Depression, Anxiety, and Pain: precision tools to measure behavior and improve treatment

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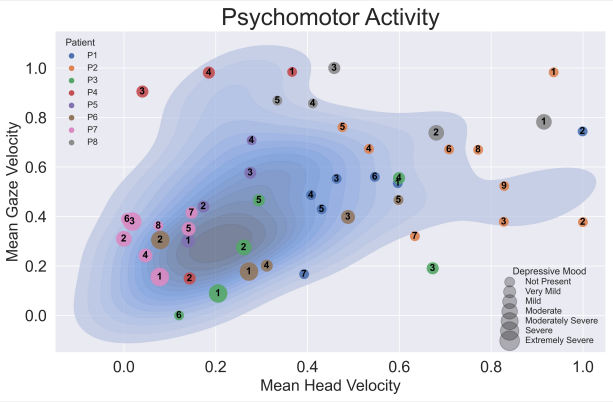
Introduction.
Chronic pain affects up to 28% of U.S. adults, costing ~$560 billion each year.[1] Depression and anxiety are markedly frequent among people in chronic pain: a third of patients have either depression or anxiety and about half have both depression *and* anxiety.[2] Depression and anxiety complicate treatment as physicians often struggle to correlate that narrative with a pathophysiology that they can treat. *Bridging the divide between patient experience and pathophysiology remains a critical barrier to more effective treatment.*[3]

We introduce the Pain Intervention and Digital Research (Pain-IDR) program—a new research clinic that seeks to address this barrier. As part of our larger research portfolio, we present preliminary tools that quantify:
(1) A depression and anxiety phenotype
(2) A digitized emotional state assessment



1 Depression-Anxiety Phenotype.

We sought to quantify a DA phenotype using large-scale questionnaire data in the UK Biobank. To test the feasibility of this approach, we extended a data reduction strategy we have successfully employed with behavioral data.[4]

Dataset. We used 1,029,903 non-imputed responses to depression and anxiety questionnaires from 49,043 people.

Analysis. We used canonical correlation analysis (CCA) to summarize the responses and define 7 canonical scores (CCA Score 1 shown at right).

Result. Depression and anxiety symptoms have a highly significant correlation (rho=0.7, p=0 based on analytic null distribution from 1,000 CCA iterations on randomly permuted data) and can be used to predict one score from the other.

Take-home. Pilot analyses demonstrated that CCA can summarize otherwise noisy DA questionnaire data as a quantitative phenotype.

2 Digitized emotional state assessment.

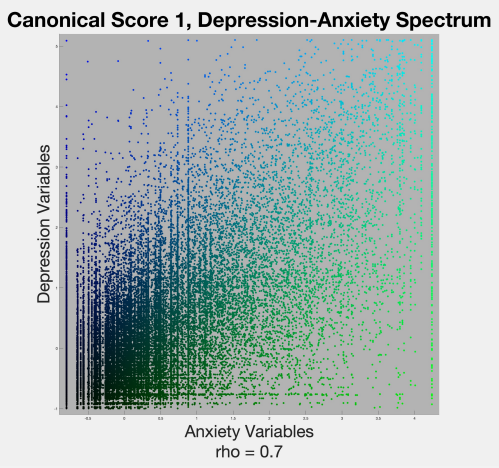
This tool was developed in previous work,[5] we present these results to demonstrate a facet of what we will collect at the Pain-IDR.

Dataset. Open-ended questions were used to elicit natural, nonstructured spoken responses from admission to discharge in 48 sessions from 8 acutely ill psychiatric inpatients at Yale University.

Analyses. We used inexpensive, consumer-grade equipment and publicly available, automated tools to derive face, acoustic, and linguistic measures. We reference clinician-ratings standardized in the Brief Psychiatric Rating Scale (BPRS) to show that the derived measures infer clinically relevant phenotypic information about disease state within sample and in an independently collected, external validation set (142 sessions in 81 patients).

Result. Face psychomotor activity (mean head pose velocity and mean gaze velocity along the y-axis) tracks clinician-rated depression score. The trajectory of faster head and gaze movement as depressive mood score decreases among participants (left).

Take-home. Digitized emotional state assessments are feasible with consumer-grade devices and open-source software.



Future Directions.
The Pain-IDR is a new research clinic that develops quantitative tools to assist patients and clinicians in optimizing treatment selection.

The depression-anxiety phenotype and digitized emotional state assessment form part of a larger initiative to define High-frequency Ecological Recordings of Mobility, Emotion, and Sociability (HERMES) phenotypes. We expect the HERMES workflow to identify a digital biomarkers that assess and monitor chronic pain patients and, in the future, provide decision support regarding efficacious treatment.

For more information about the Pain-IDR or the HERMES workflow, please email Dr. Barron (dbarron2@bwh.harvard.edu) or follow him on Twitter (@daniel__barron).

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4. Barron, D. S. *et al.* Transdiagnostic, Connectome-Based Prediction of Memory Constructs Across Psychiatric Disorders. *Cereb Cortex* 371 (2020) doi:10.1093/cercor/bhaa371.
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