The Effect of a Distracter Task on the Recognition of Tactile Icons

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Abstract

Vibrotactile cues have considerable practical potential for discreetly presenting the output from a mobile or wearable device, and a body of work has appeared empirically investigating how best to design them for such purposes. However, it is currently unclear if the performance observed in these lab based studies will be maintained in more realistic, distracting real world scenarios. Here, we present one study examining this issue. We measure user performance with a set of 9 two-dimensional tactile icons and observe how this performance changes when participants are engaged in a transcription task. The results indicate that performance was degraded during the distracter task, but that one of the dimensions (body site) was considerably more resilient to this manipulation that the other (stimulus roughness).

1. Introduction

Vibrotactile cues are a practical modality in which to convey discreet feedback from mobile or wearable devices. The required actuators are small, robust and have modest power and control requirements. Indeed, they already a standard feature in mobile phones. This suitability to mobile interaction scenarios has led to the development of a broad body of research. Some wearable vibrotactile systems deal with demanding application domains – for instance, van Erp and colleagues [5, 6] present work on cues to aid speed boat navigation, and to train athletes. These systems feature numerous tactors and cues tend to be distinguished solely by the body site they are applied to.

However, recent research considers more commonplace situations, in particular how to support the everyday use of a handheld device [e.g. 3]. Much of this has focused on creating a framework which maximizes the abilities of users to discriminate among a set of tactile icons (often called tactons [1]) by varying parameters such as amplitude, frequency, rhythm and stimulus site and then systematically testing recognition performance [1, 2]. While this work is approaching the stage where designers can confidently select cues that users will experience as distinct, one issue that has remained unaddressed is the influence of distraction – the existing work is lab-based, and has not considered the busy, attention-demanding environment that more accurately characterizes real world mobile device use. It is far from clear whether the performance observed in these artificial settings will be maintained outside them, when users are situated in and relating to complex contexts, tasks and situations. This paper presents an initial experiment exploring this issue.

Figure 1. Tactile device on subjects arm.

2. Study

The study involved measuring user performance in recognizing compound tactons featuring two varying cues: location and rhythm. We used three VBW32 tactors [4] attached to a Velcro band around the participants wrist (5 cm back from the base of the thumb) such that one was situated on the left side, one on the centre top and one on the right side. We also used three waveforms, all sine waves of 250 Hz and 500 ms in length. One was amplitude modulated by a 50Hz sine wave, one by a 30Hz sine wave, and the final one left alone. These cues were taken from Brown *et al.* [1] and range from rough to smooth. Figure 1 shows the experimental system (which was covered with light cloth during the study to obscure visual cues).

The study was conducted in a quiet office with the user in front of a desktop PC and wearing noise cancelling headphones. Participants experienced 4 basic stages. Initially, they were presented with a GUI allowing them to play each of the 9 tactons; they were free to use this for 5 minutes. Trials in the remainder of the study had the same basic form, each consisting of a pause followed by the display of one of the tactons, which the user then had to identify using a simple GUI.

Participants first completed a 27 trial practice phase (each tacton, 3 times) with a 3 second pause between trials, followed by a similar control (or measurement) phase twice this size. Finally, participants completed a 54 trial typing (or distraction) phase featuring a pause of randomly varying length between trials (in the range 10-25 seconds). During this stage they also had to transcribe a series of short poems into a window on the screen. They were instructed to type rapidly and an adaptive speed monitor (a green icon when they exceeded their average rate, a red one when underneath) reinforced this.

The study had 8 participants (5 male, 3 female, with a mean age of 28), all workers at our institute. The main metric was error rate – the study tested whether the ability to recognize the tactons was reduced when participants were engaged in a distracting typing task.

3. Results

The data from the control and typing phases of the experiment are shown in Figure 2. We present the mean number of correct responses and also the partially correct ones: those in which at least one of the parameters was correctly recognized. We conducted paired t-tests on these data and all three comparisons revealed significant differences (at $p<0.05$ or better), indicating that performance decreased during the typing task. Comparing the number of trials in which participants correctly identified the body site of the cue against those in which they correctly identified its roughness also led to a significant difference ($p<0.001$).

4. Discussion and Conclusion

The main experimental result is clear: distraction, at least in the form of a transcription task, negatively affects the ability to recognize tactons. However, some qualifying comments should be made. Firstly, transcription involves specific mental and physical processes. The acts of reading, comprehending and typing occupy both the mind and the body, and it is perhaps unreasonable to generalize from this situation to other less cerebral ones. For example, it is unclear whether the differences observed here would also emerge if we considered performance when users were taking a walk. A further caveat is that we presented feedback to the wrist (as it is a likely candidate site for a wearable display), but also engaged the hands and forearms in the distracter task. Such a physical overlap is likely to exacerbate the influence of the distraction.

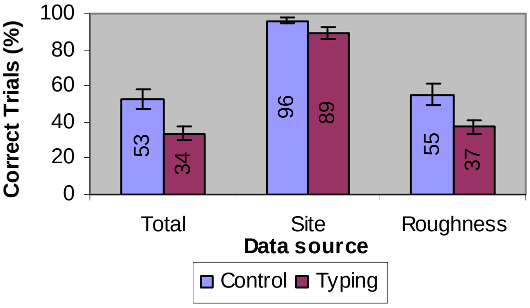

Figure 2. Error data from experiment.

It is also worth briefly comparing the results to the previous literature. The data from the control condition are similar those reported by Brown *et al.* [1], a fact which is strongly supportive of the validity of the results. Brown also suggests that body site may be a more reliable kind of cue than roughness (at least with the VBW32 tactors we used), a suggestion that is borne out not only by this study, but that is also consistent with research dealing with localized vibration stimuli in demanding situations [e.g. 6]. Choosing this pair of stimulus parameters has allowed this study to show not only that distraction exerts an influence on recognition performance, but that an appropriate selection of parameters can make the difference between user performance that hovers around chance (in the case of roughness perception) to that which approaches 90% accuracy (in the case of body site). This is an important distinction we hope to investigate and clarify in our future work and one that already has clear implications for designers and systems developers.

References

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