Vibrotactile Displays for Conveying Pulse Oximetry Information

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Background: Several studies have tested if vibrotactile displays can convey information about patient vital signs to anesthesiologists. Results have been promising [1][2][3]. However most studies have used complex sets of vital signs and complex patterns. In the present experiments, we explored the potential for a vibrotactile display of HR and SpO$_2$ ranges to be conveyed effectively via three tactors (vibrotactile motors) on a sleeve worn on the upper arm [4][5].

Methods: HR range was mapped to the locations of three tactor(s) on the upper arm, the middle tactor indicating normal HR, middle and high tactors indicating high HR, and the high tactor indicating very high HR. The pattern was similar for low and very low HR, but using middle and low tactors. SpO$_2$ range was mapped to the number of times each tactor was activated: once for normal SpO$_2$, twice for low SpO$_2$, and three times for very low SpO$_2$. Non-clinical participants attended to sequences of the vibrotactile patterns. They tapped on a footpedal when the HR and SpO$_2$ value changed, and identified the new HR and SpO$_2$ values vocally. Under no load, participants identified vibrotactile signals only; under low load participants also moved small pellets between two locations; and under high load participants also moved small pellets between locations using laparoscopic graspers. Expt 1 tested with no load, Expt 2 and 3 compared performance under low and high load and in Expt 3 HR and SpO$_2$ changes were very infrequent.

Results: Participants could invariably detect changes in HR and/or SpO$_2$, and they identified those changes with accuracy significantly above 90% (Expt 1)[4]. With high load, identification dropped significantly compared with low load, but did not differ statistically from 90% (Expt 2). When changes in HR and/or SpO$_2$ occurred only every three minutes, and participants worked under low or high load conditions, participants’ ability to identify SpO$_2$ did not differ from 90% in any condition, except when participants tried to identify HR under the high load, where accuracy dropped to 72.5% (Expt 3) [5].

Conclusions: Non-clinicians can identify vibrotactile pulse oximetry ranges with acceptable levels of accuracy, except when task load is high and signals become infrequent. Further testing should be performed with clinician participants. Improved mapping of vibrotactile patterns to vital sign ranges may also help. At present we are testing an alternative mapping of HR and SpO$_2$ to tactors that may support robust identification even with high task load and rare changes in vital sign values.

References:
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