Supporting Meditative Awareness through affordable Wearables

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Contents

1 Introduction

In our world of ever growing connectivity resulting in almost permanent availability and a multitude of additional sensory stimuli, high levels of stress have become more and more common to a lot of people. Regarding these developments effective stress reduction techniques like meditation are getting more important for the general population.

With the growing need for effective stress reduction, science needs to catch up. Since meditation especially has proven to be very potent in the area of stress relief [1] but very hard to grasp scientifically as a whole, based on the fact that it represents a complex mental activity which uses a variety of brains functions some of which are not fully understood by today's scientists. As well as the science of the mind, meditation is still an area which needs to be investigated further.

To contrast the topic of this elaboration we try to connect guidance during meditation with affordable wearables. The guidance should provide usability similar to popular meditation apps like Headspace [3] and Calm [2], which aim to provide an easy entry point into a personal mediation practice with a focus on guided meditations, where every meditation session provides auditory guidance for the user.
Since wearables experienced steady advancements in recent years the possibility of a big variety of new and unforeseen use cases opened up [4]. Regarding these developments the elaboration should try to identify wearables which improve the way of supporting the meditator in a more profound and customized way. Based on these findings the article aims to evaluate if there are suitable and affordable wearables which are able to track the awareness during meditation.

Therefore the article tries to identify fitting measurement parameters first to help finding the right wearables to measure one's meditation success. Some parameters like lower Heart Rate, slower breathing or Skin resistance are being used to measure the relaxation during meditation. Others indicators like higher Heart Rate Variability or Nervous System Activity and Stress Hormones can show short term and long term levels of stress. While measurement parameters as Electrical Brain Waves or plotting the activity of Brain Areas can give insight into the inner workings of the brain during meditation. Based on the measurement parameters the article is looking which devices are normally used to measure the parameters and if there exist equally deployable wearables which are reliant and affordable enough to make them usable for the average consumer.

All in all the article will evaluate if there are currently affordable wearables which are cheap enough for everyday use and able to improve the meditation sessions of its users. Finally the text tries to give an outlook regarding possible further developments of wearables to measure the users meditation practice in everyday life.

2 Measurable parameters and fitting devices

2.1 Introduction

Since Dr. Herbert Benson published his Paper ”Relaxation Response” in 1974 relaxation was scientifically identified as a direct result of meditation. It coins parameters like heart rate, stress hormones and blood flow to certain areas of the brain as indicators for relaxing results of meditation.

2.2 Nervous System Activity

2.2.1 Interpretation

The ANS is split into the Sympatatic Nervous System (SNS), which is associated with stimulating nervous system activity and Parasympathic Nervous System (PNS), which is associated with relaxation. Since autonomic function of the central nervous system use certain areas of the brain its current activity can be visualized with neuroimaging techniques. Today Functional magnetic resonance imaging (fMRI) is the most commen of these techniques. (s. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4726771/) fMRI can provide detailed images of human brain that reflect localized changes in cerebral blood flow and oxygenation induced by sensory, motor, or cognitive tasks. (s. https://www.sciencedirect.com/science/article/pii/0165027094901910) But because MRIs need a very strong magnetic field to function the current devices are very large and not suited for a use as wearable. Alternatively Functional Near-Infrared Spectroscopy (fNIRS) can be used. fNIRS maps human brain function by penetrating the skull with near-infrared light by illustrating the hemoglobin concentration in different brain areas. (s. https://www.sciencedirect.com/science/article/pii/S10538119130 Which can be worn as mobile caps or headbands.

2.2.2 Possible Devices

wearable fNIRS: https://www.sciencedirect.com/science/article/pii/S1053811913007003

2.3 Heart Rate

2.3.1 Interpretation

Exposure to a stressors results in elevated heart rate (https://onlinelibrary.wiley.com/doi/full/10.1111/j.154 474X.2005.10101.x - Abstract and https://www.jstor.org/stable/23995394?seq=1).

2.3.2 Possible Devices

One possible Device for measuring ones heart rate is a heart rate monitor which normally is clipped on the finger or strapped around ones chest. The price range for chest strapped heart rate monitors, which is the most accurate option (s. https://europepmc.org/article/med/28709155) is around 30-150€(s. Amazon suche herzfrequensmesser brust), but can be even below 5€in cheap fitness tracker wristbands, which include several sensors for measuring bodily function and may therefore not optimized for accuracy regarding the other measuring options (s.https://europepmc.org/article/med/28709155).

2.4 Heart Rate Variability

2.4.1 Interpretation

Heart rate responds dynamically to physiologic changes (https://onlinelibrary.wiley.com/doi/full/10.1111/j.474X.2005.10101.x - Abstract). When heart rate increases due to activating physiologic stimuli the interval between two concurrent heart beats becomes smaller and vice versa, this variability is the basis for the heart rate variability (HRV) measurement (s. https://www.nature.com/articles/s41746-019-0150-9 - Fig 3). The two main variations in HRV-measurements are short-term measurements (mostly 5 minutes) and 24h measurements. Analysis of HRV provides the ability to evaluate the current state of the autonomic nervous system (ANS), its main regulator. The ANS is split into the Sympatatic Nervous System (SNS), which is associated with stimulating nervous system activity and Parasympathic Nervous System (PNS), which is associated with relaxation. The current balance between SNS and PNS are reflected in the current HRV value. When the SNS dominates HRV decreases and with and an dominant PNS increases HRV (s.https://link.springer.com/article/10.1007/s11517-006-0119-0). Since the state of relaxation therefor PNS activity is an important indicator of deep meditation, HRV presents as a good measurement parameter for real time evaluation of meditation.

2.4.2 Possible Devices

There exist certain apps which can measure HRV with a heart rate monitor as describes in Section 2.2.2.

2.5 Skin Resistance

2.5.1 Interpretation

The skin conductance response, also known as the electrodermal response defines the improved properties of the skin as an electrical conductor, when either external or internal stimuli occur which are physiologically arousing (s. https://www.media.mit.edu/galvactivator/faq.html).

2.5.2 Possible Devices

s. https://www.media.mit.edu/galvactivator/faq.html

2.6 Stress Hormones

2.6.1 Interpretation

Adrenalin (also known as epinephrine) is excreted by the adrenal glands as an response to activation of the sympathetic nervous system. A elevated blood level of adrenalin triggers the bodies fight or flight response and is an indicator of short term stress.
Cortisol results from hormonal signaling in the HPA axis, which consists of the hypothalamus, the pituitary gland, and the adrenal glands. The cortisol release is follows the initial adrenalin surge and keeps the body in an alert state for long periods at a time. Even so it rises and falls naturally throughout the day chronically elevated blood levels of cortisol can serve as a indicator of long term stress. (s. https://www.health.harvard.edu/staying-healthy/understanding-the-stress-response)

2.6.2 Possible Devices

The current Adrenalin level is more often measured with a urine test than with a blood test (s. https://medlineplus.gov/ency/article/003561.htm). Whereas Cortisol also allows testing of saliva in addition to blood and urin tests. Most recently scientists at Stanford developed an on-body Cortisol measurement with a patch-type wearable sensor (s. https://advances.sciencemag.org/content/4/7/eaar2904.short). 2.) https://www.nature.com/articles/s41598-017-13684-7 -¿ conclusion

2.7 Electrical Brain Waves

2.7.1 Interpretation

EEG measures the electrical activity in the brain with the use of metal electrodes which are directly attached to certain points of the head which represent certain areas of the brain. Magnetoencephalography (MEG) allows direct imaging of human brain electrophysiology by measurement of magnetic fields generated at the scalp by neural currents. Real time 3D data is created based on Mathematical analysis of those fields (s. https://www.nature.com/articles/nature26147). MEG: https://gizmodo.com/this-brain-scanner-is-way-smaller-than-fmri-but-somehow-1824034849

2.7.2 Possible Devices

https://penntoday.upenn.edu/news/innovative-technology-wearable-portable-EEG-moves-brain-monitoring-from-lab-to-real-world https://brainbit.com/ https://www.gtec.at/product/gnauti research/

3 Evaluation sufficiency of found wearables to measure meditation

4 Conclusion

5 Outlook on possible further development regarding wearables for measuring meditation

Like mentioned in the Introduction of this text there are already meditation apps which try to support the meditator.
With regards to the past where the developed devices one could project that technical devices become more powerful and versatile in the future. In parallel a lot of this devices also shrunk in size. Especially the last point is a very important aspect for further development in the field of wearables, since smaller objects are less obstructive to wear on the human body and make it possible to combine several devices into one wearable which provides a wider range of functionality. As a result the meditation apps will be able to be a lot more accurate and personalized in the way they support the mediator.
Furthermore it is important to mention that for becoming broadly used wearables have to be affordable for the average user. Especially in the areas of measuring the nervous system activity and electrical brain waves device range is still high and has room for improvement. Which the technological advances and optimization of production processes or materials could provide.

Big Data and machine learning are also two very interesting fields in the regard to the combination of meditation and wearables. Since wearables constantly collect data this data can be shared in the cloud and allow machine learning algorithms to find patterns in meditation which can be used to optimize meditation sessions or even find new insight in to the processes and insights of the meditating brain.

6 Glossary

7 Appendix

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