Who post more negatively on social media? A large-scale sentiment analysis of Weibo users

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Abstract

Negative behaviours on social media have been widely researched in cyberpsychology studies. However, studies using actual usage data are still limited, especially for the Chinese social media Weibo. The present study aims to investigate the relationship between Weibo users' actual usage and negative online behaviours. We located 2463 Weibo users who had posted highly negative posts after screening 10,483,628 comments under nine trending topics. Their publicly visible usage data were collected and 4,273,442 microblogs (including 234,379 original posts) were analysed using sentiment analysis. Results show that the users' percentage of negative posts was positively correlated with their number of posts, number of followers, number of followings and Weibo account levels. The majority (94.84%) of the 2463 negative comment releasers did not frequently post negative microblogs; less than 50% of their total original posts were negative. Women posted more negatively than men. The present study contributes to the understanding of Weibo users' negative posting behaviours. More investigations are needed for the reasons for negative behaviours on social media and the approaches of predicting negative online behaviours from general usage data.

Keywords Negative posts · Weibo users · Sentiment analysis · Big data

Social media has been one of the most popular online applications in the world. The number of global social media users was above 3.6 billion in 2020 and will reach 4.41 billion in 2025 (Statista, 2022). Negative online behaviours on social media, including posting negative microblogs, commenting aggressively, and other antisocial behaviours, have been widely investigated in recent years (Tomaiuolo et al., 2020). The reasons behind such behaviours appear to be complicated and might include personal factors (e.g., personality) (Buckels et al., 2014) and contextual factors (e.g., bad online conversation atmosphere) (Cheng et al., 2017). Cheng et al. (2017) found that aggressive online behaviours could be better explained by online conversation context and momentary mood rather than individual's history of negative behaviors online, and they believe that any internet user can become "trolls (those who behave negatively and antisocially online)". Tomaiuolo et al.'s (2020)

review concludes that "trolls" could be detected by many approaches including analysing their posts, user threads, user behaviours and social relationships. It thus seems necessary to investigate whether users' daily using behaviours (e.g. number of posts) can be associated with their negative behaviours such as posting negative microblogs on social media.

It remains debatable whether internet use frequency or screen time can be linked with mental health problems and negative emotions, since studies reported contradictory findings (e.g., Lepp et al., 2014; Orben & Przybylski, 2019). Problematic or pathological internet users were found to have higher levels of mental health issues such as anxiety, depression and stress (Elhai et al., 2017; Brand et al., 2019; Hussain et al., 2020). It is thus possible that problematic internet usage can be reflected in people's poor mental health condition (e.g., anxiety) and then shown in actual negative online behaviours. However, most of the studies on internet and mental health relied on self-reported internet usage, levels of problematic internet use and mental health issues. Although Peterka-Bonetta et al. (2021) identified the link between unhealthy usage (social media use disorder) and the number of posts on Twitter, studies based on social

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media users' actual usage data are still scarce, especially for Chinese social media such as Weibo. It remains unknown whether frequent or heavy users of Weibo behave more negatively on social media. Thus, the present study aims to investigate the relationship between Weibo users' actual use (publicly visible use data) and negative behaviours online. This paper will review the literature about negative emotions linked with internet use and negative behaviours on social media, introduce the research aims and methods of the present study, report the results of data analysis and discuss the findings in relation to existing literature.

Literature review

Internet use and negative emotions

The relationship between internet use frequency or time and mental health issues remains unclear. Lepp et al. (2014) found that the frequency of smartphone use (the time spent on phones and texting) was positively associated with anxiety among a group of undergraduate college students in the USA. However, other studies found no significant relationship between screen time and well-being among adolescents in Ireland, the UK and the USA (Przybylski & Weinstein, 2017; Orben & Przybylski, 2019; Weiser, 2001) proposed a theoretical model of the social and psychological effects of internet use and suggested that internet use for social purposes might reduce psychological well-being while internet use for practical or information seeking purposes can increase happiness. According to Weiser's (2001) theory, the socially driven usage of social media (e.g. Twitter) might predict lower psychological well-being. It thus seems that the relationship between internet usage and well-being depends on the purpose or the specific online application.

Problematic or pathological internet use, rather than internet use frequency, seems to be a predictor of mental health issues. The Interaction of Person-Affect-Cognition Execution (I-PACE) model indicates that specific internet use disorders (e.g., gaming disorders) could be predicted by psychopathological factors such as depression and social anxiety, and in turn intensify a person's core characteristics including psychopathological issues (Brand et al., 2016, 2019). The link between problematic internet use and mental health issues is bidirectional, in that problematic internet use leads to more mental health issues and vice versa. Brand et al. (2016) point out that in early stages of problematic internet use when users can be easily satisfied, gratification is the main driving force; in later stages, compensation (instead of gratification) becomes the main motivation for internet usage and leads to negative consequences such as negative emotions. Social media users probably have more

negative emotions when they use social media to compensate for their craving rather than simply gratifying themselves (Brand et al., 2016, 2019). For example, problematic mobile phone use or problematic social networking sites use was found to be associated with negative emotions such as anxiety and depression (Elhai et al., 2017; Hussain et al., 2020; Gao et al., 2012; Yu & Zhou 2021). However, self-reported internet or social media use might not reflect the real situation. It thus seems necessary to investigate individuals' real internet usage (e.g. number of posts and negative expressions) besides self-perceived use or problematic use.

Several studies have applied big data techniques (e.g. obtaining massive internet users' numbers of public online posts) and sentiment analysis to investigate individuals' actual behaviours and expressions on social media such as Twitter (e.g. Qiu et al., 2012; Golbeck et al., 2011; Mayor & Bietti, 2021; Peterka-Bonetta et al., 2021). Actual internet use was found to be associated with mental health issues (Guntuku et al., 2019), personality (Golbeck et al., 2011) and problematic internet use (Peterka-Bonetta et al., 2021). For example, Guntuku et al. (2019) found that anxious and depressive Twitter users set profiles and post images differently (e.g., more grayscale images and single face in profiles). The number of actual social media posts were found to be negatively correlated with internet use disorder levels (Peterka-Bonetta et al., 2021). Given the well-established link between internet use disorder and mental health issues such as anxiety and depression (Elhai et al., 2017; Brand et al., 2019; Hussain et al., 2020), it seems necessary to explore whether actual internet use behaviours (number of posts) are associated with mental health or negative emotions. It remains unclear whether more internet use indicates more negative expressions.

Furthermore, most of the big data studies on social media behaviours focused on Twitter or Instagram, while the Chinese social media such as Weibo were less investigated. Weibo (https://weibo.com/) was considered as the Chinese version of Twitter, and Weibo and Twitter users were found to behave differently based on content analysis and sentiment analysis (Gao et al., 2012). For example, Weibo users tend to post more about their personal affairs and less about opinions on organizations such as political parties (Gao et al., 2012). Thus, the research findings among Twitter users might not be generalisable for the Weibo context. It thus seems particularly necessary to explore Weibo users' actual behaviours and online expressions using massive data obtained from public websites. To the best of the authors' knowledge, few studies have investigated Weibo users' actual online behaviours (e.g. number of posts) and negative expressions (based on sentiment analysis).

Gender difference in internet usage

Earlier studies found that women tended to use internet for social interaction or education while men used internet for entertainment or leisure (Weiser, 2000). More recent studies report that men use smartphones less for social purpose, and women are more likely to be addicted to use smartphones based on self-reported data (e.g. Jenaro et al., 2007; Van Deursen et al., 2015). However, literature on gender difference for actual (not self-reported) behaviours on social media is still scarce. Peterka-Bonetta et al. (2021) reported that women posted more on Instagram per day than men significantly ($p = .004$) and less on Twitter insignificantly ($p = .942$). Gender difference might exist for actual use intensity of some applications, and little is known about gender difference for actual positive or negative emotional expressions on social media. Based on the review of Event-Related Potential (ERP) studies, Yuan and Li (2012) concluded that women are more susceptible to mildly unpleasant events and even neutral stimuli. In other words, neuropsychological evidence suggests that women are more likely to perceive life events or their surroundings as negative. It thus seems possible that women post more negatively on social media, but more actual usage studies are still needed.

Negative behaviours on social media

A growing number of studies have concerned about the negative behaviours on social media such as cyberbullying and "trolling" behaviours (e.g., Smith et al., 2008; Hardaker, 2010; Kyriacou & Zuin, 2016; Cheng et al., 2017; Craig et al., 2020; Tomaiuolo et al., 2020). Cyberbullying can be defined as "the electronic transmission of distressing messages and images which target an individual repeatedly" (Kyriacou & Zuin, 2016, p.34). Given the fast development of information technology and electronic devices, it has negative and harmful impacts, especially on adolescents and young people (Smith et al., 2008; Slonje & Smith, 2008; Kyriacou & Zuin, 2016). "Trolls" on the internet can be defined as individuals who display negative and aggressive online behaviours that trouble the others and interrupt online conversations (Hardaker, 2010; Cheng et al., 2017; Tomaiuolo et al., 2020). In a large-scale cross-country study among 180,919 adolescents in 42 countries, Craig et al. (2020) found that time spent on social media, problematic social media use, and frequent online conversation with strangers were associated with cyberbullying behaviours. It seems the frequency of social media use can be linked with cyberbullying. However, based on an experimental study imitating online discussions, Cheng et al. (2017) found that trolling behaviours were situational and depended on the context of online conversations and individuals' mood at the time. Therefore, negative or aggressive online behaviours might be related to either personal (e.g., time spent on social media) or situational factors (e.g., the context of online conversation). However, besides the time of social media use and conversation contexts, it remains unclear whether those who post negative comments on social media always post negatively in their own microblogs. It thus seems necessary to investigate actual online behaviours (e.g., number of posts, percentages of negative posts) of the negative comment senders on social media.

The present study

It appears that frequent internet use might be linked with negative emotions and negative expressions according to existing evidence. However, it remains unclear whether frequent users of social media post microblogs more negatively. It seems necessary to explore the potential reasons for social media users' negative posts using the actual usage data among a large sample of users. To our knowledge, no existing study has ever explored the users of Weibo (the Chinese social media similar to Twitter) in terms of their usage and negative posts under the Chinese context. Therefore, the present study has several aims: (1) to investigate the relationship between Weibo (microblog) users' actual usage (e.g., number of posts, number of followings, account level, etc.) and negative online expressions; (2) to explore whether gender difference exists for Weibo use intensity and the percentage of negative posts; (3) to select a group of social media users who post highly negative comments in Weibo at the moment of data collection, obtain their publicly accessible online posts, and investigate if they generally post negatively in their own public posts.

Hypothesis development

Based on the empirical and theoretical literature reviewed above, hypotheses are built according to the research aims as below:

H1: Weibo use intensity is positively associated with the users' percentage of negative posts.

H2a: Women are more active on Weibo (with higher use intensity).

H2b: Women post higher percentage of negative microblogs on Weibo.

H3: Weibo users who post highly negative comments under the others' microblogs also tend to post negatively in their own public posts.
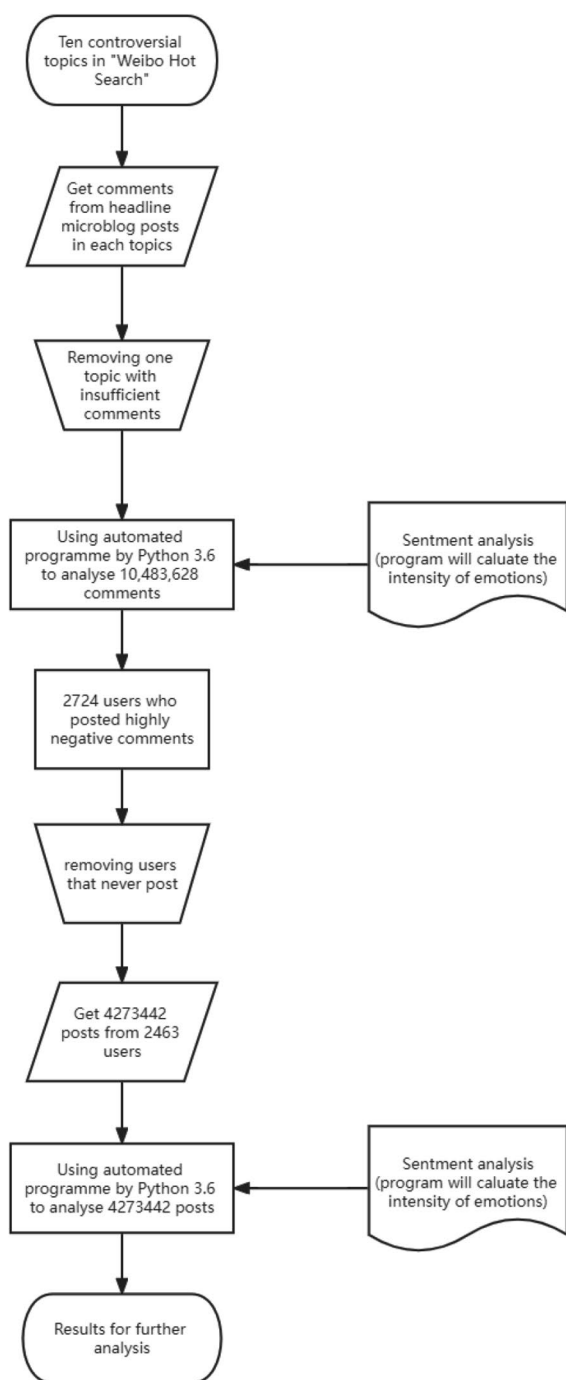
Fig. 1 The process of data collection

Methods

Sampling method

The present study investigated actual online behaviours of active Weibo users who post negative comments. The sampling method shown in Fig. 1 includes three steps: (1) Weibo

users' 10,483,628 comments from the headline microblogs of 9 controversial trending topics/hashtags were selected; (2) Sentiment analysis for the comments were conducted and 2724 Weibo users with highly negative comments were selected; (3) Users with no original posts were excluded and 2463 users were finally kept for further sentiment analysis and statistical analysis. The detailed sampling process is further explained as below.

For Step 1, two researchers selected 10 controversial topics/hashtags from the real-time trending topics ("Weibo Hot Search") in Weibo.com from 4th to 8th May 2021, and deleted one topic with insufficient comments. The researchers selected the headline microblogs in the remaining 9 topics and used Python 3.6 to build an automated program (combining with Weibo API) to obtain all the 10,483,628 comments (including users' multiple comments and replies to other users).

For Step 2, all the comments and their replies were analysed using the lexicon for sentiment analysis developed by the Information Retrieval Research Laboratory of Dalian University of Technology (Xu et al., 2008). In sentiment analysis, the comment texts were scored according to emotional adjectives and emotional adverbs. Two parameters named as "calculate_pos" and "calculate_neg" were obtained, which represent the intensity of positive emotions and negative emotions of the comment text respectively. Totally 2724 users were selected for further analysis whose calculate_neg/calculate_pos ratio was greater than 3 (i.e., the comment was highly negative).

For Step 3, after excluding the users who have never posted microblogs, 2642 users were selected for further analysis. Data analysis of their recent 2000 micro-blogs or original micro-blogs in the past two years was then carried out. There were 2463 users who had posted original micro-blogs.

Data analysis

In the stage of data analysis for actual online behaviours, 2463 users' 4,273,442 microblog posts (including 234,379 original posts) were analysed. In sentiment analysis for each Weibo post, two indexes were generated according to algorithm, namely "calculate_pos" and "calculate_neg" (both were floating-point numbers), which were based on the use of positive and/or negative adjectives and their corresponding adverbs. When "calculate_neg" was greater than "calculate_pos", the Weibo post was defined as a negative post. Then we calculated the percentage of negative posts of the 2463 users (negative posts/all original posts). Neutral and positive posts ("calculate_neg" ≤"calculate_pos") were not considered in the present study.

Table 1 Descriptive Statistics

	Min	Max	Mean	SD	Median	Skewness	Kurtosis
Number of original posts	1	1982	95.16	193.45	29.00	4.53	26.74
Number of posts	1	94,113	1735.06	5110.01	296.00	8.96	119.10
Number of followers	0	1,222,958	3396.17	42425.81	102.00	20.16	473.29
Number of followings	0	13,727	370.52	558.05	214.00	8.70	156.03
Weibo level	0	48	14.03	12.87	9.00	0.96	−0.28
Membership level	0	7	1.18	1.87	0	1.67	1.60
Percentage of negative posts	0	1.0000	0.2183	0.1809	0.2000	1.11	2.26

Note. N = 2463

Besides the percentage of negative posts, the other publicly accessible information of the user accounts was obtained including: the number of posts, the number of original posts, the number of followers, the number of followings, the Weibo level and the membership level. The Weibo level is a reflection of users' activity on Weibo. Users with higher Weibo levels use Weibo more frequently and for longer periods of time. Weibo users need to pay regularly for their membership levels and accumulate active days to upgrade their membership levels. Users with higher membership levels use Weibo more frequently, spend more money and use more Weibo functions (e.g. using pictures in comments, pinning posts on personal homepage, blocking the other users, following more people than ordinary accounts, etc.). Subsequently, the obtained data were analyzed for descriptive and correlational analyses. Due to the non-normal distribution of the data, Spearman's rho was used to calculate the correlations and Mann Whitney U-tests were performed to test gender differences.

Results

Descriptive statistics

Totally 2463 Weibo users who had posted 4,273,442 microblogs (including 234,379 original microblogs) were included in data analysis. There were 890 men (36.1%) and 1573 women (63.9%). On average, 21.83% of their original microblogs were negative as shown in Table 1. The variables were not normally distributed according to the skewness and kurtosis values. A Mann-Whitney U Test revealed a significant difference in the percentage of negative posts between men (Median = 0.1786, n = 890) and women (Median = 0.2059, n = 1573), U = 637,747, z = −3.68, p < .001. As shown in Table 2, women had higher percentages of negative posts, more original posts, more total number of posts, more followers and followings, and higher account levels than men (*p* < .001).

Figure 2 shows that most of the 2463 Weibo users did not post more negative microblogs than positive ones. The number of negative posts of 730 (out of 2463) users only accounted for 10% or less of their total number of original posts. Most (2336 out of 2463) (94.84%) users (negative comment releasers in the 9 headline microblogs) posted negative posts no more than half of their total original posts. Only 23 users' negative posts accounted for more than 90% of their total number of original microblogs.

Correlational analysis

Table 3 shows the results of nonparametric correlational analysis. The percentage of negative posts was significantly correlated with the number of original posts, (r_s = 0.21, p < .01), the number of posts (r_s = 0.14, p < .01), the number of followers (r_s = 0.07, p < .01), the number of followings (r_s = 0.05, p < .05) and Weibo level (r_s = 0.05, p < .01). In line with the results of the Mann-Whitney U Test, women had more negative posts than men (r_s = 0.07, p < .01).

Discussion

Summary of the findings

This study explored the relationship between the percentage of negative microblog posts and actual behaviours (e.g., number of posts, followers, followings) of 2463 Weibo users. Those users were selected because they commented negatively (calculate_neg/calculate_pos ratio > 3) under the headline microblogs in the real-time trending topics at the moment of data collection. Sentiment analysis of 4,273,442 microblog posts shows that most of the 2463 users did not always post negatively in their own original microblogs (posted negative microblogs no more than half of their total original posts), which rejects hypothesis 3. Women were more active on Weibo (e.g., more posts, followers and followings) and posted more negatively than men users, which supports hypotheses 2a and 2b. More posts, more followers, more followings and higher account levels were correlated with a higher percentage of negative posts, which supports hypothesis 1.
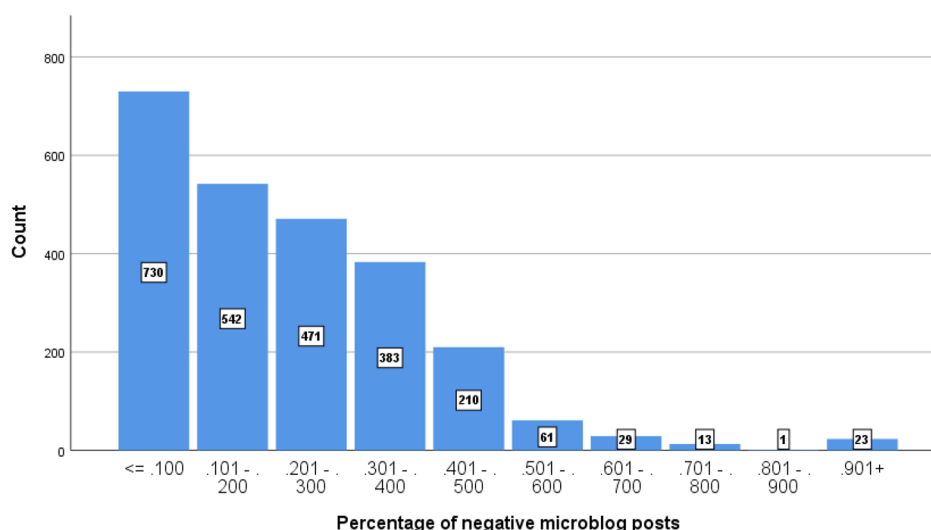
Fig. 2 Percentage of negative microblog posts. *Note. N = 2463*

Table 2 Gender difference for the number of original posts, number of posts, number of followers, number of followings, Weibo level, membership level, and percentage of negative posts

	Women N = 1573	Men N = 890		
	Mean rank	*Mean rank*	*U*	*z*
Number of original posts	1333.93	1051.85	539652.00	-9.46[***]
Number of posts	1340.94	1039.46	528625.00	-10.11[***]
Number of followers	1290.43	1128.73	608074.50	-5.42[***]
Number of followings	1307.41	1098.71	581360.50	-7.00[***]
Weibo level	1309.61	1094.83	577906.50	-7.28[***]
Membership level	1283.37	1141.21	619186.00	-5.29[***]
Percentage of negative posts	1271.57	1162.07	637747.00	-3.68[***]

Note. ***p < .001

Theoretical and practical implications

There are theoretical and practical implications of the present study. Weiser's (2001) theoretical model suggests that internet use for social purpose can be harmful to psychological well-being. The present study found that higher Weibo use intensity was correlated with the higher percentages of negative Weibo posts. If publishing Weibo posts is considered as internet use for social purpose and more negative posts reflect low well-being, the present study can explain Weiser's (2001) theory that more social use predicts lower well-being. However, further explorations are needed to investigate whether people who post frequently and negatively on social media truly feel unhappy in their lives. Brand et al.'s (2016) theory suggests that problematic internet users, in later stages (with higher levels of specific internet use disorders), use online applications for compensation instead of gratification and may experience mental health problems. It is unknown whether the Weibo users in the present study were problematic users and whether they post negatively and frequently because they are in the "later stages". Therefore, more studies can focus on social media users' actual behaviours and their levels of internet use disorders, similar to Peterka-Bonetta et al.'s (2021) trial.

Table 3 Correlations

	1	2	3	4	5	6	7	8
1. Percentage of negative posts	-							
2. Gender	0.07[**]	-						
3. Number of original posts	0.21[**]	0.19[**]	-					
4. Number of posts	0.14[**]	0.20[**]	0.58[**]	-				
5. Number of followers	0.07[**]	0.11[**]	0.35[**]	0.59[**]	-			
6. Number of followings	0.05[*]	0.14[**]	0.31[**]	0.58[**]	0.55[**]	-		
7. Weibo level	0.05[**]	0.15[**]	0.20[**]	0.54[**]	0.76[**]	0.45[**]	-	
8. Membership level	0.02	0.11[**]	0.30[**]	0.28[**]	0.37[**]	0.25[**]	0.29[**]	-

Note. N = 2463, *p < .05 (2-tailed), **p < .01 (2-tailed)

Gender: "1" = men, "2" = women

Previous studies suggest that more internet/smartphone use was linked with more negative emotions such as anxiety (e.g. Lepp et al., 2014). Similarly, the present study proved that more use of Weibo (more posts) indicates a higher percentage of negative posts based on sentiment analysis of 4,273,442 microblog posts by 2463 Weibo users. It seems that heavy social media users are more likely to express themselves negatively in public because they need to release their negative emotions. However, internet/smartphone use might include activities on a variety of specific internet applications, including social media use. Therefore, more investigations on different applications are needed in order to confirm the link between internet/smartphone usage and real-time negative posts.

Peterka-Bonetta et al., (2021) found that active social media users (with more posts) reported lower levels of smartphone/internet use disorders, and they argue that healthy social media (Twitter and Instagram) users post more frequently than unhealthy ones (those with high levels of smartphone/internet use disorders). However, the present study shows that those who post more microblogs in Weibo expressed more negatively. It remains unknown whether the active Weibo users included in the present study (with more negative posts) were healthy social media users as described in Peterka-Bonetta et al., (2021). Thus, more investigations should be conducted to test whether active social media users were truly healthier users but more likely to express themselves negatively. Besides, the significant difference between Twitter and Weibo, as found by (Gao et al., 2012), could be another important reason for the doubtful results discussed above. It remains unknown whether Twitter users with higher activeness post more negative tweets, as the Weibo users did in the present study.

Previous studies show that aggressive online behaviours were caused by the context of online conversation and situational mood rather than individuals' history of bad behaviours (Cheng et al., 2017). In line with this, the present study found that posting highly negative comments in public does not mean a high percentage of negative posts in Weibo. In other words, it appears that behaviours such as commenting on the others' or participating in public online conversations are not the same as posting one's own microblogs as online self-expression. More specifically, it is possible that social media users post very aggressive comments under the others' microblogs but rarely post negatively in their own microblogs. Thus, the predicting factors of negative online behaviours on social media appear to be complex and more investigations are needed. It is necessary to further explore whether individuals' history of online behaviours, personal characteristics (e.g., personality and gender), or online conversation contexts had a larger impact on their online behaviours.

Previous studies reported that women preferred to use internet for social purpose (Weiser, 2000), post more on Instagram (Peterka-Bonetta et al., 2021) and were more likely to be addicted to smartphones (Van Deursen et al., 2015). Similarly, the present study, based on big data mining techniques, identified that women were more active on Weibo (with more posts, followers and followings on Weibo and higher Weibo levels) and posted more negative personal microblogs on Weibo. Thus, it appears that gender difference exists for the use intensity of social media and negative online expressions; women seem to be more likely to express themselves on Weibo and post more negatively.

Limitations and future directions

There are some limitations of the present study. As Weibo posts could be set as public or only visible to friends, the results of the present might be biased because the researchers could not detect and analyse the users' private posts. For practical reasons, the present study only selected 2463 Weibo users from the headline microblogs of nine trending topics who posted highly negative comments (calculate_neg/calculate_pos ratio > 3). This might be a limitation since the users who did not always comment on headline microblogs of trending topics or participate in public conversations were not included, though one aim of the present study was to investigate the users who comment highly negatively in online conversation. The data in this study were not normally distributed and only non-parametric analysis was performed. This could be a limitation since other analysis approaches such as multiple regression and structural equation modelling were not suitable to be conducted. The present study did not use self-reported surveys to test the Weibo users' personal characteristics such as personality, which could be another limitation. Furthermore, the Weibo users' gender could be incorrect since the default gender of Weibo accounts was woman and the users might want to hide their real gender information. Thus, the results of gender difference for negative posts of the present study could be biased.

As discussed above, future studies could focus on different internet/smartphone applications besides Weibo to further test the link between internet/smartphone usage and real-time negative self-expressions. It is necessary to compare Twitter and Weibo users and explore if the users from the two platforms behave differently in terms of posting negative microblogs or comments. Besides, more studies could investigate the relationship between real-time social media behaviours (e.g., number of posts) and self-reported personal characteristics or mental health problems, and compare the results with existing research evidence (Peterka-Bonetta et al., 2021). Another focus of future studies could be the link between gender and negative online

behaviours as the present study found that women post significantly more negative microblogs than men. However, basic sentiment analysis might ignore some ambiguous or ironic expressions. It seems important to conduct mixed methods studies (e.g. combing sentiment analysis and qualitative analysis) to explore such complex topics of negative online behaviours (e.g. verbal aggression).

Conclusion

The present study explored the relationship between Weibo users' actual usage data (use intensity) and their percentages of negative posts among 2463 Weibo users who comment highly negatively in specific online conversations. Sentiment analysis of 4,273,442 microblog posts indicates that a higher percentage of negative posts was significantly correlated with higher use intensity or activeness on Weibo. Women post more microblogs than men and had a higher percentage of negative posts. Posting highly negative comments in public online conversations does not mean posting negative personal microblogs regularly. This study contributes to the understanding of Weibo users' behaviours especially their negative expressions. Future studies could explore and compare user behaviours on Weibo and other online social platforms using the methods applied in the present study. Studies are also needed to explore the complex reasons for negative behaviours (e.g., cyberbullying, trolling behaviours) on social media and the approaches of predicting negative online behaviours from general usage data.

Declarations

Conflict of interest The authors declare that they have no conflict of interest.

Ethics This study has been approved by the Ethics Committee of the Department of Psychology, School of Education, Soochow University.

References

Brand, M., Wegmann, E., Stark, R., Müller, A., Wölfling, K., Robbins, T. W., & Potenza, M. N. (2019). The Interaction of Person-Affect-Cognition-Execution (I-PACE) model for addictive behaviors: Update, generalization to addictive behaviors beyond internet-use disorders, and specification of the process character of addictive behaviors. *Neuroscience & Biobehavioral Reviews*, *104*, 1–10. https://doi.org/10.1016/j.neubiorev.2019.06.032

Brand, M., Young, K. S., Laier, C., Wölfling, K., & Potenza, M. N. (2016). Integrating psychological and neurobiological considerations regarding the development and maintenance of specific Internet-use disorders: An Interaction of Person-Affect-Cognition-Execution (I-PACE) model. *Neuroscience & Biobehavioral Reviews*, *71*, 252–266. https://doi.org/10.1016/j.neubiorev.2016.08.033

Buckels, E. E., Trapnell, P. D., & Paulhus, D. L. (2014). Trolls just want to have fun. *Personality and individual Differences*, *67*, 97–102.

Cheng, J., Bernstein, M., Danescu-Niculescu-Mizil, C., & Leskovec, J. (2017, February). Anyone can become a troll: Causes of trolling behavior in online discussions. In *Proceedings of the 2017 ACM conference on computer supported cooperative work and social computing* (pp. 1217–1230).

Craig, W., Boniel-Nissim, M., King, N., Walsh, S. D., Boer, M., Donnelly, P. D., & Pickett, W. (2020). Social media use and cyber-bullying: a cross-national analysis of young people in 42 countries. *Journal of Adolescent Health*, *66*(6), S100–S108. https://doi.org/10.1016/j.jadohealth.2020.03.006

Elhai, J. D., Dvorak, R. D., Levine, J. C., & Hall, B. J. (2017). Problematic smartphone use: A conceptual overview and systematic review of relations with anxiety and depression psychopathology. *Journal of Affective Disorders*, *207*, 251–259. https://doi.org/10.1016/j.jad.2016.08.030

Gao, Q., Abel, F., Houben, G. J., & Yu, Y. (2012, July). A comparative study of users' microblogging behavior on Sina Weibo and Twitter. In *International Conference on User Modeling, Adaptation, and Personalization* (pp. 88–101). Springer, Berlin, Heidelberg.

Golbeck, J., Robles, C., Edmondson, M., & Turner, K. (2011). Predicting personalityfrom twitter. In 2011 IEEE Third International Conference on Privacy, Security, Risk and Trust and 2011 IEEE Third International Conference on Social. Computing, 149–156. https://doi.org/10.1109/PASSAT/SocialCom.2011.33

Guntuku, S. C., Preotiuc-Pietro, D., Eichstaedt, J. C., & Ungar, L. H. (2019, July). What twitter profile and posted images reveal about depression and anxiety. In *Proceedings of the international AAAI conference on web and social media* (Vol. 13, pp. 236–246).

Hardaker, C. (2010). Trolling in asynchronous computer-mediated communication: From user discussions to academic definitions. *Journal of Politeness Research: Language Behaviour Culture*, *6*(2), 215–242. https://doi.org/10.1515/jplr.2010.011

Hussain, Z., Wegmann, E., Yang, H., & Montag, C. (2020). Social Networks Use Disorder and Associations with Depression and Anxiety Symptoms: A Systematic Review of Recent Research in China. *Frontiers in Psychology*, *11*, 211. doi: https://doi.org/10.3389/fpsyg.2020.00211

Jenaro, C., Flores, N., Gómez-Vela, M., González-Gil, F., & Caballo, C. (2007). Problematic internet and cellphone use: Psychological, behavioral, and health correlates. *Addiction Research & Theory*, *15*(3), 309–320. https://doi.org/10.1080/16066350701350247

Kyriacou, C., & Zuin, A. (2016). Cyberbullying and moral disengagement: An analysis based on a social pedagogy of pastoral care in schools. *Pastoral Care in Education*, *34*(1), 34–42. https://doi.org/10.1080/02643944.2015.1134631

Lepp, A., Barkley, J. E., & Karpinski, A. C. (2014). The relationship between cell phone use, academic performance, anxiety, and satisfaction with life in college students. *Computers in Human Behavior*, *31*(1), 343–350. https://doi.org/10.1016/j.chb.2013.10.049

Mayor, E., & Bietti, L. M. (2021). Twitter, time and emotions. *Royal Society open science*, *8*(5), 201900.

Orben, A., & Przybylski, A. K. (2019). Screens, teens, and psychological well-being: evidence from three time-use-diary studies. *Psychological Science*, *30*(5), 682–696. https://doi.org/10.1177/0956797619830329

Peterka-Bonetta, J., Sindermann, C., Elhai, J. D., & Montag, C. (2021). *How objectively measured Twitter and Instagram use relate to self-reported personality and tendencies toward Internet/Smartphone Use Disorder*. Human Behavior and Emerging Technologies.

Przybylski, A. K., & Weinstein, N. (2017). A large-scale test of the goldilocks hypothesis: quantifying the relations between digital-screen use and the mental well-being of adolescents. *Psychological Science*, *28*(2), 204–215.

Qiu, L., Lin, H., Ramsay, J., & Yang, F. (2012). You are what you tweet: Personality expression and perception on Twitter. *Journal of research in personality*, *46*(6), 710–718. https://doi.org/10.1016/j.jrp.2012.08.008

Slonje, R., & Smith, P. K. (2008). Cyberbullying: Another main type of bullying? *Scandinavian Journal of Psychology*, *49*, 147–154. https://doi.org/10.1111/j.1467-9450.2007.00611.x

Smith, P. K., Mahdavi, J., Carvalho, M., Fisher, S., Russell, S., & Tippett, N. (2008). Cyberbullying: Its nature and impact in secondary school pupils. *Journal of child psychology and psychiatry*, *49*(4), 376–385. https://doi.org/10.1111/j.1469-7610.2007.01846.x

Statista (2022). Number of social network users worldwide from 2017 to 2025 (in billions). Retrieved June 6, 2022, from: https://www.statista.com/statistics/278414/number-of-worldwide-social-network-users/

Tomaiuolo, M., Lombardo, G., Mordonini, M., Cagnoni, S., & Poggi, A. (2020). A Survey on Troll Detection. *Future Internet*, *12*(2), 31. https://doi.org/10.3390/fi12020031

Van Deursen, A. J., Bolle, C. L., Hegner, S. M., & Kommers, P. A. (2015). Modeling habitual and addictive smartphone behavior: The role of smartphone usage types, emotional intelligence, social stress, self-regulation, age, and gender. *Computers in Human Behavior*, *45*, 411–420. https://doi.org/10.1016/j.chb.2014.12.039

Weiser, E. B. (2000). Gender differences in Internet use patterns and Internet application preferences: A two-sample comparison. *Cyberpsychology and behavior*, *3*(2), 167–178. https://doi.org/10.1089/109493100316012

Weiser, E. B. (2001). The functions of Internet use and their social and psychological consequences. *CyberPsychology & behavior*, *4*(6), 723–743. https://doi.org/10.1089/109493101753376678

Xu, H., Lin, H., Pan, Y., Ren, H., & Chen, J. (2008). Constructing the Affective Lexicon Ontology. *Journal of the China Society for Scientific and Technical Information*, *27*(2), 180–185.

Yu, L., & Zhou, X. (2021). Emotional competence as a mediator of the relationship between internet addiction and negative emotion in young adolescents in Hong Kong. *Applied Research in Quality of Life*, *16*(6), 2419–2438. https://doi.org/10.1007/s11482-021-09912-y

Yuan, J., & Li, H. (2012). The Human Susceptibility to the Valence Strength of Emotional Stimuli: Neural Mechanisms. *Advances in Psychological Science*, *20*(1), 10–18. https://journal.psych.ac.cn/xlkxjz/CN/Y2012/V20/I1/10