Automated Extraction of Fatigue Content from Voice Diary Data

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SUBMISSION DETAILS

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Methodological Issue Being Addressed Is it feasible to extract measures of patient fatigue from multi-lingual voice diary data using a fully automated analytic pipeline, and will these measures correlate with patient reported outcomes?

Introduction Patient reported outcomes (PRO) are a cornerstone of clinical trials but can be too burdensome for high frequency use. Fatigue is present in many neurological and immune mediated inflamatory disorders and chronic diseases such as IBD, and is often the symptom with the greatest patient impact.
A daily voice diary could provide a low-burden method for collecting high-frequency patient fatigue symptom data, but manual transcription and analysis of this data would limit scalability.
We developed an automated analytic pipeline to extract fatigue symptom content from multi-lingual voice diaries. We evaluated whether fatigue symptoms measures derived using this method correlate with validated PRO measures of fatigue.

Methods The IDEA-FAST consortium is investigating digital biomarkers of fatigue and sleep in neurological and immune disorders. A feasibility study was conducted prior to a larger clinical observational study. This included an optional brief daily voice diary task delivered via an app. Patients with Parkinson's disease, Huntington's disease, Lupus, Rheumatoid Arthritis, Primary Sjogren's Syndrome, IBD and healthy controls were recruited. Patients were English, Dutch and German speakers and completed daily voice diary entries in their own language, over the course of a four-week study.
Patients also completed the FACIT-F Fatigue Scale weekly.

The voice diary data was transcribed and translated to English using the Whisper ASR model. The translated transcripts were divided into sentences and each sentence manually labelled by content type, including whether the sentence describes a state of fatigue or subjective energy.

The all-roberata-large-v1 pretrained large language model was used to obtain semantic vectors for each sentence.

The sentences "I feel tired" and "I feel full of energy" were chosen as canonical descriptions of fatigue or energy in this dataset, and semantic vectors were calculated for these two reference sentences. For each sentence we calculated the cosine distance to the closest reference sentence and constructed a fatigue score as (1 – normalised closest reference distance)2, multiplied by -1 if the sense was negative (closest to "I feel tired").
For each participant the mean of their weekly FACIT-F score was calculated and correlated with the mean of the semantic fatigue measure.

Results 64 participants opted to record voice diary entries, producing 853 diary entries, consisting of 5.96 hours of voice audio data. The transcription, translation and tokenisation pipeline yielded 3980 sentences, of which 386 were manually coded as being either fatigue or energy related. The aggregated fatigue scores for each patient obtained by the automated analytic pipeline across the study correlated with aggregate weekly FACIT-F scores with a correlation coefficient of .2731 and p value of .0332 (95% CI [0.02, 0.49]).

Conclusion These data demonstrate the feasibility of automatically extracting patient symptoms from unstructured speech. These symptom scores correlate with validated scale measures. The pipeline can extract symptom scores without reliance on human transcription or translation, potentially enabling deployment at scale. Further analytical work will examine the validity of this finding by exploring other reference sentences and address reliability by analysing data at multiple timepoints.

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Guidelines I have read and understand the Poster Guidelines

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