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Neurologists can identify diagnostic linguistic features during routine seizure clinic interactions

Laura Jenkins[a1], Jeremy Cosgrove[b], Paul Chappell[c], Ammar Kheder[d], Dilraj Sokhi[e2], Markus Reuber[a]

[a]Academic Neurology Unit, University of Sheffield, Royal Hallamshire Hospital, Glossop Road, Sheffield, S10 2JF, UK
[b]Department of Neurology, Leeds General Infirmary, Leeds Teaching Hospitals NHS Trust, Great George Street , Leeds, LS1 3E, UK
[c]Department of Sociology, University of York, Heslington, York, YO10 5DD, UK
[d]Department of Neurology, Sheffield Teaching Hospitals NHS Foundation Trust, Glossop Road, Sheffield, S10 2JF, UK

[1]Present address: Faculty of Medicine & Health Sciences, Queen's Medical Centre, Nottingham
[2]Present address: Aga Khan University Hospital, P. O. Box 30270-00100, Nairobi, Kenya

Correspondence to: Laura Jenkins, Faculty of Medicine & Health Sciences, Queen's Medical Centre, Nottingham, NG7 2UH. Laura.Jenkins@nottingham.ac.uk

Abstract

The diagnostic distinction between epilepsy and psychogenic nonepileptic seizures (PNES) can be challenging. Previous studies have demonstrated that conversation analysts can identify linguistic and interactional features in transcripts and recordings of interviews with seizure patients that reliably distinguish between epilepsy and PNES. In this study, ten senior neurology trainees took part in a one-day intervention workshop about linguistic and interactional differences in the conversation behaviour of patients with epilepsy and those with PNES. Participants were familiarised with a 12-item questionnaire designed to capture their conversational observations immediately after talking to a patient with seizures. After the intervention, 55 initial outpatient visits of patients referred to seizure clinics were video and audio recorded. All medical diagnoses were confirmed two years after initial presentation on the basis of a chart review (including MRI and EEG findings) by a fully trained epilepsy expert. Post-visit questionnaires relating to patients confirmed to have epilepsy (n=20) or PNES (n=13) were analysed. Doctors' mean responses to 6 of the 12 questions about linguistic and interactional observations differed significantly between the epilepsy and PNES groups. Receiver operating curve analysis showed that a summation scale based on items demonstrating significant between-group differences correctly classified 81.8% of patients as having epilepsy or PNES. This study shows that a brief Conversation Analytic teaching intervention can enable neurologists to identify linguistic and interactional features supporting the differentiation of epilepsy and PNES as they take their patients' history in routine seizure clinic consultations, potentially improving diagnostic accuracy.

Key words

Epilepsy; Non-epileptic seizures; doctor-patient communication; improving diagnostic accuracy; intervention; conversation analysis

1.0 Introduction

1.1 Distinguishing between epilepsy and non-epileptic seizures

An epileptic seizure is a “transient occurrence of signs and/or symptoms due to abnormal excessive or synchronous neuronal activity in the brain” [1]. The manifestations of psychogenic non-epileptic seizures (PNES) resemble those of epileptic seizures [2, 3], but PNES are not associated with epileptic cortical discharges. Instead most PNES are considered as a non-wilful dissociative response to distressing internal or external stimuli [4]. In view of the phenomenological similarities between PNES and epilepsy [5], it is not surprising that this differential diagnosis represents a particular clinical challenge. Epilepsy tends to be over-diagnosed, and it typically takes several years before a correct diagnosis of PNES is made: over three quarters of patients with PNES are initially (and inappropriately) started on treatment for epilepsy [6]. The consequences of misdiagnosis may be far-reaching, particularly when patients with PNES are given ineffective emergency treatment for epilepsy with potentially serious side effects [7].

"Gold standard" diagnoses can only be made in patients in whom it is possible to carry out simultaneous recordings of behaviour (with a video-camera), electrical brain activity (using electroencephalography, EEG) and heart rate (using electrocardiography, ECG) during habitual seizures [8]. However, such recordings are inaccessible for many and fail to capture attacks in about one third of patients [9]. Even when seizures are captured during observation with video-EEG, health professionals need to establish that the recorded seizures were typical of events occurring at home. For all of these reasons, in clinical practice, the diagnosis relies heavily on the doctor's interpretation of the patient's history and witness accounts of events [10].

Although traditional medical teaching underlines the importance of factual details relating to seizure manifestations for the distinction of epileptic seizures and PNES, reports by patients or witnesses are often inaccurate and therefore unhelpful [e.g. [11] [12]]. Although comprehensive profiles of factual features capturing a wide range of patients' seizure subjective experiences by self-report questionnaire may correctly classify four out of five patients with epilepsy or PNES[13], yes/no questions about a more limited number of features are of doubtful diagnostic value. Further, single items traditionally thought by doctors to help distinguish between PNES and epilepsy (such as whether seizures have been observed from reported sleep) have been shown not to distinguish well between PNES and epilepsy [14]. Some observations (such as closed eyes during a convulsive seizure) differentiate well between epilepsy and PNES when video-EEG recordings are available but have little diagnostic value when they are only reported by witnesses or patients [11]. While the elicitation and interpretation of the patient's history thus remains the cornerstone of diagnosis, this process is fraught with difficulties.

1.2 Previous linguistic and interactional findings

A series of previous studies applied linguistic and interactional research methods to transcripts and video recordings of discussions between patients and doctors about seizures. In these encounters, clinicians used an unusually open history-taking approach, which allowed patients to describe their seizure experiences with little direction or interruption [15, 16]. The analysis of the patients' descriptions, grounded in the qualitative methodology of Conversation Analysis (CA) [17-19], identified two contrasting conversational profiles which were closely linked to patients' medical diagnoses: whereas patients with epilepsy were likely to volunteer detailed talk about subjective seizures

symptoms, patients with PNES tended to avoid symptom descriptions and to focus on the circumstances or consequences of their seizures [20]. In later studies linguists were shown to be able to use these features of patients' conversational behaviour accurately to predict a patient's medical diagnosis [21], with linguistic raters correctly predicting 85% of diagnoses subsequently confirmed by video-EEG. In contrast, only 40% of the working diagnoses formulated by the referring neurologists' prior to admission were supported by the video-EEG findings [21]. However, it has also been shown that the conversational features which the linguistic raters used to make their diagnostic predictions require doctors to adopt the unusually open style of questioning used in the original research studies. The traditional, more directive history-taking style routinely employed by neurologists in seizure clinics reduces patients' opportunities to exhibit the described diagnostic features [22].

1.3 Objectives

We have previously demonstrated that traditional history taking characterised by series of closed or category-constricted questions limits patients' ability to exhibit conversational features of potential diagnostic value. However we have also shown that it is possible to change the history-taking style of neurologists in routine seizure clinics and to increase the potential for the observation of diagnostically relevant aspects of patients' communication behaviour with a one-day training intervention[23]. In the present study we explore whether, following this intervention, doctors are able to detect some of the diagnostically relevant features in patients' talk which were identified more laboriously and post-hoc by highly trained Conversation Analysts using detailed transcripts as well as the close review of video-recordings of the clinical interactions in earlier studies.

2.0 Method

This study is based on 55 recordings of interactions between ten neurology speciality registrars and patients obtained from specialist seizure outpatient clinics at the Royal Hallamshire Hospital in Sheffield and the General Infirmary at Leeds, between October 2012 and December 2013 after these senior neurology trainees had undergone a one-day-training intervention described previously[24].

2.1 Data

The data are a subset taken from a larger corpus of consultations which were recorded as part of a communication intervention study. Doctors' interactional activities were compared before and after the workshop, and a description of the whole pre- and post-intervention data set is available elsewhere [23].

Patients' medical diagnoses were formulated two years after their enrolment in the study on the basis of a clinical record review by neurologists with a particular interest in seizure disorders. Medical diagnoses took account of the outcome of the clinical assessment by the neurology speciality registrar who saw the patient in the context of the study and who discussed each case with a fully-trained consultant neurologist subspecialising in the treatment of patients with seizure disorders at the time. The final medical diagnoses also took into consideration the results of investigations which took place at or after the initial

outpatient clinic visit (such as EEG and MRI brain scans), in addition to considering the outcome of any therapeutic interventions.

Six cases were excluded because data were missing or incomplete, and a further 16 cases were excluded because the patients had received a diagnosis other than epilepsy or PNES and previous linguistic findings have only been demonstrated within these two diagnostic categories. Thirteen of those excluded with other diagnoses were found to have experienced syncope; a condition which has previously been shown to be readily distinguishable from seizures (either epileptic or nonepileptic) with a short series of yes/no questions[25-27].

This study focuses on the remaining 33 consultations. These consultations involved six of the ten doctors who had taken part in the training. The other four did not see any patients with these diagnoses in the post-training phase of this project.

Ethical permission was granted by the NRES Committee Yorkshire & The Humber - Bradford Leeds, and all patients provided written informed consent.

2.2 Intervention

The one-day intervention workshop inspired by CA consisted of a range of presentations and interactive data sessions using video data recorded in the seizure clinic. The sessions began by introducing CA as a method, and then described previous findings on the differential diagnostic markers. Finally a new approach to asking questions aiming to

optimise patients' opportunity to demonstrate the previously described interactional and linguistic diagnostic features was introduced [for a more detailed description of the intervention see [23, 28]]. In the final session of the workshop participants were familiarised with a scoring questionnaire for conversational phenomena, which they were asked to complete immediately after each encounter recorded in the subsequent part of our study (see section 2.3).

The workshop was delivered once in Sheffield and once in Leeds to ensure the ten doctors on both sites could participate. One of the ten doctors was unable to attend either session in person and viewed video-recordings of the workshop sessions.

2.3 Linguistic features questionnaire

Inspired by the 17-item Diagnostic Scoring Aid (DSA) developed previously to guide the post-hoc analysis of transcripts and video-recordings of doctor-patient encounters by conversation analysts [21], we developed a much simpler questionnaire designed to guide doctors to reflect on interactional and linguistic features immediately after a clinical encounter with a seizure patient presenting for their first appointment.

Our post-interview interactional observation questionnaire included a total of 12 conversational observations focusing on interactional phenomena, reflective items (how the consultation had made the doctor feel) and items relating to the conversational contributions of third parties (only to be rated if third parties were present). Doctors were

asked to respond to each item on a 7-point Likert scale, ranging from 1 ("not at all") to 7 ("very much so"); details of the questions included are provided in the results section.

2.4 Statistical analysis

Doctors' mean scores for each item, as well as summation scores, were compared between the two diagnostic groups. As the assumptions of parametric tests were not met, Mann-Whitney U tests were performed. A summated scale of the relevant questionnaire items was produced, with the aim of producing a single instrument that could discriminate between epilepsy and PNES. Receiver operator characteristic (ROC) curve statistics were produced to assess the sensitivity and specificity of the individual questionnaire items and the resulting scale, and to identify a cut-off point above which epilepsy could be differentiated from PNES.

3.0 Results

3.1 Participants

The doctors' ages ranged from 30 to 37 years, all in their 6-10th year of postgraduate medical training. Clinic conversations were captured from three female and three male doctors.

Of the 33 patients included in the analysis, 20 had a diagnosis of epilepsy, and 13 of PNES. In total, 19 patients were accompanied (14 with epilepsy, and 5 with PNES; see table 1 for further demographic and clinical details).

Enter table 1 here

3.2 Comparing mean ratings on linguistic features

The median scores of doctors' ratings of each interactional observation were higher for patients with epilepsy, and this difference was significant for items 2b-2f.

Enter table 2 here

Doctors noted during the consultations that patients with epilepsy were more likely to volunteer seizure descriptions, to focus on the descriptions of seizure symptoms, to provide details about seizure descriptions, and to focus on seizure symptoms over consequences. Patients' descriptions were more likely to be characterized by formulation effort.

Doctors also rated epilepsy patients lower on the reflective observations, though this was only significant for item 3b ("the interview was challenging for me"). There were no significant differences in the doctors' ratings of interaction between patients and third parties in the two diagnostic groups (see table 2 for further details).

ROC curves were employed to compare the predictive capacities, sensitivity and specificity of the questionnaire items that show significant associations with the diagnoses of epilepsy or PNES (see figure 1). These items were then combined to create a single summated scale (item 3b was reverse-scored for the summation scale, and item 2b was not included

because the low sensitivity showed little potential for diagnostic prediction; see table 3 for further details). The contributing items (2c,2d,2e,2f, and reversed 3b) showed an acceptable to high level of internal consistency (Cronbach's alpha = 0.785). As Table 3 shows, the area under the ROC curve for the summated scale is 0.84 (SE = 0.71, asymptotic significance = 0.001). The optimal diagnostic cut-off score of the summation scale suggested by the ROC curve is 21, yielding a sensitivity of 85% and a specificity of 77%. This indicates that a cut-off of 21 will classify 81.8% of individuals correctly, with scores above this suggesting epilepsy and scores below suggesting PNES. A comparison of the median summation scales for patients who attended alone and those attending with a companion revealed no significant difference, implying that it is legitimate to combine these two subgroups for this analysis, and that doctors observations in relation to the contributing four questions can be diagnostic in either clinical scenario (accompanied median=23, unaccompanied median= 25, U=239.5, p=0.27).

Enter figure 1 here

Enter table 3 here

4.0 Discussion

This study demonstrates for the first time that conversational features, previously identified in research settings by post-hoc analysis of video-recordings and transcripts as having diagnostic value in differentiating between patients with epilepsy and PNES, can be

identified by doctors in routine clinics as they talk to patients newly presenting with a seizure disorder.

Differentiating between epilepsy and PNES has been shown to be problematic with serious implications for the patients [29]. This study provides a possible means of improving diagnostic accuracy in the form a relatively straightforward and low-cost post-interview questionnaire. Our findings show that not only paying attention to the content of patients' histories, but also to how they put together and present their symptoms and concerns, can provide diagnostically useful insights in everyday clinical settings. Furthermore, doctors' reflections on their own response to the consultation (e.g. their sense of how challenging a particular consultation was for them) can be valuable as part of their diagnostic reasoning.

Importantly, these diagnostic interactional observations were made after the participating doctors had taken part in a one-day training workshop which aimed to familiarise them with the previously described interactional differences between conversations with patients with epilepsy and those with PNES. The workshop was also intended to persuade doctors to adopt a more open history-taking approach, which has previously been shown to increase the opportunity for patients to exhibit the diagnostic conversational behaviour [30]. This involved asking patients an open question such as "How can I help you?" at the beginning of the consultation, and then using interactional tools such as nodding, and reception markers (such as "hmm") or silence to encourage the patient to continue their narrative. This approach gave patients more interactional space to describe their concerns in their own terms [22-24]. Patients were later asked to talk about the first, worst and last seizure they had experienced, each time using the same techniques to encourage the patient to talk,

ensuring that overall, at least in the initial stages of the consultation, patients had much greater flexibility to determine the agenda of the consultation [28].

Our results showed that the observations we asked about in relation to third parties did not significantly predict the patient's diagnosis. However, only five of the patients with PNES were accompanied, so the failure of questions about the conversational contributions of third parties observed here should not be interpreted as a definitive finding. Having said that, these observations about third parties had not previously been used in any studies in which linguists were asked to predict medical diagnoses whilst blinded to medical information about patients. The questions about third parties' communication behaviour were based on findings that were only beginning to emerge at the time of the intervention. These findings have been characterised in greater detail more recently[31], and it is possible that these items could have had greater differentiating potential if more accompanied encounters had been captured, they had been explained more clearly in the intervention workshop, or if these questions had been formulated differently[31].

The data were collected within eight months of doctors taking part in the intervention, and we are unable to testify as to the longevity of the workshop's impact in terms of whether doctors might require refresher training to continue to be able to identify these features over time. It is a further limitation of our findings that all participants in the training days were neurology speciality registrars. We chose to target doctors of this level of seniority because they are expected to make diagnostic decisions independently but are still undergoing training. The effectiveness of the intervention in doctors with a more limited understanding of the diagnostic challenge or with greater clinical routine is still unexplored.

Last but not least, the mode of diagnosis by review of all available records after two years of follow up means that PNES and epilepsy diagnoses were not based on the "gold standard" in this setting, i.e. the recording of typical seizures by video-EEG [8]. However, in order to prove the contribution which can be made by interactional or linguistic findings when patients present for an initial expert assessment, we had to apply our method to patients at the point of diagnosis. We could have enrolled patients with more chronic seizure disorders characterised by more frequent seizures, but this would not have proven the potential of conversational observations in the initial diagnostic process. In fact previous conversation analytic studies based on patients in whom all diagnoses had been proven by video EEG could be criticised because they may have captured "iatrogenic" communication behaviours shaped by interactions with doctors over many years.

Despite these limitations the findings reported in this paper demonstrate that a brief conversation analytic communication workshop can not only change the way that doctors question patients in the seizure clinic, but equips them with the ability to identify linguistic features using a simple questionnaire which can help differentiate between patients with epilepsy and those with PNES. In the context of this particular diagnostic challenge, associated with significant physical, social and psychological implications for patients, this low intensity intervention is available to improve the diagnostic process in the seizure clinic. This study is the first to show that a simplified, "online" method of observation of interactional phenomena can make an effective contribution to the diagnostic process and justifies replication in a larger study.

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6.0 Disclosure of Conflict of Interests

None of the authors has any conflict of interest to disclose.

7.0 Ethical publication statement

We confirm that we have read the Journal's position on issues involved in ethical publication and affirm that this report is consistent with those guidelines.

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Tables and figures

Table 1. Demographic information

	EPILEPSY (n=20)	PNES (n=13)	Overall	P value
Proportion of female patients	9 (45%)	8 (62%)	17 (85%)	n.s.
Number accompanied	14 (70%)	5 (38%)	19 (58%)	n.s.
Mean age (years)	36	45	37	n.s.

Table 2. Interactional observations on the linguistic features questionnaire and diagnosis of epilepsy or non-epileptic seizures.

	Median score (n=33)	EPILEPSY median score (mean rank) (n=20)	PNES median score (mean rank) (n=13)	Mann-Whitney U
1) **Patient diagnosis**				
2) **Interactional observations**				
a. The patient focuses on seizure symptoms in the initial open phase (e.g. mentions symptoms spontaneously)	4	5 (20.93)	3 (15.10)	106.5
b. The patient readily volunteers descriptions of seizure symptoms (including last thing they remember and the next thing they remember and seizure suppression attempts).	5	6 (21.50)	3 (14.30)	94.5*
c. In response to enquiries the patient readily provides more detailed seizure descriptions	5	6 (22.33)	3 (13.13)	77.0**
d. The patient provides detailed seizure descriptions	5	5.5 (22.07)	3 (13.50)	82.5*
e. The patient focuses more on the symptoms of the seizures rather than the consequences of seizures or the situations in which they occurred.	5	6 (22.93)	2 (12.30)	64.5**
f. The patient's seizure descriptions are characterised by formulation effort (reformulation, hesitations, pauses).	4	4.5 (22.33)	2 (13.13)	77.0**
3. Reflective Observations				
a. There were awkward moments during the consultation.	2	1 (17.10)	3 (20.47)	128.0
b. The interview was challenging for me.	2	1 (15.67)	4 (22.47)	98.0*
c. I found the interview exhausting.	1	1 (16.38)	4 (21.47)	113.0
4. Third Parties	(n=19)	(n=13)	(n=5)	
a. The patient seemed to prefer the accompanying person to speak on their behalf.	2	2 (11.46)	1 (10.07)	42.5
b. The accompanying person seemed keen to speak for the patient.	2	3 (11.61)	1 (9.79)	40.5
c. The accompanying person encouraged the patient to speak to you.	1	2 (11.71)	2 (9.57)	39.0

°: scores ranging from 1: "not at all" to 7 "very much so"

*: Significant p<.05

**: Significant p<.01

Figure 1. Receiver Operating Characteristic Curves based upon scores for linguistic features questionnaire for patients with epilepsy or PNES (n=33)

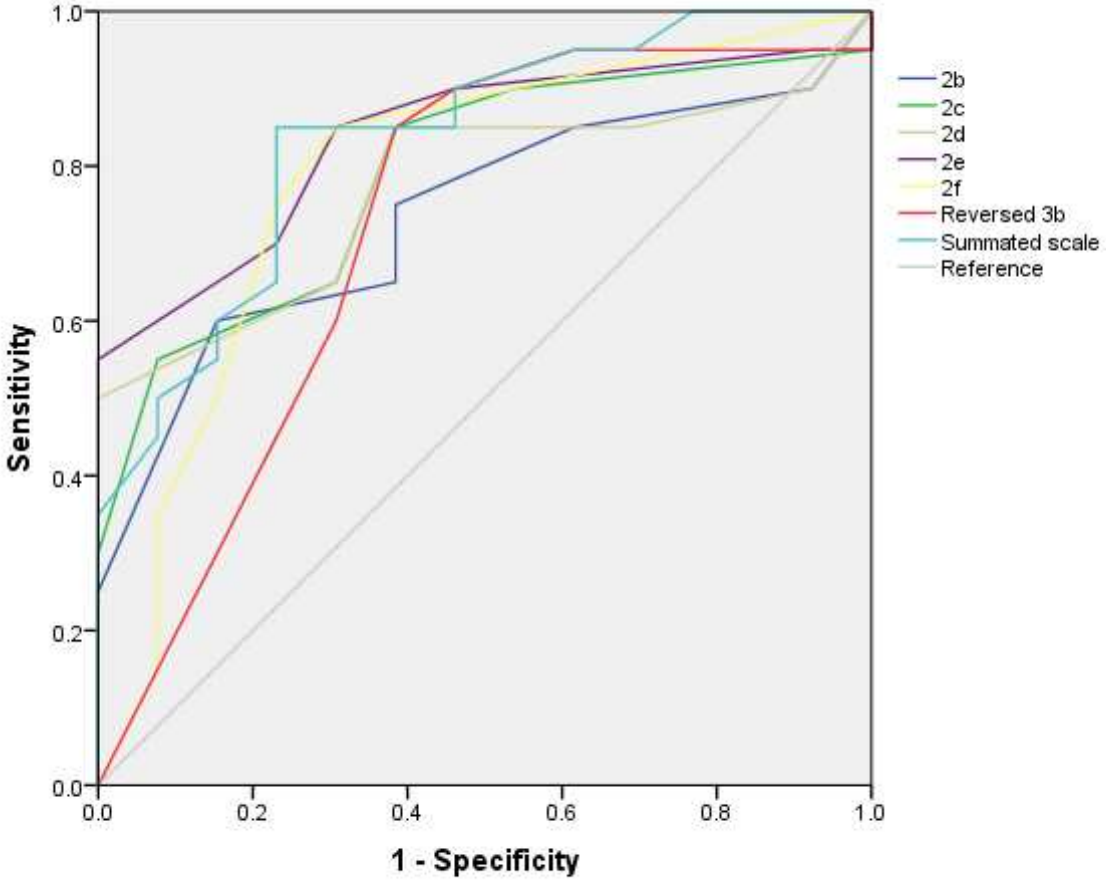

Table 3. Performance of individual questionnaire items and summated scale for predicting epilepsy or PNES

	Area under curve	SE	Sig.	Cut-off point	Sensitivity	Specificity	**Positive predictive value (PPV)[1]**	**Negative predictive value (NPV)[2]**
2b	.737	.087	.023	3.5	.75	.62	**.75**	**.62**
2c	.790	.079	.005	3.5	.85	.62	**.77**	**.73**
2d	.771	.083	.009	3.5	.85	.62	**.77**	**.73**
2e	.838	.070	.001	3.5	.85	.69	**.81**	**.75**
2f	.788	.087	.006	2.5	.85	.69	**.81**	**.75**
Reverse 3b	.723	.098	.033	5.5	.85	.62	**.77**	**.73**
Summated scale	.837	.071	.001	21	.85	.77	**.85**	**.77**

1) PPV: Probability with which a score above the cut-off value predicts a diagnosis of epilepsy with a probability of 75%

2) NPV: Probability with which a score below the cut-off value predicts that the diagnosis is not epilepsy (i.e. that the diagnosis is PNES).