Research article

Media framing and expression of anti-China sentiment in COVID-19-related news discourse: An analysis using deep learning methods

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A R T I C L E   I N F O

A B S T R A C T

This study focuses on news content related to China and COVID-19 during the COVID-19 pandemic and investigates how media frame, affected the emergence of anti-China sentiments through a case study of Japanese online news discourse. We collected large-scale digital trace data including online news and comments during the COVID-19 pandemic. By employing deep learning-based sentiment classifications, we were able to measure the extent of anti-China sentiments expressed through comments during the pandemic's different phases and on different types of news content. Our results provide empirical evidence that the news media's negative depictions of China and coverage related to political and international relations issues increased as the prevalence of COVID-19 in Japan increased. Importantly, since this coverage can prompt the expression of anti-China sentiment, we argue that the framing used by the media can provide discursive contexts that escalate COVID-19 issues into a broader expression of anti-China sentiment. This study not only identifies the impact of media frames on the expression of anti-China sentiment but also contributes to the development of methods for detecting public opinion and measuring the framing effect with big data and advanced computational tools.

1. Introduction

1.1. Background

The COVID-19 pandemic has spread worldwide and thus constitutes a massive global health crisis. The pandemic has not only caused massive death tolls and economic loss but also influenced individual behaviors and opinions in several ways (Bavel et al., 2020). For example, one of the most prominent related issues is the increase in intolerant, unsympathetic, and hostile sentiments expressed toward outgroup members; in this case study in the Japanese context, we focus on whether there has been a rise in expressed anti-China sentiment (Chung and Li, 2020; Shimizu, 2020). In particular, online discourse is typically considered a hotbed of right-wing populism and xenophobia and thus may also be related to the spread of anti-China sentiment in the context of the COVID-19 pandemic (Caiani and Kröll, 2015; Ekman, 2019; Engesser et al., 2017; Heiss and Matthes, 2020; Krämer, 2017; Müller and Schwarz, 2021; St\vetka et al., 2020; Wahlström et al., 2021; Wahlström and T;ornberg, 2021). More specifically, this study focuses on online news discourse. Typically, online news websites provide a comment function through which users can participate in public discussions and

express their opinions on online news items (Schindler and Domahidi, 2021; Toepfl and Piwoni, 2015). In most cases, the comment function is located beneath the news content; thus, comments are usually highly relevant to the news content and can be directly linked to it, which allows us to investigate how the media frame affects expressed sentiment and opinion in such comments.

Taking advantage of this situation, the current study employed big data and computational methodology to investigate how COVID-19-related news induces the expression of anti-China sentiment. We retrieved a large amount of data and constructed a large-scale digital trace dataset including a variety of online news items relating to both COVID-19 and China and the corresponding comments for each item. Next, we employed sentiment analysis based on deep learning methods to capture each comment's sentiment regarding China. Specifically, we utilized natural language processing (NLP) with transformers (Devlin et al., 2019) to perform the sentiment classification task. Indeed, our results show that compared to previous language models, this methodology can more satisfactorily identify sentiments. By unifying these data, this study allowed us not only to investigate the emergence of and changes in the expression of anti-China sentiments in COVID-19-related news but also to directly capture the highly granular relationship

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between media content and the corresponding responses. Moreover, we used framing theory and its proposed process model to understand how the media has influenced the expression of anti-China sentiments. On the one hand, we examined the news valence and topics to understand how the media constructed an information environment and conveyed specific frames around news related to China. On the other hand, we identified and characterized sentiment expressions from individual comments to investigate how the expression of anti-China sentiment can be amplified and reinforced through exposure to specific media frames.

The paper is structured as follows. First, we introduce the background, theory, aim and analysis framework of the research in the rest part of section 1. Second, we introduce the data collection, annotations, and analysis processes in this study, with a specific focus on the applications of the transformer-based model on the sentiment analysis in section 2. Then, section 3 demonstrates the analysis results and examined the developed hypotheses. Finally, section 4 discusses how the media frame can contribute to the expression of anti-China sentiment, as well as the implications and limitations of this study.

1.2. Media and anti-China sentiments during the COVID-19 pandemic

There is wide consensus that serious crisis situations, such as natural disasters or pandemics, lead to the development of a hostile attitude toward outgroup members (Eichelberger, 2007; Roberto et al., 2020). Among the various potential factors, this study specifically focuses on the impact of media frame on hostile attitudes.

The content of media reporting can affect audiences' opinions since the way people understand issues typically depends on how such content is presented (Vreese et al., 2010). Since the first infectious case was identified in China, China has been consistently and directly associated with the virus throughout the COVID-19 pandemic, using strongly negative and biased naming strategies ('the China coronavirus' or 'the Wuhan virus') or even misinformation and conspiracy theories containing negative narratives and terms such as the '5G coronavirus' and 'bioterrorists' when referring to China and the evolving pandemic (Pennycook et al., 2020); this practice may have amplified xenophobic and racist tendencies toward China (Reny and Barreto, 2020). The other typical media frame that may have elicited the expression of anti-China sentiment relates to Chinese politics and international relations, including assertions of the Chinese government's secrecy and delayed response to COVID-19 and criticisms of China's 'mask diplomacy'. In these terms, the COVID-19 pandemic is an unprecedented global issue in terms of not only the epidemiology of the disease but also the debates that have arisen since its emergence, which encompass a wide scope of concerns. Since the disease has had a truly international characteristic, the 'narrative battle' debate on the attribution of responsibility and the resultant transformation of the international order has gained considerable attention (Fox, 2021; Huang, 2021; Jaworsky and Qiaoan, 2021). Especially due to territorial disputes, national anxiety, and historical frictions, xenophobia toward China has been represented as a long-term issue in East Asian countries, including Japan and Korea. These extended debates about COVID-19 might introduce conflicts and amplify existing tensions with China, which may potentially induce a further surge in the expression of anti-China sentiment. Despite such potentially important effects, whether and how the media framing of the narrative sparked xenophobia toward China or even the expression of anti-China sentiment during the COVID-19 pandemic has not been fully examined. To shed light on the role of the media frame in such a context, this study investigates how online news content related to COVID-19 and China has been framed and how it has contributed to the expression of anti-China sentiment.

1.3. Research case

We chose Japanese online news discourse as our research context. In Japan, online right-wing activism that advocates for extreme nationalism

and stirs up hostile attitudes toward outgroups, especially Korean and Chinese populations, has been a central concern for several years (Cho and Park, 2011; Higuchi, 2018; Ito, 2014; Smith, 2018; Suzuki, 2015, 2019). Specifically, the feelings toward China are extremely icy among Japanese people (Pew Research Center, 2019), which can trigger the expression of hostile sentiments during critical situations such as the COVID-19 pandemic. With this broad context in mind, we argue that as COVID-19 cases were first detected in China and the virus spread to Japan fairly early, causing severe losses, the topic of COVID-19 may have easily generated negative sentiments in Japan toward China.

Additionally, hostile sentiments toward China are typically related to nationalistic, violence, dishonest among Japanese people (Pew Research Center, 2016; NPO, 2019) as a result of territorial disputes, national anxiety, and historical problems. Thus, it is reasonable to assume that the Japanese population views political and international issues related to China in a negative light. From this perspective, Japan is an appropriate case for examining whether these issues can trigger a higher degree of expressed anti-China sentiment and, moreover, to determine the mechanism driving the influence of existing stereotypical views expressing negative sentiments.

1.4. Hypothesis development

The goal of this study is twofold. First, we examine the emergence of anti-China sentiment expressed in Japanese online news discourse. Second, we aim to explain the expression of anti-China sentiments in COVID-19-related news discourse from the perspective of the media frame using the hypotheses discussed in this section. More specifically, as the perception of country or community is always largely dependent on media presentations (Gabore, 2020), we assume that the media frame impacts sentiment toward China during the COVID-19 pandemic. In practice, media content might carry ideological connotations and stereotypical definitions that tend to promote and reinforce particular images and identities (Fürsich, 2010). If the specific frames that are more likely to induce the expression of anti-China sentiment became more salient as COVID-19 spread, the increasing amounts of anti-China sentiment expressed in news discourse can be attributed to an agenda of the news media.

Frame theory originated with E. Goffman's famous frame analysis (Goffman, 1974) and has prevailed in a wide variety of fields, such as social movement research (Benford and Snow, 2000), cultural analysis (DiMaggio, 1997), and communication studies (Oliver et al., 2019). Regarding function, a frame activates certain types of schemas and then evokes or triggers a response from people (Wood et al., 2018). Thus, media framing is conceptualized as the mediating mechanism through which the media's depictions of social groups activates schemas that influence individual opportunity and willingness to express sentiments toward that social group.

As a form of public culture, a frame is produced by several public actors, such as politicians, journalists, and media outlets, and is rendered publicly available. Thus, news coverage not only conveys information but also helps construct and maintain specific frames (Boomgaarden and Vliegenthart, 2009; Oliver et al., 2019). One of the central functions of a frame is to select and emphasize some aspects of reality and ignore and discard others (Diehl et al., 2015). As Entman put it, 'to frame is to select some aspects of a perceived reality and make them more salient in a communicating text, in such a way as to promote a particular problem definition, causal interpretation, moral evaluation, and/or treatment recommendation for the item described' (Entman, 1993, p.52). In our case, news articles about China and COVID-19 not only report factual information but also emphasize specific aspects of the facts to make them salient to readers. In this study, we focus on two frame elements that may have evoked negative sentiments toward China: frame valence (Schuck and Vreese, 2006) and problem definition (Entman, 1993; Matthes and Kohring, 2008).

Valence framing is defined as the positive or negative terms used to present and evaluate the targeted issues or objects (Schuck and Vreese, 2006); here, we postulate the news frame's valence is defined by the overall tone of news coverage toward China. We hypothesize below that a negative frame valence evokes the expression of negative sentiment toward China in the online news discourse through exposure to news coverage indicating the negative aspects of China.

The problem definition refers to 'both the central issue under investigation and the most important actor' (Matthes and Kohring, 2008, p.266). In this study, we identified particular topics as the central problem of news coverage. For example, news articles discussed the COVID-19 pandemic in the context of international politics or focused on its economic consequences. The aspect that is focused on, politics or economy, may affect the reader's expressive attitudes toward the news through the cognitive schema evoked.

Thus, based on frame theory, this study attempts to provide insights into the expression of anti-China sentiment through the examination of the following hypotheses.

First, this study seeks to confirm the dynamics of anti-China sentiment expression and media frames from the perspective of the aforementioned frame elements during the COVID-19 pandemic. We hypothesize the following:

H1a. The extent of anti-China sentiment expressed in COVID-19-related news discourse increased as COVID-19 spread across Japan.

H1b. The number of news items on the pandemic with a specific valence frame or topic frame increased as COVID-19 spread across Japan.

Next, this study investigates the connection between the news frame and audiences' expressed sentiment. Therefore, we examine how the valence of media frames influences individual willingness to express sentiments in their comments. Intuitively, there is strong reason to expect a connection between the increasingly negative depictions of China in the news and the anti-China sentiments expressed in comment sections. Accordingly, we hypothesize the following:

H2. Audiences express a greater number of anti-China sentiments in the comment section when exposed to negative online news coverage related to China.

Beyond the valence of the media frame, we examine how news topics affect the extent of the expression of anti-China sentiment in terms of activating preexisting stereotypes.

A key component in this argument is the concept of stereotypes. Situated conceptualization theory suggests that people constantly accumulate conceptual knowledge through their experiences in various situations and store general perceptions of and attitudes toward objects and issues in their memory, which can persist in the long term and influence their perceptions and processing of subsequent information (Barsalou, 2016). In our case, we apply situated conceptualization theory to explain how stereotypes can affect expressed sentiment. With stereotypes, individuals can actively draw inferences about objects without detailed concrete information (Entman, 1993; Kepplinger et al., 2012; Scheufele, 1999). Stereotypes also help in information processing by activating specific cognitive units in memory when individuals need to understand new issues (Hwang et al., 2007). Thus, a stereotype can be reactivated to aid an individual in conceptually processing salient and relevant aspects when he or she is exposed to related information and, moreover, can guide the individual's subsequent cognitive processes (Dixon, 2006, 2008; Domke et al., 1998). We consider two important assumptions here: (1) The activation of a preexisting stereotype depends on the type of news topic. Based on the theory of cognitive accessibility (Oliver et al., 2019), a more enhanced and accessible scheme is used when a relevant judgment is needed, consequently influencing audiences' opinions. (2) When exposed to content related to politics and international relations, preexisting negative stereotypes toward China are more accessible for many Japanese people than other topics are. This assumption is plausible because previous empirical research has revealed public views
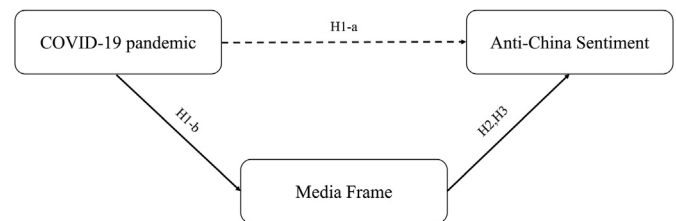

Figure 1. Framework of analysis.

emphasizing the negative aspects of Chinese politics and problematic international relations between China and Japan. With these two assumptions, we expect that news topics related to political matters are more likely to trigger Japanese people's preexisting negative stereotypes of China, thus evoking the expression of negative sentiments. For instance, a headline such as 'Chinese government exerted information control policy over COVID-19 issues' may validate and reinforce preexisting stereotypical attitudes toward China, further triggering an unfavorable sentiment. Thus, our third hypothesis is as follows:

H3. Japanese audiences express a greater number of anti-China sentiments in comment sections when exposed to news coverage tackling particular topics, such as politics or international relations, due to their existing stereotypical negative views on these issues.

In summary, our proposed analytical framework aims to examine the mechanism shown in Figure 1. After confirming that the expression of anti-China sentiment increased as the spread of COVID-19 in online news discourse increased, this study subsequently examines the role of the media frame in such developments. On the one hand, we examine whether an increasing number of infections increased the salience of specific media frames (H1a/H1b). On the other hand, we examine whether this media frame prompts an increase in the expression of anti-China sentiment (H2/H3). If the hypotheses are supported, this would be a good reason to argue that the expression of anti-China sentiment can be as least partly explained by the organization of the media frame.

2. Data and methods

2.1. News article data

We collected COVID-19 news related to China published on Yahoo News by searching for news articles with the terms 'China' ("中国" in Japanese) and 'COVID-19' ("コロナ" in Japanese) in headlines. Yahoo News is one of the most widely used online news websites in Japan[1]. The collected news articles covered the period from 21 January to 13 May 2020. This data collection period is relevant and significant because it covers the beginning, peak, and lessening periods of the pandemic in China and Japan, providing a comprehensive understanding of the expression of anti-China sentiments during the pandemic. Given our aim of investigating news articles and comment sections, we restricted our data to news containing at least one comment, resulting in a total of 754 news items.

2.2. Measuring the media frame

We asked three coders with native-level Japanese ability to read the headlines and contents of news and then required them to annotate each news piece by sentiments and topics. The majority of annotations were adopted. When a consensus could not be reached, we asked an additional coder to decide on the label.

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[1] According to the data provided by Yahoo! Japan, 87% of smartphone users in Japan are using Yahoo News. For detail, please refer to https://ads-promo.yahoo.co.jp/topics/cp/ld201911/ (Accessed Dara:2022/06/12).

Regarding frame valence, we labeled the valence of news articles in terms of whether they portrayed China, including Chinese people, the Chinese government, and other issues or objects related to China, as positive, moderate, or negative. Specifically, we examined (1) whether China was represented with an overall negative narrative and (2) whether the news frames highlighted certain negative aspects of China.

Regarding the definition of problems in the frame, we coded each news article using a topic label from a list of categories: 'politics/international relations', 'economics', 'disease', and 'other'. For clarity, the 'disease' topic specifically included news reporting on infections and measures applied to combat the disease, while long-term concerns and issues related to COVID-19, such as economic loss and global politics, were included in another category that more accurately described the content of the article[2].

2.3. Comment data

We collected a total of 84,209 comments and matched them with the targeted news article. There were 19,253 users who had published comments; the median and Q3 of the number of comments published by each user were 2 and 3, respectively. That is, most comments were published by different users. Additionally, to prevent the possibility that the comments expressing anti-China sentiment were dominated by the same group of users, we took the comments published by users who had made 10 or more comments and calculated the mean of the sentiment score of comments (Negative $= -1$, Other $= 1$) for each user. Among the users' actively published comments, the mean and standard error of the sentiment score were -0.267 and 0.310, respectively; in other words, few users repeatedly published comments with anti-China sentiment. Taken together, the collected comments reflect the general sentiments expressed rather than the sentiments of only a few individuals in the online news discourse; therefore, the potential bias that the trend of anti-China sentiment might only be caused by repeat commenters can be excluded.

2.4. Sentiment analysis with deep learning

Sentiment analysis (Barberá et al., 2021; Young and Soroka, 2012) seeks to reveal the inherent sentiments within texts by applying natural language processing (NLP) and two main methods: dictionary methods and supervised machine learning. The former utilizes a predefined dictionary that contains relevant words or phrases with corresponding sentiment labels. Based on the dictionary, a sentiment is attributed to each text by counting the number of words or phrases matched to each sentiment label. Although dictionary methods are easy to implement, as they focus only on words or phrases and do not rely on contextual information, effective performance is strongly dependent on the dictionary's quality and fitness, thus restricting the generalizability of the findings. On the other hand, supervised machine learning involves human effort to train a model to detect sentiments in texts by providing sample data that has already been given a sentiment label before the learning process. Although human effort is required to provide accurately labelled data, researchers can construct a specific training dataset to guide a model to complete a corresponding detection or classification task; thus, research using a successfully trained model may consider broader information and have greater flexibility than research using dictionary methods.

The concrete ability to detect sentiment depends on the model applied, and almost all current, state-of-the-art approaches are based on deep learning models. However, establishing an end-to-end deep learning model used to be greatly challenging since it can be both time-consuming and resource-intensive. With advances in the field of NLP, the transfer learning paradigm has gained popularity among researchers and

Table 1. Sentiment classification performance with different deep learning models.

	Accuracy	Precision	Recall	*F*-1 Score
BERT	75.00%	74.92%	75.00%	74.84%
RoBERTa	**80.86%**	**80.85%**	**80.86%**	**80.75%**

appears to be a promising framework for applying deep learning methods to solve realistic problems. Typically, implementing pretrained models includes two main phases: feature extraction based on a pretrained model and fine-tuning. Pretrained models are usually trained on a massive textual corpus and can thus capture the universal features of text, which is an extremely helpful skill for enhancing the performance and effectiveness of natural language understanding. Feature extraction involves a process that represents text as dense vectors based on a pretrained model that contains informative semantic and context knowledge and extracting this information to serve as the initial input for the further target task. In the fine-tuning phase, for a certain input text, the overall representations are classified based on which the probability of sentiment is calculated by adding a task-specific output layer that connects the pretrained model and the target task. When training the model, the parameters in the pretrained model are frozen, and only the parameters in the fine-tuning layer are updated. In summary, by establishing a relatively small amount of annotated data related to the target of interest, researchers can effectively establish a deep learning model to deal with diverse tasks.

In practice, we used transformer-based models, including BERT and RoBERTa, to train a classifier to identify whether a targeted comment expresses unfavorable sentiments toward China. The pretraining embeddings are obtained from HuggingFace[3]. For the fine-tuning step, we constructed a sentiment classifier by simply adding one dense layer on top of the embedding layer. The contextualized representation was then fed into the linear layer with softmax activation to predict the sentiment classification.

The sentiments of comments are annotated with a similar process to the annotations of news frames. Then, we trained the model using a total of 2,000 annotated comments. To avoid overfitting, we monitored the learning process with validation data ($N = 250$) and stopped when the validation accuracy passed its peak. Finally, we measured accuracy, recall, and the F1 score with test data ($N = 250$). Table 1 shows the performance of different models in the sentiment classification task. We can confirm that transformer-based models provide a reliable classifier for identifying comments expressing anti-China sentiments. The best performing model was applied to detect anti-China sentiment in all comments.

3. Results

3.1. Dynamics of China-related news, comments, and anti-China sentiments during the pandemic

This section provides a general picture of the dynamics of China-related news, comments, and anti-China sentiments during our targeted research period.

Figure 2-a presents the number of daily confirmed COVID-19 cases in Japan. Infections began to rise in Japan in March 2020 and increased rapidly in April 2020, which pushed the Japanese government to declare a state of emergency.

Figure 2-b presents a time series graph of the number of news articles published with different sentiments. Although the first news article was published in the early period, the number of articles did not significantly

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[2] Please refer to the Appendix for some examples of annotations.

[3] We used "cl-tohoku/bert-base-japanese-whole-word-masking" for BERT and "rinna/japanese-roberta-base" for RoBERTa.
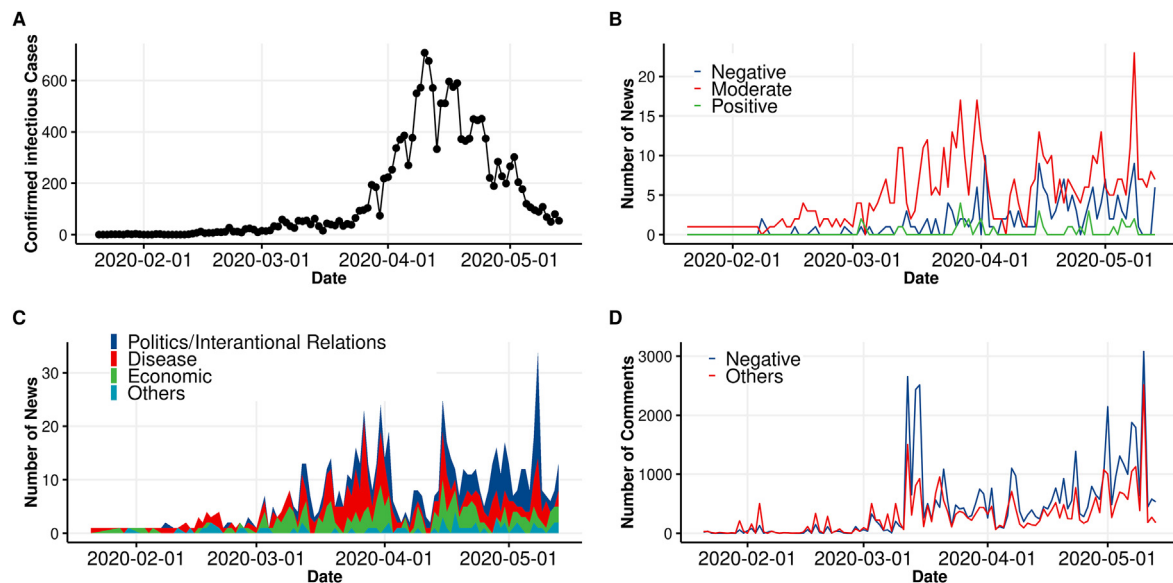
Figure 2. Dynamics of COVID-19 news articles and comments expressing different sentiments.

increase until the beginning of March 2020. Subsequently, we can observe that there was an increase not only in the total number of news articles but also in the number of negative news articles that were being published simultaneously, which echoed implications indicated by previous studies (Chakraborty and Bose, 2020) in the Japanese context.

Figure 2-c presents a time series graph of the number of news articles published regarding different topics. Here, we specifically focus on news articles related to politics or international relations, which are assumed to be more likely to activate negative stereotypical views toward China among Japanese people. We found that this kind of news article did not frequently emerge during the initial period of the COVID-19 pandemic; rather, articles related to politics and international relations began to increase in March 2020 and then continuously predominated media discussions.

Figure 2-d presents the dynamics of anti-China sentiments expressed in the comment sections. Generally, the number and proportion of negative comments allow us to estimate the extent of these expressed sentiments, and we find that as the number of news articles increased, the number of comments increased as well, revealing a relationship between the number of news articles and comments. Thus, in parallel with the number of news articles, the number of comments remained low until March 2020 and increased rapidly from there. Comments expressing

unfavorable sentiments toward China were a continuing trend that saw a considerable increase in days after new stories were published. That is, the start of increased anti-China sentiment expression coincided in time with the shift of the media frame.

Ultimately, we found that although COVID-19 is certainly a global pandemic, neither news producers nor audiences paid much attention to it when it was rapidly spreading only in China. Rather, it was at the beginning of March 2020, when Japan began facing the threat of COVID-19, that the pandemic truly gained attention and the expression of anti-China sentiments began to emerge continuously. It seems that the dynamics of rates of infection, media frames and expressed anti-China sentiment represent similar patterns. For a more intuitive understanding of how the media frame and expressed anti-China sentiment changed with the spread of COVID-19, we considered March 1st as a turning point: From January to February 2020, COVID-19 initially broke out and spread across China, while Japan was not severely affected. Starting in March, COVID-19 infections in Japan began to rise. A comparison of the two periods provided insights into the dynamics of the media frame and the anti-China sentiments expressed. On the one hand, as shown in Figure 3-a, compared to the period from January to February, the period from March to May had an increased proportion of both news with a negative valence and news related to politics/international relations. We also compared the
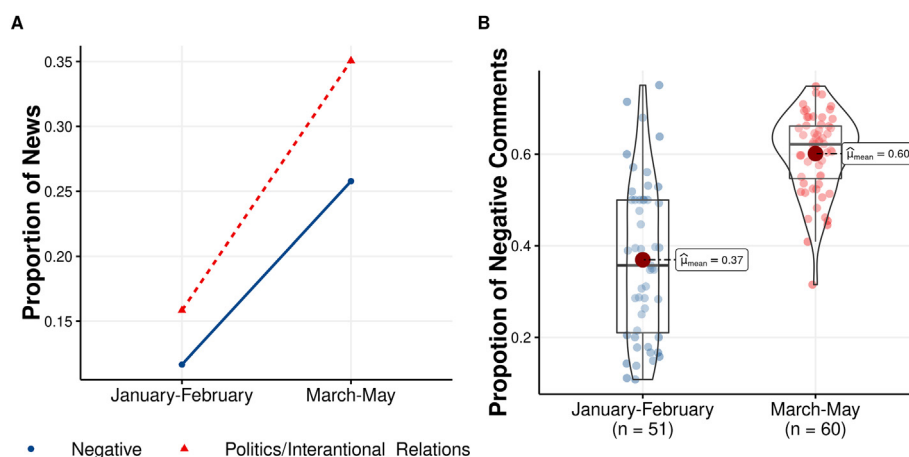

Figure 3. (A) Comparison of the proportion of each news frame in each period (B) Comparison of the proportion of comments expressing anti-China sentiments in each period.

proportion of comments expressing anti-China sentiment each day between two periods, and as shown in Figure 3-b, the number of comments expressing anti-China sentiments increased significantly after March.

The above dynamics indicate rough connections between increases in news with specifically negative frames and audience expressions of anti-China sentiments as COVID-19 spread across Japan.

Here, we employed a cross-correlation function (CCF) to clarify these connections. CCF measures chronological relations between time series x and time-shifted time series y. The outcome value identified by CCF can be interpreted as a metric that describes how recent infections affected anti-China sentiment expressed in news coverage and comments posted about that coverage. We computed the proportion of negative comments to all comments, the proportion of negative news articles and news articles related to politics or international relationship issues to all articles for each day to measure the dynamics of the media frame and the expressed anti-China sentiment.

Figure 4 presents the cross-correlation between the number of infections, the news frames and the expressed anti-China sentiment. The horizontal dashed lines indicate the boundary of white noise, and the values of the CCF must lie beyond that interval to be significant; the positive correlation coefficients indicate that the increase in the perception of the threat of infection could have led to the increase in anti-China sentiment expressed in the comments. Additionally, we find that the spread of infections led to an increase in negative news and news related to politics and international relations, which supports H1.

3.2. The framing of China in news coverage

This section investigates how China was portrayed in the news coverage in Japan. First, we compared the distribution of news articles according to frame valence and found that moderate news articles accounted for the majority (N = 543). However, the number of news items containing positive depictions of China was limited (N = 35), while the number of negative news items was considerably high (N = 176).

Moreover, from the perspective of the frame topic, in addition to the news articles directly related to disease (N = 263), there were a greater number of news articles focused on politics and international relations (N = 241) than on economic issues (N = 186) or other issues (N = 64).

Next, we considered that the extent of negativity toward China might vary among different topics. Figure 5 presents the distribution of news sentiments for different topics. Overall, the proportion of news negatively depicting China was different in each topic. Specifically, the sentiments of news articles addressing politics and international relations were considerably more negative and biased than those of other articles. Furthermore, it should be noted that China's positive aspects were less frequently reported across all topics, implying that China is typically portrayed in a negative manner and associated with negative aspects in news coverage. In summary, the distribution of news sentiments revealed that the media are less likely to report on and represent China in a positive light, particularly when referring to certain topics, and the negative aspects of China tend to be extensively emphasized.

3.3. How audiences perceived and responded to news articles

Our results reveal that a considerable number of news articles depict China in a negative light, and this characteristic is rather significant in the news related to politics/international relations. The next question, then, is how the different news frames contribute to the way that people express their sentiment through online news comments.

Figure 6 compares the proportion of comments expressing negative sentiment toward China across different news valence frames. Our results show that when the news coverage emphasized a negative valence, there were more anti-China sentiments expressed in the comments section (μ = 0.63). Therefore, we can conclude that the valence of an article is related to the expression of anti-China sentiment in its comment section, thus supporting H2.

Figure 7 illustrates how news articles on different topics can trigger reactions through comments. We found that the extent of anti-China
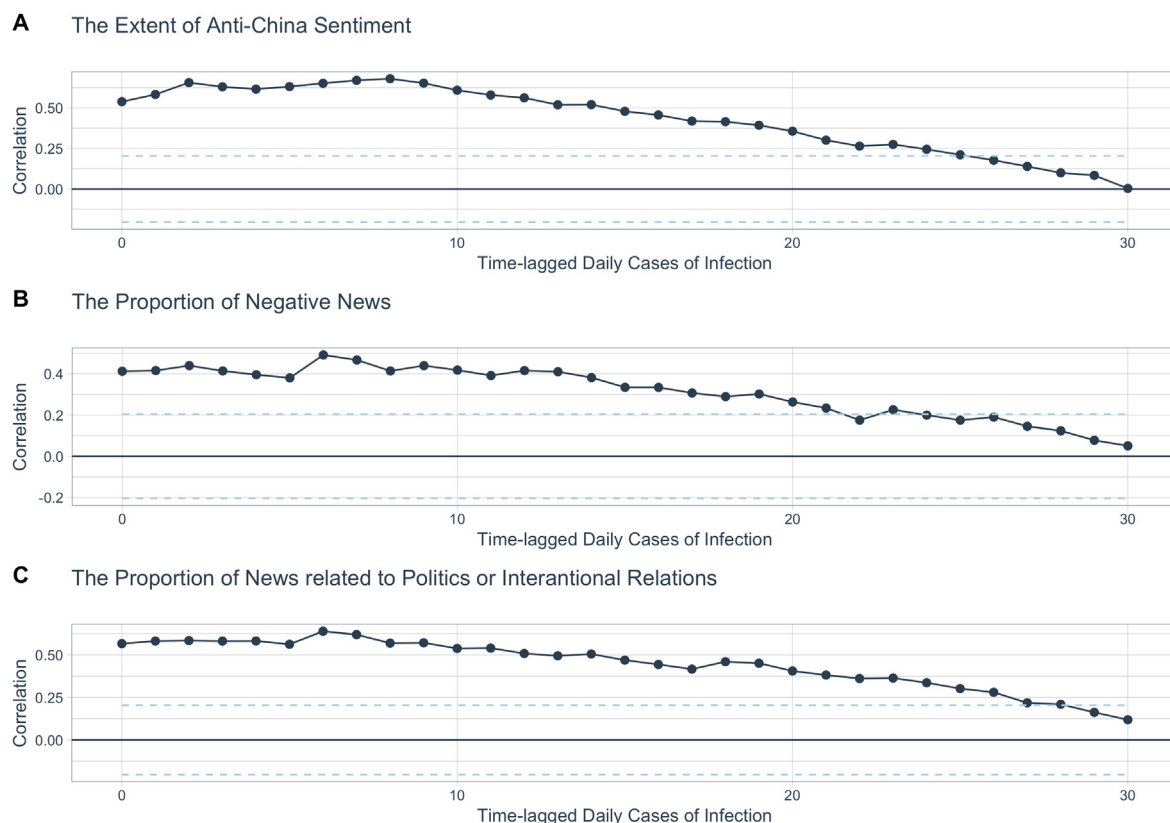

A The Extent of Anti-China Sentiment

B The Proportion of Negative News

C The Proportion of News related to Politics or Interantional Relations

Figure 4. Cross-correlation among the perception of the threat of infection, the news frame and the anti-China sentiment expressed in online news discourse.[4]
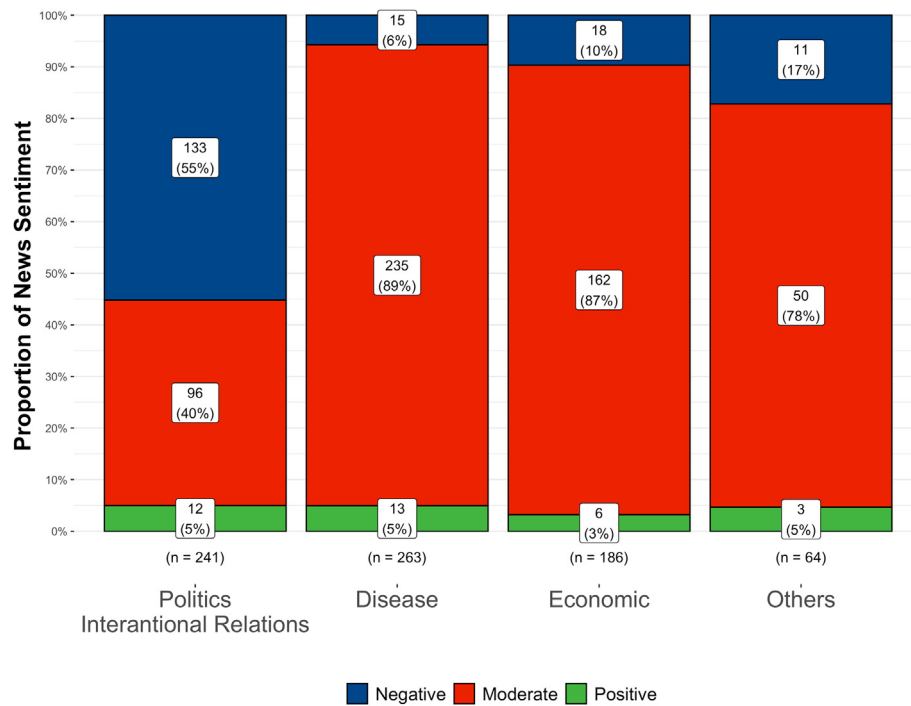
Figure 5. Proportion of news articles with different sentiments across topics.
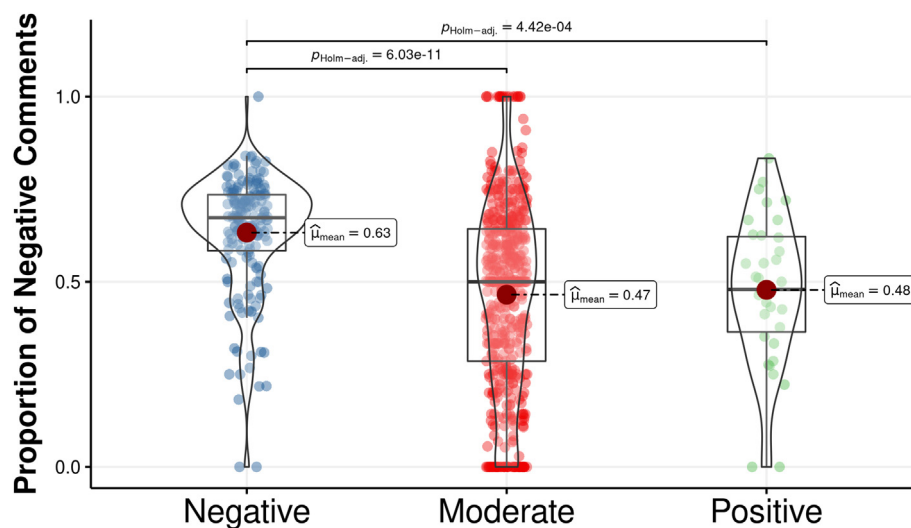

Figure 6. Extent of anti-China sentiments in the comments on news with each sentiment.

sentiments expressed in comments varied across topics. More specifically, in the news related to issues on politics or international relations, the comments expressed a significantly higher level of anti-China sentiment than the comments on other topics ($\mu = 0.64$), which supports H3.

To confirm the robustness of the aforementioned relationship among infections, news frames and anti-China sentiment, we conducted regression analysis using the proportion of comments expressing negative sentiments on each news article (0–1) as the dependent variable to describe the extent of anti-China sentiment. The results shown in Table 2 generally indicate how the topic and valence of a news frame can affect audience responses to the news topic, news valence and infections as independent variables. Specifically, since the CCF indicates that recent infections can affect the anti-China sentiment expressed, we used the mean average of daily infections over 14 days, which is a widely accepted metric for the maximum incubation period for COVID-19 infection (McAloon et al., 2020), before the day news article was published. Additionally, to compare the effect size among different models, the unit of cases of infection was converted to the number of cases per 100 people.

Model 1 shows that an increase in infections can induce the expression of anti-China sentiments ($\beta = 0.025$). Then, Model 2 ($\beta = 0.176$) and Model 3 ($\beta = 0.156$) show that the news valence frame and news topic frame can significantly and greatly influence the anti-China sentiment expressed, which is consistent with our aforementioned analysis. Specifically, we found that the impact of the number of infections decreased over time, which indicates that the influence of an increase in infections might occur partly through an increase in negative valence and in topics

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[4] Although the first COVID-19 related news coverage appeared on 24 January 2020, there were no news articles published on the subsequent few days. To avoid a break because of this lag, CCF was computed from 1 February 2020.
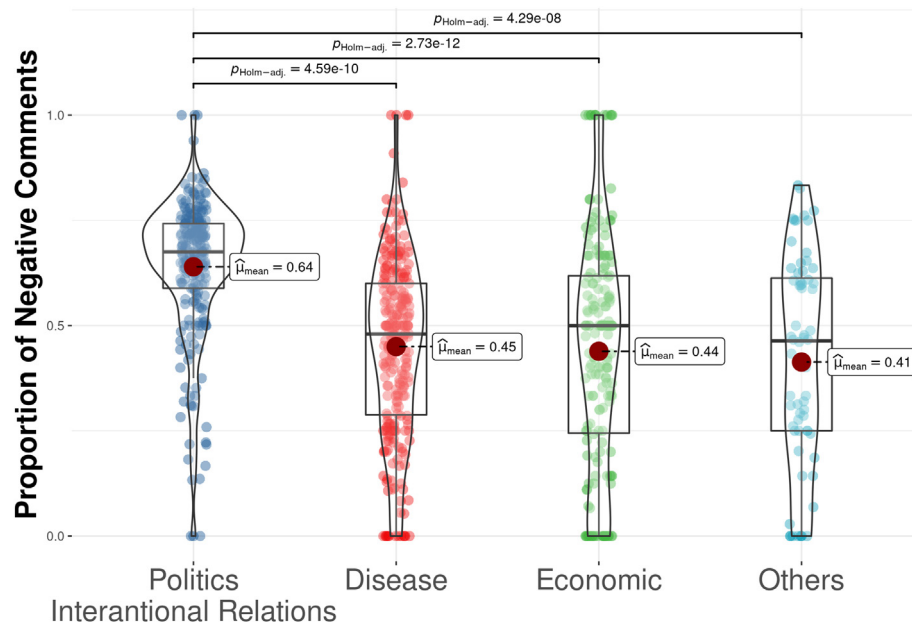
Figure 7. Extent of anti-China sentiment in comments on news on a given topic.

Table 2. Relationship between news topics and proportion of negative comments.

	Model 1	Model 2	Model 3	Model 4
Topic (Ref: Disease)				
Politics and International Relations		0.176***		0.142***
		0.020		0.031
Economic		-0.016		-0.019
		0.021		0.021
Others		-0.046		-0.053**
		0.031		0.031
News Sentiment (Ref: Moderate)				
Negative			0.156***	0.070***
			0.020	0.022
Positive			0.008	-0.019
			0.040	0.039
Cases of Infection (per 100)	0.025***	0.017**	0.018**	0.016**
	0.005	0.005	0.005	0.005
Constant	0.452***	0.420***	0.430***	0.420***
	0.013	0.016	0.013	0.016
Observations	752	752	752	752
R2	0.035	0.168	0.108	0.180
Adjusted R2	0.034	0.164	0.105	0.173

Standard errors are in parenthesis.
***p < 0.01, **p < 0.05, *p < 0.01.

related to politics/international relations in the media. Furthermore, in Model 4 in which both valence frames and topic frames are considered, we found that the impact of the valence frame largely decreased ($\beta = 0.070$) while the impact of the topic frame remained steady ($\beta = 0.142$), which implies that news articles related to politics or international relations are more likely to be associated with greater expression of anti-China sentiments in the corresponding comments.

4. Discussion

4.1. Conclusion

This study sheds light on how the media frame affects the increasing anti-China sentiment during the COVID-19 pandemic. Through the

unitization of digital trace data and deep learning methods, this study indicates that the expression of anti-China sentiments in online news discourse has increased with the prevalence of COVID-19 in Japan. Then, we attempt to investigate the underlying mechanism of such a relationship by demonstrating how COVID-19-related news coverage with a specific frame can trigger the expression of anti-China sentiments in the comment sections.

According to agenda-setting arguments, shifts in the media frame can lead to certain issues and perspectives becoming more salient and attracting greater public concern (McCombs and Shaw, 1972). In general, the media frame can be investigated from two perspectives: (1) the amount of attention devoted to a specific frame and (2) the framing strategy used to highlight various aspects of the issues. Accordingly, our results indicate that after the prevalence of COVID-19 in Japan increased, news reporting on the negative aspects of China as well as issues in politics/international relations significantly increased; that is, more attention was devoted to these frames. Additionally, from the perspective of framing strategy, we found that news related to politics/international relations is more likely to emphasize specific aspects of China. In this regard, our study provides insight into the dynamics of agenda setting in news related to COVID-19 and China, which can explain the increasing expression of anti-China sentiment.

From the perspective of frame valence, our results confirm that news articles emphasizing negative descriptions of China are more likely to induce the expression of anti-China sentiments. This finding is not surprising: Several previous studies have indicated that audiences tend to perceive and understand issues in the ways suggested by the information they receive (Igartua and Cheng, 2009; Klingeren et al., 2015; Matthes and Schmuck, 2017; Schemer, 2012). Moreover, it has been surmised that negative information is typically more salient and memorable than positive information (Lau, 1985) and can thus be more persuasive (Vreese et al., 2010). Therefore, an increase in negative frames in the news that emphasize the negative aspects of China can be considered a potential key factor in the increase in expressed anti-China sentiment.

From the perspective of the topic frame, we found that news articles related to politics and international relations induced more expressed anti-China sentiments than other topics did. Specifically, in the regression analysis, we found that news articles related to politics/international relations still induced a greater expression of anti-China sentiment by controlling the effect of the news valence. This suggests that when the received information is related to these topics, even if the news coverage

makes no explicit mention of China's negative aspects, it can still induce the expression of anti-China sentiments.

These results have important implications for understanding anti-China sentiment during the COVID-19 pandemic. On the one hand, this study highlighted the importance of contextual factors in understanding anti-China sentiments during the COVID-19 pandemic. Many Japanese people had already adopted negative attitudes toward China due to issues in politics and international relations, such as territorial disputes, military threats, and foreign policy, before the pandemic (NPO, 2019). News articles related to politics and international relations have related COVID-19 to existing stereotypes and consequently led to the expression of negative sentiments. Indeed, rather than negative attitudes toward Chinese people due to the self-protective response to possible infection, the negative attitudes toward the Chinese government constitute the main features of expressed anti-China sentiment in Japan. On the other hand, this study indicates the role of the media frame in shaping anti-China sentiment. We find that the number of news articles related to politics and international relations increased over time; although the underlying anti-China sentiment among Japanese might have never truly changed, the extent of expressed anti-China sentiment would increase with the increasing discursive contexts provided by media. As an agenda builder, the news media can decide how extensively to emphasize certain perspectives on issues and express certain emotional valences related to issues through the organization of the media frame. In this sense, news media can contribute to the increasing salience of anti-China sentiment by providing raw materials to activate stereotypes and opportunities to express anti-China sentiments. These findings highlight the potentially harmful effects of the media frame and provide implications for dealing with racism and xenophobia in future infectious disease outbreaks.

Regarding our methodological contribution, through the chosen methodology, we demonstrated how using digital trace data coupled with computational methods can help us understand the condition and dynamics of anti-China sentiments expressed during the COVID-19 pandemic. In fact, our sentiment classification analysis aligns with previous studies that argued that negative depictions in the news are more likely to induce negative sentiments among audiences (Boomgaarden and Vliegenthart, 2009; Klingeren et al., 2015; Schemer, 2012; Schlueter and Davidov, 2013). Thus, our findings support the semantic accuracy of the deep learning classifier that we built for this study. Moreover, sentiment analysis can contribute to a wide range of academic fields, including sociology, psychology, and communication, by extracting emotions, subjectivity, and opinions from textual data. In particular, the application of computational methods, along with the continued development of big data, has tremendous potential to predict sentiments on a large scale in a more effective, faster, and potentially even more reliable way than human judgment. Given its unique advantages, interdisciplinary research is needed to incorporate big data sources and computational methods into social science research. This study provides an example of how this innovative methodology can be applied practically in combination with observational digital trace data and advanced natural language processing technology. Specifically, this study utilized transformer-based models, and we show that even by introducing only a simple dense layer in the downstream task, transformer-based models can outperform previous methods, which indicates that advanced pre-training models have great potential for dealing with large-scale text datasets through the implementation of simple fine-tuning. Thus, this methodology opens up potential new avenues for future studies that aim to understand individual opinions and behaviors in the information environment by unitizing digital text data.

4.2. Limitations

Despite our study's important insights and methodological strengths, we must acknowledge some of its limitations. First, it should be noted that this study focuses specifically on the extent of anti-China sentiment expressed among Japanese citizens using data sources consisting of digital news articles and online news comments. Because the implications of this study are based on an exclusive focus on COVID-19-related online news discourse in a specific country, the results may not fully explain the expression of anti-China sentiment in a hybrid media environment. Thus, further research is needed to examine key conclusions and draw a more comprehensive picture of the association between the expression of anti-China sentiment and the media frame. Second, this study indicates that audiences' preexisting stereotypes led to a biased interpretation and understanding of certain news coverage. However, this discussion assumes that most Japanese citizens have preexisting stereotypical views toward China. Although we have provided previous survey data to support our assumption, considering that previous studies' target populations do not completely overlap with those of our study, further research is needed to measure the presence and extent of preexisting stereotypical views to draw more robust conclusions.

Declarations

Author contribution statement

Zeyu Lyu: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Hiroki Takikawa: Conceived and designed the experiments; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Data availability statement

Data will be made available on request.

Declaration of interests statement

The authors declare no conflict of interest.

Additional information

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