Usability and User Experience, Vol. 39, 2022, 140–145
https://doi.org/10.54941/ahfe1001701

Verification of the Effects of a Personalized Evacuation Alerts Using Behavioral or Location Information with the Sense of Urgency in a Disaster

Tomoki Yano, Kouyou Otsu, and Tomoko Izumi

Ritsumeikan University 1-1-1, Noji-Higashi, Kusatsu-City, Shiga, JAPAN

ABSTRACT

In this study, we focus on disaster alert services that send disaster information to personal mobile devices (i.e., smartphones) and consider the textual expressions of alerts that generate a sense of urgency. To achieve this goal, we focus on the location information acquired from the GPS and the behavioral information of the user acquired from the accelerometer on the device. Using this information, alert expressions that identify individuals so that they feel as if they are being addressed directly are generated. We set three degrees of expression for the location and behavioral information, respectively. To verify the effectiveness of the alert expressions, a comparative verification experiment was conducted. As a result of this verification, it is shown that textual expression using location information tends to be more effective for the individuals who feel that the message is directed at them.

Keywords: Disaster prevention, Textual expression, Personalized alert

INTRODUCTION

Delayed evacuation from a huge disaster is one of the factors that increase the impact on people. It has been identified that it is difficult to urge early evacuation after a disaster because people tend to underestimate information that is inconvenient for them; this is called normalcy bias. The most effective way to urge evacuation is to directly contact each of the evacuees, such as by calling them. That is, information to evacuees should be provided in a manner that makes them feel as if it is being said to them directly.

In this study, we focus on disaster alert services that send disaster information to personal mobile devices (i.e., smartphones) and consider the textual expressions of alerts that generate a sense of urgency. Because people always carry their smartphones with them, we expect that personal expression of alerts will be possible using the information available on their own smartphones. Studies have examined the ways in which textual expressions improve evacuation awareness. For example, Tanaka et al. (2011) showed that using unfamiliar adverbs in relatively concise Japanese textual expressions encourages rapid evacuation. In another study, textual expressions considering psychological factors were proposed, and the effects of enhancing evacuation

© 2022. Published by AHFE Open Access. All rights reserved.

awareness were compared (Yasui et al. 2020). The psychological factors considered in their study were fear-arousing communication (Janis et al. 1953), majority synching bias (Takayama et al. 2014), and impatience. However, no studies have examined textual expressions that focus on what makes evacuees feel that it is a personal message addressed to me.

In this study, we focus on the location information acquired from GPS and the behavioral information of the user acquired from the accelerometer on the device. We assume that if an alert with textual expression that seems to identify the individual user by using the information is provided, the user receiving it will feel as if it is being said to them directly. We set nine patterns of alert expressions by combining expressions based on location and behavioral information. To verify the effectiveness of the alert expressions, we conducted a comparative verification experiment for the nine textual expressions.

TEXTUAL EXPRESSION OF EVACUATION ALERT

In this study, we assume flooding caused by heavy rain and consider the textual expression of evacuation alerts for the flooding. For information obtained from a device, we focus on the location information acquired from the GPS and the behavioral information of the user acquired from the accelerometer. That is, by receiving a message with a text expression that includes detailed position information and specific state information, a user will feel as if it is being said to them directly.

Regarding the degree of identification of individuals, three degrees of concreteness of expression were set for location and behavioral information, respectively. Specifically, for location information, the first indicates that the river has flooded, the second one gives the name of the flooded river, and the last shows the distance from the flooded river to the current location of the user. For behavioral information, the first includes no information about the user's behavior, the second indicates that the user is reading the alert message, and the last mentions how the user is operating the smartphone (e.g., the smartphone is in the user's hand or on a user's desk). We set nine patterns of alert expressions by combining the expressions based on location and behavioral information. Table 1 shows the nine expression patterns. In the table, the columns show the concreteness of the location information, and the rows show the concreteness of the behavioral information. The text in the table includes the river name (e.g., Kusatsu River) and the distance from the river (e.g., "2.7km") applied in the experiment (explained in the next section).

COMPARATIVE EXPERIMENT

To verify the effect of the text expressions shown in the previous section, we conducted a comparative experiment. The nine textual expressions were evaluated in terms of awareness of evacuation, directness of the message to a receiver, and a sense of urgency.

Table 1. Textual expression of evacuation alert for flooding.

	[1] Only river	[2] River name	[3] River name and distance
[A] Non	[1-A] You are in danger near the river. Please evacuate.	[2-A] You are in danger near the Kusatsu River. Please evacuate.	[3-A] You are in danger at 2.7 km from the Kusatsu River. Please evacuate.
[B] Reading state	[1-B] The area near the river is dangerous. Please evacuate if you are reading this message.	[2-B] The area near Kusatsu River is dangerous. Please evacuate if you are reading this message.	[3-B] The location 2.7 km from the Kusatsu River is dangerous. Please evacuate if you are reading this message.
[C] How a user operates	[1-C] The area near the river is dangerous. Please evacuate if you are reading this message holding your phone..	[2-C] The area near Kusatsu River is dangerous. Please evacuate if you are reading this message holding your phone.	[3-C] The location 2.7km from the Kusatsu River is dangerous. Please evacuate if you were reading this message holding your phone.

Experimental Procedure

We first explained the flow and contents of the experiment to the participant and obtained their consent to participate in the experiment. Then, we had the participant perform the specified daily task, English translation, alone in a dark room hearing rain sounds. While the participant was performing the task, they received one of the nine evacuation alerts on their phone. The participant confirmed it and then completed the questionnaire. After completing the questionnaire, they resumed the English translation. Each participant repeated this process five times. The time interval for receiving the alerts was set randomly at 3, 4, and 5 min each time. During the experiment, the experimenter left the room and observed the participant using a camera located in the room. Then, the experimenter selected the five messages from the nine messages shown in Table 1 and presented them manually in random order .

Results and Discussion

We had 18 participants, and each alert expression was evaluated by 10 participants. In the questionnaire, we asked the following questions:
Q1. Do you want to evacuate after reading this message?
Q2. Did you think that a disaster was happening close to you when you read this message?
Q3. Did you think this message was directed at you?
Q4. Did you feel a sense of urgency when you read this message?

For each question, the participants answered on a seven-point scale (1 = strongly disagree, 7 = strongly agree).

Tables 2, 3, 4, and 5 present the average scores for Q1, Q2, Q3, and Q4, respectively. For all questions, comparing the differences depending on the

Table 2. Questionnaire results for Q1 (awareness of evacuation).

	[1]	[2]	[3]	Average
[A]	3.90	3.10	4.20	3.73
[B]	2.60	4.00	4.40	3.67
[C]	3.80	4.00	3.80	3.87
Average	3.43	3.70	4.13	3.76

Table 3. Questionnaire results for Q2 (degree of closeness to the disaster).

	[1]	[2]	[3]	Average
[A]	3.90	4.10	4.90	4.30
[B]	3.40	4.20	5.50	4.37
[C]	4.70	4.20	4.90	4.60
Average	4.00	4.17	5.10	4.42

Table 4. Questionnaire results for Q3 (directness of the message).

	[1]	[2]	[3]	Average
[A]	4.20	3.80	5.50	4.50
[B]	3.20	4.60	5.50	4.43
[C]	3.90	5.00	3.70	4.20
Average	3.77	4.47	4.90	4.38

Table 5. Questionnaire results for Q4 (a sense of urgency for disaster).

	[1]	[2]	[3]	Average
[A]	4.10	3.10	4.40	3.87
[B]	2.60	3.80	5.00	3.80
[C]	3.80	3.80	3.90	3.83
Average	3.50	3.57	4.43	3.83

specificity of the location information, it tends that there are positive answers in expression 3-A, 3-B, and 3-C, which show the river name and distance. In the case of using only the river name (i.e., case [2]), some of the questions had positive answers, for example, Q2 in Table 3 or Q3 in Table 4. Textual alerts with no river information were evaluated as negative in many cases. Comparing the differences in behavioral information, there is no common trend in these results for the questions. For each question, the most highly rated behavioral information for each location was different. However, when looking at the combination of the two types of information, expression 3-B was the most highly rated for all questions.

Two-way ANOVA was conducted for location and behavioral information. Table 6 shows the *p*-values obtained from the analysis. There are no significant differences in the factors of behavioral information. For the location factor, there are significant differences or trends, except for Q1. In addition, the results show the interaction effects for Q3 and Q4.

Table 6. Results of a two-way ANOVA.

	Q1	Q2	Q3	Q4
behavioral information	0.887	0.802	0.831	0.988
location information	0.241	0.048**	0.093*	0.053*
behavioral * location	0.169	0.585	0.096*	0.095*

*:p<0.1, **:p<0.05

By increasing the concreteness of the location information presented, the average values of the answers tended to be positive. In particular, the rated values were high for the text that added distance information to the river name; there is a significant difference in the questions about the degree of closeness to the disaster. For the question about the directness of the message and a sense of urgency, we also found a significant tendency in terms of location information. In this experiment, the river name and specific distance values âŁ‹âŁ‹were presented for the "distance from the flooded area," so it is considered that it was easy to feel a sense of urgency. However, we could not see the effect of the concreteness of behavioral information. The reason for this can be found in the text expressions of "you are reading the message" and "you are reading this message holding your phone." These expressions seem to specify the state of the receiver of the information, but this is a natural behavior of the receiver reading the message. Therefore, many participants may not have interpreted the message as their actions were identified and the message was directed at them. Thus, although we cannot see the effect of concreteness of the behavioral information, it is shown that the concreteness of the location information tends to increase the sense of urgency and the sense of directness of the message.

CONCLUSION

In this study, we discussed the text expressions of alerts that generate a sense of urgency in a disaster or that make the evacuees feel as if they are being addressed directly. Assuming flooding of the river due to heavy rain, this study presented nine patterns of text expressions using location and behavioral information obtained from mobile devices. Although we did not observe the effect of concreteness of the behavioral information in the comparative verification, it was shown that the concreteness of the location information tends to increase the sense of urgency and sense of directness of the message. Our future work will examine other expressions of behavioral information and verify their effects.

ACKNOWLEDGMENT

This study was supported in part by JSPS KAKENHI (grant number JP20K11911).

REFERENCES

Janis, I. L., Feshbach, S. (1953). "Effects of fear-arousing communication", *The Journal of Ab-normal and Social Psychology*, 48(1), 78–92.

Takayama, Y., Hirosaki, M. (2014). "Quick Evacuation Method for Evacuation Navigation System in Poor Communication Environment at the Time of Disaster", *Proc. in the 2014 International Conference on Intelligent Networking and Collaborative Systems*, 415–429.

Tanaka, K., Kato, T. (2011). "Perceived danger can be influenced by how the emergency information is expressed", *The Japanese journal of cognitive psychology*, 9(1), 1–7.

Yasui, T., Kitamura, T., Izumi, T., Nakatani, Y. (2020). "A Validation of Textual Expression about Disaster Information to Induce Evacuation", *Proc. in the 22th International Conference on Human-Computer Interaction (HCI'20)*, 289–301.