may be relative to other agendas. On the other hand, some agendas inevitably involve framing. For example, "Support for the needy and increase in the number of suicides" includes the political attitude that people who have fallen into hardship due to COVID-19 should be supported, and "Expand PCR test" includes that the PCR test should be expanded. Above all, "The overall attitude and policy of the government in dealing with COVID-19 is not good" occupied the top spot on the Twitter agenda. Tweets that totally criticize the government and the ruling party, such as criticizing the inappropriate behaviors of government officials, are classified into this category. This category clearly contains political attitudes that are critical of the government and the ruling party. Judgments of the importance of these agendas are involved in framing, whether people agree or disagree with the issues. In our study, the analysis is limited to the relative importance of these categories. The effect of framing, which involves directing people's attitudes about an issue, is stronger than that of agenda-setting function, people's recognition of an issue. Therefore, a one-shot survey is limited in its measurement. If we want to strictly measure the framing effect, a randomized controlled experiment would be necessary. Of course, this is a matter of degree, but we limit our analysis to people's agenda recognition based on data limitation. Specifically, we ranked the importance of each category from the content data of the media (media agendas) and an internet survey (public agendas), and analyzed correlations between media agendas and public agendas. Based on the aforementioned, the research question for Study 1 is as follows:

RQ1: What are the characteristics of Twitter's agenda-setting function?

To answer this question, we need to establish a comparison object. Therefore, we compare Twitter to two popular newspapers in Japan (*Yomiuri Shimbun* and *Asahi Shimbun*) to clarify the characteristics of Twitter's agenda-setting function. In particular, following the relevant studies (Takeshita, 2008; McGregor & Vargo, 2017; Vargo et al., 2014), we focus on the duration the agenda-setting function works and whether the agenda-setting effect differs depending on people's political attitudes (liberal or conservative).

2.2 Hypothesis

Twitter is different from mass media in that anyone can post and spread information at any time. Information streams on Twitter seem to change in a shorter span than those on newspapers, which are created by a formal decision-making by an entity and published once or twice a day for a fixed period of time. McGregor & Vargo (2017) analyzed the variability of Twitter trends using the ARIMA model and noted that the salience of the Twitter agendas was highly correlated with that of the Twitter agendas from the previous day or two. In other words, Twitter agendas change in a very short period of time. In the context of social movements, Eltantawy & Wiest (2011) pointed out that the utility of social media lied in the speed of information diffusion compared with that of print media. The speed of information diffusion has been highlighted as one of the factors of "flaming" phenomenon, a situation where the internet is flooded with critical comments about what a person or company has said or done (Pfeffer et al., 2014). Therefore, the following hypothesis is considered:

H1: Twitter's agenda-setting function works faster than that of the newspapers.

Research results have been unclear on whether the Twitter agenda is more associated with political liberals or conservatives. Vargo et al. (2014) and McGregor & Vargo (2017) comprehensively collected Twitter log data mentioning election-related topics during the 2012 U.S. presidential election, and then classified official media accounts on Twitter by partisan attitudes, and examined their relationships with tweets by ordinary users. The dependent variable in Vargo et al. (2014) was the agenda network (third-level agenda-setting) in the tweets of ordinary users

categorized as Obama supporters and Romney supporters. The result indicated that Romney supporters were more strongly associated with information originating from partisan media accounts. By contrast, the dependent variable in McGregor & Vargo (2017) was the major agenda (first-level agenda-setting) in tweets of ordinary users, categorized into three categories according to the number of tweets during the election period. The result indicated that the correlation between liberal media tweets and high-frequency users was the highest. Since the two studies differed not only in the dependent variable but also in the method of analysis, it is difficult to obtain a unified view. Therefore, we do not set any particular hypothesis on this issue.

2.3 Methods

We conducted the analysis in Study 1 using Spearman's rank correlation coefficient of the media agendas and public agendas, following McCombs & Shaw (1972). For the analysis, it was necessary to identify the media agendas and the public agendas, and this task was conducted as follows. The data used in this study consisted of content data from Japanese newspapers, Twitter, and an internet survey. First, we identified the agendas in the newspapers and Twitter. The content analysis period is from September 16, 2020, when the new government took office in Japan, to December 12, 2020, the day before the last day of the internet survey. Regarding newspapers, we analyzed the two most popular newspapers in Japan, *Yomiuri Shimbun* and *Asahi Shimbun*. We extracted articles from the general section of the newspapers' Tokyo morning edition (Yomiuri: pages 1 to 3 and Asahi: pages 1 to 4) that included the word "*corona* (in Japanese)" in article titles or texts through online databases "Yomidas Rekishi Kan" and "Kikuzo II Visual". We limited our analysis to the general section because that is where the news the editors deem most important is published. This procedure is appropriate because the media agendas in agenda-setting research refer to the issues that have been relatively emphasized in news reports within a certain period of time. For Twitter, we used the Twitter API to obtain all the tweets that included the word "*corona* (in Japanese)" during the periods. As we view Twitter as a medium, it is inappropriate to equate a tweet that has not been shared at all with a tweet that has been shared a lot. Twitter is designed to make frequently shared tweets more likely to be seen by people, so we can view the issues shared a lot as

relatively emphasized Twitter agendas. Therefore, we conducted a content analysis on tweets retweeted more than 1,000 times. In this way, we would also minimize the impact of bots.

We then categorized articles and tweets using the method of the grounded theory approach and created the top 20 categories based on frequencies mentioned by both media (Table 1). Categorizing was conducted by the author alone. The method is as follows. Summaries of each data are transcribed onto an excel sheet. After a certain amount of data are collected, they are grouped according to the content, and names are given to each group. Next, new data are transcribed, and those that fit into the existing groups are labeled as the existing group name. If not, the data are withheld from labeling. When a certain amount of data are collected, the grouping process is performed again, and new groups are created as necessary. These processes are repeated to check all the data. In this way, the top 20 groups were created. Of the tweets analyzed, those that did not fit into any of the 20 categories, such as tweets related to illegal receipt of COVID-19-related subsidies and the consumption tax cut for COVID-19 were excluded because their mention numbers were too small to be considered as agendas. We also excluded tweets that contain the word "*corona*" but are not related to COVID-19, such as "I want to do *something* when the *corona* is converged" and using the word "*corona*" in a facetious manner.

In addition, to clarify the duration the agenda-setting function works, agenda-ranking tables were created for 2 months, 1 month, 2 weeks, and 1 week before the survey. The result is presented in Table 1. This is the ranking of agendas of the newspapers and Twitter.

Table 1 Newspaper agendas & Twitter agendas

	Newspapers								Twitter							
	2 months		1 month		2 weeks		1 week		2 months		1 month		2 weeks		1 week	
	Rate	Rank	Rate	Rank	Rate	Rank	Rate	Rank	Rate	Rank	Rate	Rank	Rate	Rank	Rate	Rank
Public policies to promote the economy (such as "GoTo Travel", "GoTo Eat")	17.4%	1	22.5%	1	17.5%	2	18.8%	3	7.9%	5	8.9%	4	10.4%	3	15.1%	3
Information on the number of infected people (including cluster outbreaks) in Japan and abroad	12.0%	2.5	10.4%	3.5	7.0%	6	6.3%	4.5	14.5%	2	13.8%	3	7.9%	4	8.9%	4
Vaccine development and securing and provision of vaccines by the government	12.0%	2.5	16.9%	2	22.8%	1	27.1%	1	1.4%	18	0.8%	18.5	1.2%	17.5	2.2%	10
Difficulties in the medical field and strengthening of medical resources	9.5%	4	10.4%	3.5	13.2%	3	20.8%	2	11.3%	3	14.1%	2	18.3%	2	16.2%	2
The impact on corporate profits (such as bankruptcy and closure of businesses)	7.4%	6	2.6%	10.5	0.0%	18	0.0%	17	2.2%	15	1.6%	15	2.1%	13	2.2%	10
Infection control measures by government and companies (such as cluster measures, telework promotion and short-term business)	9.0%	5	9.5%	5	11.4%	4	6.3%	4.5	2.9%	12	3.0%	9.5	1.5%	16	1.7%	13
Deterioration of the employment situation (including decrease in salaries)	6.4%	7	7.8%	6	8.8%	5	2.1%	10.5	1.8%	16	0.8%	18.5	0.6%	19	0.0%	19.5
Hosting of the Tokyo Olympics	4.9%	8	4.3%	7	2.6%	9.5	2.1%	10.5	1.5%	17	1.3%	16.5	1.2%	17.5	0.6%	18
Impacts on the macroeconomy (such as stock prices, GDP and consumption)	4.1%	9	2.6%	10.5	1.8%	12.5	0.0%	17	0.3%	20	0.3%	20	0.0%	20	0.0%	19.5
Transportation of people to and from overseas (such as business and tourism)	3.1%	11.5	2.6%	10.5	2.6%	9.5	2.1%	10.5	3.5%	10	4.6%	6	4.0%	8	3.4%	8
Infection prevention (such as virus infectivity, situations where people are susceptible to infection and effectiveness of masks)	3.6%	10	2.6%	10.5	2.6%	9.5	4.2%	6.5	8.0%	4	7.3%	5	4.9%	5	5.6%	5
Impacts on school and university education (including entrance examination and tuition fees)	3.1%	11.5	1.3%	14	2.6%	9.5	2.1%	10.5	1.2%	19	1.3%	16.5	1.8%	14.5	1.1%	16
Support for the needy and increase in the number of suicides	3.3%	13	3.5%	8	3.5%	7	4.2%	6.5	2.7%	13	2.5%	13	3.0%	11	1.7%	13
Cultural events (such as live music concerts)	0.8%	16	0.0%	18.5	0.0%	18	0.0%	17	4.1%	8	2.7%	11.5	1.8%	14.5	1.1%	16
Expand PCR test	1.5%	14	1.3%	14	0.9%	14.5	2.1%	10.5	2.4%	14	2.2%	14	2.4%	12	1.1%	16
Overall attitude and policy of the government in dealing with COVID-19 is not good	1.3%	15	1.3%	14	1.8%	12.5	2.1%	10.5	17.0%	1	21.0%	1	22.9%	1	26.8%	1
Celebrities infected (such as entertainers, athletes and politicians)	0.5%	17	0.4%	16	0.9%	14.5	0.0%	17	5.9%	6	4.4%	7	4.6%	6.5	2.2%	10
Campaigns of businesses (such as restaurants) that are doing their best even during the rCOVID-19 pandemic	0.0%	19.5	0.0%	18.5	0.0%	18	0.0%	17	4.0%	9	2.7%	11.5	3.4%	9.5	3.9%	7
Symptoms (including sequelae) of new coronaviruses	0.3%	18	0.0%	18.5	0.0%	18	0.0%	17	4.2%	7	3.7%	8	4.6%	6.5	4.5%	6
Way of the mass media (such as TV and newspapers) report.	0.0%	19.5	0.0%	18.5	0.0%	18	0.0%	17	3.1%	11	3.0%	9.5	3.4%	9.5	1.7%	13
Number of articles or tweets	391		231		114		48		910		630		328		179	

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The survey data used in this paper were obtained through an internet survey in Japan. The survey was conducted from December 10, 2020, at approximately 22:00 JST to December 13, 2020, at approximately 14:00 JST. The questionnaire was distributed to 23,659 individuals who registered with a research panel through Cross Marketing Inc., an internet research company in Japan, and its affiliates. We obtained 1,000 samples from respondents aged 15–64, living in Tokyo, whose distribution of gender and age were assigned according to the population distribution of Tokyo (as of January 2020). We focused on respondents living only in Tokyo because the content analysis focused on the newspapers published in Tokyo.

The survey asked the following questions regarding the 20 items in Table 1.

> *Topics regarding COVID-19 have become important topics in Japan today. How much interest do you have in the following topics with regard to COVID-19? Please indicate your level of interest on a scale ranging from 1 to 10. (1 = Not at all interested, 10 = Very interested)*

The respondents who gave the same answers to all items in this question were excluded from the analysis. As a result, the sample size for the analysis was 903. Statistics based on gender and age are listed in Appendix 1. The total score for each item, multiplied by the score and its frequency, is presented in Table 2. This is the ranking of the public agendas.

Spearman's rank correlation coefficient can only tell us the correlation of each ranking, but it cannot identify factors that affect people's cognition of agendas. In other words, we cannot exclude the possibility that agendas happen to be correlated due to factors other than the media outlets. Therefore, we conduct analyses by groups through creating groups according to the status of media uses, to corroborate the relationship between people's agendas and media agendas. It is important to note that tendencies to use particular media are also associated with other media uses. In this survey, the respondents were asked about the time spent on 11 types of media (detailed in Appendix 2). The time spent on Twitter was positively correlated with those of all media except television and direct conversations. The time spent reading newspapers was positively correlated with those of all media, except internet video watching. In other words, if we simply use Twitter browsing time and

newspaper reading time as variables, we cannot eliminate the influence of other media outlets. Therefore, we conducted the following operation:

$$\text{Twitter browsing orientation} = \frac{\text{Twitter browsing time}}{\text{Time spent on all media outlets}}$$

and

$$\text{Newspaper reading orientation} = \frac{\text{Newspaper reading time}}{\text{Time spent on all media outlets}}.$$

The result of these formulas is the relative proportions of Twitter and newspapers in daily media consumption, respectively. These descriptive statistics are presented in Table 3. Next, we created groups with a Twitter browsing orientation more than the median and the median or less. Similarly, we created groups with a newspaper browsing orientation more than the median and the median or less. In addition, we created groups with a liberal tendency more than the median and the median or less. We then created ranking lists of public agendas for each group. The method of measuring the liberal tendency is described in detail in the relevant section of Study 2.

Through the above process, we created seven agenda-ranking tables for the entire sample, for groups with high and low Twitter browsing orientation, for groups with high and low newspaper reading orientation, and for a liberal group and a conservative group. For each of these, we examined the correlation with the agenda-ranking tables for the newspapers and Twitter by periods.

Table 2 Public agendas (n = 903)

	Public agendas	
	frequency × score	Rank
Public policies to promote the economy (such as "GoTo Travel", "GoTo Eat")	5,405	9
Information on the number of infected people (including cluster outbreaks) in Japan and abroad	5,582	5
Vaccine development and securing and provision of vaccines by the government	5,857	2
Difficulties in the medical field and strengthening of medical resources	6,003	1
The impact on corporate profits (such as bankruptcy and closure of businesses)	5,451	8
Infection control measures by government and companies (such as cluster measures, telework promotion and short-term business)	5,384	10
Deterioration of the employment situation (including decrease in salaries)	5,557	6
Hosting of the Tokyo Olympics	4,479	19
Impacts on the macroeconomy (such as stock prices, GDP and consumption)	5,159	13
Transportation of people to and from overseas (such as business and tourism)	4,975	16
Infection prevention (such as virus infectivity, situations where people are susceptible to infection and effectiveness of masks)	5,839	3
Impacts on school and university education (including entrance examination and tuition fees)	4,693	17
Support for the needy and increase in the number of suicides	5,158	14
Cultural events (such as live music concerts)	4,562	18
Expand PCR test	5,328	11
Overall attitude and policy of the government in dealing with COVID-19 is not good	5,470	7
Celebrities infected (such as entertainers, athletes and politicians)	3,804	20
Campaigns of businesses (such as restaurants) that are doing their best even during the rCOVID-19 pandemic	5,231	12
Symptoms (including sequelae) of new coronaviruses	5,827	4
Way of the mass media (such as TV and newspapers) report.	5,139	15

Table 3 Twitter browsing orientation & newspaper reading orientation

	Frequency	Minmum	Max	Median	Mean	SD
Twitter browsing orientation	889	0	0.803	0.013	0.055	0.100
Newspaper reading orientation	889	0	0.563	0.012	0.042	0.067

2.4 Results

Table 4 summarizes the results. The overall trend is that while the newspaper agendas are correlated with several groups over a span of one to two months, those of Twitter are only correlated with the public agenda rankings for a 1-week term. These results suggest that Twitter has an agenda-setting function only for a shorter period of time compared with newspapers. Therefore, H1 was supported.

Table 4 Rank correlation coefficients between media agendas and public agendas

	Newspapers				Twitter			
	2 months	1 month	2 weeks	1 week	2 months	1 month	2 weeks	1 week
Public (entire) (n = 903)	.469*	.450*		.518*				.540*
	0.037	0.046		0.019				0.014
Twitter browsing orientation (high) (n = 444)	.471*	.458*		.520*				.554*
	0.036	0.042		0.019				0.011
Twitter browsing orientation (low) (n = 445)				.472*				.516*
				0.036				0.020
Newspaper reading orientation (high) (n = 444)	.500*	.485*		.530*				.498*
	0.025	0.030		0.016				0.025
Newspaper reading orientation (low) (n = 445)				.475*				.552*
				0.034				0.012
Liberal tendencies (high) (n = 414)				.508*				.546*
				0.022				0.013
Liberal tendencies (low) (n = 489)	.539*	.506*		.486*				.488*
	0.014	0.023		0.030				0.029

Note: The top row of each column shows a Spearman's rank correlation coefficient, and the bottom row shows p-values. Only values with p-values less than 5% are listed.

**: $p < 0.01$, *: $p < 0.05$

In terms of media uses, the correlation coefficient with the Twitter agendas (1 week) is larger for the higher Twitter browsing orientation group than for the lower one. Similarly, the group with higher newspaper reading orientation has a larger correlation coefficient with the newspaper agendas (1 week) than the lower one and has a correlation with the newspaper agendas of a 1–2-month term. Note that no significant correlation was observed between the newspaper agendas and Twitter agendas throughout the entire period. With regard to political attitudes, the correlation coefficient with the Twitter agenda (1 week) was approximately .058 points larger for the group with high liberal tendencies than that for the group with low liberal tendencies.

2.5 Discussions

As hypothesized, Twitter's agenda-setting function worked in a relatively short-term. Looking at the newspaper agendas and the Twitter agendas for 1 week, the correlation coefficient with the Twitter agendas was larger for all groups although only slightly, except for the higher newspaper reading orientation group. The newspapers, by contrast, were correlated with the agendas of several groups on a 1–2-month term. This would represent a different function of both media. Newspapers can build agendas slowly over a long period of time, whereas Twitter can build them in a short-term.

Since Spearman's rank correlation coefficient reveals only a simple bivariate correlation, it is difficult to demonstrate whether the aforementioned phenomenon reflects the characteristics of the media or is influenced by other factors. Thus, the analyses by the groups can be useful. Since the correlation coefficients with the Twitter agendas are higher for the higher Twitter browsing orientation group than for the lower one, we can at least assume that the higher the proportion of time spent browsing Twitter in daily life, the more people's agendas resonate with the Twitter agendas. The same is true for newspaper reading. The higher newspaper reading orientation group has a larger correlation with the newspaper agendas than the lower one. These imply that there is a certain degree of influence of the media on the public agendas.

In terms of political attitudes, the Twitter agendas were relatively strongly correlated with the agendas of the group with higher liberal tendencies. This is consistent with the results of the Twitter log data analysis in two aspects. First, the most popular Twitter agenda throughout the entire period was criticism of the government and the ruling party. The second is the evaluation for the "Go To Travel" program[1], which was a key policy of the Japanese government. In contrast to the newspapers which tend to be neutral in their reporting, of the tweets surveyed that mentioned the policy, 79.2% (n = 77) were critical of the policy. Based on the study's survey data, a negative correlation was observed between liberal tendencies and the degree of approval for the government ($r = -.336$, $p < .0001$). Therefore, it is possible that there is a liberal bias in the discourses on Twitter. This point will be further analyzed in Study 2.

3. Study 2

The analysis by the rank correlation is limited by two major weaknesses. The first is that it can only test correlations at the aggregate level. In other words, they cannot capture the characteristics of individuals who are likely to resonate with the discourses on Twitter. Second, controlling for other variables is not possible. Although we conducted the analyses by the groups in Study 1, there are limitations to the analysis where influential factors such as demographic attributes and interest in COVID-19 are not controlled for. Therefore, in Study 2, we focus on the generators of the Twitter agendas, those who have tweeted or retweeted on COVID-19. By analyzing their characteristics, we can approach biases of information on Twitter albeit indirectly.

RQ2: What are the characteristics of those who have tweeted or retweeted on COVID-19?

3.1 Hypotheses

Tanaka & Hamaya (2019) investigated the biases of people who wrote on the internet. Generally, when people are asked whether they agree or disagree with political issues, the distribution of opinions is close to a normal distribution. Tanaka & Hamaya (2019) calculated the distribution of opinions on the revision of Article 9 of the Japanese Constitutional Law based on the number of online postings. They found that “strongly disagree” or “strongly agree” was the most common, i.e., the distribution of opinions was valley-shaped. This result implied the more people had strong opinions, the more they tended to post them on the internet. In the context of agenda-setting research, McGregor & Vargo (2017) found that high-frequency tweeters were more strongly correlated with the agendas of partisan media accounts. Therefore, the following hypothesis is set:

H2-1: Politically extreme people are more likely to (a) tweet or (b) retweet on COVID-19.

As mentioned earlier, it is not clear from relevant studies whether the Twitter agendas are more associated with liberals or conservatives (McGregor & Vargo, 2017; Vargo et al., 2014). Therefore,

we reference the following two aspects of the results of Study 1 in this paper. (1) The correlation coefficient with the Twitter agendas is larger for the group with higher liberal tendencies. (2) The top Twitter agenda throughout the entire period is criticism of the government and the ruling party. Based on these two points, we formulate the following hypothesis:

H2-2: People with liberal tendencies are more likely to (a) tweet or (b) retweet on COVID-19.

In addition, this study examines motivations of those who tweet or retweet on COVID-19. As mentioned earlier, given that there are many posts critical of the government on Twitter, such a situation resembles a “Flaming” phenomenon. Yamaguchi (2017) conducted an empirical analysis on the motivations of people who participated in flaming. The results revealed that 60% to 70% of those who participated in flaming wrote on the internet out of a sense of justice, such as “I participate in flaming because I couldn’t forgive.” In addition, the model analysis revealed that those who believed that “flaming makes society better”, which Yamaguchi (2017) labeled as “justice type”, were more likely to participate in flaming. To put this in the context of this study, people who criticize the government on Twitter are motivated by a sense of justice to make society better by condemning the government's failures. Therefore, we formulate the following hypothesis:

H2-3: People who view “flaming” positively are more likely to (a) tweet or (b) retweet on COVID-19.

3.2 Methods

First, we looked at the descriptive statistics of how many people have tweeted or retweeted on COVID-19. Second, to test the aforementioned hypotheses, we conducted binomial logit model analyses. The dependent variables are “whether or not individuals have tweeted on COVID-19 in the past two to three months” and “whether or not individuals have retweeted on COVID-19 in the past two to three months.” For each of these, the variable was set to “0” for “Not at all” and “1” for the others in Tables 6–1 and 6–2. The explanatory variables were created as follows.

Strength of political orientations and liberal tendencies

For political attitudes, we followed Tanaka & Hamaya's (2019) measurements and set the following 10 items. The responses were scored on a seven-point scale (1 = agree, 2 = moderately agree, 3 = slightly agree, 4 = neither agree nor disagree, 5 = slightly disagree, 6 = moderately agree, and 7 = disagree).

[1] Amend Article 9 of the Japanese Constitutional Law.

[2] Increase social security spending.

[3] Allow married couples to choose their own family name.

[4] Between economic growth and environmental protection, I want to give priority to environmental protection.

[5] Nuclear power plants should be abolished immediately.

[6] The government should guarantee jobs and income to some extent.

[7] Teach patriotism to children in schools.

[8] China's invasion of the Japanese territorial sea should be eliminated even if military force is used.

[9] I think the ex-prime minister Abe's administration was trying to take Japan back to the dark days before World War II.

[10] Between the interests of the nation as a whole and the interests of the individual, I give priority to the interests of the individual.

The responses for these items were examined using factor analysis (number of factors = 2, maximum likelihood method, and promax rotation). As a result, [3] and [10] were excluded because of low communality (.103 and .113, respectively). The responses for the remaining eight items were scored on a scale from 1 to 3 for liberal responses and −3 to −1 for conservative responses, with "neither agree nor disagree" being 0. Then, these responses were combined, and their average was the individuals' liberal tendencies. In other words, if individual i's answer to question j is (q_{ij}= −3,

−2, −1 0, 1, 2, 3), liberal tendencies are expressed as $lib_i = (\sum_{j=1}^{8} q_{ij})/8$. The strength of political orientation is expressed as $ext_i = |lib_i - lib_0|$. Since the strength of political orientation is the bias of one's thinking toward either liberals or conservatives, the larger the absolute value of a person's liberal tendencies *lib*, the more extreme that person's orientation. Therefore, we can take the absolute value as an indicator of the strength. The value of lib_0 on the right side is the median value, and the value of ext_i becomes larger as the opinions become more extreme, so ext_i is an indicator of the strength of political orientation. This method is called the "folding method" and is often used as an indicator of an individual's political orientation (Barberá, 2015; Lee et al., 2014).

Attitudes toward flaming

The following two measurements were created based on those used in Yamaguchi (2017) for attitudes toward flaming. For each of them, we asked a question on a seven-point scale ranging from "agree" to "disagree" and scored them by inverting the numbers corresponding to their responses.

> *What do you think about "flaming?" Please choose one that is closest to your opinion. Flaming is a phenomenon in which the internet is flooded with critical comments about what a person or company has said or done.*

[1] It is good for society because it exposes corporations' injustice and celebrities' anti-social behavior (such as discriminatory remarks).
[2] It improves society by punishing the misbehavior of ordinary people who do not have morals.

Cronbach's alpha of the responses to these two items was 0.737, which was sufficient, so we combined the two items to create a variable that measures the flaming orientation.

Control variables

For control variables, we used basic demographic attributes (gender, age, education, and annual

household income), Twitter browsing orientation (defined in Study 1), interest in COVID-19, interest in politics, approval degree for the government, and attitude toward COVID-19 and society. It is easy to assume that higher Twitter browsing orientation leads to tweeting or retweeting. Similarly, for interest in COVID-19, it is assumed that the higher the interest, the higher the probability of tweeting or retweeting. The same situation also applies to interest in politics. Therefore, these factors should be controlled. Furthermore, the approval degree for the current government and liberal tendencies are negatively correlated ($r = -.336$, $p < .0001$). Based on Study 1, it is possible that Twitter has become a main platform for spreading dissatisfaction with the current government. In other words, it is possible that people who are negative toward the current government in the first place are also developing criticisms of the government on COVID-19-related topics. This can be easily assumed from the empirical finding that in Twitter, negative information tends to influence people more than positive information does (Hennig-Thurau et al., 2015). Therefore, it is necessary to set the approval degree for the current government as a control variable. In addition, given that the period in which the survey was conducted was in the midst of the "third wave" of the COVID-19 outbreak in Japan and that Tokyo recorded the highest number of infections (December 12: 620 people), it is easy to assume that information behavior would change as a result. Therefore, the attitude toward COVID-19 and society should also be controlled. The measurement is as follows: "A: It is important to maintain employment and the economy even in the face of COVID-19." and "B: It is important to reduce and refrain from various activities to prevent the spread of infection." In this survey, we asked respondents to indicate which of the two options they thought was closest to their opinion on the seven-point scale (the number closer to B is larger).

Basic statistics

The basic statistics of the explanatory and control variables are listed in Table 5.

Table 5 Basic statistics of explanatory variables and control variables

	Frequency	Minmum	Max	Median	Mean	SD
Gender （male = 0; female = 1）	903	0	1	0	0.50	0.50
Age	903	15	64	41	40.72	13.13
Dummy of a university graduate	903	0	1	1	0.70	0.46
Annual household income	903	0	2250	550	676.88	460.06
Twitter browsing orientation	889	0	0.803	0.013	0.055	0.100
Interest in COVID-19	903	1	7	5	5.18	1.37
Interest in politics	903	1	7	5	5.02	1.50
Approval degree for the government	903	1	10	4	4.15	2.12
Attitude to COVID-19 and society	903	1	7	4	3.90	1.73
Strength of political orientations	903	0	3.13	0.38	0.61	0.60
Liberal tendencies	903	–3	3	0.13	0.12	0.85
Flaming orientation	903	1	7	4	3.76	1.32

3.3 Results

In this survey, we asked respondents how many tweets and retweets on the topic of COVID-19 they had posted per month on average over the past two to three months. The results are presented in Tables 6–1 and 6–2. About 25.8% of Twitter users tweeted on COVID-19. Similarly, 24.0% of Twitter users retweeted on COVID-19. We also conducted an analysis based on the number of tweets and retweets by multiplying the average number of tweets and retweets of each choice by their frequencies. The results revealed that 2.1% of users generated 54.3% of COVID-19-related tweets, and 3.1% generated 62.3% of the retweets. This means that more than half of the COVID-19-related discourses on Twitter were generated by a small number of users, so it can be expected that there are some biases in the information shared on Twitter.

Table 6–1 Frequency of tweets related to COVID-19 (in the past 2–3 months)

	n = 430 (Twitter users)	n = 903 (Total sample)
Not at all	74.2%	87.0%
once a month	6.5%	3.3%
2–3 times per month	8.8%	4.7%
4–9 times per month	3.7%	1.8%
10–19 times per month	2.8%	1.3%
20–29 times per month	1.9%	0.9%
30–59 times per month	1.2%	0.6%
60–99 times per month	0.7%	0.3%
100–199 times per month	0%	0%
200 or more times per month	0.2%	0.1%

Table 6–2 Frequency of retweets related to COVID-19 (in the past 2–3 months)

	n = 430 (Twitter users)	n = 903 (Total sample)
Not at all	76.0%	88.0%
once a month	5.8%	2.9%
2–3 times per month	7.2%	3.7%
4–9 times per month	3.0%	1.6%
10–19 times per month	3.3%	1.6%
20–29 times per month	1.6%	0.9%
30–59 times per month	1.6%	0.8%
60–99 times per month	0.9%	0.4%
100–199 times per month	0.5%	0.2%
200 or more times per month	0%	0%

Note: n = 430 on the left side of the table refers to the number of people who had registered on Twitter in the past 2–3 months.

Analyses by model

Based on the above, the model used in this study is defined as follows, with individuals as denoted by *i*:

$$logit[P(Tweet_i = 1)] = \log\left(\frac{P[Tweet_i]}{1 - P[Tweet_i]}\right)$$

$$= \alpha + \beta_1 Charactristics_i + \beta_2 Control_i + \gamma_1 Political_i + \gamma_2 Flaming_i$$

The model is a logit model. All variables on the right side are standardized, and whether to retweet or not is formulated by converting the left side into $logit[P(RT_i = 1)]$. Each symbol refers to the following.

$Tweet_i$: A dummy variable indicating whether or not *i* has tweeted on COVID-19 related topics. The value is 1 if *i* tweeted and 0 otherwise.

$P(Tweet_i = 1)$: Probability of being a $Tweet_i$

$Charactristics_i$: An attribute vector of *i*. Specifically, it is a vector with four variables: gender, age, education, and annual household income.

$Control_i$: A vector on the control variables of *i*. Specifically, a vector with five variables: Twitter browsing orientation, interest in COVID-19, interest in politics, approval degree for the current

government, and attitude toward COVID-19 and society.

$Political_i$: A vector on the political attitudes of i. Specifically, it is a vector with two variables: strength of political orientations and liberal tendencies.

$Flaming_i$: A vector on the attitude toward flaming of i.

Tables 7–1 and 7–2 present models in which all these variables are fed. As for whether or not individuals tweeted (Model 1), looking at the control variables, there were negative correlations for gender (a dummy variable of female) and age and positive correlations for Twitter browsing orientation and interest in COVID-19. In particular, the standardized regression coefficient for Twitter browsing orientation was large (*Exp(B)* = 2.455, $p < .0001$), so this had relatively large explanatory power for whether people tweet or not. As for the explanatory variables, while there was a significant positive correlation for liberal tendencies (*Exp(B)* = 1.276, $p = .045$), there was no significant correlation for the strength of political orientation and the flaming orientation. Therefore, H2-2(a) was supported, whereas H2-1(a) and H2-3(a) were not supported.

As for whether or not individuals retweeted (Model 2), there was a negative correlation with age and Twitter browsing orientation had a positive correlation (*Exp(B)* = 2.459, $p < .0001$). As for the explanatory variables, there was a significant positive correlation with the flaming orientation (*Exp(B)* = 1.397, $p = .006$), whereas there was no significant correlation with the strength of political orientation and liberal tendencies. Therefore, H2-3(b) was supported, whereas H2-1(b) and H2-2(b) were not supported. Notably, analyses were conducted using the SPSS software version 26 and replicated using the R programming language.

Table 7–1 The result of a binomial logit model analysis (Model 1)

Dependent variable: tweet

	Exp(B) (standardized)	SE	p-value	95% CI
Gender	.739*	.121	.012	[.583, .936]
Age	.713**	.128	.008	[.554, .917]
Dummy of a university graduate	1.168	.119	.192	[.925, 1.474]
Annual household income	.960	.115	.726	[.767, 1.203]
Twitter browsing orientation	2.455**	.114	2.73E–15	[1.965, 3.068]
Interest in COVID-19	1.518**	.141	.003	[1.151, 2.002]
Interest in politics	.973	.137	.839	[.744, 1.272]
Approval degree for the government	1.224	.123	.102	[.961, 1.558]
Attitude to COVID-19 and society	1.025	.124	.844	[.803, 1.307]
Strength of political orientations	1.026	.115	.824	[.819, 1.284]
Liberal tendencies	1.276*	.122	.045	[1.005, 1.621]
Flaming orientation	1.244	.117	.063	[.988, 1.565]
Constant	.100**	.133	1.24E–67	
				Nagelkerke's R^2 =.286

**: p < 0.01, *: p < 0.05 n = 889

Table 7–2 The result of a binomial logit model analysis (Model 2)

Dependent variable: retweet

	Exp(B) (standardized)	SE	p-value	95% CI
Gender	.852	.124	.195	[.668, 1.086]
Age	.732*	.134	.020	[.563, .952]
Dummy of a university graduate	1.174	.123	.193	[.922, 1.495]
Annual household income	.916	.121	.469	[.723, 1.161]
Twitter browsing orientation	2.459**	.113	2.12E–15	[1.969, 3.071]
Interest in COVID-19	1.314	.144	.057	[.992, 1.740]
Interest in politics	1.115	.146	.454	[.838, 1.485]
Approval degree for the government	1.021	.126	.868	[.797, 1.308]
Attitude to COVID-19 and society	1.059	.127	.653	[.825, 1.359]
Strength of political orientations	1.102	.116	.400	[.879, 1.382]
Liberal tendencies	1.217	.122	.107	[.959, 1.546]
Flaming orientation	1.397**	.121	.006	[1.102, 1.771]
Constant	.091	.137	6.95E–69	
				Nagelkerke's R^2 =.283

**: p < 0.01, *: p < 0.05 n = 889

3.4 Discussions

For liberal tendencies, there was a significant positive correlation only in Model 1. On the other hand, for the flaming orientation, there was a significant positive correlation only in Model 2. Moreover, the standardized regression coefficients of the flaming orientation in Model 2 were relatively large, which indicates a relatively large impact on the decision-making process of retweeting COVID-19-related topics.

These results suggest two implications. First, the result that being liberal connotes that a person is more likely to tweet is consistent with the results of Study 1. The agenda regarding COVID-19 on Twitter resonated with liberals. Therefore, it is natural that tweeters, as the generators of agendas, tend to be liberal. Second, there is a difference in nature between tweeting and retweeting. This matter can only be discussed hypothetically because there is no related research. The psychological cost of retweeting is considered relatively lower than that of tweeting because retweeting is a reaction to original tweets. Unlike tweeting, which requires the creation of original text, retweeting can be done in one click. Therefore, the decision-making process to retweet is considered to be less burdensome than the decision to tweet. Based on this nature of retweeting and the fact that the measurements used in this study equated flaming with seeking justice, it is possible to see that people with liberal tendencies, motivated by their political attitude, create original tweets, and some of those tweets are then retweeted by flaming-oriented people driven by a sense of justice. This seems to be how information about COVID-19 spreads on Twitter. Note that Yamaguchi (2017) asked about the experience of “writing on the internet”, which is rather similar to tweeting when analyzing the motives of participating in flaming. This inconsistency may be due to the nature of COVID-19, which is a phenomenon more familiar to the daily lives of citizens than the issues analyzed by Yamaguchi (2017) such as “a part-time clerk’s prank” and “An imitation in Olympic Emblems.” With regard to COVID-19, there may be cases where people tweet purely for their own or their close ones’ health. Retweeting, however, may include the intention to spread critical information.

By contrast, the correlation with the strength of political orientation, which was significant in previous studies, was not significant. This also could be attributed to the differences in the topics

addressed. The topic covered in Tanaka & Hamaya (2019) was “whether to agree or disagree with the revision of Article 9 of the Japanese Constitutional Law,” which is a topic somewhat distant from the daily lives of citizens. In addition, the topics covered by McGregor & Vargo (2017), such as economy, environment, and diplomacy, were highly abstract. In comparison, COVID-19, the subject of this study, is an infectious disease that directly affects the health and life of individuals, a familiar topic in the daily lives of citizens. Therefore, it is possible that a person need not have a strong political orientation to disseminate or spread information on COVID-19.

4. Conclusions

In Study 1, we found that Twitter can have an agenda-setting function in the short-term and its agendas resonate with individuals who have liberal tendencies. Study 2 suggested the situation of the Twitter-sphere regarding COVID-19 where individuals with liberal tendencies generate tweets, and some of those tweets are then retweeted by flaming-oriented people driven by a sense of justice. These findings pave the way for the relationship between social media and the public in the field of agenda-setting research and reinforce existing studies that provide evidence about the non-representativeness of opinions on the internet (Toriumi, 2020; Tanaka & Hamaya, 2019). Furthermore, by showing the different nature between tweeting and retweeting, this paper encourages future research on information dissemination and diffusion.

This paper has some limitations. Since this study is based on a one-shot survey, it is not possible to clarify the causal relationship between variables. In other words, the model cannot reveal the direction of causality between Twitter agendas and public agendas or the direction of causality between liberal tendencies and tweeting behavior. In the future, it is necessary to identify causal relationships using time series data.

Notes

1. “Go To Travel” is a government policy to subsidize the purchase of travel packages and hotel accommodation to stimulate tourism demand, which has shrunk due to COVID-19. This policy has been temporarily suspended from December 2020 because of the re-spread of COVID-19 infection.

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Appendix 1. Sample Composition (Table A1)

Table A1. Research sample size
(age and gender separate)

Age Range	Male	Female	Total
15–19	27	26	53
20–24	39	41	80
25–29	43	45	88
30–34	42	45	87
35–39	52	52	104
40–44	54	52	106
45–49	59	60	119
50–54	56	51	107
55–59	44	44	88
60–64	37	34	71
Total	453	450	903

Appendix 2. Time spent on media outlets

For the following 11 types of media, we asked questions about the time spent per day looking back over the past two to three months, separately for weekdays and holidays, on an eight-point scale.

[1] Twitter

[2] TV (including TV station websites and apps)

[3] Newspapers (including websites and apps of newspaper companies)

[4] Magazines (including websites and apps of magazines)

[5] Conversations with family, friends, and acquaintances through message apps (LINE, Messenger,

etc.), phone calls, and emails (exchanging messages and making calls)

[6] Internet news (Yahoo! News, LINE NEWS, SmartNews, various portal sites, etc.)

[7] Social media other than Twitter (LINE timeline, Facebook, Instagram, etc.)

[8] Video sharing platforms (YouTube, Niconico Douga, etc.)

[9] Personal blogs (including those of celebrities) and Roundup websites

[10] Direct conversations with family, friends, or acquaintances

[11] Internet bulletin boards (5 channels, etc.)

The choices are in the following eight levels. The averages of each choice were used as variables: [1] 0 minutes, [2] 1 to below 15 minutes, [3] 15 to below 30 minutes, [4] 30 minutes to below 1 hour, [5] 1 to below 2 hours, [6] 2 to below 3 hours, [7] 3 to below 5 hours, and [8] 5 hours or more. The variables were averaged using the following formula:

$$\frac{\text{Time spent on weekdays} \times 5 + \text{Time spent on weekends} \times 2}{7}$$