SHORT REPORT

'Jumping to conclusions' bias in functional movement disorders

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ABSTRACT

Background Patients with functional neurological disorders often report adverse physical events close to the onset of functional symptoms. However, the mechanism via which a triggering event may set off a functional condition is lacking. One possibility is that patients make abnormal inferences about novel information provided by physical triggering events. In this study, the authors aimed to specifically investigate whether patients with functional movement disorders have abnormalities in probabilistic reasoning.

Methods The authors used a well-studied probabilistic reasoning paradigm, 'the bead task', in 18 patients with functional movement disorders and 18 healthy agematched controls. The authors assessed the number of beads that participants needed to reach a decision and changes in the certainty of their decisions when confronted with confirmatory or contradictory evidence.

Findings Patients with functional movement disorders requested on average significantly fewer beads before reaching a decision than controls (3 vs 6 beads). When confronted with potentially disconfirmatory evidence, patients showed a significantly greater reduction in confidence in their estimates than controls. 40% of patients reached a decision after one or two beads whereas no controls showed this bias.

Interpretation Patients with functional movement disorders requested less information to form a decision and were more likely to change their probability estimates in the direction suggested by the new evidence. These findings may have relevance to the manner with which patients with functional neurological disorders process novel sensory data occurring during physical triggering events commonly reported at onset of symptoms.

INTRODUCTION

Functional neurological disorders are common and disabling[1] but their pathophysiology is still unclear. A historically influential explanation is that psychological stressors lead to unconsciously produced physical symptoms. However, psychological stressors can be identified in only a proportion of patients,[2] and these (eg, childhood adversity) often occur years prior to onset of functional symptoms.[3] The neurobiological mechanism via which symptoms might be produced by psychological stressors is lacking.

Patients often report a physical event at onset of functional symptoms that appears phenomenologically related to subsequent symptomatology (eg, painful limb injury in patients with subsequent functional fixed dystonia,[4] panic attacks with shaking of the limbs and dissociation from the environment in patients with subsequent non-epileptic seizures).[5] However, such events, particularly painful injury and physical illness, are almost universal occurrences that do not trigger functional symptoms in most people who experience them. Therefore, could there be differences in the manner in which patients who develop functional symptoms make inferences about novel information, and use such information to guide future behaviour?

As a preliminary exploration of this question, we used a well-known paradigm in psychiatric research, the 'bead task'.[6] In this paradigm, participants assess (within a Bayesian reasoning framework) the probabilities of events on the basis of empirical evidence. Deluded patients have been found to exhibit a tendency for the early acceptance of hypotheses formed in this task based on much more limited evidence than controls. This style of reasoning is known as 'jumping to conclusions' bias and has been suggested to favour the formation of abnormal inferences, ultimately leading to the adoption of delusional beliefs.[7] In this study, we hypothesised that similar reasoning abnormalities might be present in patients with functional movement disorders (FMD), which would favour formation of abnormal inferences about the sensory data arising during the physical event and could contribute to the development of functional symptoms.

METHODS

Participants

We recruited 18 patients with clinically established or documented FMD according to criteria of Fahn and Williams[8] from the Movement Disorder outpatient clinics at the National Hospital for Neurology and Neurosurgery, and 18 healthy age-matched controls recruited from a departmental register of volunteers. The study was approved by the local Ethics Committee and informed consent to take part was obtained.

Design and measures

Bead task

The reasoning task was similar to previous designs.[6] Participants were presented with two jars each containing 100 beads: Jar A with 85 red and 15 blue beads and Jar B with 85 blue and 15 red beads. Both jars were then hidden from view. Participants were told that the experimenter would choose one jar and draw beads one at a time from this jar. Beads would be replaced in the jar after each draw.

Two conditions were performed in the same order in each participant. In condition 1, 'draws to decision' methodology was employed. Here, participants requested as many beads as they deemed necessary to decide from which jar the beads were being drawn. Beads (red: R; blue: B) were presented in the following sequence: RRRBRRRRRBBRRRRRRRRB. After each draw, participants were asked if they were certain which jar had been chosen. Participants were told that they were allowed as many trials as they needed to be completely sure. The dependent variable was the number of draws taken to reach a decision (draws to decision). We classified as 'extreme responding' participants who required two or fewer draws before making a decision.

In condition 2, 'draws to certainty' methodology was used to assess the response to confirmatory or contradictory evidence. All participants saw the same 20 beads sequence: RRRBRRRRBRBBBRBBBBRB. After each draw, participants were asked to indicate their estimates of the likelihood of Jar A or Jar B having been chosen by placing a mobile pointer along a scale. The first 10 beads supported the hypothesis that beads were being drawn from Jar A (predominantly red beads), but the final 10 beads were inconsistent with this hypothesis. In this condition, the trial continued for 20 draws for all participants. The dependent variables were: (1) effect of confirmatory evidence: the estimate given after the second bead (red) was drawn minus the estimate given after first bead (red) was drawn; (2) effect of disconfirmatory evidence: the estimate given after the third bead (red) was drawn minus the estimate given after fourth bead (blue) was drawn (positive values indicate reduction in confidence); and (3) final decision after the last draw with respect to the probability that Jar A had been chosen.

Questionnaires

To estimate the intelligence level of participants, the 12-item short form of Raven's Progressive Matrices test was used.[9]

Delusional ideation was assessed using the Peters *et al* Delusions Inventory (PDI-21) which includes 21 questions asking whether or not the participant has a particular idea. Total scores range from 0 to 336.[10]

Participants completed the Hospital Anxiety and Depression rating scale (HADS) with reference to their mood the week prior to testing.[11]

Statistical analyses

PASW statistical package (V.18, Chicago, USA) was used for statistical analysis. p Values reported for categorical variables were calculated with the use of Fisher's Exact Test. Mann–Whitney U test was used to compare differences for numerical variables between groups. In order to determine the independent contribution of Raven's matrices scores, delusional ideation and anxiety and depression subscales of the HADS to the bead task performance, a simple linear regression analysis was first performed. A multiple linear regression analysis was subsequently performed. In a first step, those variables which were contributing factors to the bead task performance in the simple analysis were entered as covariates. In a second step, group status was entered in the analysis. A two-tailed α level of 0.05 was used as the criterion for significance in all analyses.

RESULTS

Baseline clinical and demographic features of the participants are given in table 1.

Table 1 Results

	FMD (n=18)	Controls (n=18)	p Value
Age (years)			
Mean±SD	43.5±12	48.2±14	0.33
Female/male	12/6	10/8	0.73
Disease duration (years)			
Mean±SD	5.4±4.5	–	–
Type of FMD, n (%)			
Tremor	12 (67)	–	–
Dystonia	5 (28)	–	–
Myoclonus	1 (5)	–	–
Treatment, n (%)			
SSRIs	4 (22)	–	–
Benzodiazepines	2 (11)	–	–
None	12 (67)	–	–
Raven's matrices score			
Mean±SD	7.6±2.3	8.7±2.7	0.13
PDI-21 total score			
Mean±SD	35.7±32.9	18.9±21.2	0.34
HADS score, mean±SD			
Anxiety subscale	11.0±3.9	5.6±3.4	0.001
Depression subscale	9.2±4.2	3.0±1.8	<0.001
Total	20.2±7.3	8.1±4.2	<0.001
Draws to decision			
Mean±SD	2.5±1.2	5.56±2.0	<0.001
Effect of confirmatory evidence*			
Mean±SD	0.5±15.4	5.5±2.2	0.32
Effect of disconfirmatory evidence†			
Mean±SD	4.8±33.2	−2.6±5.4	0.02
Final decision (jar B chosen) in condition 2			
n (%)	10 (56)	3 (17)	0.03

*Effect of confirmatory evidence: the estimate given after the second bead (red) was drawn minus the estimate given after first bead (red) was drawn; positive values indicate an increase in confidence.
†Effect of disconfirmatory evidence: the estimate given after the third bead (red) was drawn minus the estimate given after fourth bead (blue) was drawn; positive values indicate a reduction in confidence.
FMD, functional movement disorder; HADS, Hospital Anxiety and Depression Scale; PDI-21, Peters *et al* Delusions Inventory of 21 questions; SSRIs, selective serotonin reuptake inhibitors.

In condition 1, a significant difference between groups was found for draws to decision: patients requested significantly fewer draws before making a decision than controls (U=33.50, z=−4.21, p<0.001) (table 1 and figure 1). Seven patients (40%) but no control participants met criteria for 'extreme responding'.

In condition 2 (table 1), a significant difference between groups was found when confronted with potentially disconfirmatory evidence: patients had significantly greater reduction in confidence, whereas controls were more likely to make no change or to continue to affirm their initial hypothesis by increasing their degree of certainty (U=94.5, z=−2.28, p=0.02). There were no significant differences between groups regarding the effect of confirmatory evidence. Ten patients and only three controls chose Jar B as their final decision (p=0.03).

There were no significant differences between groups in Raven's matrices scores (U=87.0, z=−1.50, p=0.13) or PDI-21 scores (U=74.0, z=−0.79, p=0.43) (see table 1). Patients scored significantly higher than controls on anxiety and depression subscales of the HADS (U=52.5, z=−3.47, p<0.001; U=30.0, z=−4.2, p<0.001; respectively). We assessed whether Raven's matrices, PDI-21, anxiety and depression scores were individual predictors of the reasoning performance. In the simple linear regression analysis, only anxiety and depression scores were associated with draws to decision (R^2=0.22, p=0.004; R^2=0.27,

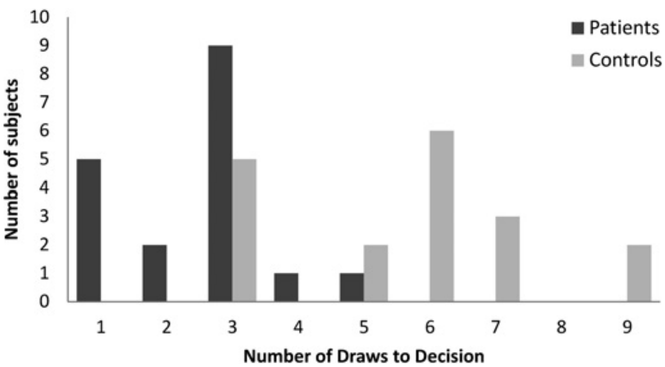

Figure 1 Number of draws to decision for patients and controls in condition 1.

p=0.001, respectively). Since anxiety and depression scores were significantly higher in patients than in controls, we investigated in more detail whether belonging to one group or the other was a potential confounder factor. When both anxiety and depression scores were considered in a multiple linear regression analysis and their contribution was adjusted in a second step by group status, neither anxiety nor depression scores were predictive factors to draws to decision ($\beta=-0.06$, $p=0.73$; $\beta=-0.036$, $p=0.87$, respectively).

DISCUSSION

In this study, we assessed probabilistic reasoning in patients with FMD using the bead task, a classic paradigm in psychiatry research for the study of belief formation under conditions of uncertainty.[7] We found differences in probabilistic reasoning between patients with FMD and healthy participants. First, patients required less evidence before making a definite decision on the task. Second, patients integrated new, potentially discomfirmatory evidence into their decision making differently than controls. They were more likely to make changes in their probability estimates in the direction suggested by the new evidence and to make a final decision consistent with this new evidence. Both aspects of the bead task are conceptually related to frontal lobe functions such as set shifting and impulsivity, and similar abnormalities have been found in delusional patients. These data appear not to be influenced by the higher levels of depression and anxiety found in the patient group.

How might these preliminary data help to inform our understanding of the underlying mechanism of symptom production in FMD? This experiment was prompted by the association between physical triggering events and the production of phenomenologically related symptoms in patients with functional neurological disorders. The process of making inferences on the causes of sensory data and incorporating these into an internal model of the world is central to a modern Bayesian approach to understanding the brain.[12] Impulsivity in decision-making may reflect an abnormal overweighting of the importance of sensory data which causes an inappropriate updating of internal models relating to the data. Extrapolating such a reasoning style to sensory data occurring during a physical triggering event, this might produce inappropriate updating of expectations regarding future sensory data, for example, an expectation of pain, abnormal movement or weakness, which might drive future physical symptoms. This initial formulation, although speculative, could form the basis of a testable neurobiological framework for FMD. In a recent study, we have demonstrated that patients with functional tremor have virtually no tremor during ambulatory recordings and yet report tremor to be present most of the time, which we have interpreted within a Bayesian framework of abnormal dominance of expectations over sensory data.[13] This framework is also interestingly in line with neurobiological formulations currently proposed to explain delusions.[14]

Patients were more likely to respond to potentially disconfirmatory evidence by changing their probability decision in the direction of the new evidence, seemingly at odds with the fixity with which illness beliefs are sustained by this patients group. Indeed, a similar question has been raised by those studying delusions. Here the suggestion has been, supported by experimental evidence, that over time beliefs shift from a more flexible 'goal-directed' ventral corticostriatal system to a more inflexible 'habit-related' dorsal striatal system.[15] If this is also relevant to functional disorders, then the period following the initial triggering event must be important in creating persistence and fixity of abnormal beliefs. This would be consistent with the negative correlation between time to diagnosis and chance of recovery previously found in functional disorders[16] and the fact that, at least in the early stages, simply explaining the diagnosis can lead to long-term resolution of symptoms.[17] In contrast, fixity of illness belief is associated with poor long-term outcome.[18] Though we highlight the similarity of performance of patients with FMD on this task and previous studies of patients with delusions, the lack of difference between FMD patients and controls in the PDI-21 inventory indicates that patients with FMD are not suffering generally from delusional beliefs.

Limitations

We acknowledge limitations to our study. First, the sample size is small and we cannot exclude that in a larger cohort data may be different. However, we chose patients with clinically typical FMD using standardised criteria and feel that they do accurately represent patients with these diagnoses. Second, FMD patients tend to have concomitant mood abnormalities as measured by HADS. However, multiple regression analysis revealed that anxiety and depression scores were not predictors of the draws to decision. This is in line with several reports that have failed to find an association between performance on the bead task and mood disturbance.[19–21] Future studies could nevertheless compare the cognitive style of FMD patients with depressed and anxious patients without FMD. Third, while we have controlled for the presence of delusions in general, we have not measured other psychiatric comorbidities such as personality disorder that could be confounding the results.

In conclusion, we present preliminary evidence of a 'jumping to conclusions' style of cognitive reasoning in patients with FMD. These data may have relevance to the manner with which patients with functional symptoms process novel sensory data occurring during physical triggering events commonly reported at onset of symptoms.

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