Transmission of Rumor and Criticism in Twitter after the Great Japan Earthquake

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Abstract

The purpose of this study was to examine psychological factors that affect the transmission of rumor and criticism in social media during disasters. 40 students at Chiba University evaluated 10 rumor tweets and corresponding 10 criticism tweets that were posted in Twitter after the Japan March 11 Earthquake. Among some psychological factors, only importance was related to intended transmission of rumor. Surprisingly, accuracy and anxiety were not predictors of any transmission. Estimated transmission of criticisms was higher when its importance was high, while that of rumor did not vary according to importance. Interestingly, although participants estimated that criticisms were spread more than rumor, they intended to transmit rumors as much as criticisms.

Keywords: Rumor; criticism; disaster; social media; technology; communication

Introduction

A 9.0 magnitude earthquake hit northeastern Japan on March 11, 2011. The Great East Japan Earthquake triggered powerful tsunami waves and a series of aftershocks, which caused a devastating damage to the country.

During the disasters, social media played an important role in obtaining and transmitting information to understand the situation. An example is Twitter, which enables its users to send and read text massages of up to 140 characters, known as "tweets," and to forward a message by re-tweeting a tweet to followers through a single click.

Communications during disasters increasingly relies on social media like Twitter. One reason is that social media allow immediate and interactive information transmission. This advantage, for example, led to the discovery and rescue of some individuals who were isolated in a disaster area after the Japan Earthquake. Although social media can play an important role in sharing information and coordinating disaster response, social media can also facilitate the dissemination of false information, potentially creating widespread panic. After the Japan Earthquake, for example, Twitter was immediately filled with tweets about the disaster that included not only useful information but also false rumors (Ogiue, 2011; Tachiiri, 2011). The spread of false rumors about the disaster became a major social problem, and the Japanese government called attention to false rumors on the Internet.

Given the growing use of social media in people's everyday life, cognitive science research needs to examine how people process information using social media technologies. This work contributes to this need by analyzing the transmission of rumor and criticism in Twitter after the Japan Earthquake. During disasters, factors such as time pressure and psychological stress come into play, and each individual's decision and action can have significant impact. For instance, the immediate and far-reaching spread of false information can be detrimental. Thus, it is important to study how users interact with information in social media.

Although Twitter is a new technology started in 2006, the spread of false rumors during disasters is not a new phenomenon (e.g., Prasad, 1935; Sinha, 1952). For example, Prasad (1935) categorized rumors after the great Indian earthquake of 1934. He found that the same types of rumors about earthquakes appear again and again in different locations during the past 1,000 years (Prasad, 1950).

Rumor study caught attention after World War II (see Rosnow & Foster, 2005). Rumor was defined as "*unverified and instrumentally relevant information statements in circulation that arise in contexts of ambiguity, danger, or potential threat and that function to help people make sense and manage risk*" (DiFonzo & Bordia, 2007, p.13). It was distinguished from gossip, defined as an evaluative statement about someone's private lives.

Past rumor studies revealed psychological factors that affect rumor behavior, such as accuracy, anxiety, and importance of rumors, and examined rumors in different situations, including universities, organizations, and communities (Anthony, 1973; DiFonzo & Bordia, 2000; Rosnow, 1991; Rosnow, et al., 1988; Walker & Beckele,

1987). However, few of the past work have examined rumors in social media, which allow users to communicate with a large number of people who are physically distant. Thus, it is unclear whether we can apply the findings from past studies to rumor transmission in Twitter.

In addition to the abundance of rumors in Twitter, we noticed that many people tried to stop the spread of false rumors by criticizing the rumor tweets. It was not only the government and organization but also many individual Twitter users who posted criticism tweets. A number of studies have shown that refutation decreases the level of belief in rumors (e.g., Allport & Postman, 1947; Bordia, et al., 2000; Iyer & Debevec, 1991). Thus, criticism tweets could minimize the impact of false rumors by making users critical. Even if false rumors spread widely in Twitter, the negative effect of false rumor would be curbed if criticisms also spread. For this reason, examining how criticisms spread in Twitter deserves attention.

In the current study, we examine the psychological factors that affect rumor and criticism transmission using actual tweets posted after the Japan Earthquake. Specifically, we study whether perceived accuracy and importance of tweets and anxiety arising from the tweets relate to the intended and estimated transmission of the tweets.

Method

Participants

Forty students (18 male, mean age 20 years) from Chiba University in Japan participated for course credit. In addition, they received a gift card in the amount of 500 Japanese yen (about $6.5). The experiment was conducted from October 19 to November 1, 2011. Chiba University is located in one of the areas affected by the disasters.

Stimuli

We collected 10 rumor tweets related to the disasters following the Japan Earthquake and 10 criticism tweets that criticized the corresponding rumor tweets (see Appendix). Each tweet was posted in Japanese on Twitter between March 11 and September 7, 2011. Each of the 20 tweets was converted to a 700×162 pixels image in the PNG format (see Figure 1). The user name associated with each tweet was generated by randomly combining alphabet and number. The image also contained the actual date when the original tweet was posted. We created each criticism tweet by adding the word "RT" (an abbreviation for Re-Tweet), the user name of the corresponding rumor tweet, and part of the rumor tweet to the criticism (see Figure 1, bottom). The maximum number of characters in each tweet image was 140 in Japanese.

Design and Procedure

The within-subject factors were tweet type (rumor vs. criticism) and transmission (intended vs. estimated). Participants accessed the experiment through the Internet using computer. They were instructed to answer all questions within 50 minutes. The experiment consisted of the four phases in the following order:

1. Rumor tweet Participants answered the following eight questions about each rumor tweet: (1) Familiarity – Have you heard this information? (Yes, No); (2) Anxiety – How anxious did you feel when you heard this information? (1 Not at all, 7 Highly anxious); (3) Importance – How important do you think this information is? (1 Not at all, 7 Highly important); (4) Intended receiver – Who should know this information? (Family, Friend, Victims, Many Japanese, Many people abroad, Anyone, Other); (5) Intended transmission – How many people do you think should know this information?; (6) Self-accuracy – How accurate do you think this information is? (1 Not at all, 7 Highly accurate); (7) Estimated transmission – How many people do you think have already known this information at present?; (8) Others-accuracy – How accurate would others think this information is? (1 Not at all, 7 Highly accurate). Each tweet was presented in a random order.

2. Criticism tweet The design and procedure were the same as those of the rumor tweet phase.

3. Demographic information There were demographic questions and other questions about the degree of damage experienced and familiarity with Twitter and media.

4. Debriefing Each participant was explained the purpose of the experiment. It was emphasized that the tweets in the experiment might be false, and that the spread of false rumor was becoming a social problem after the disaster. In addition, for further information, we recommended useful books and websites that examined the false rumors related to the disaster.

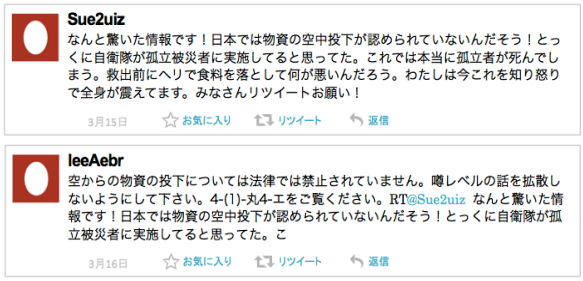

Figure 1: Top) A rumor tweet – "*Air drop of supplies is not allowed in Japan! I though it has already been done by the Self-Defense Forces. Without it, the isolated people will die! I'm trembling with anger. Please retweet!"* Bottom) A corresponding criticism tweet – *"Air drop of supplies is not prohibited by the law. Please don't spread rumor. Please see 4-(1)-丸 4-エ."*.

Results and Discussion

On average, the tweets we used were relatively unfamiliar to the participants. The range of proportion of participants who were familiar with 10 rumors was from 0% to 38% (M = 22.5%). That of 10 criticisms was 0% to 43% (M = 9.8%). The overall results are shown in Appendix.

Table 1: Pearson's Coefficients of Correlation in Rumor and Criticism tweet

	Rumor tweet					Criticism tweet				
	1	2	3	4	5	1	2	3	4	5
1. Self-accuracy										
2. Others-accuracy	.62**					.79**				
3. Anxiety	.64**	.35*				.29	.14			
4. Importance	.80**	.44**	.71**			.73**	.59**	.57**		
5. Intended transmission	.29	.22	.02	.32*		.24	.28	.08	.26	
6. Estimated transmission	-.05	.14	-.23	-.11	.31*	.13	.16	.26	.03	.47**

Note. $^{+}p < .10$, $*p < .05$, $**p < .01$

We removed outliers of intended and estimated transmissions using the Smirnov-Grubbs test. Analyses were repeated until no additional outliers were observed.

We examined the relationship between the four psychological factors (self-accuracy, others-accuracy, anxiety, and importance) and transmission (intended and estimated). Each mean of these factors was shown in Appendix. Table 1 shows Pearson's coefficients of correlation among these factors.

Self-accuracy and Others-accuracy Self-accuracy was positively correlated with the other three psychological factors: others-accuracy, anxiety, and importance (r = 0.62, 0.64, 0.80, $p < .001$, respectively) in the rumor condition. In the criticism condition, it was positively correlated with others-accuracy and importance (r = 0.79, 0.73, $p < .001$, respectively), while it was not significantly correlated with anxiety. The relationships between others-accuracy with the other factors showed the same pattern as self-accuracy.

In order to examine the relationship between self-accuracy and others-accuracy in detail, we performed a repeated-measures ANOVA on accuracy rate as the dependent variable, familiarity (familiar vs. unfamiliar) as the between subject factor, tweet type (rumor vs. criticism), and accuracy (self vs. others), as the within-subject factors. All three main effects were significant (F (1, 796) = 24.7, 21.7, 70.3, respectively. $p < .001$): The familiar condition (M = 4.8, SD = 1.7) were more accurate than the unfamiliar condition (M = 4.2, SD = 1.7), the criticism condition (M = 4.7, SD = 1.5) were more accurate than the rumor condition (M = 3.9, SD = 1.7), and others-accuracy (M = 4.6, SD = 1.4) was higher than self-accuracy (M = 4.0, SD = 1.8).

The interaction between tweet type and accuracy was also significant (F (1, 796) = 66.3, $p < .001$, Figure 2). Simple main effect of tweet type was significant only on self-accuracy (F (1, 1592) = 61.7, $p < .001$): The rumor condition (M = 3.4, SD = 1.8) was less accurate than the criticism condition (M = 4.7, SD = 1.7). Simple main effect of accuracy was significant only on rumor tweet (F (1, 796) = 136.6, $p < .001$): Self-accuracy (M = 3.4, SD = 1.7) was lower than others-accuracy (M = 4.5, SD = 1.5).

These results show that participants evaluated rumor tweets less accurately than criticism tweets; however, they estimated that others would evaluate rumor tweets as accurate as criticism tweets. This result indicates that participants think that they can detect unreliability of a rumor tweet but that others cannot. There is a tendency for participants to underestimate the ability of others to evaluate accuracy of a rumor.

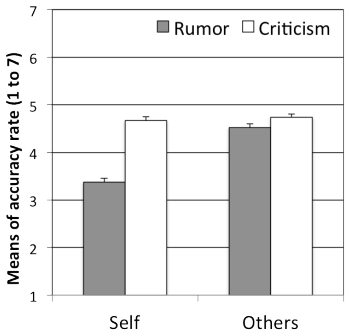

Figure 2: The analysis revealed that the bar of self-accuracy in the rumor condition was lower than the other three bars. Each bar shows the mean of 40 participants and 10 tweets. Error bars represent standard errors.

Anxiety The means of anxiety in the rumor and the criticism conditions were 4.0 (SD = 1.9) and 3.0 (SD = 1.8), respectively. In the rumor condition, anxiety was positively correlated with self-accuracy, others-accuracy, and importance (r = 0.64, 0.35, 0.71, $p < .001$, p = 0.05, $p < .001$, respectively). On the other hand, anxiety was positively correlated with importance (r = 0.57, $p < .001$) in the criticism condition, while there was no correlation between anxiety and any accuracy. Thus, we found that the more accurate participants perceived rumors were, the more anxious they became. In contrast, anxiety was not correlated with accuracy in criticism tweet. In other words, if a tweet adopts a writing style in which it criticizes other tweet, participants' perceived accuracy of the tweet does not influence anxiety.

The inconsistency in accuracy and anxiety between the present study and past studies may be due to the differences in the measurement of transmission. An index to measure rumor transmission used in many studies was proportion assessed by dividing the number of rumor passed along by the number of rumor heard (e.g., Rosnow, et al., 1986; Rosnow, et al., 1988; DiFonzo & Bordia, 2000). By contrast, in the present work, the transmission was measured by asking to how many people a participant intended to transmit a rumor.

Importance The means of importance in the rumor condition and the criticism condition were 4.0 (*SD* = 1.9) and 4.3 (*SD* = 1.9), respectively. Importance was positively correlated with the other three psychological factors. It was also positively correlated with intended transmission in the rumor condition (r = 0.32, p = 0.04). On the other hand, there was no significant correlation in criticism tweet.

Intended and Estimated Transmission Intended transmission was correlated with no psychological factors except for importance in the rumor condition. Estimated transmission was not correlated with any psychological factors. It was positively correlated only with intended transmission in both the rumor condition and the criticism condition (r = 0.31, 0.47, p = 0.05, 0.002, respectively).

The nonsignificant relationship between anxiety and rumor transmission is inconsistent with the past finding that anxiety was related to rumor spread (e.g., Anthony, 1992; Jaeger, et al., 1980; Prasad, 1935; Pezzo & Beckstead, 2006; Rosnow, et al., 1988; Walker and Beckerle, 1987). As the mean anxiety of rumor in this study was approximately at the center of the 7-point scale, it would be unlikely that we observed a floor or ceiling effect as Pezzo & Beckstead (2006) pointed out.

Of all psychological factors examined in the current study, importance was the only factor that was related to rumor transmission. The more important participants evaluated a rumor, the more they intended to transmit it. This result is congruent with the past studies showing that a positive relationship of importance to transmission (see DiFonzo & Bordia, 2007). Unlike the past work, in which the relationship between importance and transmission did not reach statistical significance (e.g., r = 0.12, p > 0.30 in Rosnow et al., 1988), the current study found a strong relationship between importance and transmission. This relationship was found only in intended transmission, but not in estimated transmission. Thus, participants distinguished these two questions of transmission; subjective importance of rumor had an effect on subjective intension of transmission, not on expected behavior of others.

Rumors vs. Criticisms

A tweet type (rumor vs. criticism) by transmission (intended vs. estimated) analysis of variance was conduced, with means of 10 tweets (Table 2) in each tweet type as a dependent variable. The main effect of transmission was significant, F (1, 40) = 16.7, p < .001: Intended transmission was higher than estimated transmission. The main effect of tweet type and interaction between two factors did not reach statistical significance. This is, we think, because familiarity in both rumor and criticism was very low. Approximately only 16% of participants were familiar with the tweets. Most tweets were new to participants, and, thus, they estimated that a tweet had not been spread as much as they wanted to transmit it.

As a next step, each response of intended transmission and estimated transmission was classified into two conditions according to importance rate: low importance (1 to 4) and high importance (5 to 7). We performed this classification in the rumor condition and the criticism condition separately. There was no main effect of tweet type on intended transmission as the dependent variable by analysis of variance (ANOVA), with tweet type (rumor vs. criticism) and importance (high vs. low) as the between subject variables, F (1, 779) = 0.6, p = 0.4, while the main effect of tweet type was significant on estimated transmission as the dependent variable, F (1, 717) = 38.0, p < .001: Estimated transmission rates in the criticism condition (M = 1,036,225.4, SD = 2,789,937.5) were higher than the rumor condition (M = 115,900.4, SD = 284,913.2).

Table 2: Means and standard deviations for intended transmission and estimated transmission in the rumor condition and the criticism condition.

	Intended transmission		**Estimated transmission**	
	Rumor	Criticism	Rumor	Criticism
Mean	8,451,611	10,414,968	123,811	1,125,707
(*SD*)	(13,242,046)	(18,640,311)	(121,392)	(1,815,517)

Note. Each mean is of 40 participants.

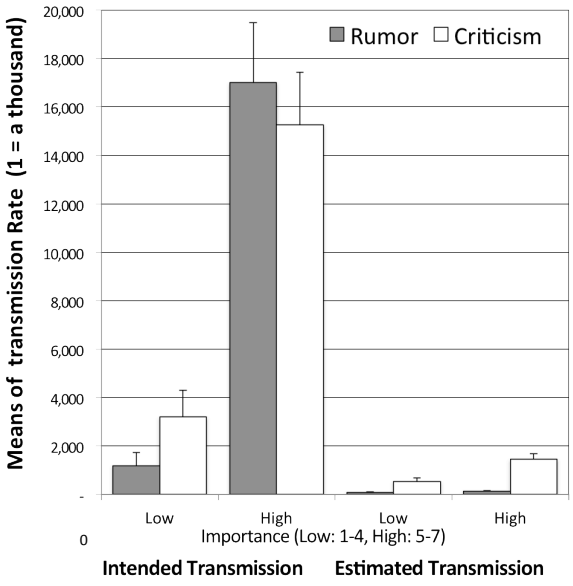

Figure 3: There was no significant difference between rumors and criticisms on intended transmission, while the two-way ANOVA on estimated transmission revealed the interaction between tweet type and importance. Error bars represent standard errors.

The interaction between tweet type and importance was also significant on estimated transmission F (1, 717) = 8.3, p = .004 (see right four bars in Figure 3). The simple main effect of importance was significant only in the criticism condition, F (1, 375) = 10.4, p = 0.001: Estimated transmission rate of the criticism condition was higher in

high importance condition (M = 1,455,451.9, SD = 3,250,638.1) than low importance condition (M = 536,565.9, SD = 2,011,841.9). There was no significant difference in estimated transmission of the rumor condition between high and low importance conditions. The simple main effect of importance was significant on intended and estimated transmission, F (1, 779) = 62.3, F (1, 717) = 11.4, $p < .001$, respectively: transmission rate in importance high condition (Intended transmission: M = 144,816.0, SD = 312,746.4, Estimated transmission: M = 1,455,451.9, SD = 3,250,638.1) was higher than importance low condition (Intended transmission: M = 94,578.9, SD = 261,279.8, Estimated transmission: M = 536,565.9, SD = 2,011,841.9).

In intended transmission, there was no significant difference between rumor and criticism tweet. Regardless of tweet type, the more important a tweet was, the higher the participants' intended transmission was. This result shows a simple relationship between importance and intended transmission. On the other hand, importance had an effect on estimated transmission by interacting with tweet type. While the degree of importance of rumor tweets did not influence on estimated transmission, that of criticism tweets did influence on estimated transmission; the more important a criticism tweet was, the higher the participants' estimated transmission was. These results show a discrepancy between intended and estimated transmissions in terms of tweet type. If people actually could transmit rumor and criticism as they intended, rumor and criticism should be spread at the same rate in Twitter. Thus, they should estimate a similar pattern of transmission of rumor and criticism. However, participants estimated that important criticisms were more spread than important rumors. This may imply that estimated transmission, in the present study, reflects participants' wish that criticisms should be shared more than rumors.

With regard to criticism tweet, it was operationally defined, in the current study, as a tweet that criticized a rumor tweet by citing it. While accuracy of rumor was correlated to anxiety, accuracy of criticisms was not correlated to anxiety. This result indicates that accuracy of a criticism does not increase anxiety. One interpretation is that the perceived accuracy of criticisms reduces anxiety compared to rumors. Similarly, Bordis, DiFonzo, & Haines (2005) showed that rumor denials reduced anxiety by interacting with personal relevance and source credibility.

Besides, criticism tweets were evaluated more accurate and more important than rumor tweets. There are two important points here. First, approximately 90% participants were unfamiliar with the criticisms on average. Second, participants were not given any strong evidence to show that each criticism was truthful. Based on the definition of rumor (DiFonzo & Bordia, 2007, p.13), the criticisms presented in the current study are also considered a kind of rumor. In this perspective, the difference between a criticism tweet and a rumor tweet in this study was whether it adopts criticizing form citing an original tweet. Why were criticism tweets evaluated as more accurate and more important than rumor tweets? One possible explanation is that, if a tweet has a criticizing form citing an original tweet, the accuracy and importance of the criticizing content are raised relatively to the accuracy and importance of the cited original tweet.

Limitation and Future Research

The measurement of transmission is one limitation of this study. In terms of ethical consideration, tweet transmission was measured by asking intended and estimated transmission instead of measuring how participants actually spread tweets. The actual spread of tweet is also affected by the number of follower a user has. Thus, even if a participant intend to transmit a tweet to a few million people, if the user has only a few follower, the tweet will not be transmitted so much. We need to pay attention to the difference between intended or estimated transmission and actual transmission.

The order of rumor tweet and criticism tweet was fixed in the current study: All participants were given rumor tweets first, and then criticism tweets. Thus, the possibility, which responses to criticism tweets were influenced by the responses to rumor tweets, was not excluded. What if we receive criticism tweets first? Do psychological responses to criticisms help minimizing the spread of false rumor? Further research is needed to examine this possibility by comparing the experiment presented in the present study as a condition with another conditions with the different order of rumors and criticisms.

Conclusions

The major contributions of the present study were (1) to reveal the relationship between psychological factors and information transmission using real tweets posted after the earthquake; and (2) to compare rumor tweet and criticism tweet. As a general conclusion, perceived importance seems to be a main predicator of tweet transmission. Better understanding of users' behavior through continued work in this area can help the design and use of social media systems, which in turn will help minimize the spread of false information during disasters, and enhance people's social media literacy.

Acknowledgments

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Appendix. Rumor and criticism tweets and familiarity, accuracy, anxiety, importance, and transmission rate of the tweets.

Tweet type		Summary of tweet	Familiarity	Accuracy		Anxiety	Importance	Transmission	
				Self	Others			Intended	Estimated
1	R	My friend at a insurance company said "Cancer insurance commercials stopped after the nuclear accidents."	25%	3.6	4.6	3.9	4.3	8,455,462	100,210
	C	If you put it that way, sure. But that's a false rumor.	0%	4.9	5.0	2.7	4.0	9,018,592	356,047
2	R	According to my friend, a radioactive material was detected from urine after he ate sushi.	38%	3.3	4.5	3.7	3.8	5,928,793	206,139
	C	It's unclear the radioactive material was caused by the fish.	3%	4.7	4.6	2.8	4.2	7,573,040	38,752
3	R	Toxic substance will drop with rain due to an explosion at Cosmo oil company.	8%	3.0	4.1	3.6	3.4	3,489,061	55,591
	C	That's a definitely false rumor. NHK denied it.	43%	5.2	5.0	2.5	5.1	8,973,592	2,128,116
4	R	Medical license is deprived by MEXT if a doctor gives a certificate of being exposed to radiation.	35%	3.6	4.8	4.5	4.1	8,508,545	141,873
	C	The license cannot be deprived easily by MEXT or MHLW.	0%	4.8	4.8	2.9	4.0	13,904,373	582,892
5	R	Robberies and rapes occurred during the Kobe earthquake.	3%	3.1	4.2	4.0	4.0	11,334,509	99,545
	C	Few robberies and rapes occurred. Victims helped each other orderly. Why do you spread lies and false rumors? Stop it.	8%	4.7	4.8	3.5	4.9	7,057,882	1,284,337
6	R	It was denied strongly, but after all, the meltdown occurred.	8%	3.7	4.9	4.3	4.2	15,360,119	108,083
	C	Has the possibility of a meltdown been pointed out, hasn't it?	8%	4.3	4.1	3.2	4.1	16,840,780	1,531,965
7	R	Air drop of supplies is not allowed in Japan!	30%	3.2	4.3	4.3	3.9	8,428,024	155,370
	C	Air drop is not prohibited by the law.	0%	4.8	5.0	2.6	4.5	5,186,518	967,029
8	R	Tokyo Electric Power Co.'s workers run and left. They were drinking in other city.	28%	3.0	4.2	3.8	3.4	2,876,451	49,975
	C	Tokyo Electric Power Co. "The workers were found dead."	13%	4.2	5.0	4.4	4.3	12,279,433	1,561,848
9	R	Did anyone watch "Senior vice transport minister Tsujimoto protested against the rescue operation by US army" on NHK?	33%	3.8	5.0	4.2	4.4	4,237,578	138,179
	C	There's no source but the tweet, so it would be a rumor.	0%	4.5	4.6	2.9	3.7	7,497,978	392,898
10	R	Chubu, Kansai, and Kyusyu Electric Power companies are beginning to transfer electricity to Kanto. Please cooperate!	20%	3.5	4.8	4.1	4.2	14,685,952	111,262
	C	Transfer is impossible because of the difference in frequency.	25%	4.8	4.7	2.7	4.2	8,799,558	1,562,686

Note. R = rumor, C = criticism. Accuracy, Anxiety, Importance, Transmission = the means of 40 participants. Familiarity = the proportions of participants who answered that they heard the rumor.