Improving diagnostic procedures for epilepsy through automated recording and analysis of patients' history

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BACKGROUND

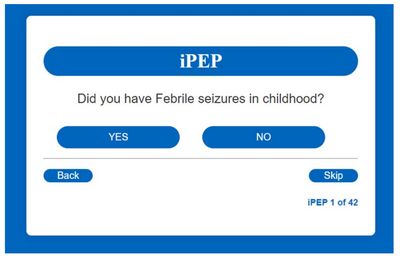
- Transient Loss of Consciousness (TLOC) describes a loss of awareness characterised by amnesia, abnormal motor control, loss of responsiveness and a short duration with a full recovery
- Most cases are caused by epilepsy, functional (dissociative) seizures (FDS), or syncope (fainting)
- Approximately 20% of people are misdiagnosed in primary care
- Current clinical decision tools are hindered by the differentiation between epilepsy and FDS
- Research has shown that people with epilepsy or FDS describe their seizures differently

RESEARCH QUESTIONS

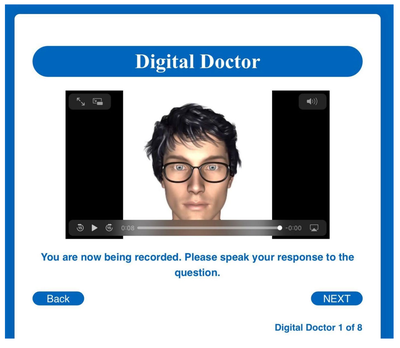
1. Are there differences in how people with epilepsy or FDS describe their seizure to a virtual agent?
2. Can an automated analysis of language differentiate between epilepsy and FDS?
3. Can clinical decision tools for TLOC be improved by incorporating an automated analysis of language

APPLICATION DESIGN

36-item binary symptom questionnaire administered to patients



Recording spoken descriptions to 8 questions about the most recent attack.



PARTICIPANTS

- Recruited from Royal Hallamshire Hospital in Sheffield and charities
- Completed procedure through web application
- Diagnosis confirmed through medical records or self-disclosure

	N	Epilepsy	FDS	Syncope
iPEP	76	24	36	16
Spoken descriptions	61	20	29	12

EPILEPSY RESPONSE PROFILE

Repetitions — Hesitancy

I got up (0.5) because I felt slightly s:ick (0.6) and went over to the sink but **I'm not exactly sure I** couldn't exactly remember (0.9) that (0.8) a:nd it **lasted for about (0.4) lasted for** (.) .hh (.0) **you know, five or ten seconds I think but it ff I thought I'd been out for half an hour** (1) um (0.5) and there was a **strange sense of (0.3) sort of hallucinations** or something like that like (.) .h almost like dream images but I **couldn't describe them (6.2)**

Subjective symptoms

Information about unconscious period — Meta-discursive comments

FDS RESPONSE PROFILE

(2.1) Most of the time **I feel nothing**] before I collapse (0.4) until I come round (0.6)

Conflating unconscious period and the seizure — Complete negations

WHA:T (3.7) **PLEASE TELL ME WHAT HAPPENED THAT YOU CAN REMEMBER WHEN YOU LAST LOST CONSCIOUSNESS** (2.8) with this (0.8) ah (1.0) **what do I say to that?**

Involving accompanying others — Resistance to answering the question

IPEP

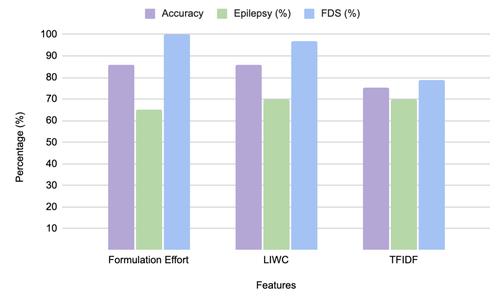
A Support Vector Machine trained using Leave-One-Out Cross Validation and the binary iPEP responses was trained to generate a baseline.

Accuracy (%)	Epilepsy (%)	FDS (%)	Syncope (%)
65.8	54.2	72.2	68.8

LANGUAGE ANALYSIS

Support Vector Machines were trained using Leave-One-Out cross validation for the binary classification between epilepsy or FDS using three different feature sets:

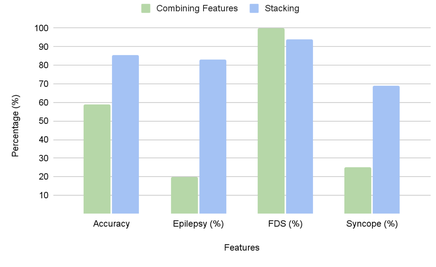
- 7 features designed to measure hesitancy and formulation effort
- 21 Linguistic Inquiry and Word Count categories based upon previous Conversation Analysis research
- TF-IDF vectors based on verbs, adverbs, and adjectives (N determined using gridsearch).



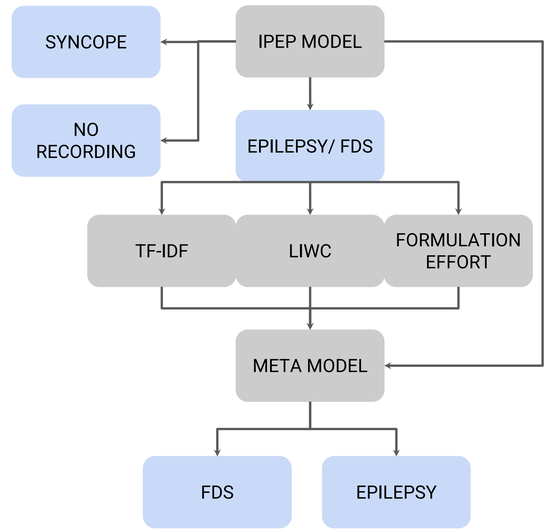
INTEGRATING IPEP & LANGUAGE

Two methods of integrating the iPEP and language features were compared:

1. Training a single model using all features and all diagnoses
2. A model stacking approach (see next section) that restricted the language analysis to iPEP predictions of epilepsy or FDS



MODEL STACKING



A representation of the model stacking algorithm.
The **grey** boxes represent the different machine learning models.
The **blue** boxes represent diagnostic predictions.
All predictions were used to evaluate.

FUTURE RESEARCH

- Increase recruitment
- Explore data driven features
- Incorporate witness information
- Identify language features for syncope
- Improving application design
- Explore broader questions

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