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COMFORTABLE SENSOR WRISTBAND FOR AMBULATORY ASSESSMENT OF ELECTRODERMAL ACTIVITY

Ming-Zher Poh (1,2); Nicholas C. Swenson (1); Rosalind W. Picard (1)

(1) MIT Media Laboratory, Massachusetts Institute of Technology, Cambridge, MA, USA.
(2) Harvard-MIT Division of Health Sciences and Technology, Cambridge, MA, USA.

Aims: Despite improvements in measuring equipment since the discovery of electrodermal phenomena more than 100 years ago, much of the research in this area has been limited to observational measurements performed over short periods of time in lab settings or artificial clinical environments. Our goal is to develop a wearable electrodermal activity (EDA) sensor that is low-cost, light, comfortable and unobtrusive to the user's activities for long-term ambulatory measurements of EDA.

Methods: We developed a wristband with data logging, data forwarding (wireless) as well as data processing capabilities. We integrated the sensor module into a regular wristband made out of terrycloth and used dry Ag/AgCl electrodes for recording. We also compared the performance of fabric electrodes to the Ag/AgCl electrodes. We tested our sensor's capabilities for EDA measurements under physical (n = 15), cognitive (n = 15) and emotional stressors (n = 13). For each experiment, we also evaluated the use of the ventral side of the distal forearms as a recording site for EDA measurements compared to palmar sites.

Results: All participants reported that the wearable EDA wristbands felt comfortable throughout the study. Recordings from our system using the Ag/AgCl electrodes and a FDA approved commercial system were strongly correlated (median correlation coefficient, $\tilde{r} \geq 0.9$) during the baseline, task and recovery period for all 3 experiments. Correlation between the fingers and distal forearm was very strong ($\tilde{r} \geq 0.8$) during the baseline and recovery periods. During the physical, emotional, and cognitive tasks, $\tilde{r}$ was lower but the correlations remain moderately strong ($\tilde{r} \geq 0.5$).

Discussion: The strong correlations between our device and the commercial system indicate that our device functions as intended. While palmar electrodes are encumbering, easily lost and frequently subjected to motion and pressure artifacts, our wrist-worn sensor does not impede the user's use of their hands, and is thus easier to wear for days and weeks. Evidence from the analysis of correlation of EDA between fingers and distal forearms suggest that there are large interindividual differences with a low proportion (<19%) of negative correlations. This could be due to differences in sweat gland distribution or skin sudomotor innervation.

Conclusions: Overall, our findings indicate that the ventral side of the distal forearms also produces sweat responses to emotional stimuli and is a suitable recording site for EDA. We have developed a novel wearable EDA sensor that is unobtrusive to the user's daily activities, non-stigmatizing and enables comfortable long-term assessment of EDA.