Introduction to the symposium on Ambulatory Skin Conductance

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Ambulatory skin conductance as we see it now emerging on the market with products like the Affectiva Q-sensor and the Basis B1, was promoted already in 1997 by Picard and Healey [1]. Also prototype devices such as the Empatica E3, the Smartband, and the Philips DTI-2 ([3] and figure 1) typically measure skin conductance at the base of the wrist, since this is a convenient measurement position. However, traditionally skin conductance (electrodermal activity, or galvanic skin response) is measured on the fingers, the palmar region of the palms, or on the soles of the feet. A traditional skin conductance measurement usually is also corrected with a baseline measurement, while for ambulatory measurements this needs to be self-calibrating. These differences in measurement position and procedure are among the factors that cause differences in measurement results.

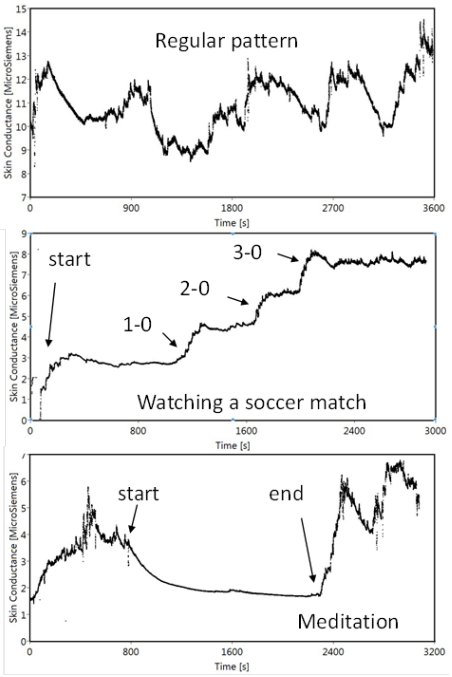

Figure 1. Skin conductance patterns obtained with the Philips DTI-2 prototype sensor wristband.

A comparison of skin conductance at the base of the wrist and on the fingers was published by Poh et al . (2010) [2]. A high accuracy and a strong correlation is claimed. In a study by van Dooren et al. (2012) [4] no less than 16 positions were compared. Fingers, foot, and forehead clearly offer the highest skin conductance with strongest skin conductance responses. At the wrist the responses are weaker but still present. On other body locations almost all skin conductance responses were absent. Apparently differences between measurement locations exist (see figure 2), although it is not clear whether these differences preclude the user of trustworthy ambulatory (wrist) measurement positions.

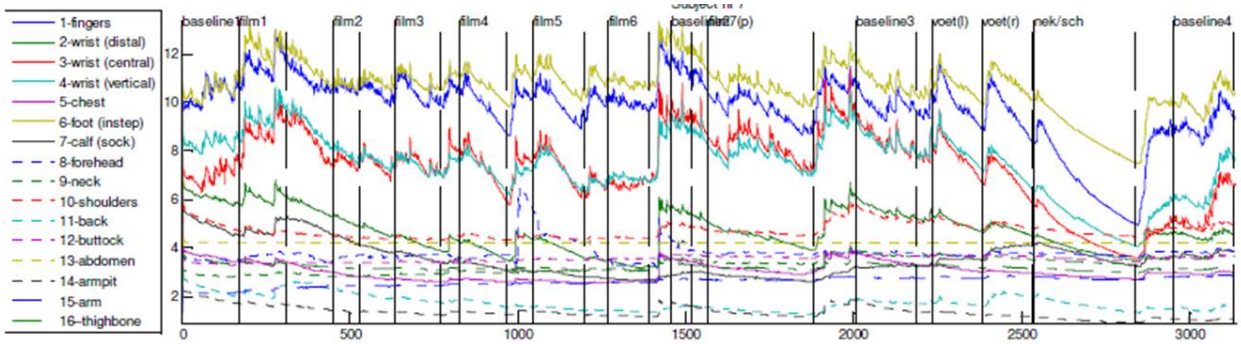

Figure 2. Skin conductance measured at 16 body positions simultaneously while subjecting the participant to a visual stimulus.

Another peculiar skin conductance phenomenon is the occurrence of non-responders and hyperresponders (see figure 3). Boucsein addresses it in his book (2012) [5]. Especially with psychopaths and schizophrenics non-typical electrodermal responses have been reported. Both non-responders and hyperresponders are sometimes removed from laboratory measurements, but have to be dealt with in practical applications.

This symposium addresses the applicability of ambulatory skin conductance measurement for practical applications. Are the measurements trustworthy enough to warrant useful applications, even when not measured at the traditional measurement positions? Is it possible to do formal baseline measurements in practical applications, and if not, is that a problem? How often do we find non-responders or hyperresponders in the populations of our interest?

The 5 contributors to the Ambulatory symposium each address these questions from a different angle. On the one hand, Eco de Geus presents data that shows that even properly baselined ambulatory skin conductance measurements should be supported by other measurements to give a true impression of the activity of our sympathetic nervous system. Nevertheless, the other symposium contributors explore the possibility of practical applications. Rafal Kocielnik describes a system that helps employees to get a better impression of their daily stress patterns, whereas Matthijs Noordzij explores the use of ambulatory skin conductance in the care for severely mentally disabled patients. Ewout Meijer discusses new developments in the old science of detection of deception, for instance expanding the domain to group measurements, which requires new measurement methodologies. Finally, Henk Nijman focuses on extracting useful information from skin conductance measured on patients in psychiatric wards, like indicators of upcoming aggression.

Overall we hope that this symposium gives a balanced overview of trustworthiness of ambulatory skin conductance measurement in practical applications.

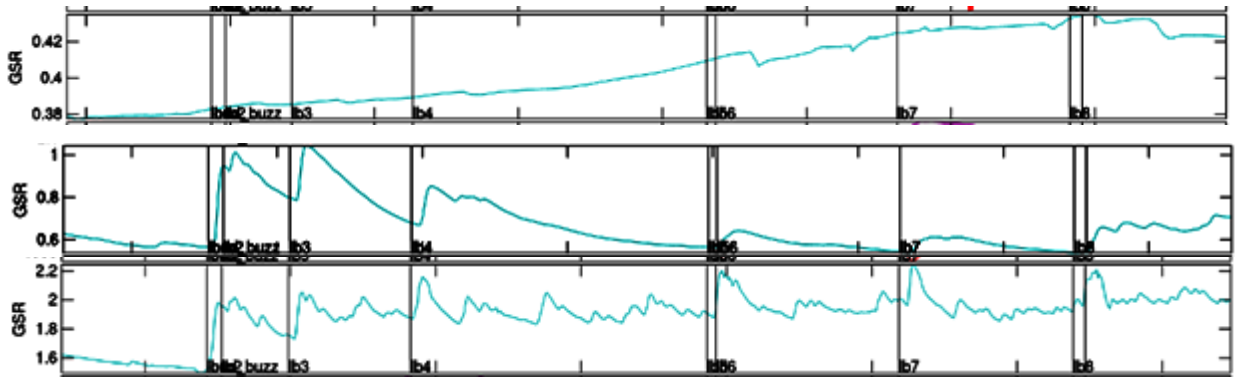

Figure 3. Skin conductance trace measured at the fingers during a number of loud buzzes (lb1 until lb8) : a) non-responder, b) normal response dying out, and c) hyperresponder.

References

[1] Picard, R.W., Healey, J. (1997). Affective wearables. *Personal Technologies, **1**(4),* 231-240.

[2] Poh, M.-Z., Swenson, N.C., Picard, R.C. (2010). Wearable sensor for unobtrusive, long-term assessment of electrodermal activity. *IEEE Transactions on Biomedical Engineering **57**(5),* 1243 – 1252.

[3] Ouwerkerk, M., Dandine, P., Bolio, D., Kocielnik, R., Mercurio, J., Huijgen, H., Westerink, J. (2013). Wireless multi sensor bracelet with discreet feedback. In *Proceedings of the 4th Conference on Wireless Health (WH'13),* 1–3 November, Baltimore, MD, USA. Article No. A6. New York, NY, USA: ACM.

[4] van Dooren, M., de Vries, J.J.G., Janssen, J.H. (2012). Emotional sweating across the body: Comparing 16 different skin conductance measurement locations. *Physiology & Behavior **106**(2),* 298–304.

[5] Boucsein, W. (2012). *Electrodermal Activity* (2nd ed.). New York, NY, USA: Springer Science+Business Media, LLC.