MOODMETRIC IN RESEARCH

Introduction to technology and data analysis

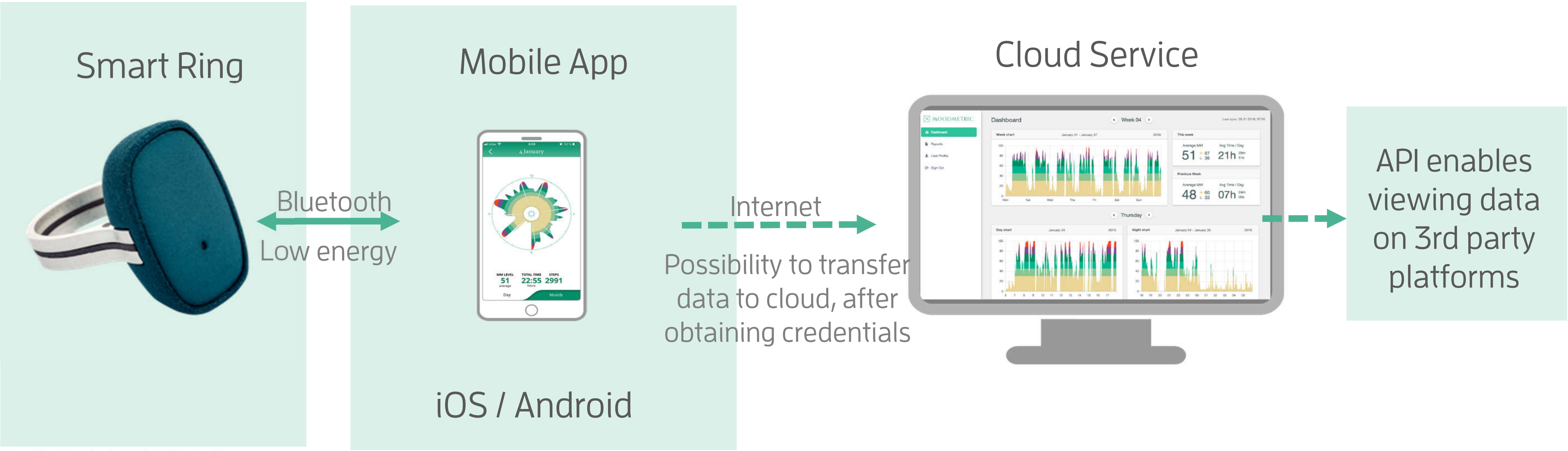
– The Moodmetric smart ring as a field research tool to study electrodermal activity

2020

MOODMETRIC

The Moodmetric measurement enables new and unique field research

- The Moodmetric index / the MM level (1-100) is calculated from the electrodermal activity raw signal
- The Moodmetric index
  - is robust, resistant to motional artefacts and comparable among users
  - is visible on the mobile app in real time
  - can be obtained as Excel or CSV format from the Moodmetric cloud or transferred via API
- Measured sample rate: 3 S / sec, stored sample rate: 1 S / min

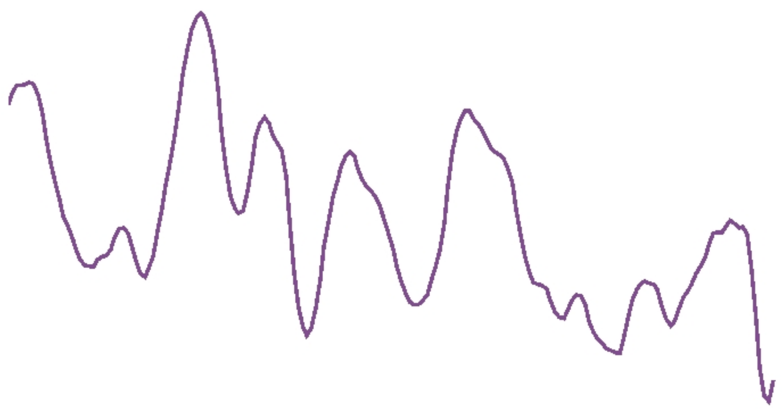


The Moodmetric ring as a research tool

- The Moodmetric ring provides **real-time and long term data on the activity of the sympathetic nervous system**.
- It provides the possibility to study **cognitive and emotional load** of an individual in normal daily life, outside a laboratory setting.
- The data provided by the ring can be applied in studies and research of, for example, learning, user experience, cognitive and emotional reactions, social interaction, and health and well-being.
- The Moodmetric measurement is especially suited for tests where measuring needs to be continuous and last for days or weeks:
  - the ring is easy to wear
  - the app for storing and viewing data can be downloaded to the user's smartphone free of charge
  - battery life of the ring is one week and charging takes only some two hours
  - the cloud service enables remote monitoring

What is typical to electrodermal activity signal?

- Electrodermal activity (EDA) reflects the functions of the autonomic nervous system (ANS) and is often used in evaluation of mental states, e.g. short- and long-term stress. The physiological stress reaction is strongly related to sympathetic nervous system (SNS). Because skin conductivity is mainly a result of sweat gland activity solely controlled by SNS, EDA is one of the most direct methods to measure the stress related ANS responses.
- Electrodermal activity is also known as skin conductance or galvanic skin response.
- The EDA raw signal is a continuously changing curve with no repeating pattern. Frequency and amplitude of the curve change according to SNS is activity.



What are challenges in studying the EDA raw signal and what Moodmetric provides to solve these?

- The EDA raw signal is sensitive to motional artefacts
  - The studied person should stay still during the measurement
  - When the sampling frequency is high and the signal is streamed continuously, the person needs to very near the receiving device
  - *Studying the raw signal requires a laboratory setting*
- The EDA signal is a specific physiological signal, with many relevant features. Understanding the raw signal requires good knowledge of relevant literature and preferably prior measurements with several different devices.

Moodmetric has understood these challenges and wants to provide a tool that is valid for field research

- The Moodmetric index (the MM level) has been developed to provide analysis of the raw signal
- The Moodmetric ring is very well suited to long term and continuous use in daily life.

The Moodmetric measurement data

- The Moodmetric indexed data – the Moodmetric level - is informative and accurate. This data is visible in real time on a smartphone app and it can be accessed via Moodmetric cloud.

The Moodmetric level describes the activity of the sympathetic nervous system on a scale of 0 to 100. The index is comparable among wearers and robust to motional artefacts.

- The basic principle of the algorithm is that it compares changes in electrodermal activity to the typical, standard values measured for the particular individual over the time of wearing the Moodmetric ring.
- The MM level is determined from the typical features associated with electrodermal activity: skin reactions per minute (SCR frequency), reaction amplitude, % of SCL value (SCV value), raw level of skin conductance (SCL).

The Moodmetric measurement data is available in several ways

- The Moodmetic Cloud → practical and available for both consumers and researchers.
- The Moodmetric API is available upon request. The API enables viewing of the data in the Moodmetric cloud through an external platform.
- **Software Developer Kit:** The Moodmetric SDK allows to develop mobile applications which can make use of the Moodmetric measurement data. SDK is available for download at https://www.moodmetric.com/research/
- **Raw data:** The Moodmetric ring does not store raw data due to limited memory size. Raw data detected by the ring can be accessed only by direct streaming from the ring to a Windows PC via BLE dongle.

  Requirement to understand the general limitations with EDA raw signal. Requirement of prior knowledge of EDA. Currently Moodmetric does not provide an analysis software to work with the signal. If you wish to analyse specific features of raw signal, you can calculate the parameters you mentioned.

  How do I work with the Moodmetric raw data?

  - You need a Windows PC and a special BLE dongle
  - Download the needed tools at https://www.moodmetric.com/research/
  - Study the SDK documentation

Summary

The Moodmetric smart ring provides both raw data and data with facilitated interpretation.

The ring and data analysis have been developed for field research. The Moodmetric index (the MM level) is a result of aiming to provide the best possible tool to study stress and arousal continuously and in long term, in daily life. The ring makes it possible to study raw data, but we at Moodmetric hope that in addition to laboratory spot measurements, long term measurements at the field would more and more come into picture.

Moodmetric currently does not provide analysis tools to examine the raw data.

The Moodmetric smart ring is commercially available. In addition to research, it is a tool for personal and occupational well-being.

Publications

Tomppa Pakarinen, Julia Pietilä, Hannu Nieminen. 2019. Prediction of Self-Perceived Stress and Arousal Based on Electrodermal Activity https://ieeexplore.ieee.org/document/8857621.
41st International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC).

Jari Torniainen, Benjamin Cowley, Andreas Henelius, Kristian Lukander, Satu Pakarinen. 2015. Feasibility of an electrodermal activity ring prototype as a research tool https://ieeexplore.ieee.org/document/7319865. 37th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC).

Jari Torniainen, Benjamin Cowley. 2016. A short review and primer on electrodermal activity in human computer interaction applications https://arxiv.org/abs/1608.06986

Päivi Heikkilä, Anita Honka, Sebastian Mach, Franziska Schmalfuß, Eija Kaasinen and Kaisa Väänänen. 2018. Quantified Factory Worker: Expert Evaluation and Ethical Considerations of Wearable Self-tracking Devices. https://dl.acm.org/citation.cfm?doid=3275116.3275119 In Proceedings of Academic Mindtrek conference (Mindtrek 2018). ACM, Tampere, Finland.

Jussila, J., Venho, N., Salonius, H., Moilanen, J., Liukkonen, J., & Rinnetmäki, M. (2018, October). Towards ecosystem for research and development of electrodermal activity applications. https://dl.acm.org/doi/10.1145/3275116.3275141 In Proceedings of the 22nd International Academic Mindtrek Conference (pp. 79-87). ACM.

Moodmetric in health & well-beig

Moodmetric is a company providing services for both research and health and well-being. The Moodmetric stress management services are based on studies that have applied the Moodmetric measurement and research of electrodermal activity in general.

The scientific background for interpreting the Moodmetric index in stress management

1. Autonomic nervous system homeostasis (Cannon 1932)
2. Electrodermal activity as a psychological biomarker of stress (Boucsein 2012)
3. The relation between stress and performance (Yerkes & Dodson 1908)
4. Job-related affective wellbeing (Warr 1987)

Boucsein, W. (2012). *Electrodermal activity*. 2nd ed. Boston, MA: Springer US.

Cannon, W. (1932). *The Wisdom of the Body*. New York: Norton.

Warr, P. (1987). *Work, Unemployment, and Mental Health*. Oxford: Clarendon Press.

Yerkes, R. M., & Dodson, J. D. (1908). The relation of strength of stimulus to rapidity of habit-formation https://doi.org/10.1002/cne.920180503. *Journal of comparative neurology and psychology*, 18(5), pp. 459-482.

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