DISASTER RESEARCH AND MANAGEMENT SERIES
ON THE GLOBAL SOUTH
SERIES EDITOR: AMITA SINGH

AI and Robotics in Disaster Studies

Edited by
T. V. Vijay Kumar
Keshav Sud

palgrave
macmillan

Editors
T. V. Vijay Kumar
School of Computer and Systems Sciences
Jawaharlal Nehru University
New Delhi, India

Keshav Sud
Data Science
Keurig Dr Pepper
Burlington, MA, USA

ISSN 2662-4176 ISSN 2662-4184 (electronic)
Disaster Research and Management Series on the Global South
ISBN 978-981-15-4290-9 ISBN 978-981-15-4291-6 (eBook)
https://doi.org/10.1007/978-981-15-4291-6

This Palgrave Macmillan imprint is published by the registered company Springer Nature Singapore Pte Ltd.
The registered company address is: 152 Beach Road, #21-01/04 Gateway East, Singapore 189721, Singapore

CHAPTER 4

Optimal Visual Cues for Smartphone Earthquake Alert Systems: Preliminary Data from Lab and Field Experiments

Eran Lederman, Tomer Shemi, Noga Ensenberg-Diamant, Lior Shalev, Amir Hazan, Naama Marcovits, Yona Weitz, Or Haklai, Tal Badichi, Bar Segal, Dan Fishbein, and Hillel Aviezer

It's 9 pm and you are enjoying a glass of good wine and the company of friends in your living room. Suddenly, your cellphone sends an alert and you realize you have several seconds before a major earthquake hits your town. Without delay, you rapidly run for cover outside. Although your home is severely damaged—you and your loved ones are saved. Several

E. Lederman (✉) • T. Shemi • Y. Weitz • O. Haklai • T. Badichi • B. Segal • D. Fishbein
Bezalel Academy of Arts and Design, Jerusalem, Israel

N. Ensenberg-Diamant • H. Aviezer
Hebrew University of Jerusalem, Jerusalem, Israel

L. Shalev • A. Hazan • N. Marcovits
eVigilo, Englewood Cliffs, NJ, USA

T. V. V. Kumar, K. Sud (eds.), *AI and Robotics in Disaster Studies*, Disaster Research and Management Series on the Global South,
https://doi.org/10.1007/978-981-15-4291-6_4

years ago, such a scenario may have seemed like pure science fiction but recent advances in early detection of seismic P waves (before the destructive S waves) have rendered it a reality (Allen & Kanamori, 2003). For example, at an August 2014 earthquake in California's Napa county, people received an alert five seconds before the destructive magnitude-6.0 shaking begun (Gerber, 2014).

While the geo-technological advances in earthquake detection are capable of sending an alert to end-user's mobile phones, the physical nature of the alert has received little attention by government agencies and has undergone little development over past years. For example, the alerting system "ShakeAlert" (Burkett, 2014) developed by the U.S. Geological Survey (USGS) includes a combination of auditory warnings and graphical displays while the interface of the US national alerting system includes a text message with an auditory cue—in both cases, it is unclear if these specific characteristics are indeed optimal for the human end-user (see Fig. 4.1). While the specific characteristics of the alert may seem inconsequential for natural disasters that take hours to build up they are utterly critical in the case of earthquakes because of the extremely short duration between the alert onset and the event.

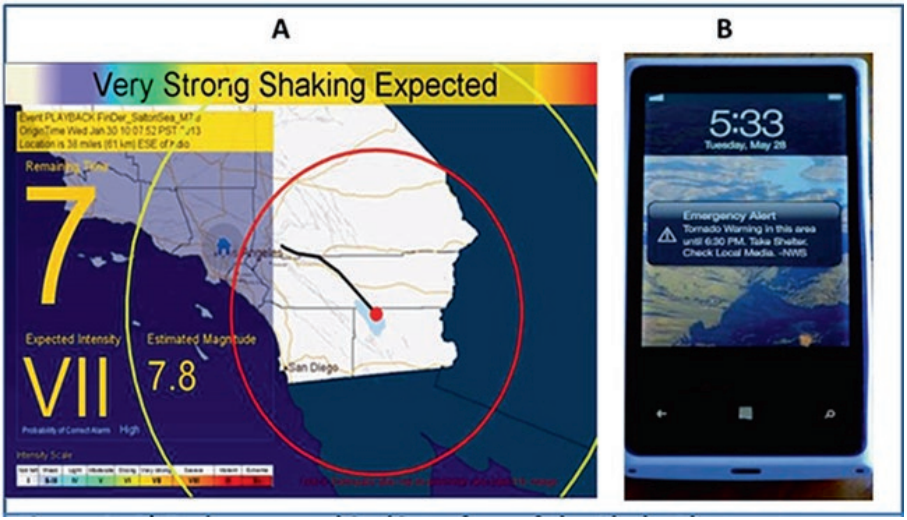


Fig. 4.1 Examples of end-user interfaces in alert systems apps. (a) "ShakeAlert" system. (b) National emergency alerting system (EAS)

Aside from comparing between classic alert visual stimuli such as text (e.g., the word "DANGER") and hazard icons (e.g., ⚠), we were further interested in a potentially new class of alert stimuli, namely, that of social-emotional nature. Emotional signals such as facial expressions are a primitive and evolutionary based signaling system of affective relevance (Bänziger & Scherer, 2010; Schmidt & Cohn, 2001). The emotional value of facial expressions is recognized universally and cross culturally and they are often considered a biologically hardwired and evolutionary-adaptive signal (Ekman, 1972, 2007; Elfenbein & Ambady, 2002; Marsh, Elfenbein, & Ambady, 2003; Sauter, Eisner, Ekman, & Scott, 2010; Susskind et al., 2008). Because of the natural inherent importance of facial expressions, they serve as optimal stimuli for conditioning paradigms. For example, electric shocks are rapidly and readily conditioned to fearful faces but less so to happy faces (Ohman, 2000).

The inherent biological significance of facial expressions can be demonstrated in humans from a very early age. Four-month old infants can discriminate facial expressions of anger, fear and surprise (Serrano, Iglesias, & Loeches, 1992). At the age of twelve months, infants successfully use information about an adult's direction of gaze and emotional expression to predict adult action and they efficiently utilize negative expressions of caregivers as danger cues (Mumme, Fernald, & Herrera, 1996).

Facial signals, in particular negative expressions, are highly potent attractors of attentional processing even when presented outside the scope of awareness. In fact, negative facial expressions are recognized and oriented to even among visual neurological patients in whom spatial awareness is impaired due to stroke (Vuilleumier & Schwartz, 2001). Experimental methods which allow presenting stimuli without visual awareness such as continuous flash suppression (Yang, Zald, & Blake, 2007) and binocular rivalry (Yoon, Hong, Joormann, & Kang, 2009) also demonstrate a superiority for facial expressions in emerging out of unconscious processing and breaking into awareness.

In addition to our interest in the potential utility of facial expressions as "attention grabbers", faces may hold additional advantages for alerting systems. Unlike traditional alert systems that simply bombard the end-user with info and "throw him in the water" on his own. A social alerting system can actually serve as an agent that guides the end-user through the process, potentially serving as a source of motivation, encouragement and guidance. This may give faces an advantage as users may socially connect with the alerting interface, improving their experience of trust and perceived safety when using the app.

Contemporary studies and innovative technologies are already able to identify individual people within a large audience by means of face photographs only. It is clear that face recognition and data mining technologies are increasingly being improved by the use of big data and artificial intelligence.

Examples of the use of these technologies can be seen in the software developed by FACE2GEN that uses facial phenotypes to facilitate comprehensive and precise genetic evaluations or by FindFace software capable of detecting faces, emotions, gender and age of people by analyzing their photos only.

While the above examples demonstrate how technology can aid at the data collection from faces, faces may also be efficient as an alerting stimulus. Our side in this study deals with how to improve and correct the cellular alert for an earthquake, first and foremost in the attention capture, and the ability to motivate people to act quickly and efficiently in light of the danger they face.

Experiment 1. Optimal Stimuli for Capturing Peripheral Attention

One challenge to alert systems is that they must attract user's attentions while placed outside the center of visual attention. Consider the case of Jane who is deeply immersed in her favorite Netflix show playing on TV while her smartphone is placed on the sofa beside her. Jane's reaction to information appearing on her phone (e.g., an email notification) may be delayed simply because her focus of visual attention is elsewhere.

In experiment 1 we created an ecologically valid experimental setting to test which stimuli would best capture participant's attention while they are engaged in watching a comic video. Specifically, participants were requested to detect numbers presented together with alerting stimuli (text, icons and fearful faces) presented on a separate screen, peripherally to the main task video. Our dependent variable was the reaction time to responding to the number.

Methods

Participants 30 students (18 females, Mean age = 24) from the Hebrew University participated in the experiment for course credit or payment.

Stimuli and Materials The main task for participants involved watching an 18 minute "best bits" YouTube video of the sitcom *Friends*. Alongside the main task, a concurrent "attention capture task" took place. Stimuli for the attention capture task included alert faces, alert icons and alert texts. Alert faces included 10 facial expressions of fear from the ADFES database (Hawk, Van der Schalk, & Fischer, 2008). Alert icons included 10 graphic icons conveying danger (e.g., skull and cross bones). Alert texts included single word exclamations such as "Danger".

All stimuli were equated for size and average visual angle.

Procedure The main task video clip was presented at full screen size on an 18 inch ThinkPad laptop placed directly in front of the participants at a distance of ~60 cm. They were instructed to observe the clips carefully as they would be asked to answer questions regarding the storyline at the end of the experiment. While watching the video, a concurrent attention capture task took place to the right or left side of participants. A second computer screen was placed at a distance of 50 cm, turned slightly towards the participant. Three categories of alerting stimuli (faces, icons and text) were randomly presented on this peripheral screen every 30–90 seconds. In order to keep participants as naïve as possible, they were told that a number with a stimulus above it will be occasionally presented. Their task was to detect the number and press the key corresponding to the presented number as quickly as possible. While the video ran uninterrupted during the entire task, the numbers and alert icons appeared on screen for 1000 ms on each trial, and were then removed. No feedback was given for the attention side task. Upon completion of the experiment, participants were given a brief quiz about the video. This was intended to confirm that attention was adequately located to the main task.

Results All participants successfully answered the questions about the video, indicating that their attention was adequately attended to the content of the video. Our main dependent variable was the RT to detection of the numbers on the peripheral screen. To this end, the mean reaction times to correct pressing of the numbers keys was compared across the 3 conditions. Figure 4.2 presents the RT for the pressing of correct numbers in each of the alert conditions. A 3-way repeated measures ANOVA run on the mean RT data indicated a significant effect of the condition [$F(2,58) = 6.6$, $p < 0.003$, $\eta_p^2 = 0.18$]. Paired t-tests across conditions indicated that the RT in the text condition was slower than in the icon condition ($t(29)=3.7$, $p<0.001$ and slower than in the face condition ($t(29)=2.4$, $p<0.023$). However, no significant difference was found between the graphic alert icons and between the faces ($t(29)=0.9$, $p=0.34$).

Discussion Experiment 1

The results of experiment 1 demonstrated more efficient attention capture when alert icons and faces were presented than when alert text was. However, icons and faces were equally deficient in capturing attention.

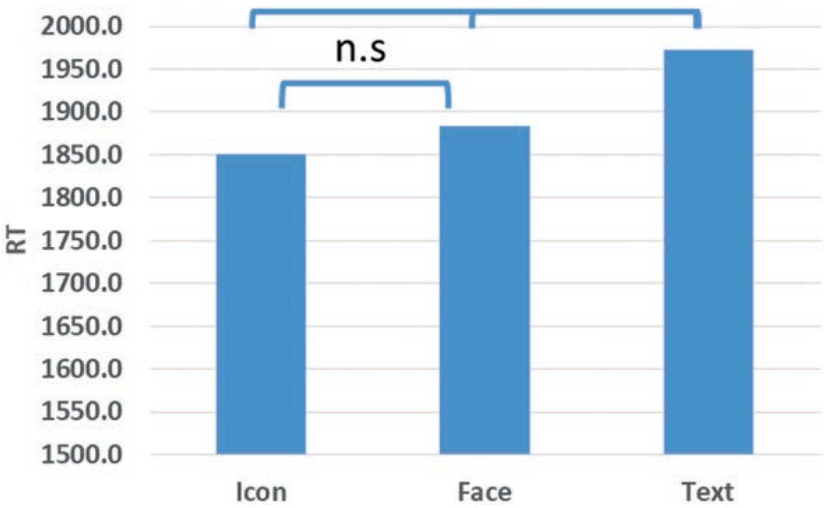


Fig. 4.2 Reaction time (RT) results of experiment 1. Icons and faces resulted in faster responses than text

This finding may be important given the popular prevalence of text in many alert apps, which may be suboptimal. In experiment 2 we continued to examined compare alert faces and icons in a more real-life setting. Unlike lab experiments in which multiple stimuli are repeated many times, real-life alerts are a one-shot, unexpected event. It was thus imperative to examine the alert value and accompanied psychological perceptions of faces and icons in a more ecological field-study setting.

Experiment 2. Optimal Stimuli, Personalization and Practice in a Real-Life Field Experiment

In order to examine optimal alert interfaces in real-life ecological settings, we conducted a controlled field experiment. This allowed us to examine the efficiency of reactions to different alert stimuli and the optimal personal experience and learning process associated with such stimuli in a real-life setting. Specifically, the study examined the impact of several factors: stimuli of alert (icon, face), the process of personalization (choosing one's icon/face vs. having it assigned randomly), and practice (with or without).

Based on study 1, we did not expect a main effect of the stimuli as both proved equally efficient in capturing attention. We did, however, predict a main effect of practice as this effect was established in multiple studies (e.g., Johnston et al., 2011). With regard to personalization, we predicted an interaction: due to the special status of faces in social, interpersonal interactions we expected that personally choosing one's alert would enhance performance more strongly for faces than for icons. Humans are highly acquainted with the social task of analyzing the attractiveness, expressiveness and traits read from faces. As such, choosing a favorite face for an alert stimulus may create a more meaningful and engaging experience than choosing a graphic icon.

In addition to examining the motor aspect of the alert response (i.e., RT to reactions), we were also interested in the psychological reactions participants developed towards different stimuli and conditions. Specifically, we predicted that participants would experience more positive experiences (e.g., feeling more confident, safe and trusting of the alert) when alerted by a face than by an icon. This would be the case due the personal feelings and social attachment that may arise when encountering faces vs. icons, the latter being non-personal by nature.

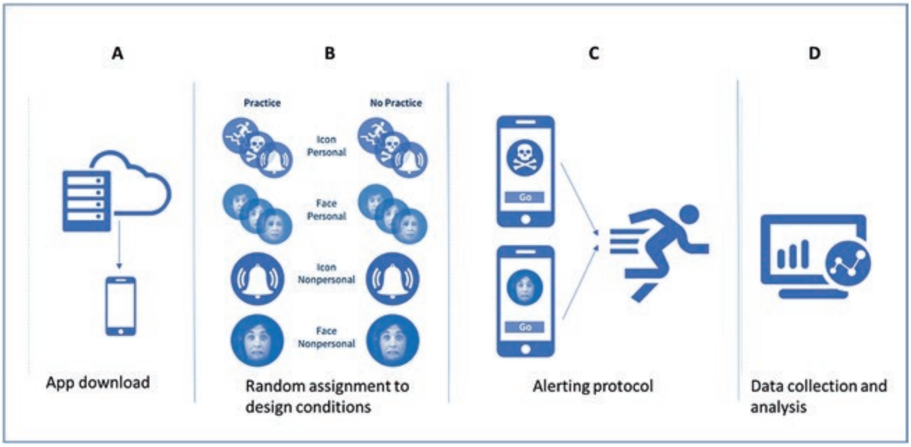


Fig. 4.3 Illustrative layout of the experimental design and procedure of experiment 2

Methods

Participants 220 participants were recruited from an Israeli online participant pool (Panel4all) and compensated with ~10$US for completing the study.

Stimuli 3 faces and 3 icons were chosen from those used in experiment 1. These visual stimuli appeared together with an auditory alert sound and a vibrating sensation. Thus all conditions were conducted with identical auditory and vibration alerts which were intended to enhance the likelihood of response.

Design The design was a 2 (stimuli: face, icon) x 2 (personalization: yes, no) x 2 (practice: yes no), between subject design. See Fig. 4.3 for the experimental design and procedure layout (Fig. 4.3).

Task and Procedure

Participants were randomly assigned to the different conditions and downloaded the app via a link received through the online subject pool. After reading the basic instructions and giving consent, participants

Fig. 4.4 Example of the app layout and alert procedure. Left image portrays the stage of personalization of the face alert image. The right image portrays the surprise alert

were exposed to 3 stimuli on the screen (3 icons or 3 faces). In the personalization condition, subjects were given 10 seconds during which they were requested to choose one of the 3 stimuli which they would like to appear as their alert stimuli. The choice was indicated by pressing on the screen. In the non-personalization condition, the 3 stimuli (3 icons or 3 faces) appeared for 10 seconds and one of the 3 stimuli was randomly chosen by the app. See Fig. 4.4 for an illustration of the app layout stages and alert procedure.

Next, depending on their random allocation, participants in the practice condition received a practice trial in which an alert stimulus appeared on the screen with a number below it. At the bottom of the screen was a panel with several numbers and subjects were requested to match the number below the stimuli, with the corresponding number in the panel. Immediately after the number matching, subjects were requested to walk 10 steps and press a "SAFE" button indicating that they completed the task. This practice was essentially identical to the actual alert that subjects would be exposed to during the actual experiment. Participants in the no-practice group did not go through with this procedure.

In order to invoke and disseminate the experiment, we collaborated with eVigilo, a tech company specializing in mass-notification of cellular alerts. The technology that was delivered by eVigilo for this experiment, was based on eVigilo product Smart-eVigilo, an Emergency Mass-Notification and Alert multi-channel solutions, where its Server side send the messages and collect the response, and its application based product served as the end user side of the experiment. Smart-eVigilo is a Web based mission critical system, designed to operate under extreme conditions of emergency in order to save lives.

Using eVigilo's technology, a week after enrolling, participants were mass alerted by surprise with the initiation of the actual alerting procedure. The alert was triggered around 18:00 pm and mass disseminated to all subjects simultaneously. Subjects had no prior knowledge regarding the date or time when the alert would occur. As noted, the actual alert was identical to the practice procedure and responses were recorded by the app.

Following the completion of the app alert task, participants were diverted to the online panel website and were requested to complete a brief survey about their user experience during the alert. In the survey, participants were requested to indicate with a 1–7 scale how safe they felt during the alert, and to what degree they would trust the app in case of a real emergency. Subsequently, they were thanked for their participation and compensated.

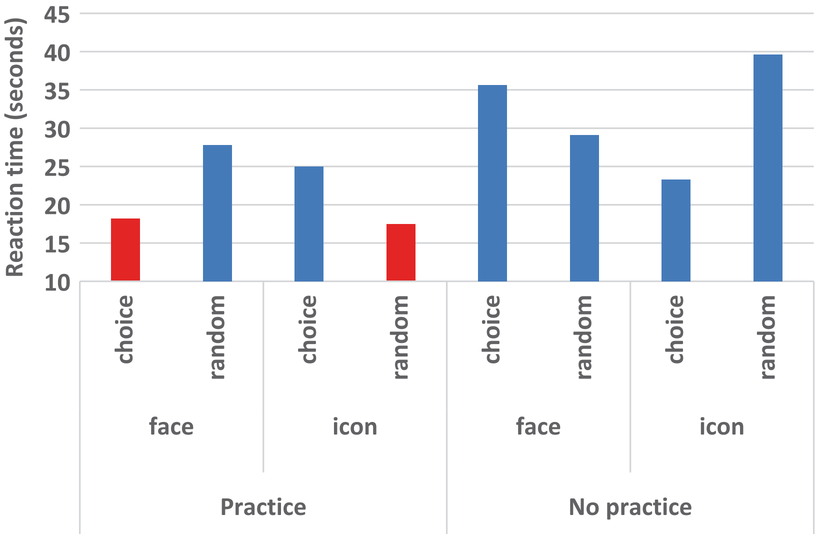
Results

Data Preparation Due to the uncontrolled, field nature of the experiment, a relatively large proportion of subjects did not respond in a timely manner to the alert (e.g., subjects that were driving at the time of the alert, subjects who did not have their phones next to them, etc.). A data quality report from eVigilo (who collected the data their servers) indicated subjects with invalid or corrupt data logs, subjects that had not pressed the "SAFE" button, and subjects that failed to respond to the alert altogether. Among subjects that did complete the experiment, a cutoff of 120 sec was used to remove people that responded very slowly—likely due to not seeing or being able to respond in a timely manner. After exclusion, we remained with an N =155. The N within the different groups ranged from 49 to 12. Given the variance and the low N in some of the groups, the statistical power of our experiment was low. We therefore opted for a lenient threshold and pursued marginal interaction trends to increase the likelihood of detecting effects in the data. Consequently, the findings should only be viewed as exploratory and should be interpreted with caution, awaiting an additional large-scale replication.

Results

Reaction Time A 2 (stimuli: face, icon) x 2 (personalization: yes, no) x 2 (practice: yes no), between subject ANOVA was run on the RT data (data reported in seconds) A significant main effect of practice indicated that participants, were overall faster with practice (M=21.8, SD=14.4) than without practice (M=31.8, SD=23), $F(1,147)=8.93$, $p < 0.001$. Additionally, a significant 3 way stimuli x personalization x practice interaction was revealed, $F(1,147)=5.5$, $p < 0.02$.

In order to characterize the 3 way interaction, we ran separate stimuli x personalization ANOVA's for the practice and no practice conditions. Within the practice condition, a marginal stimuli x personalization interaction was found, $F(1, 57)=3.3$, $p=0.07$. A trend was found indicating that faster RT's were associated with personalization (i.e., choice) of faces as well as with non-personalization of icons. Within the no-practice condition, a marginal stimuli x personalization interaction was found, $F(1, 90)=3.4$, $p=0.06$. A trend was found indicating that faster RT's were associated with personalization of icons, as well as with the non-personalization of faces.



User Experience Ratings

In Case of a Real Earthquake, How Likely Would You Be to Trust This App?

A practice x stimuli interaction emerged F(1,147)=6.3, p<0.01, indicating that with practice, faces received a higher degree of trust than icons. By contrast, without practice, an opposite pattern emerged.

In Case of a Real Earthquake, How Safe Would You Feel with This App?

A practice x stimuli interaction emerged F(1,147)=6.5, p<0.01, indicating that with practice, faces received a higher degree of safety ratings than icons. By contrast, without practice, an opposite pattern emerged.

To What Degree Did I Feel Safe During Walking During the Alert?

A trend for a practice x personalization interaction emerged F(1,114)=3.1, p=0.78, indicating that with practice, personalization resulted in a higher degree of safety ratings than non-personalization. By contrast, without practice, an opposite pattern emerged.

Overall Mood During the Experiment

No main effects or interactions approached significance for the ratings of overall mood (significance levels ranging from p=0.24 to p=0.78), suggesting that the previously reported findings in user experience did not results from generalized mood effects, but rather from specific differences in user experience.

Discussion Experiment 2

Experiment 2 offers a unique field approach to studying optimal alert stimuli and procedures. While the study is notably underpowered, some interesting conclusions may be tentatively deduced from the data, awaiting future replication and extension. First, the robust beneficial role of practice in alert compliance and performance emerged in our findings. Any alert application being considered in the future should likely consider this important factor. Second, our results suggest that personalization, i.e., one's ability to choose their own alert, is only beneficial for face stimuli, but not for classic graphic icons of alert. While the personalization process takes additional time, it may well be worth the effort. Participants consistently rated the face alerts as more trustworthy and enhancing of a safe user experience. Importantly, faces may induce a more interpersonal relation between users and the app, thereby increasing compliance and improving performance.

General Discussion

Earthquake alerts allow participants several seconds (~10) to rapidly realize the alert is taking place, and to act (e.g., get out of a building). With such brief time intervals, literally every second counts. To date, alert systems have focused on the mere notification of subjects, with little thought devoted to the medium and procedure of this alert. However, our lab and field studies strongly suggest that developers can optimize their alert systems by choosing the right kind of visuals, allowing the appropriate personalization with these visuals, and having subjects practice the response protocol.

In experiment 1 we demonstrated the superior attention capture when alert icons and faces were presented than when alert text was. The use of text is surprisingly common in many alert systems. Aside from the limitation of literacy, text may be suboptimal for capturing attention. Having established the advantage of visual cues in capturing attention, Experiment 2 continued to compare alert faces and icons in a more real-life setting. Overall our preliminary results hint to possible future protocol guidelines. Aside from the obvious importance of practice our results suggest that personalization is only beneficial for face stimuli. Most importantly, participants consistently rated the face alerts as more trustworthy and enhancing of a safe user experience. Considering the high drop out and attrition rates that many apps have, establishing a personal social bond with a face avatar may increase usability and performance.

These novel results shed important light on the optimal underlying factors of efficient alert systems and may help design such systems in the future. Artificial intelligence still needs to bridge many gaps with regard to creating effective tools for generating high-quality personal cellular alerts. In particular, the ability to use artificial intelligence in order to collect data and design optimal alerts customized for the unique needs of the user may be a promising and exciting direction. User habits, preferences, emotional state and personality may all be taken into account after obtained from user data. While such a vision seems of great importance, the research and technology have not yet reached the level of maturity that will enable the creation of an accurate personalized cellular alert. However, such gaps are minimizing rapidly and technologies available today seemed unimaginable several years ago.

As noted, we view our studies as a first tentative step towards more established research in the field. Aside from significant increases in power that our study (especially experiment 2) suffers from, many important questions remain unanswered. In both experiments, the auditory alert was held constant either by omitting it (experiment 1) or by using a constant alert sound across all conditions (experiment 2). The acoustic alert is without doubt a critical component of any alert, but little is known about how it interacts with the visual cue. Given the advantage of face stimuli found in our work, future studies may compare the utility of human alert voices vs. artificial alert sounds (beeps/sirens).

An additional direction not covered here is that the potential of the personalization process is probably much more complex than offered in our limited design. Different personality individuals may benefit from choosing a face avatar that best suits their liking. Factors such as race, gender, attractiveness and personality attributes of the alert face may all contribute to the ideal alert system. Looking at the more distant future, user characteristics obtained with consent may be analyzed and used to improve the alert procedure and medium. For example, practice is important, but over-practice may lead to burnout. A system that customizes and optimizes the practice routine to the unique characteristics of the user may improve the alerts efficiency.

In our vision, the role of the alert app extends far beyond the initial activation of participants. Rather, the app should continue to serve as a companion to the user throughout the entire event. This may include the process of taking cover, being trapped, seeking for loved ones and friends, and assessing safe harbors. In all these processes, expressing dynamic emotions from the app, and reading expressions from the user may be critical. While futuristic, we believe these directions reflect current trends. However, only additional research will establish which protocols are ideal for optimizing the alerting process.

Acknowledgments This study was supported by a grant (#47953) from the Israeli Ministry of Science, Technology & Space.

References

Allen, R. M., & Kanamori, H. (2003). The Potential for Earthquake Early Warning in Southern California. *Science, 300*(5620), 786–789.

Bänziger, T., & Scherer, K. R. (2010). Introducing the Geneva Multimodal Emotion Portrayal (Gemep) Corpus. *Blueprint for Affective Computing: A Sourcebook*, 271–294.

Burkett, A. (2014). ShakeAlert—An Earthquake Early Warning System for the United States West Coast. http://pubs.usgs.gov/fs/2014/3083/pdf/fs2014-3083.pdf

Ekman, P. (1972). Universals and Cultural Differences in Facial Expressions of Emotion. In J. Cole (Ed.), *Nebraska Symposium on Motivation* (Vol. 19, pp. 207–283). Lincoln, NE: University of Nebraska.

Ekman, P. (2007). *Emotions Revealed: Recognizing Faces and Feelings to Improve Communication and Emotional Life*. Macmillan.

Elfenbein, H. A., & Ambady, N. (2002). On the Universality and Cultural Specificity of Emotion Recognition: A Meta-Analysis. *Psychological Bulletin, 128*(2), 203.

Gerber, M. (2014). After 6.0 Earthquake, Flames Light Up Napa Mobile Home Park. *Los Angeles Times.*

Hawk, S. T., Van der Schalk, J., & Fischer, A. H. (2008). *Moving Faces, Looking Places: The Amsterdam Dynamic Facial Expressions Set (ADFES)*. Paper presented at the 12th European Conference on Facial Expressions, Geneva, Switzerland.

Johnston, D., Tarrant, R., Tipler, K., Coomer, M., Pedersen, S., & Garside, R. (2011). Preparing Schools for Future Earthquakes in New Zealand: Lessons from an Evaluation of a Wellington School Exercise. *The Australian Journal of Emergency Management, 26*(1), 24.

Marsh, A. A., Elfenbein, H. A., & Ambady, N. (2003). Nonverbal "Accents" Cultural Differences in Facial Expressions of Emotion. *Psychological Science, 14*(4), 373–376.

Mumme, D. L., Fernald, A., & Herrera, C. (1996). Infants' Responses to Facial and Vocal Emotional Signals in a Social Referencing Paradigm. *Child Development, 67*(6), 3219–3237.

Ohman, A. (2000). Fear and Anxiety: Evolutionary, Cognitive, and Clinical Perspectives. In M. L. J. M. Haviland-Jones (Ed.), *Handbook of Emotions* (2nd ed., pp. 573–691). New York: Guilford Press.

Sauter, D. A., Eisner, F., Ekman, P., & Scott, S. K. (2010). Cross-Cultural Recognition of Basic Emotions through Nonverbal Emotional Vocalizations. *Proceedings of the National Academy of Sciences, 107*(6), 2408–2412.

Schmidt, K. L., & Cohn, J. F. (2001). Human Facial Expressions as Adaptations: Evolutionary Questions in Facial Expression Research. *American Journal of Physical Anthropology, 116*(S33), 3–24.

Serrano, J. M., Iglesias, J., & Loeches, A. (1992). Visual Discrimination and Recognition of Facial Expressions of Anger, Fear, and Surprise in 4-to 6-Month-Old Infants. *Developmental Psychobiology, 25*(6), 411–425.

Susskind, J. M., Lee, D. H., Cusi, A., Feiman, R., Grabski, W., & Anderson, A. K. (2008). Expressing Fear Enhances Sensory Acquisition. *Nature Neuroscience, 11*(7), 843–850.

Vuilleumier, P., & Schwartz, S. (2001). Emotional Facial Expressions Capture Attention. *Neurology, 56*(2), 153–158.

Yang, E., Zald, D. H., & Blake, R. (2007). Fearful Expressions Gain Preferential Access to Awareness during Continuous Flash Suppression. *Emotion, 7*(4), 882–886.

Yoon, K. L., Hong, S. W., Joormann, J., & Kang, P. (2009). Perception of Facial Expressions of Emotion during Binocular Rivalry. *Emotion, 9*(2), 172.