RADAR-base: Major Depressive Disorder and Epilepsy Case Studies

Background
Emerging mobile health technology could provide opportunities for remote monitoring and interventions for people with mental health and neurological disorders. RADAR-base is a mobile/web health data collection platform built around Confluent and Apache Kafka. Here we report progress on studies into two brain disorders: major depressive disorder and epilepsy. Initial results show smartphones and wearable devices have potential to improve care for patients with depression and epilepsy.

Aim 1: Major depressive disorder
An ambulatory study monitoring MDD patients is being conducted across three sites. The objective is to collect regular self reported symptoms and metrics, such as sleep and ambulatory behaviour. High resolution data is being collected over a period of up to two years for each participant. Features from the passive data will be used to predict the mood state of participants, using both the questionnaires collected through the 4MT app, and through less frequently collected email questionnaires.

Aim 2: Epilepsy
An in-hospital study is being carried out at two epilepsy monitoring units, to compare wearable devices against the gold standard of clinician labelled events using video EEG. The goal in this study is to develop an algorithm to detect or predict seizures, and to compare the capabilities of study devices for a follow-up ambulatory study.

HOW IT WORKS
RADAR-base is composed of back-end infrastructure and a front-end mobile app stack for active monitoring of participants requiring conscious action (e.g., questionnaires, audio questions, timed tests), and pRMT, a native Android app for passive monitoring of participants via smartphones and wearable sensors. In addition, devices with data available from another cloud service through an API can be integrated, which is the case for Fitbits worn in the MDD study.

The two studies, MDD and epilepsy, generate data with very different complexity, volume, frequency and duration, displaying the versatility of the RADAR-base platform.

- Remote data collection for up to concurrent 500 participants with major depression over the course of 2 years.
- In-Hospital high frequency data collection for Epilepsy seizure detection for a period of ~1 week per subject.

RESULTS AND VISION
The preliminary data from the MDD study shows a range of depressive symptoms, with a mean PHQ-8 score of 10.4 and standard deviation of 6.2 in the 76 PHQ-8 questionnaires so far recorded. Five participants have had a depressive episode, progressing from a PHQ-8 score < 10, no depression, to a score > 10, current depression, in the following questionnaires. Of those, one returned to a ‘no depression’ state after a week. There is, therefore, already a small amount of intra-individual variation recorded, although longitudinal effects should become clearer as the follow-up data collection period continues.

A tonic EDA response during the post-ictal period has been noted, and often occurs within the RADAR-EPI dataset. An example is given in Figure 3 showing an Empatica E4 recording of acceleration and EDA over a night’s sleep. The EDA trace shows tonic peaks in the EDA, but they do not coincide with a seizure, as the tonic peaks in the EDA occur at 05:05 followed by a large increase in skin conductance, with a peak at 05:10. There are other tonic peaks in the EDA, but they do not coincide with a seizure-like accelerome coherent trace. Equally, there is not evidence of tonic or repetitive elsewise confusible characteristics in the inter-ictal period being followed by an EDA response. Although not totally consistent across all participants and all seizures, it is a general pattern that illustrates the potential to use multiple modalities for increased specificity.

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