HFES EU 2018

A Tactile Interface for Identification of Hazardous Situations During Operational Movement

Industrial Engineering and Management
Human Factors Engineering (Ergonomics)

Nuphar Katzman and Tal Oron-Gilad
Dept. of Industrial Engineering and Management
Ben Gurion University of the Negev, Beer Sheva, Israel
E-mail: Nuphar Katzman - nuphar@post.bgu.ac.il, Tal Oron-Gilad, Ph.D -orontal@bgu.ac.il

Introduction

- Most of the **communication** between soldiers is handled via busy overt **audio** and cluttered **visual** devices [1].
- A possible **solution** is to add information in the **tactile modality** [2-4].
- If properly implemented in operational settings, adding **tactile alerts** can:
  - **Enhance** user performance.
  - **Improve** transfer and processing of information.
- Previous work with SMEs led to the identification of three key topics in which tactile cues can be useful during operational missions: Warnings, increasing Awareness or giving Orders [5].

Objectives

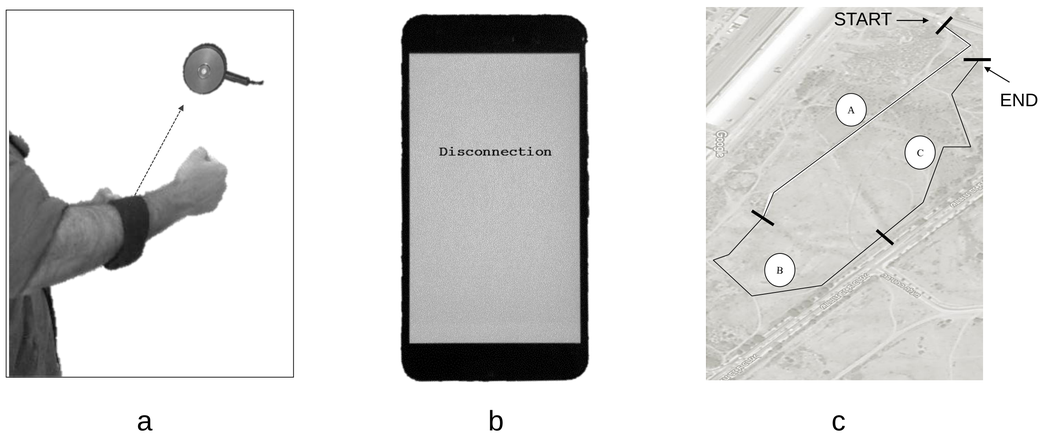
Our aim was to examine the added value of tactile interfaces during operational movement. The focus was on squad commanders' response time to alerts and their ability to distinguish between two kinds of tactile alerts.

H1: Use of Tactile alerts will positively influence the commanders' response time to information gathered from other squad members about surrounding fixed targets compared to visual alerts or hand-signs. *H2:* Commanders will distinguish between two different tactile signals.

Method

Participants. 11 Infantry commanders and 24 Infantry soldiers (as squad members, 4 in each experiment), ages 23-30. Participants were all military reserve soldiers who have been on active duty in the year prior to the study.

***Apparatus*.** Tactile system - Two tactors on a lower arm strap (Figure 1a); Visual system- mobile display (Figure 1b); Navigation map, showing three sections A,B,C of a route (Figure 1c); Subjective Questionnaire.



a b c

Figure 1. The experimental apparatus: a. Tactile wearables, b. Visual mobile display, c. Navigation map

Experimental Design. A between-subject design for the operational area (three different geographical areas). Each navigation route was divided to 3 sections (A, B and C). A within-subject design for the type of alerts: each commander-participant experienced three communication modes (visual, tactile or hand-signs). Each commander-participant began the experiment with one of the three modes and switched modes between sections A, B and C.

Task. The commander was required to navigate along the route and identify fixed targets. In case of target detection by one the squad members, an alert was initiated (either tactile, visual or hand-signs) and the commander had to detect and report the targets as soon as possible. For tactile alerts, two categories were initiated, to indicate the severity of the target distance (long distance/short distance). At the end of the experiment session commander-participants filled a questionnaire and all 5 participants were debriefed.

Results

Response time to the warning

The time in seconds from the moment one of the squad members "sent" a warning to the commander, until it was reported by the commander to the experimenter.

Figure 2. Response time to disconnection by area and alert modality

The time until detection of warning with tactile alerts was significantly faster than for visual alerts or hands-signs (Figure 2) for all areas.

Classification of Tactile Alerts *(by severity - long or short distance)*

Of 99 alerts, 97 alerts were classified correctly. In one mistake made, a participant regarded a short distance warning as long distance warning, and in another, a participant regarded a long distance warning as short distance warning. Due to a very high rate of success, no statistical test was performed.

Subjective Questionnaire

The subjective questionnaire was distributed to the commander-participants at the end of the experiment. Overall, participants were in favor of the tactile alert, although they were a bit reluctant to say that it could replace other types of alerts. Although participants had no problem in distinguishing between the two tactile alerts, they were still hesitant to state that.

Table 1. Mean degree of agreement (5-point scale) to statements regarding the tactile system

Degree of agreement with:	Mean	SD
The tactile alert was easily felt	4.91	0.3
I think it was easy to distinguish between alerts on the hand arm and left arm	4.91	0.3
I think the tactile alert can be useful in operational movement	4.73	0.47
I think integration of tactile interface can provide advantages in operational environments	4.55	0.52
I think the tactile alert may help transfer information quietly and secretively	4.45	0.69
I think the tactile alert can be a substitute to visual or auditory interfaces	3.36	1.03
I think it was easy to distinguish between alerts for long distance and short distance	3	0.77
I think the intensity of the tactile alert should be stronger	2.27	1.35
I think the tactile system was more disturbing than useful	1.64	0.67

Discussion

Both hypotheses were confirmed, i.e., the response time for tactile alerts was faster and participants could distinguish between two types of tactile patterns during movement and identify them correctly.

Tactile interfaces can be useful under fielded dynamic conditions. Tactile cues can potentially be used for varied information delivery necessary in the battlefield, communicating warnings, increasing awareness, or giving commands. While accepted positively by users, they are not yet recognized as substitute for other modalities.

To test the robustness of our findings, future work should include examination of the suggested cue meaning, while relevant events occur in the scenario under different conditions.

Acknowledgment

This work was supported by the US Army Research Laboratory through the GDLS subcontract no: GDLS PO 40253724 (B.G. Negev Technologies and Applications Ltd) under Prime Contract no W911MF-10-2-0016 (Robotics Consortium), Robotics CTA 2015-2020, T2C1S3C, Michael Barnes, Technical Monitor. The views expressed in this work are those of the authors and do not reflect an official Army policy.

References

1. Krausman AS, Elliott LR, Pettitt RA (2005). Effects of visual, auditory, and tactile alerts on platoon leader performance and decision making. Technical Report ARL-TR-3633, U.S. Army Research Laboratory (ARL)
2. Elliott LR, Schmeisser ET, Redden ES (2011) Development of Tactile and Haptic Systems for U.S. Infantry Navigation and Communication. In: Human Interface and the Management of Information. pp 399–407
3. Myles K, Binseel MS (2007). The Tactile Modality: A Review of Tactile Sensitivity and Human Tactile Interfaces. Technical Report ARL-TR-4115, U.S. Army Research Laboratory (ARL)
4. Brown LM, Brewster SA, Purchase HC (2005) A first investigation into the effectiveness of Tactons. First Jt Eurohaptics Conf Symp Haptic Interfaces Virtual Environ Teleoperator Syst 167–176
5. Katzman N, Oron-Gilad T, Salzer Y (2015) Tactile interfaces for Dismounted soldiers : User-perceptions on content, context and loci. In: Proceedings of the Human Factors and Ergonomics Society Annual Meeting. pp 421–425