

ESCAPING THE CLUTCHES OF FAKE NEWS? EXPLORING THE MECHANISMS OF ONLINE OPINION CLIMATE ON SOCIAL MEDIA USERS' IMMUNITY

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ABSTRACT

Social media have become a crucial medium for the viral spread of fake news. However, past researches have primarily focused on the causal motivations behind the spread of fake news, neglecting how users, through self-cognitive processes, can counteract the dissemination of fake news and build their own immunity. Based on the cue consistency theory and cognitive response theory, this study investigates how the online opinion climate influences users' ability to build immunity against fake news. The study considers the mediating role of users' reflexive open-mindedness and the moderating effect of social bots' disclosure. Using a situational experimental approach, the results indicate that an inconsistent and abundant online opinion climate enhances users' ability to identify and immunize against fake news. Furthermore, implicit disclosures by social bots assist users in critically evaluating the authenticity of news. This study provides new insights for social media platforms and corporate decision-makers in addressing fake news.

Keywords: Online opinion climate; Reflective open-mindedness; Social bots' disclosure; Fake news immunity; Social media

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1. Introduction

The widespread use of social media has facilitated users' abilities to access and share information. However, fake news is interwoven, confusing and misleading users (Horner et al., 2022; Zhou & Zafarani, 2020), much like a viral spread akin to an "epidemic" (Bodaghi & Oliveira, 2022; Li et al., 2023). Fake news refers to fabricated information that mimics the formal structure of news media content but deviates in its organizational process or intent (Lazer et al., 2018). Often shorter in length and more provocative than genuine news, fake news can have adverse effects on both the economy and society (An et al., 2023). For instance, fake news suggesting that a COVID-19 vaccine might alter the human genome rapidly proliferated. This not only damaged the reputation and profitability of vaccine manufacturers but also incited societal panic and jeopardized public health security (Broniatowski et al., 2020).

Social bots actively engage and amplify this situation: by targeting users, these bots exploit the structure of online accounts to respond and reference the fake news, shaping public opinion and manipulating users into further disseminating fake news. Specifically, these bots manipulate mainstream viewpoints to create a consensus, leading users into a manipulated opinion climate (Guo & Vargo, 2015). However, despite the crucial strategic role that social bots play in guiding public opinion through viral dissemination, revealing the identity of these bots may reshape users' judgment (Escolà-Gascón et al., 2021; González-Bailón et al., 2021). Users may become aware of the puppeteer behind the scenes manipulating the opinion climate and deceiving them (Luo et al., 2019). Thus, whether users act as receivers, disseminators, or debunkers of fake news, escaping the manipulation of bots at the cognitive level becomes an urgent priority for developing immunity against fake news.

The public's thoughts, attitudes, emotions, and behavioral tendencies towards social events, or clarifications posted on public platforms such as mobile Internet and social media, together constitute the opinion climate (Godes et al., 2005). Fake news thrives in the public opinion climate characterized by explosive dissemination and an open environment. Previous research has indicated that implicit cues within social media assist users in perceiving the existence of fake news, such as opinion consistency (Wischniewski et al., 2022), prominence and influence of news dissemination (Müller, 2022), and information volume and polarization (Wang et al., 2018). The algorithmic features of social media determine the promotion of content with higher visibility and engagement to users. Users often form opinions on events based on comments while browsing news. Drawing on the cue consistency theory (Slovic, 1966), opinion consistency and volume can be considered as social media cues contributing to the opinion climate.

The diverse information landscape of the social media environment influences users' cognitive abilities and alters their response behavior (Kohout et al., 2022). According to cognitive response theory, the overall response to information requires cognitive processing and reflection, with reflexive open-mindedness serving as a key cognitive process characterized by diverse and logical thinking (Greenwald, 1968). Reflexive open-mindedness is a more advanced analytical thinking tendency to thoughtfully and actively reflect on one's own biases and beliefs (Baron, 2019; Pennycook & Rand, 2019). The activation of reflexive open-mindedness prompts social media users to identify information from multiple perspectives (Barakat et al., 2021). This internal mechanism also encourages users to no longer blindly trust the opinion climate on social media and, instead, seek authoritative information through a restoration of rational cognitive thinking (Ning et al., 2021). Ultimately, this process aids users in developing immunity against fake news. The analogy of immunity is derived from the medical term "vaccination" (Basol et al., 2020). In this paper, fake news immunity refers to the production of "antibodies" at the cognitive level by providing a "vaccine" to prevent the spread of fake news, that is, the activation of reflective open-mindedness, and the ultimate realization of users' immunity to fake news.

Although a large number of fake news detection algorithms and models have been proposed, these methods to combat fake news still have certain limitations (Bazmi et al., 2023; Hwang & Lee, 2024). First of all, corrective measures can only be taken after the spread of fake news. In fact, fake news has already brought some negative effects. Secondly, it undermines freedom of expression and provokes a heated public debate about Internet censorship and artificial intelligence involvement. In addition, artificial intelligence can also help fake news evade detection, and the ability of seamless integration between artificial intelligence and news is increasing (Vosoughi et al., 2018). For example, Facebook attempted to alert users by flagging suspicious articles in 2017, which subsequently proved ineffective and removed the feature (Patricia et al., 2020). Finally, existing studies have found that cognitive attitudes play a key role in users' sharing of fake news (Ajina, 2023). This is because when users' beliefs are easily affected by the complex social media opinion climate, they have a high tendency to share fake news (Hu & Apuke, 2023). Through prebunking and adopting inoculation techniques, high levels of cognitive alerting and critical skills are required for inoculation against fake news (Lewandowsky & van der Linden, 2021; Musi et al., 2022). Therefore, this study believes that it is more important to simply resist fake news and treat the symptoms rather than the root cause, so that the cognitive belief of users' perspective will not be shaken by the appearance of fake news, and thus obtain immunity to fake news.

Addressing above research gaps, this study, grounded in the cue consistency and cognitive response theories,

investigates how opinion consistency and volume serve as cues in the information environment, promoting user immunity to fake news. The study considers the mediating role of reflexive open-mindedness and the moderating effect of social bots disclosure. Theoretically, this research contributes to understanding the mechanisms of social media bots in propagating and amplifying fake news, as well as the cognitive processes and behaviors through which users immunize themselves against fake news. On a practical level, the study results guide users in developing sound cognitive thinking and immunizing themselves against fake news, facilitating the standardization of social media management and timely responses by businesses.

2. Theoretical background

2.1. Opinion consistency and opinion volume: two key clues of opinion climate

The cue consistency theory refers to the formation of attitudes and behaviors by individuals based on multiple cues and their consistency in received information. When the degree of consistency among various sources of information is high, these cues hold greater integrative value and exert influence on individual attitude and behavior changes (De Roeck et al., 2016; Slovic, 1966). This theory, applied in various contexts such as webpage design (Xu et al., 2013), e-commerce live streaming (Fei et al., 2021), and product reviews (Byun et al., 2021), considers the multitude of cues from information sources and their consistency. Research indicates that multiple information sources possess integrative value in altering individuals' cognitive thinking and behavioral dynamics (Maheswaran & Chaiken, 1991). For instance, the synergistic consistency of cues such as price and popularity can enhance the value perception of web pages (Xu et al., 2013). Consistent cues on social media, like information and image consistency, positively impact users' cognitive understanding and emotional identification (Hsieh, 2023). However, when cues are inconsistent, individuals tend to give more weight to negative cues, believed to be more diagnostic and informative (Tu et al., 2022). In the context of social media, users receive various cues from the opinion climate, subsequently altering their attitudes and behaviors. In light of the proliferation of fake news, adopting the cue consistency theory as a theoretical foundation holds significant research relevance.

The social media opinion climate represents a public sentiment trend, amalgamating numerous expressions of opinions and attitudes openly shared by users on social media platforms (Duncan et al., 2020). It is considered a pivotal cue influencing individuals' cognition and behavior (Boudreau & MacKenzie, 2014). Given the complexity of the social media environment and user conformity tendencies (Kohout et al., 2022), research has shown that users' intent to propagate fake news is influenced by group opinions consistency and volume (Wang et al., 2018). Opinion consistency refers to the extent to which individuals desire their opinions to align with those of the majority or other opinion leaders (Wang et al., 2018). Previous studies have focused on exploring its impact on the willingness of social media users to express their opinions (Chun & Lee, 2022). Research indicates that diverse perspectives and opinions on social media during unexpected events are crucial factors in shaping the opinion climate (Liu et al., 2022). Scholars have also confirmed a significant relationship between the perception of opinion climate and the silence of minority opinion holders based on the spiral of silence theory (Ordoñez & Nekmat, 2019). Opinion volume refers to the scale of opinion formation on social media (Wang et al., 2018). The anonymity and openness of the internet provide users with unrestricted opportunities to express opinions, leading to an exponential growth in information and opinion volume (Kohout et al., 2022). Fake news permeates social media topics and opinions, significantly impacting its dissemination scale and influence. Research has explored the role of opinion volume in the initial impression and belief transformation of social media users regarding fake news, with large-scale opinions potentially leading users to reach a fake consensus (Wang et al., 2018). Based on the cue consistency theory, both opinion consistency and opinion volume serve as two crucial cues in the social media opinion climate. On one hand, they facilitate the rapid spread and proliferation of fake news, and on the other hand, they also influence users' attitudes and behaviors.

2.2. Reflective open-mindedness

According to the cognitive response theory, individuals actively link received external information with their feelings and beliefs, ultimately resulting in an overall response (Greenwald, 1968). Cognition is stimulated by external information cues. For instance, based on the cognitive response theory, consumers perceive usefulness of augmented reality products only when positively guided by companies (Kowalczyk et al., 2020). The outcome of information errors is determined by individuals' cognitive responses to the source of information (Zhou & Shen, 2022). In the context of social media information overload, cognitive overload and attitude defense experienced by social media users ultimately influence their attitudes and behaviors towards information (Wang et al., 2023). Therefore, based on the cognitive response theory, particularly in the context of rampant fake news, it is necessary to explore how social media users form cognition and responses in complex social media environments.

The proliferation of fake news can easily trigger different patterns of thinking and behavior (Hou et al., 2020). Typically, when people encounter information, they tend to rely on intuition and reject using additional cognitive resources to process the information further (Gilbert, 1991), making them susceptible to falling into the trap of fake

news. Previous research has shown that reflexive open-mindedness is associated with the ability to discern true from fake news (Bago et al., 2020; Pennycook et al., 2020), and can play a positive role in resisting fake news and increasing truth discernment on social media (Pennycook & Rand, 2019, 2020). Reflexive open-mindedness refers to a rule-based, conscious, and logical thinking process that enables individuals to actively accept and articulate biases and beliefs they have formed (Baron, 2019), and make decisions based on clear information content. It depends on three prerequisites: cognitive ability (i.e., intelligence), specific knowledge, and analytical thinking tendency (Stanovich et al., 1998). For example, individuals with reflexive open-mindedness can critically examine themselves and make accurate judgments by overcoming the initial errors generated by autonomous thinking and being willing to accept new information while reassessing their viewpoints (Stanovich & Toplak, 2019). Therefore, reflexive open-mindedness can effectively help social media users reflect on and correct incorrect intuitions (Cham et al., 2023) and help users recognize fake news (Bago et al., 2020).

2.3. fake news immunity

When users become aware of the existence of fake news, they need to take measures and actions. Traditional methods of combating fake news often have a time delay, where fake news is debunked through fact-checking after it has been amplified and disseminated (Walter et al., 2021). For example, based on the spread of fake news about COVID-19 vaccines on social media platforms, research has found that companies should play a role in stopping the spread of fake news, making users aware of its existence, and demonstrating the legal and ethical necessity of doing so (Gisondi et al., 2022). There is also research on the effectiveness of enhancing social media literacy skills in order to reduce the spread of fake news on social media (Xu et al., 2024). However, this study argues that as the primary viewers and disseminators of fake news, the behavior of social media users plays a crucial role in either facilitating or suppressing its spread (Apuke et al., 2023).

The inoculation theory in informatics indicates that after informing users in advance of the possible harm of fake news, only the cognitive thought triggering process similar to the production of "psychological antibodies", which can be understood as the activation of reflexive open-mindedness mentioned in 2.2, can make individuals immune to fake news (McGuire, 1961; Pfau, 1997). This is because even after correcting fake news, people may still be affected by previous fake news, suggesting the need for more effective strategies to boost the public's immunity (Lewandowsky et al., 2012). Previous studies have demonstrated that prebunking and inoculation techniques operate on an individual level for achieving cognitive immunity to thinking (Lewandowsky & van der Linden, 2021). Improving users' media literacy, educating them on how to identify fake news, and verifying information before sharing it can help mitigate the spread of fake news (Yuan et al., 2023). High levels of cognitive alertness and critical skills are necessary to ensure that users are immune to fake news (Musi et al., 2022). Therefore, the "immunity" of users at the cognitive level is the fundamental way to combat fake news (Sander, 2022). In conclusion, it is valuable for this study to place users at the center and systematically explore the role of users' autoimmune behaviors in inhibiting the spread of fake news (Apuke et al., 2023; Barakat et al., 2021; Guo et al., 2023; Wei et al., 2023).

2.4. Social bots disclosure

Robot identity disclosure refers to whether consumers are aware of the true identity of a robot before making consumption decisions (Zhu & Zhang, 2023). In the context of social media platforms, the process by which artificially controlled social bots disclose account attributes and information to users is referred to as social bot disclosure. While some scholars argue that social bots may not be the sole drivers of fake news dissemination, studies have demonstrated that users' limited exposure to social bots on social media can have a significant impact on the larger group, as information spreads quickly and accurately across various topics (Halevy et al., 2022; Song et al., 2023). Social bots are increasingly becoming more active and engaged in daily interactions on social media platforms (Wischniewski et al., 2022). The higher the level of identity disclosure, the more reliable the published content is considered to be (Choi et al., 2022). Users unknowingly collaborate with social bots, collectively forming a group intelligence that can influence the opinion climate on social media, promote the spread of fake news, and even surpass the dissemination achieved by either social bots or humans alone (Kollanyi et al., 2016). Users often struggle to distinguish between genuine users and social bots since social bots can mimic human behavior through language interactions (Hlee et al., 2023). Furthermore, due to the absence of standardized guidelines for disclosing the identity of artificial intelligence at the societal level, decisions regarding disclosure are largely left to corporations (Bonsón et al., 2021). Empirical evidence indicates that when social bots are disclosed and recognized as such, users are more inclined to display negative sentiments towards them (Luo et al., 2019). In an era of rampant fake news, where social media has become the primary channel for news dissemination and user communication, the presence of undisclosed social bots manipulating the social media opinion climate can further confuse users (Escolà-Gascón et al., 2021). Prior research has confirmed that social bots play a role in shaping the social media opinion climate (Escolà-Gascón et al., 2021; González-Bailón & Domenico, 2021), but few studies have examined their impact on users' psychological and cognitive responses specifically from the perspective of social bots disclosure.

3. Hypotheses

3.1. Social media opinion climate and user's immunity to fake news

The opinion climate is formed by the aggregation of comments and opinions expressed by numerous social media users on a particular topic or event (Duncan et al., 2020). Opinion consistency and volume are considered two key cues of the opinion climate (Wang et al., 2018). Social media users are exposed to a plethora of information and selectively perceive multiple opinions based on their preferences. When opinions become highly consistent, users may question the source of these opinions, suspecting them to be from "internet water armies" due to the similarity in wording and expressions (Song et al., 2022). Additionally, the personalized recommendation algorithms of social media platforms repeatedly present users with opinions that align with their own, creating a pressure towards conformity and increasing the likelihood of users unwittingly spreading fake news. However, when opinions diverge, users face difficulties in determining the validity of contrasting views, resulting in cognitive barriers to information processing. Research has shown that when information processing is disrupted, social media users are more likely to consume news without sharing it, effectively immunizing themselves against fake news (Kumar et al., 2023). Furthermore, the abundance of opinions is indicative of the spread of fake news, as users tend to focus on highly discussed news due to the herd mentality and limited time and energy resources (Wang et al., 2018). In such an environment, users receive more diverse opinions, which prevents them from intuitively and rapidly aligning with a specific viewpoint. Users consciously develop a defense mechanism against popular topics, tending to adopt a cautious attitude and avoiding being misled by fake news in their behavior (Pennycook et al., 2020). Accordingly, this study proposes the following hypothesis.

H1a: The lower the consistency of opinions, the more likely users are to be immune to fake news.

H1b: The greater the volume of opinions, the more likely users are to be immune to fake news.

3.2. The mediating role of reflective open-mindedness

Reflexive open-mindedness refers to the subjective thinking process that individuals engage in when they encounter information (Baron, 2019). In this study, it can be interpreted as the cognitive process through which users attempt to make sense of facts in response to the cues provided by the opinion climate influenced by fake news (Guo et al., 2023). When users are exposed to a large quantity of inconsistent opinion climates, they first develop behavioral immunity to fake news. On the cognitive front, they engage in more thorough thinking, carefully evaluating and processing information based on their existing knowledge (Michael et al., 2018). Research suggests that in environments characterized by uncertainty, ambiguity, and challenging demands, individuals with self-objectivity have the confidence to construct their own ideas and beliefs, thereby promoting deep cognitive processing of information (Turel & Osatuyi, 2022). Users approach information with a critical eye, reasonably questioning its authenticity and making cognitive judgments based on various cues provided by different opinions and narrative styles (Pennycook et al., 2020). As a result, the three prerequisites for reflexive open-mindedness—specific knowledge, an analytical thinking disposition, and cognitive abilities—are successively activated (Stanovich et al., 1998), indicating the activation of users' reflexive open-mindedness.

According to cognitive response theory, when users combine the received information with their own cognition, it leads to an overall behavioral response (Greenwald, 1968). While users may not be able to fully discern the truth or falsehood of information when developing behavioral immunity to fake news, the activation of reflexive open-mindedness indicates their ability to critically examine themselves and stimuli, facilitating a more comprehensive cognitive understanding of social media information (Ye et al., 2022). According to the cognitive structural model, the cognitive response, namely the activation of reflexive open-mindedness in this study, plays a key role between stimulus fake news and user persuasion (Dong et al., 2022). Users' reflexive open-mindedness prompts them to question the accuracy of information, especially when the source is unknown and when its timeliness and completeness are low (Barakat et al., 2021). They further make judgments based on different viewpoints, cues, and narrative styles. Therefore, users tend to proactively discern fake news by activating reflexive open-mindedness from the perspective of their cognitive responses, positioning themselves at the center of combating fake news (Apuke et al., 2023). This leads to a more comprehensive and cautious cognitive thinking and judgment, ultimately resulting in cognitive immunity to fake news (Guo et al., 2023). Accordingly, this study proposes the following hypothesis.

H2a: The lower the consistency of opinions, the more likely users' reflexive open-mindedness is to be activated. Reflective open-mindedness mediates the effect of the opinion consistency on users' immunity to fake news.

H2b: The greater the volume of opinions, the more likely users' reflexive open-mindedness is to be activated. Reflective open-mindedness mediates the effect of the opinion volume on users' immunity to fake news.

3.3. The moderating role of social bots disclosure

Social bot disclosure refers to the extent to which the identity of a fully automated or partially manually controlled bot account is made known on social media platforms (Cheng et al., 2021). Non-disclosure of social bots allows them to seamlessly integrate into social media and engage in conversations with other users, resembling human behavior

(Ho et al., 2018). However, this lack of transparency makes it challenging for users to differentiate between genuine users and social bots, potentially leading to concerns about the dissemination of fake news and manipulation of opinion climate. The presence of undisclosed social bots disrupts users' understanding of the opinion climate within social media platforms (Escolà-Gascón et al., 2021; González-Bailón et al., 2021), causing cognitive and behavioral deviations that may result in users trusting and spreading fake news (Pennycook & Rand, 2019). Some studies argue that users have the right to know the identity of bots (Luo et al., 2019). However, even when corporations and media outlets disclose the identity of social bots and use anthropomorphic images, users often exhibit distrust and reluctance to trust them (Luo et al., 2019; Cheng et al., 2021), further intensifying their suspicions towards the news or opinions disseminated by bots. Conversely, when social bots reveal their true identity, users become more critical of the news shared by these bots, recognizing their manipulative and deceptive nature, and subsequently immunizing themselves against fake news (Ferrara et al., 2016). Hence, this study proposes the following hypothesis.

H3a: When social bots disclose their status, the lower the consistency of opinions, the more likely users are to be immune to fake news.

H3b: When social bots disclose their status, the greater the volume of opinions, the more likely users are to be immune to fake news.

4. Methodology

This study employed experimental vignette methodology (Song and Zhang, 2024; Kim et al., 2023). Including scenarios and stimuli provided to the participants through texts and pictures, so that the participants were immersed in and truly manipulate the real world events (Aguinis & Bradley, 2014). We conducted two scenario-based experiments to test the hypothesis. Considering that weibo (similar to facebook) is a popular image-oriented social media platform in China, which is widely known and used by users, it is reasonable to choose weibo as the experimental platform. The real information interface and comment interface of the simulated weibo platform were used to increase immersion, and the opinion consistency and opinion volume were manipulated through text. Study 1 examined the main effects of opinion consistency and opinion volume on users' immunity to fake news, and tested the mediating effect of reflective open-mindedness. Study 2 verified the moderating effect of social bots disclosure. Figure 1 shows the research framework. Fake news is rampant in the public health and emergencies and has caused negative effects. Research has found that fake news about the possibility of COVID-19 vaccines altering the human genome has triggered social panic and jeopardized public health security (Musi et al., 2023). For reliability and validity, the experiments needed to be conducted in different settings, including fake news about COVID-19 vaccine (study 1) and side effects of proprietary Chinese medicines (study 2).

We recruited participants via Wenjuanxing (<https://www.wjx.cn>), a popular professional survey platform in China (also known as MTurk and Sojump, Su et al., 2021). During the online questionnaire development process, several rounds of pre and post translation, back translation and parallel translation were carried out with the help of several researchers specializing in e-commerce. The Chinese version was then edited and modified into the final version used by selected study participants. After completing the questionnaire, participants were entered into a prize draw as an incentive.

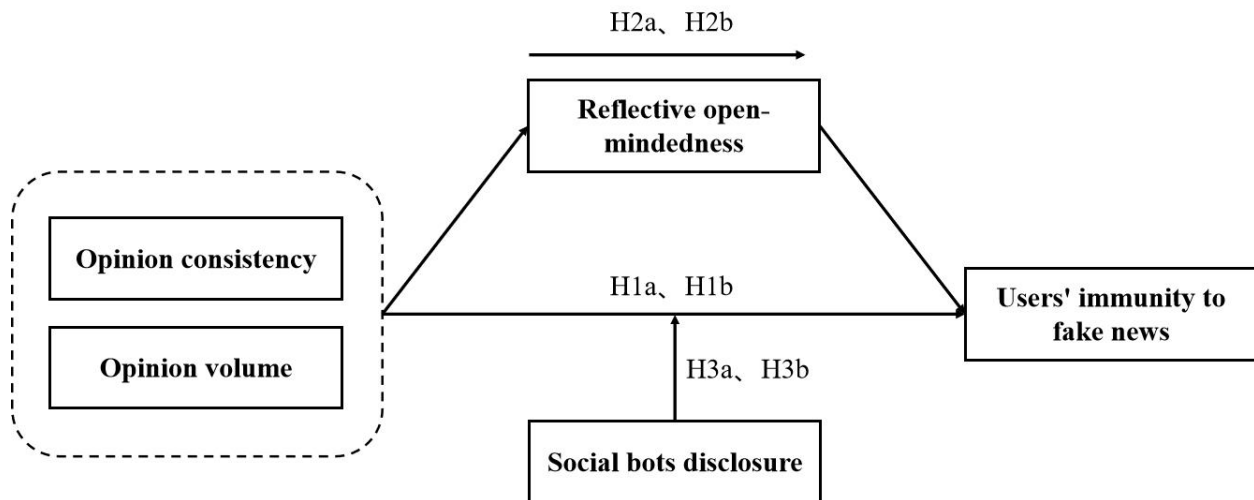


Figure 1: Research Model

4.1. Study 1

4.1.1. Experiment design and participants

Experiment 1 aimed to investigate the impact of opinion consistency and volume on users' immunity to fake news, as well as the mediating role of reflexive open-mindedness. To avoid any legal or ethical issues, a fictitious corporation was used in the scenario while the opinion content and other stimuli were real. To compare high- and low-opinion consistency and volume, we selected 40 and 10 items to represent high and low opinion volumes, respectively, and 9:1 and 5:5 for high and low opinion consistency, allowing participants to recognize the differences. This approach draws on previous research by Wang et al. (2018). To ensure the authenticity of the social media environment, a random mix of consistent and inconsistent opinions was presented, reducing the effect of opinion order on the experiment's findings.

In Experiment 1.1, a between-subject design (high consistency vs. low consistency) was used. A total of 184 undergraduates from universities in southern China took part in the study and were randomly assigned to one of two experimental scenarios. 73.9% were between the ages of 18 and 24. These participants were selected based on their ability to make informed judgments about the news and form their own opinions (Pang et al., 2016). In addition, they were local Weibo users. A between-subject design was also used in Experiment 1.2. Participants recruited from the platform were randomly assigned to either high opinion volume or low opinion volume. After excluding participants who selected the same option for all items, 175 valid questionnaires were collected. Most of the participants were between the ages of 18 and 24 (76.67%).

In Experiment 1.1, we asked participants to read the study requirements carefully. In the first step, they were instructed to imagine that they were browsing various news on social media. Second, they focused on a fake news (which the participants did not know was fake) about vaccines being harmful (see Figure 2). In the third step, participants continued to view social media opinions about the fake news. We controlled for the opinion volume that agreed, and then mixed the opinions that agreed and disagreed (see Figure 2a). Finally, participants read the scenarios, assessed the manipulation check, answered questions about reflexive open-mindedness and fake news immunity, and provided their demographics. In Experiment 1.2, except for the third step, where we controlled for the opinion consistency and randomly mixed the volume of high and low opinions (see Figure 2b), the rest was the same as in Experiment 1.1.

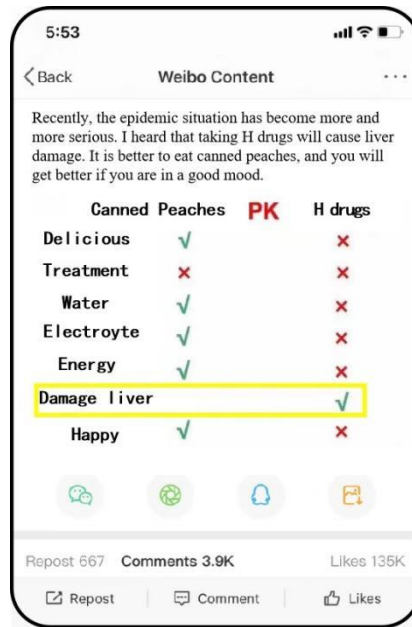


Figure 2: fake news

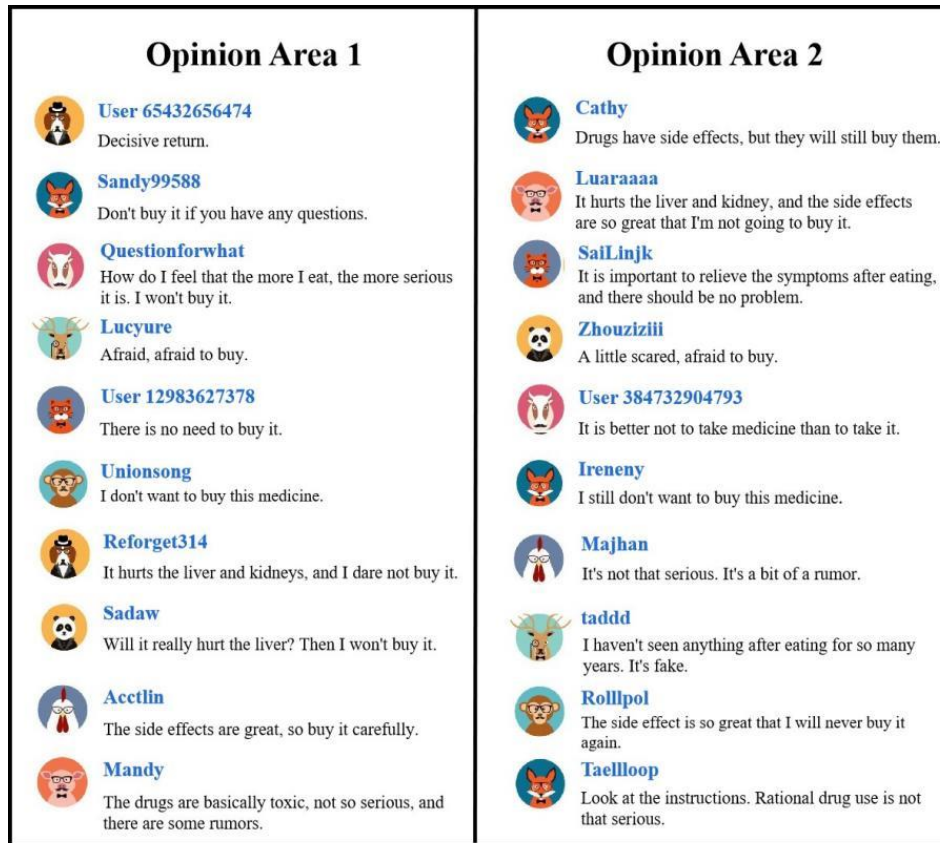


Figure 2a: Areas about opinion consistency

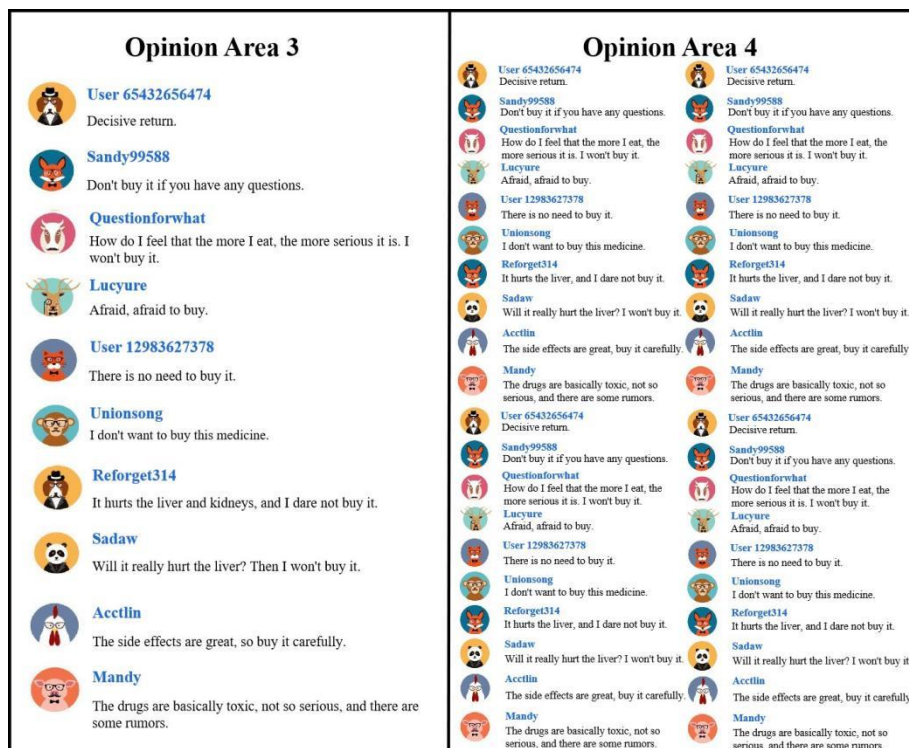


Figure 2b: Areas about opinion volume

4.1.2. Variable measures

Established or modified items and scales were used for participants' online questionnaires. In this study, the mediating variable reflective open-mindedness and the dependent variable fake news immunity were measured. All measures were measured using a seven-point Likert scale (1 = strongly disagree, 7 = strongly agree). Participants' exposure to reflective open-mindedness (Cronbach's $\alpha = 0.797$) was captured through three items from Gupta et al. (2023) and Lai et al. (2020): (1) "I think this news has caused me to think a lot" (Factor Loading = 0.835); (2) "I think I will take the initiative to reflect on my own biases and beliefs about this news." (Factor Loading = 0.794); (3) "I think I would question the authenticity of the news". (Factor Loading = 0.709). To measure participants' immunity to fake news (Cronbach's $\alpha = 0.809$), they were asked, (1) "I think this news is not credible." (Factor Loading = 0.909); (2) "I think this news is not true" (Factor Loading = 0.945); (3) "I think I will not pay attention to this kind of news anymore." (Factor Loading = 0.936). The measurement items for the dependent variable were adapted from Guo et al. (2023) and Ye et al. (2022). According to the above data, the factor loadings of each item is greater than 0.6, Cronbach's α is greater than 0.7, indicating that the internal consistency of each item is good and the reliability is high, so the robustness of the measurement model has been tested.

4.1.3. Results

Manipulation check. In Experiment 1.1, "I think the opinions published by the users are consistent" was used to determine whether the subjects identified the opinion consistency (1 = strongly disagree, 7 = strongly agree; Wang et al., 2018). Manipulation checks showed that participants could be accurately identified. The one-sample t-test showed significant differences in participants' perceptions of consistency ($M_{low} = 3.95, SD_{low} = 1.66, M_{high} = 4.78, SD_{high} = 1.64, t = 32.258, p < 0.001$). In Experiment 1.2, "I think the discussion on this topic is very hot" was used to determine whether participants differentiated the opinion volume (Wang et al., 2018). The one-sample t-test showed significant differences in participants' perceptions of volume ($M_{low} = 4.06, SD_{low} = 1.71, M_{high} = 5.60, SD_{high} = 1.16, t = 69.161, p < 0.001$). Therefore, the manipulation checks of Experiments 1.1 and 1.2 were successful.

Hypothesis tests. In Experiment 1.1, one-way ANOVA showed that opinion consistency ($F(6, 177) = 2.460, p = 0.020$) significantly affected users' immunity to fake news. Then, 95% confidence intervals were generated using SPSS26 and SPSS PROCESS v3.3 Model 4 to examine the mediation effect (Hayes, 2017). The results (Table 1) show that the mediating path of "opinion consistency-reflective open-mindedness-immunity to fake news" is significant (indirect effect = 0.3703, LLCI = 0.2980, ULCI = 0.4519), and users' reflective open-mindedness acted as a mediator. So, H1a and H2a is supported.

Table 1: Decomposition of the mediating effect of reflective open-mindedness in Experiment 1.1.

	Effect	BootSE	BootLLCI	BootULCI
Direct effects	0.4821	0.0309	0.4212	0.5430
Indirect effects	0.2522	0.0477	0.1568	0.3460
Total effects	0.7843	0.0496	0.6363	0.8323

In Experiment 1.2, opinion volume ($F(16, 158) = 1.769, p = 0.040$) also significantly affected users' immunity to fake news, and high volume had a more significant impact. The results (Table 2) again showed significant mediating pathways (indirect effect = 0.3421, LLCI = 0.2044, ULCI = 0.5035). Thus, H1b and H2b is supported.

Table 2: Decomposition of the mediating effect of reflective open-mindedness in Experiment 1.2.

	Effect	BootSE	BootLLCI	BootULCI
Direct effects	0.0746	0.0783	-0.0814	0.2306
Indirect effects	0.3421	0.0760	0.2044	0.5035
Total effects	0.4167	0.0864	0.2448	0.5886

4.1.4. Discussion

Study 1 explored the effects of opinion consistency and volume on users' immunity to fake news, and the mediating role of reflexive open-mindedness. The results show that both opinion consistency and opinion volume can activate users' reflexive open-mindedness and immune to fake news. The next study will focus on whether the disclosure of social bots has an impact on the results, further exploring other potential mechanisms by which social users are immune to fake news.

4.2. Study 2

4.2.1. Experiment design and participants

This study examined the moderating effect of social bots disclosure on users' fake news immunity. In order to ensure the universality and robustness of the experimental results, we used new experimental scenarios and different participants. We found that in addition to crisis situations, drug safety is also a major scene for the fermentation of fake news. Therefore, the background of fake news selected in study 2 is that the side effects of a proprietary Chinese medicine are maliciously amplified. In Experiment 2.1, 84 participants (75.0% aged 18-24) were recruited. Everyone had experience in using social media, 92.05% of the participants had used it for more than two hours, and most of them (90.92%) had at least heard of the existence of social bots. In Experiment 2.2, 84 participants were recruited, most of whom were 18-24 years old (70%). 95.54% of the participants used it for more than two hours, and most of them (92.92%) had at least heard of social bots, among which 51.11% knew something about social bots.

4.2.2. Variable measures

According to Wischniewski (2022), before answering questions about social bots disclosure, we gave one personal social media account data of a social bot to stimulate before answering questions. Social bots disclosure (Cronbach's $\alpha = 0.809$) was measured by three items: "I think this social media user posts a lot." (Factor Loading = 0.889), "I think this social media user's posting behavior is very simple (e.g., only repost)." (Factor Loading = 0.896) and "I think there is a high degree of automation in this social media user profile." (Factor Loading = 0.832) Other measurement items are the same as study 1, the internal consistency among the items is good, and the measurement is reliable.

4.2.3. Results

Manipulation check. In Experiment 2.1, the one-sample t-test showed that participants were able to correctly judge high and low opinion consistency ($t = 43.482, p < 0.001$). One-way ANOVA showed that the main effect of opinion consistency on users' immunity to fake news was significant ($F(6, 77) = 3.793, p = 0.001$). In Experiment 2.2, the one-sample t-test also showed that participants were also able to judge high and low opinion volume ($F(6, 77) = 3.793, p = 0.001$), and the main effect was also significant. Therefore, the manipulation checks were successful, and H1a and H1b were confirmed again.

Hypothesis tests. SPSS26 and SPSS PROCESS macro v3.4 Model 1 were used to analyze the moderating effect in both experiments 2.1 and 2.2 (Hayes, 2017). The results of Experiment 2.1 showed that under the identity disclosure of social bots, opinion consistency has a more significant positive impact on users' immunity to fake news ($\beta = 0.303, t = 2.347, p = 0.021$), the 95% confidence interval was 0.0461~0.5604, and H3a was supported. The results in Experiment 2.2 showed that the positive effect of the high opinion volume on users' immunity to fake news is more significant in the condition of bots disclosure ($\beta = 0.209, t = 2.000, p = 0.049$), the 95% confidence interval was 0.0010~0.4169, and H3b was supported again.

4.2.4. Discussion

We extend new situations in which social bots exist and are recognized in social media environments. The results found that the disclosure of social bots helped users better generate an immune response in a complex opinion climate. We've found a new way to protect users from fake news.

5. Results and discussion

5.1. Conclusions

Currently, the social media landscape is evolving from being primarily driven by humans to a more symbiotic relationship with social bots. With the diverse strategies that social bots can employ on social media, they have become a significant factor influencing the online opinion climate. Users, as both consumers and sharers of news, often gravitate towards engaging yet fake news, inadvertently propagating quickly. This proliferation of fake news poses a substantial threat to society (Ferrara et al., 2016; Vosoughi et al., 2018). Therefore, it is imperative for social media platforms and corporations, which play a pivotal role in shaping public opinion, to investigate methods to enhance users' immunity to fake news in order to curb its detrimental effects. Drawing upon cue consistency theory and cognitive response theory, this study delves into the psychological and behavioral mechanisms that contribute to users' immunity to fake news through two scenario-based experiments conducted on social media. In study 1, we confirmed that opinion consistency and opinion volume can make users immune to fake news, and also confirmed the mediating role of reflexive open-mindedness. The high volume of completely unanimous opinions appearing on social media makes it easy for users to think that water armies are fomenting the opinion climate. We further explore the internal mechanism of user immunity, and look for "vaccines" to curb the spread of fake news with users as the center. The study found that reflective open-mindedness prompts users to approach news consumption thoughtfully, enhancing their ability to identify and deflect fake news. Activating users' reflective open-mindedness actually gives users a "vaccine" to identify fake news, so ultimately strengthening users' immunity to fake news. Although social bots can naturally integrate into social media just like human users (Ho et al., 2018), their dialogue methods and posting

frequency still contain traces of human manipulation, which makes users doubt their posting opinions due to the disclosure of the identity of social bots and hope to have further reflection on the authenticity of news. This is similar to our finding that under social bots disclosure, users were able to identify fake news and the opinions associated with it. The conclusion of study 2 shows that the disclosure of social bots also becomes another "vaccine" for users to identify fake news, making users cognitively immune to fake news.

5.2. Theoretical contribution

First, this study successfully applies the cue consistency theory (Anderson, 1981; Slovic, 1966) to the research of fake news on social media, categorizing the characteristics of social media opinion climate into consistency and volume. This expands the depth of research on the cue consistency theory. The research found that a large amount of consistent opinion climate can lead users to start doubting the authenticity of the disseminated news, believing it to be a "malicious hype." Furthermore, we found that the activation of reflexive open-mindedness among users is not based on the fake news itself, but rather on the public opinion climate generated by the fake news, providing a new theoretical perspective for the study of fake news.

Secondly, this study introduces social bots disclosure as a moderating variable, which enhances the understanding of the boundary conditions of opinion climate and its impact on users' immunity to fake news. It expands the research scope of social bots disclosure, which has been recognized as an external factor that disrupts the order of social media platforms. This study uniquely focuses on the influence of disclosing the identity of social bots on users' immune behavior towards fake news. The findings of this research contribute to a better understanding of the influence of social bots disclosure on users' cognitive processes and emphasize the importance of understanding user self-immunity in the context of human-machine coexistence.

Moreover, utilizing cognitive response theory, this study comprehensively examines the entire process through which users encounter fake news, from initial stimulation and self-cognition to eventual immunization. By incorporating epidemiological concepts, the study extends and enriches the concept of immunization in the field of management. Previous studies have mainly focused on using AI to identify and prevent the generation of fake news on social media platforms (Pennycook et al., 2021). However, this study shifts its focus to users' perspectives and explores their reactions to fake news. By examining users' responses, this research provides practical insights and emphasizes the significant role of users in the process of immunizing against fake news within the rapidly evolving landscape of social media information.

5.3. Management implications

The disclosure authority management of social bots identity by platforms has important practical significance for users who are still immune to fake news when they are in the vortex of public opinion. Since bots often operate in stealth on the platform, users feel alienated and manipulated in social media platforms (Fortunati et al., 2019). Given that this study proves that the disclosure of social bots increases users' immunity to fake news, we suggest that social media platforms inform users of the identity of bots, allow verified bots to join real-time discussions with users, automatically verify information, and transfer users' distrust of bots into efficient human-machine collaboration. In addition, if the fake news has been verified, the correct news will be pushed to the user in a timely manner, and the real news with credible sources will be placed at the top of the discussion topic, so that the user can enter the echo chamber of the real news - strengthening the reflective open-mindedness.

Preventing and combating fake news in a timely manner is critical for companies, especially providers of goods or services that are vulnerable to breaking events. In addition to the vaccine suppliers and pharmaceutical companies discussed in this study, e-commerce platforms and tourist attractions that are heavily influenced by social media also need to be vigilant. By leveraging big data analytics, companies can monitor fake news in real time before it spreads widely. This is closely related to the daily operations of brand managers. We suggest that more emphasis should be placed on the human element of their operations, highlighting the emotional factors most associated with malicious social bots, and strengthening communication with users, such as replying to user comments and liking brand-related posts by users. While enhancing the corporate image, the negative impact of malicious fake news is also mitigated by user trust. At the same time, companies should also develop crisis management plans to deal with the impact of fake news on brand reputation.

Encouraging users to activate reflective open-mindedness is critical to combating fake news. Critical thinking and rational reflection can reduce the spread of fake news, enabling users to flag fake news or provide feedback to social media platforms to reduce its impact. Studies have shown that even correcting fake news does not necessarily change users' beliefs (Gimpel et al., 2021). Our research explains the critical role that reflective open-mindedness plays in breaking away from the inherent belief bias, and hopes that users should increase their confidence in their own critical thinking while improving their ability to identify fake news. In addition, the immunity behavior mentioned in this study is the hope that users can increase their resistance to fake news by being exposed to watered down examples of fake news. For example, interactive learning tools such as the "Bad News" game are being opened up to increase

awareness of fake news production strategies (Basol et al., 2020). We suggest that interactive minigame components can be inserted into social media platforms to imperceptibly build users' immunity to fake news, especially as a result of the activation of reflexive open-mindedness.

The study provides guidance for governments on ways to raise public awareness. Campaigns against fake news have been launched in many countries, but have led to discussions about the balance between freedom of expression and censorship, and have not been particularly successful. On the one hand, the government should strengthen the regulation of social media platforms and take legal action against those who produce and spread fake news. The other and most critical aspect is that governments need to raise public awareness of fake news itself, namely to acquire the fake news immunity mentioned in this study. For example, some public education activities are regularly carried out to inform users of the routines of fake news production and the evolution of social media opinion climate with actual cases and hazards. Popularize users' trust in the fake news mechanism guided by the public opinion climate, carry out cognitive psychological inoculation, and quickly jump to critical thinking, that is, realize the activation of reflective open-mindedness.

6. Limitations and future studies

The findings of this study have methodological and theoretical limitations, which motivated us to continue our research on fake news in greater depth. First, our participants were primarily selected from universities; hence, future research should select relevant groups of participants for specific types of fake news. Second, this study used the social platform Weibo. Owing to factors such as cultural or personality differences, we found that users' social media behaviors differ among countries. Thus, social media fake news should be investigated from a cross-cultural perspective to explore the behavior of users immune to fake news. Finally, the formation process of the online opinion climate is influenced not only by opinion consistency and volume but also by factors such as advertising intervention, information presentation information, and information framing, which can change users' attention to and perception of fake news.

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