Asymmetry of Electrodermal Activity on the Right and Left Palm as Indicator of Depression for People Treated with TMS

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Introduction

What are the limitations of the methods for depression diagnosis?

Though useful for semantic and billing purposes, DSM-based or depression rating scale-based approaches have limited utility for 1) determining subtypes of depression; 2) capturing variations over relatively short time periods (i.e., over the course of a day), and 3) predicting the course of the illness.

Surprising recent findings

- Amygdala activation has been shown to elicit ipsilateral Electrodermal activity (EDA) which provides a fine measure of sympathetic nervous system arousal [1-2].
- Brain imaging [3] and recent findings [4] have shown that depression might lead to larger right amygdala activation
- Therefore we hypothesize that depressed people have larger electrodermal activity (EDA) on the right than on the left palm.
- It is important to validate that hypothesis because it may lead to a discovery of an objective biomarker for the diagnosis, prognosis, and treatment of depression

Methods & Analysis

Participants

9 adults with Major Depressive Episode, undergoing Transcranial Magnetic Stimulation (TMS)

Procedure

- 6 participants attended 36, and 3 participant attended 72 daily TMS sessions lasting 20-37 minutes each
- Symptom severity was measured at baseline and throughout treatment (every 10 sessions) by a clinician

Devices

During the experiment the users wore on both palms the Q sensor, a wireless non-invasive sensor.

Measures

- Q sensor measures EDA, motion (actigraphy), and temperature.
- Clinician collected symptom severity scales every 10 sessions: 28-item Hamilton Depression Rating Scale (HAM-D28); Quick Inventory of Depressive Symptoms (QIDS); Patient Health Questionnaire (PHQ-9).

Data analysis

- We evaluated the relationship between the two palmar EDA signals during TMS sessions and depression measures. We applied a low-pass filter to each EDA raw signal (1024-point Hamming window, 3Hz cut-off frequency) to reduce motion artifacts and electrical noise. Then we calculated average EDA level on each palm for every session and subtracted the left hand from the right hand mean value to obtain mean difference (EDA_{R-L}).
- We used the linear mixed-effect with random intercepts and slopes to assess relationship between the mean EDA difference from the palms and the depression measures using the following model:

$$Dep\_sc_i = \beta_{0i} + \beta_{1i} * EDA_{R-Li} + \varepsilon_i$$

Where:

Dep_sc_i – depression scale value for i-th person
β_{0i} – i-th person intercept, $\beta_{0i} = \beta_0 + \mu_{0i}$, and $\mu_{0i} \sim N(0,\sigma_0^2)$
β_{1i} – i-th person slope, $\beta_{1i} = \beta_1 + \mu_{1i}$, and $\mu_{1i} \sim N(0,\sigma_1^2)$
ε_i – i-th person error, and $\varepsilon_i \sim N(0,\sigma^2)$

Motivations

- EDA signal changes during depression [5] and understanding its patterns is very important to study depression.
- Previous studies [4] have shown that EDA signal has strong right-dominant asymmetry around the events associated with anxiety and sadness – the emotions often experienced during depression
- Validation of EDA signal asymmetry may lead to discovery of new depression biomarker which can transform practice of diagnosis, prognosis and treatment of depression

Results

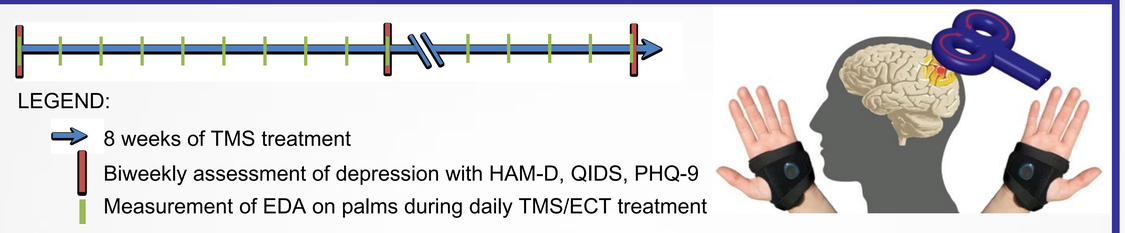

Fig. 1: Depressed patients wore Q sensors on the palms during daily TMS sessions.

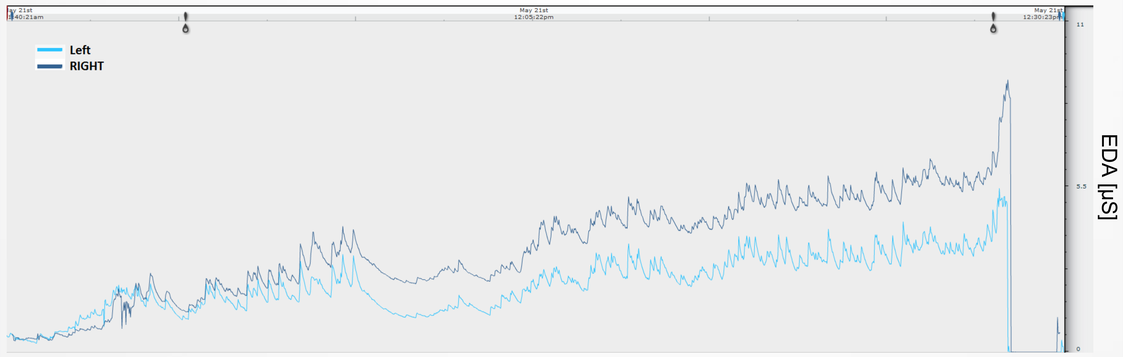

Fig. 2: Example of EDA recordings from the left (light blue) and right (dark blue) hand palm during a TMS session when right dorsolateral prefrontal cortex was stimulated

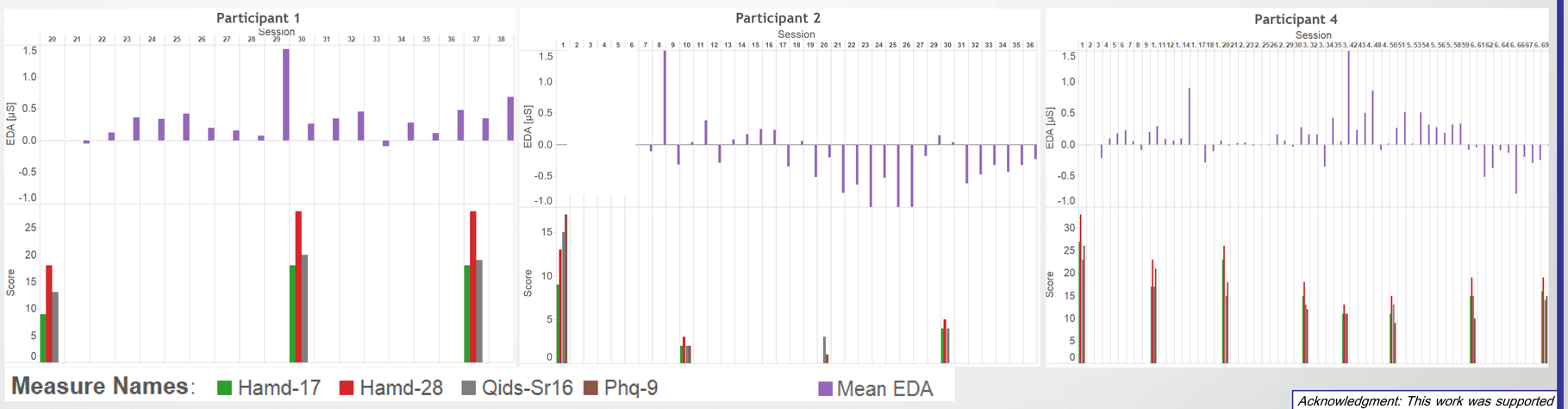

Fig. 3: EDA difference from the right and left palm averaged for every TMS session and corresponding depression measures from 3 participants.

Conclusions

Relationship between EDA and depression measures

Initial findings show that asymmetry of EDA signal from both palms measured during TMS session has a pattern associated with the depression measures. We compared QIDS scores and mean EDA difference from palms from the sessions delayed by 3 days using the described linear mixed-effect model. We obtained the value for intercept (β_0) 13.9 and for the slope (β_1) 2 ($p<.05$). This indicates that EDA signal follows the pattern of the depression scores with a delay of 3 days – when the depression worsens (improves) the EDA on the right hand becomes more (less) dominant.

Possible implications for the depression diagnosis and prognosis

These data have the potential to provide objective biomarkers to advance understanding, diagnosis and prognosis of depression. We will extend our analysis to a larger population and to an ambulatory measurements and the results, if confirmed, will enable depression early diagnosis and treatment response.

Literature cited

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Full Disclosure: Picard is a full professor at MIT and also co-founder of Affectiva, the company that made the sensors used to collect the data in this study. She participates fully in MIT's monitoring of conflict-of-interest procedures.

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