Design and Evaluation of a New Sonification for Pulse Oximetry

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Background: The auditory display of the pulse oximeter is invaluable for providing information on a patient’s heart rate and saturated oxygen levels when a clinician is engaged in tasks that divert attention from the visual display, or when the visual display is temporarily out of the line of sight, or when the clinician is overtaxed with visual information [1, 2]. The auditory display of the pulse oximeter is a sonification: a continuous mapping of numerical data into one or more auditory dimensions [3]. Sonification allows the clinician to monitor a patient’s well-being in the periphery of attention while the clinician performs other visually demanding tasks [4]. The sonification used in current commercial pulse oximeters is relatively simple: the rate of tones is mapped to heart rate and the pitch of the tones is mapped to oxygen saturation levels. Unfortunately, without regular checks of the visual monitor, clinicians’ estimates of oxygen saturation can diverge considerably from the actual values, especially as noise levels increase [5]. We designed a new sonification to make clinically important oxygen saturation thresholds and ranges more discernable, and we performed an initial evaluation of its effectiveness.

Methods: We added sound dimensions of tremolo and brightness to a conventional pulse oximetry sonification so that three clinically relevant ranges were distinguished (in principle the range boundaries could be adjusted for different monitoring contexts). In a randomised controlled trial comparing the new sonification and the conventional sonification, non-clinical participants listened to short simulated pulse oximetry scenarios. We measured participants’ (1) accuracy at identifying oxygen saturation ranges, (2) accuracy at detecting transitions into and out of an oxygen saturation target range and (3) reaction time to detect transitions.

Results: Participants using the new sonification identified oxygen saturation ranges and detected threshold transitions significantly better than those using the conventional sonification, with performance reaching maximum possible levels with the new sonification. Participants using the new sonification detected threshold transitions significantly faster than those using the conventional sonification.

Conclusion: In simple perceptual classification and discrimination tasks, the new sonification supported faster and more accurate identification of general oxygen saturation ranges and threshold transitions than the conventional pulse oximetry sonification. We are currently testing whether the new sonification retains its benefits when participants are distracted by other tasks and by ambient noise. Subsequently we will test the new sonification with clinicians in more clinically representative situations.

References:


