Feasibility of using an automated analysis of formulation effort in patients' spoken seizure descriptions in the differential diagnosis of epileptic and nonepileptic seizures

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INTRODUCTION

Transient loss of consciousness (TLOC) is defined as a loss of awareness characterised by amnesia, abnormal motor control, loss of responsiveness, and a short duration. 90% of TLOC cases are caused by epilepsy, dissociative seizures, or syncope. Around 20% of individuals who experience TLOC are initially misdiagnosed, leading to delays in treatment and recovery. Recent research has shown that it is possible to predict the cause of TLOC using questions about the history and symptoms with an accuracy of 86%, but the accuracy is impaired by the challenging differentiation between epilepsy and dissociative seizures. Conversation Analysis research has shown that there are differences in how patients with epilepsy and dissociative seizures communicate about their seizures that can be used to differentiate between epilepsy and dissociative seizures. One finding is that patients with epilepsy demonstrate more formulation effort while describing their seizure compared to patients with nonepileptic seizures.

AIMS

1. Explore whether features that can be automatically extracted from audio recordings and transcripts of speech as measures of formulation effort can be used to differentiate between epileptic and nonepileptic seizures
2. Explore the classification performance of a combination of these features using the Random Forest algorithm
3. Explore to what extent independent features contribute to the classification performance using independent comparisons between groups and exploring the performance of the algorithm using different combinations of features

METHOD

DATASET

45 recordings of a patient describing their first seizure to a neurologist (21 epilepsy, 24 dissociative seizures)

PREPROCESSING

- Audio transcribed in XML format
- Separated into individual turns
- Turns labelled with speaker, start time and end time
- Description of first seizure was manually extracted
- Text converted to lowercase
- Numerical digits and punctuation removed
- Contractions expanded
- Lemmatisation – words converted to lemma
- Pauses (>30ms) were measured using the Web RTC voice activity detector (VAD)

FEATURES

- Number of hesitations
- Number of repetitions
- Presence or absence of uncertainty keyword
- Average length of between speaker pause
- Patient pause frequency
- Average length of patient pauses
- Total length of patient pauses

STATISTICAL ANALYSIS

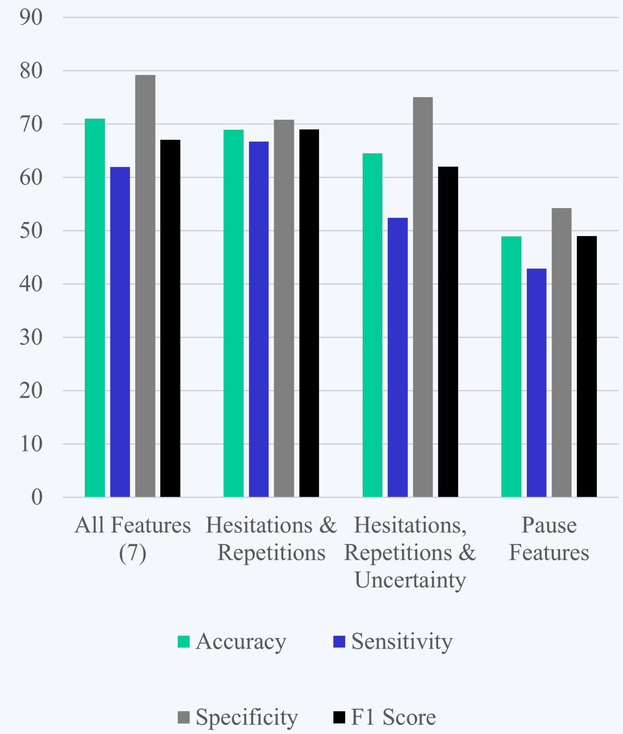
Group differences for each feature were compared using an independent t-test, Mann Whitney U test, or chi squared test as appropriate. The alpha level was set at 0.05. A Bonferroni correction was performed to reduce the risk of a type 1 error and resulted in an adjusted alpha level of 0.007 (0.05/7).

CLASSIFICATION

The Random Forest algorithm was trained by applying the nested "leave-one-out" cross validation method

RESULTS

- There were significantly more women in the PNES group and significantly more men in the epilepsy group
- There was no difference in vocabulary size, word count, or word length distribution
- Patients with epilepsy used significantly more hesitations and repetitions than patients with dissociative seizures
- There was no group difference for patient pause frequency, total patient pause time, average patient pause time, and average between speaker pause



The performance of the Random Forest model using each set of features independently.

- The best accuracy was achieved using all features
- Using hesitations and repetitions alone was a strong predictor

Diagnosis	Predicted: PWNES	Predicted: PWE
PWNES	19	5
PWE	8	13

A confusion matrix for the Random Forest model trained using all features.
PWE – people with epilepsy
PWNES – people with nonepileptic seizures

CONCLUSIONS

- Formulation effort features are helpful for differentiating between epileptic and nonepileptic seizures
- Future research should explore how well these features perform alongside other clinical variables
- This analysis provides a proof of principle that should be explored further with a larger dataset
- Can other Conversation Analysis inspired features be used?

ACKNOWLEDGEMENTS

This research project was funded by Epilepsy Research UK in the form of a PhD scholarship.