Multimodal Validation of Facial Expression Detection Software for Real-time Monitoring of Affect in Patients with Suicidal Intent

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BACKGROUND

High risk for suicide is typically assessed by clinicians using questionnaires and interviews. Although useful in a wide range of clinical settings, this assessment approach has many disadvantages e.g., misinterpretation of subtle differences in meanings of words used in emotional scales, objective and subjective biases and difficulties in reliably assessing the intensity of the emotion. Most significantly, these cues can be missed with catastrophic consequences.

In this context, we suggest that novel, non-intrusive facial affect detection technology could play a role in the clinical evaluation of suicidal ideation. We report on the acquisition of discrete emotional states (i.e., fear, sadness, joy, anger, disgust and surprise) while the patient is participating in a standardised task utilising the presentation of emotionally challenging images.

OBJECTIVES

We sought to test the hypothesis that previously validated biomarkers of high risk for suicide, namely event related potentials (**ERP**), Galvanic skin response (**GSR**) and heart rate variability (**HRV**) can be employed in combination with **facial affect** and pupil dilation measures, in a novel diagnostic battery that will ultimately increase reliability of clinical evaluations of suicidal persons.

MATERIALS AND METHODS

Participants

Suitable patients and age-/gender-matched healthy controls (subjects with no history of suicidal ideation, were recruited from South Dublin and Wicklow Mental Health Directorate. All participants were screened by an experienced psychiatrist through a standardized clinically conducted diagnosis of either depression, bipolar depression or borderline personality disorder. Clinical exclusion criteria included current alcohol dependence and/or drug misuse.

Measures acquired and data acquisition technology

Real-time facial and physiological data were acquired using the **iMotions FACET system software** package (http://imotionsglobal.com) integrated with a **Shimmer** unit to measure GSR and HRV.

Further, we acquired continuous EEG data using the **Emotiv EPOC system and headset** (http://epoc.com), a wireless high resolution revolutionary brain computer interface capable of recording EEG data comparably to traditional EEG devices. Emotiv EPOC features 14 EEG channels plus 2 references offering optimal positioning for accurate spatial resolution. Channel names based on the international 10-20 electrode location system are: AF3, F7, F3, FC5, T7, P7, O1, O2, P8, T8, FC6, F4, F8, AF4, with CMS/DRL references in the P3/P4 locations and uses sequential sampling method, single ADC, at a rate of 128 SPS or 256 SPS* (2048 Hz internal). Emotiv EPOC operates at a resolution of 14 bits or 16* bit per channel with frequency response between 0.16 - 43 Hz. The experimental set up is shown in Fig.1

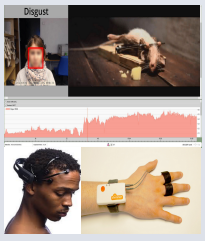

Fig.1. Top: An example of real-time face recording from a participant; bottom left, the Emotiv EPOC system; bottom right: The Shimmer Wearable Sensor System

Behavioural task employed

Data were acquired from participants during presentation of emotionally challenging images randomly selected from the Geneva affective picture database (GAPED). Images (N= 48) were subdivided in 3 categories, each containing 16 images: 1) sad (average emotional valence score: 26.7/100); 2) neutral (average emotional valence score: 55.5/100); 3) positive (average emotional valence score: 91.5/100). Each image was presented for 6 sec, with an interval of 8 sec between each image. Categories were randomized throughout the session (Fig.2).

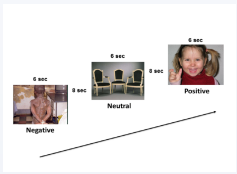

Fig.2. The image presentation task employed

PRELIMINARY RESULTS

FACET

Differences between conditions for FACET measures (N= 33) began to appear approximately 1 second after stimulus presentation (Fig.3). Post-hoc comparison for between-subjects effects revealed significant differences for "sadness": F(1,31)= 7.333, p= .011 and "anger": F(1,31)= 4.012, p= .054 (near significant)

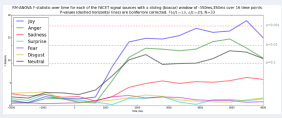

Fig.3. RM-ANOVA F-statistic over time for each of the FACET sources with a sliding (boxcar) window of -350 ms, 350 over 16 time points. P-values (dashed horizontal lines) are Bonferroni corrected. (F(*d f*1= 1.6, *d f*2= 47), N= 33

EEG/ERP

The P300 was identified to be present in the time region of approximately 300ms to 800ms post-stimulus. Average amplitude across trials within this time region was computed for each condition for each subject (N=16) for input to the RM-ANOVA model. The sum of channels O1+O2 was used as the primary epoch window. A significant relationship for stimulus type was found F(1.54, 16.941) = 5.099, p= .015. Results are Greenhouse-Geisser corrected (Fig.4).

Fig.4. Event related potentials (ERP) elicited after presentation of sad, neutral or positive images within 1000 ms epochs

GSR

Galvanic Skin Response values (N= 33) following stimulus presentation are epoched into five 3 second segments (0s-15s) with the 500ms preceding stimulus onset as a baseline. So far, a weak trend for a within-subject main effect for stimulus condition exists F(1.159, 35.493) = 2.875, p = .094

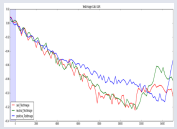

Fig.5. Galvanic Skin Response values following stimulus presentation are epoched in 1 second segments. So far, no effects have been revealed (Fig.5)

HRV

Time had a significant main effect [F(6, 102) = 12.66, p <0.001)]. Moreover, HRV was significantly different in patients (N= 10) and healthy controls (N= 9) (F(1,17)= 4.63, p= 0.046). These results are shown in Fig.6

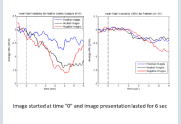

Fig.6. Heart rate variability (HRV) for patients and healthy controls during and after image presentation

CONCLUSIONS

Our preliminary results suggest that our data acquisition set up is sensitive image emotional valence. A larger subject population is needed to confirm these results and to investigate putative anomalies in suicidal patients.