Does micro-blogging make us “shallow”? Sharing information online interferes with information comprehension∗

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A B S T R A C T
Micro-blogging sites such as Twitter and its Chinese equivalent Weibo are characterized by fragmentation in information communication (FIC). Yet little is known about information comprehension in the micro-blogging context and the mechanism underlying any possible influence. Using E-Prime® to simulate information communication at Weibo, we conducted two experiments to investigate the effect of Weibo’s structural features, namely, irrelevant information interference and feedback, on information comprehension. We found that participants’ online information comprehension was negatively affected after browsing (reposting and passing) Weibo messages through the feedback function, and that this negative effect further extended to an offline reading task. Furthermore, meditation analysis showed that cognitive overload mediated the negative effect of reposting on information comprehension. The findings provide important insights into the influence of Internet technology on reading and learning.

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The rise of Web 2.0 has introduced new ways of information communication. In particular, micro-blogging sites such as Twitter and its Chinese equivalent Weibo push out news updates every second. Technological advances make access to information as easy as lifting a finger. According to CNNIC (China Internet Network Information Center), by June 2014, the number of Weibo users had reached 275 million. As Weibo and other micro-blogging sites become the primary source for people to receive information and follow news updates, information communication in the Internet age has taken the characteristics of quantitative explosion and qualitative fragmentation (Carr, 2010; CNNIC, 2014a, b; Zhang, 2011). However, do people indeed “get” what they receive? We conducted two experiments to examine information comprehension in the context of micro-blogging.

One important topic in the study of personal information management in the technological era concerns fragmentation in information communication (FIC). With the advance of technology, the information people receive is often fragmented by physical locations (i.e., different devices or different tools used to store the information), which makes it difficult for people to comprehend the information and to make decisions resourcefully and efficiently (Karger & Jones, 2006). Things become even more complicated when it comes to micro-blogging, where information may be fragmented not just by physical locations but also through a number of interrelated processes. In particular, two inherent structural features of micro-blogging, namely, irrelevant information interference and feedback function, may result in FIC and interfere with information comprehension.

Micro-blogging sites such as Twitter and Weibo strictly limit each message to a maximum number of words (e.g., 140 Chinese characters at Weibo). This may not only result in a lack of logic in the organization of the essential information, but also allow irrelevant or trivial information swamp onto the screen, making the target information fragmented and difficult to access. According to the disruption hypothesis (Mayer, Griffith, Jurkowitz, & Rothman, 2008), irrelevant information competes with the target information for the limited cognitive capability during information processing. Especially when irrelevant information is highly
interesting, the processing and comprehension of the target information suffers. In addition to increasing cognitive burden, irrelevant information may further make it difficult for viewers to build connections among pieces of relevant information and thus to fully understand the information. Research has shown that people can learn more efficiently in multimedia learning tasks when irrelevant information is kept minimum or uninteresting (Mayer, Bove, Bryman, Mars, & Tapangco, 1996; Mayer et al., 2008).

Furthermore, unlike traditional media, micro-blogging sites are more than a simple information dissemination network. They serve as an interactive platform equipped with the feedback function, where people can comment on, repost or like a post. At Weibo, for instance, 4.8% users contribute more than 80% of the original posts, whereas the majority users primarily comment on or repost others’ messages (Fu & Chau, 2013). Similarly, more than half of Twitter users never post a message, whereas the top 10% most active users contribute to over 90% of all content (Kaplan & Haenlein, 2011). Thus, the vast amount of information on micro-blogging sites is mainly a cluster of interactive communications made possible by the feedback function. The feedback function may fragment information by obscuring the authorship and disrupting the coherence of the target information (Boyd, Golder, & Lotan, 2010; Mayer, Bryman, Mars & Tapangco, 1996). Furthermore, reposting or "retweeting" messages may create cognitive overload in viewers and shorten their time in reflecting on and digesting the information they receive (Bergman, Beyth-Marom, & Nachmias, 2006).

Given the two inherent features of micro-blogging that fragment information, information comprehension may be negatively affected. We test this question using Weibo as the platform. We examined the effect of Weibo's structural features, in terms of irrelevant information interference and feedback (i.e. asking participants to make “report” or “next” responses), on information comprehension. We expected that in an online information comprehension test, an interference group would score lower than a no-interference group and a feedback group would score lower than a no-feedback group. Furthermore, we expected the negative effect of micro-blogging to spread from online to offline, whereby in an offline information comprehension test, the negative effects of irrelevant information interference and feedback would remain significant.

In addition, we propose that a key mechanism underlying the negative effect of micro-blogging on information comprehension is cognitive overload. Although each micro-blogging message consists of a maximum number of 140 words or characters, viewers are facing virtually an unlimited number of messages in processing information. Furthermore, in the micro-blogging context, the vast amount of interactive information is often characterized by uncertainty, diversity, ambiguity, novelty, and complexity, all of which can contribute to cognitive overload and in turn, compromise information comprehension (Eppler & Mengis, 2004; Paas, van Gog, & Sweller, 2010; Schneider, 1987). Thus, we predicted that cognitive overload would mediate the effect of the structural features of micro-blogging on information comprehension (see Fig. 1).

Notably, although there is known Chinese state censorship of online activity, including micro-blogging, we were interested in how people process and comprehend online information accessible to them, namely, information after censorship. Our experiments therefore resembled real-life contexts where the majority of micro-blogging users read and share existing posts (Fu & Chau, 2013; Kaplan & Haenlein, 2011), and the findings should have real-world applicability.

1. Experiment 1

1.1. Participants

Eighty undergraduate students (31 males) at Peking University, China, participated and each received 10 Yuan. Their average age was 21.23 years (SD = 2.56). Participants were recruited through psychology courses and were from diverse academic disciplines.

1.2. Procedure

The experiment was built through the software E-Prime® with a 2 (interference vs. no interference) X 2 (feedback vs. no feedback) between-subject design. There were a total of 50 messages adapted from Sina Weibo, all in Chinese. Of the 50 messages, 40 concerned the topic of helping or not helping a tumbled elderly, a topic that had aroused fierce debate in China throughout the year of 2013. In the interference group, the remaining 10 messages were statements irrelevant to the target topic, also adapted from Sina Weibo. In the no-interference group, the 10 messages were replaced with the statement “This message has been deleted,” in combination with some meaningless Chinese characters to keep the amount of information consistent between the two groups. After reading each message, participants in the feedback group had to make a choice between “report” and “next” and the computer would respond with “reposted” or “next” accordingly. Participants in the no-feedback group simply pressed “next” after reading a message to move on to the next one. The 50 messages were randomly presented and each message remained on screen for 300 ms. Participants were randomly assigned to one of the 4 groups (N = 20 per group). They were told that the study concerned people's use of Weibo and that they should respond as they usually would.

After participants finished the message-viewing task, an online information comprehension test was administered. Ten items were selected from the 40 target messages in a pretest, all with excellent discrimination values. Participants were asked to take a multiple-choice test of the 10 items based on the information they just read. Their scores on the test (0–10) were used as the index of information comprehension.

2. Results and discussion

A 2 (interference vs. no interference) x 2 (feedback vs. no feedback) analysis of variance (ANOVA) on the online information comprehension score revealed a significant main effect of feedback, $F(1, 76) = 30.74, p < .001, d = 1.24$. As predicted, participants in the feedback group ($M = 3.28, SD = 1.60$) performed worse than those in the no-feedback group ($M = 5.23, SD = 1.54$) for their online (Weibo) information comprehension. However, there was no difference in performance between the interference group ($M = 4.25$, $SD = 1.70$) and the no-interference group ($M = 4.37$, $SD = 1.63$) $F(1, 76) = 0.01, p = .94, d = 0.00$.

The results from the interference group ($M = 3.28, SD = 1.60$) and the no-interference group ($M = 5.23, SD = 1.54$) were analyzed separately. The results showed that there was a significant main effect of feedback, $F(1, 38) = 20.36, p < .001, d = 1.63$. As predicted, participants in the feedback group performed worse ($M = 3.28, SD = 1.60$) than those in the no-feedback group ($M = 5.23, SD = 1.54$) $F(1, 38) = 6.25, p = .02, d = 0.73$.

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In 2013, there were many news reports in China about cases where people were sued after helping a tumbled elderly. As a result, “to help or not to help” became the hottest topic of the year.
SD = 1.79) and the no-interference group (M = 4.25, SD = 1.92). There was no interaction between interference and feedback.

How did “repost” influence information comprehension? To further understand the negative effect of feedback function, we analyzed the responses of the 40 participants in the feedback group (interference and no-interference groups combined). For the 10 test items, if the participants reposted an item during the message-viewing task and chose the correct answer at the comprehension test, we labeled the item as repost-correct. If their answer was incorrect, we labeled the item as repost-incorrect. Participants made almost twice as many repost-incorrect responses (M = 3.16, SD = 1.98) as repost-correct responses (M = 1.65, SD = 1.37), t(39) = 18.75, p < .001, d = .89. Thus, consistent with our prediction, feedback function, in the form of repost, interfered with online information comprehension.

In sum, Experiment 1 showed a main effect of feedback, whereby participants in the feedback group performed worse on the online comprehension test than those in the no-feedback group. Furthermore, reposting a message made the message less likely to be correctly understood. Thus, making feedback to online messages interfered with participants’ understanding of the target information. We did not find significant effect of interference. We discuss this result in the General Discussion. In Experiment 2, we examined cognitive overload as a potential mediator for the effect of feedback function on information comprehension. We further test whether the negative effect of feedback function on online information comprehension would spread to offline.

3. Experiment 2

3.1. Participants

A different group of 40 undergraduate students at Peking University (17 males) took part for a payment of 10 Yuan. The average age of the participants was 21.5 years (SD = 3.36). They were recruited through psychology courses and were from diverse academic disciplines.

3.2. Procedure

All test materials were in Chinese. The same 40 Weibo target messages from Experiment 1 were used. Participants were randomly assigned to a feedback group or a no-feedback group (N = 20 per group). Same as in Experiment 1, participants in the feedback group made a choice between “repost” and “next” after reading each message, whereas participants in the no-feedback group simply read each message and pressed “next” to move on to the next one. The messages were randomly presented for 300 ms each, and participants were instructed to respond as they usually would.

After finishing the message-viewing task, participants were asked to complete an offline reading comprehension test and a Workload Profile Index Ratings (WP) task that measures cognitive overload. The order of the two tasks was counterbalanced across participants. For the offline reading comprehension test, participants were first asked to read an article, “More than a feline: The true nature of cats,” from New Scientist. The article was translated into Chinese with a total of 2176 characters. A comprehension test was compiled based on this article, including 11 multiple-choice questions that all had excellent discrimination values in a pretest. Participants’ scores on the test (0–11) were used as the index of offline information comprehension.

The Workload Profile Index Ratings (WP) were developed by Tsang and Velazquez (1996) based on Wickens (2002)’s multiple resource models. It has been shown that compared with other measurements of cognitive overload, WP has higher measurement sensitivity, validity and diagnosticity for analyzing cognitive demands of a task (Rubio, Diaz, Martin, & Puente, 2004). It measures cognitive load from eight dimensions: perceptual or central processing, response selection and execution, spatial processing, verbal processing, visual processing, auditory processing, manual output, and speech output (See Appendix A for an English version of WP). Participants were asked to rate the Weibo message-viewing task on each dimension on a 10-point Likert scale from 1 (no demand) to 10 (maximum demand). The totally ratings were summed (8–80) to index cognitive overload.

4. Results and discussion

Independent sample t-tests were conducted on the offline reading test score and the cognitive overload score. Participants in the no-feedback group (M = 5.95, SD = 1.23) outperformed those in the feedback group (M = 4.05, SD = 1.99) on offline reading comprehension, t(39) = 3.63, p = .001, d = 1.15. Participants in the no-feedback group (M = 28.50, SD = 6.13) reported less cognitive overload than those in the feedback group (M = 35.60, SD = 6.62), t(39) = -3.52, p = .001, d = -1.11. There was no order effect in terms of which task participants completed first. Thus, making feedback to online Weibo messages interfered with participants’ understanding of separate offline information and drained their cognitive resources.

4.1. Mediation effect of cognitive overload

We examined whether cognitive overload mediated the effect of feedback on offline reading comprehension. First we explored various demographic variables in relation to offline reading comprehension. A regression analysis showed that participants’ major (social science and humanity coded as 1, natural science coded as 2), β = -.31, p = .01, SE = .43, and Weibo use frequency, β = -.63, p < .001, SE = .03, were significant predictors of offline reading comprehension scores. We therefore included these two variables as covariates in our mediation analyses.

The SPSS macro was used for the mediation analyses (Preacher & Hayes, 2008). With participants’ major and Weibo use frequency as covariates in the model, feedback significantly predicted offline reading comprehension, βc = -.21, p < .05, SE = .39. Feedback also significantly predicted cognitive overload, βf = .39, p < .05, SE = 2.26. Cognitive overload significantly predicted offline reading comprehension, βo = -.28, p < .01, SE = .03. When controlling for cognitive overload, the effect of feedback on offline reading comprehension was no longer significant, βc = -.12, p > .05, SE = .40. We further conducted a bootstrapping analysis (5000 samples) to test statistical significance of the mediation effect. The results showed that the 95% confidence interval for the indirect effect [-.94, -.04] did not include 0 (MacKinnon, Fairchild, & Fritz, 2007).

![Image](image-url)
indicating that cognitive overload significantly mediated the effect of feedback on offline reading comprehension (See Fig. 2).

4.2. General discussion

Micro-blogging as a new form of media in the Internet era has profoundly shaped the way we consume and disseminate information. Although there has been much discussion concerning the influence of micro-blogging on human cognition and its inherent fragmentation in information communication (FIC), empirical research is sparse. Findings from our two experiments showed that the structural features of micro-blogging that fragment the target information had negative effects on information comprehension.

Specifically, the feedback function of Weibo interfered with participants' information comprehension both online and offline. Researchers have previously observed that people often attend to web organization characteristics and interface design such as "repost" or "like a post" rather than content messages (Wathen & Burkell, 2002). Such information competes with the messages for cognitive resources (Shenk, 1998). Furthermore, the feedback function encourages individuals to make quick responses, taking away the time individuals would otherwise use to cogitate and integrate the content information they receive. This may create a meaningful lag where the information is accumulated and diffused so fast that it is beyond individuals' cognitive capacity to process and comprehend (Klapp, 1986; Tidline, 1999). Our findings suggest that it is important to present web messages in a clear and simple context and that the organization and interface design should promote rather than interfere with people's cognitive processing.

Experiment 1 had another notable finding: "Repost" did not promote but hindered participants' online information comprehension. Messages that were reposted were more likely to be understood incorrectly than correctly. This finding has overarching implications given that the majority users of micro-blogging sites only read and repost others' messages (Fu & Chau, 2013; Kaplan & Haenlein, 2011). Indeed, retweeting or reposting has become a habitual response when people surf online, and this behavioral response is further sustained by the interface design of micro-blogging (Wang, 2013). Yet our findings reveal a downside of this behavior, that is, reduced information comprehension. This is consistent with findings from multimedia learning studies that behavioral interactions during the learning process have little cognitive benefit for learning (Moreno & Mayer, 2007).

Findings of Experiment 2 further revealed that cognitive overload mediated the effect of feedback on information comprehension. Making feedbacks through reposting creates high demands for cognitive resources, which, in turn, compromises subsequent reading comprehension. This finding is consistent with the work by DeStefano and LeFevre (2007) on hypertext reading. These researchers found that the higher cognitive processing demands a hypertext required, the lower individuals' reading performance was, and that working memory capacity and prior knowledge mediated the effect of hypertext features. Using micro-blogging as the context of our study, our findings represent an important extension to prior research. Notably, however, our study did not include a variety of other measures (e.g., intelligence, interest, and working memory) that may contribute to information comprehension. Furthermore, motivations for micro-blogging and censorship of online activity in particular sociocultural contexts may further result in complex processes that influence online information comprehension (Wang, 2013; Wang, Blenis, Ng, & Gonzalez, 2015). Future research should assess FIC's impact on information comprehension while taking into consideration of these factors.

Different from previous studies on information comprehension (e.g., Chiappe, Siegel, & Hasher, 2000; DeStefano & LeFevre, 2007; Kemper, McDowd, Metcalf, 2008), we did not find a significant effect of interference in the micro-blogging context. We suspect that, compared with other kinds of media, micro-blogging is more heavily characterized by fragmentation in information communication (Boyd et al., 2010; Mayer et al., 1996). As a result, people are not particularly engaged in deep or elaborate information processing for either target or non-target information, nor are they motivated to do so. Instead, they may simply cruise through pieces of information. This shallow processing, coupled with habitual reposting, may not only result in limited information comprehension but also make the irrelevant information fail to interfere. Alternatively, facing the vast amount of information online, people may develop strategies to actively ignore irrelevant information and therefore minimize its negative interference. Further research is needed to elucidate this issue.

In conclusion, although micro-blogging has provided us with alternative ways of expressing ourselves, connecting with others, and gaining knowledge that are unique to the Internet era, it has cognitive downsides. Especially when we are reposting and sharing information with others, we unwittingly add burden to our cognitive resources and, as a result, our own understanding of the information is compromised and our subsequent learning hindered.

Appendix A. Workload profile index ratings (WP)

The following are 8 dimensions of cognitive load. Read them carefully and be sure you understand each of the 8 dimensions.

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceptual or central processing</td>
<td>The resources required for activities like perceiving (detecting, recognizing, and identifying objects), remembering, problem-solving, and decision making.</td>
</tr>
<tr>
<td>Response selection and execution</td>
<td>These are attentional resources required for response selection and execution.</td>
</tr>
<tr>
<td>Spatial processing</td>
<td>The resources you used to process spatial information. For example, there are three foot pedals in a standard shift automobile; to stop the automobile, we have to select the appropriate pedal and stop on it.</td>
</tr>
<tr>
<td>Verbal processing</td>
<td>The resources you used to process verbal information. For example, reading involves primarily processing of verbal, linguistic materials.</td>
</tr>
<tr>
<td>Visual processing</td>
<td>The resources you used to process visual information. Some tasks are performed based on the visual information received. For example, watching TV is an example of a task that requires visual resources.</td>
</tr>
<tr>
<td>Auditory processing</td>
<td>The resources you used to process auditory information. For example, listening to music is a task that requires auditory attention.</td>
</tr>
<tr>
<td>Manual output</td>
<td>The resources you used for manual response. For example, some tasks require considerable attention for producing the manual response as in typing or playing a piano.</td>
</tr>
<tr>
<td>Speech output</td>
<td>The resources you used for speech response. For example, engaging in a conversation requires attention for producing the speech responses.</td>
</tr>
</tbody>
</table>
How much cognitive resources you devoted to the Weibo task? Please rate the Weibo task you just finished on each of the 8 dimensions from 1 to 10. A rating of “1” means that the task placed no demand on the dimension. A rating of “10” means that the task required maximum attention.

Perceptual or central processing

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

Response selection and execution

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

Spatial processing

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

Verbal processing

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

Visual processing

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

Auditory processing

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

Manual output

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

Speech output

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

References


