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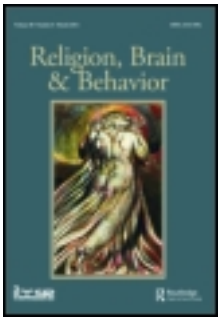

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Mystical experiences associated with seizures

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Mystical experiences associated with seizures

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Alterations of consciousness are critical factors in the diagnosis of epilepsy and seizure disorders. With this alteration in consciousness, some persons report unusual experiences that have been thought to resemble spontaneous mystical experiences. This study was designed to identify and characterize the mystical experiences associated with seizure activity, through the use of a quantitative instrument with well-documented reliability and validity for assessing the content and quality of mystical states of consciousness. Ninety-eight patients with epilepsy completed a modified version of the Mysticism Scale, of whom 86 had EEGs recorded. Fifty-five per cent of the patients in this study recalled some subjective experience in association with their seizures. However, none of the patients' descriptions met the criteria for mystical experience. Although some features of mystical experience were reported in this study, particularly those suggestive of introvertive mysticism, they were not associated with any particular lobe of the brain nor were they lateralized to either the right or left side. Mysticism Scale scores were not significantly associated with demographics, medical history including seizure risk factors and precipitants, or seizure characteristics including localization and type of seizure.

Keywords: mystical experience; epilepsy; seizures; altered consciousness; ecstatic seizures

Introduction

The pervasive occurrence of mystical experience over the centuries and across the globe suggests that the human brain is programmed to explain certain features of experience in spiritual terms (Devinsky & Lai, 2008). Mystical experiences are generally perceived to include certain positive values, attitudes, perspectives, beliefs, and emotions, and are considered to be human experiences at least potentially available to everyone (Stace, 1960). Although they are not common, mystical experiences are usually regarded as the defining moments in the lives of people who have them (Wulff, 2013).

James (1902) characterized the common phenomenological core of Christian, Vedantic, yogic, Buddhist, and Sufi mystical experiences as encompassing ineffability, a noetic quality, transience, and passivity. Following James's lead, Stace (1960), drawing upon examples from Judeo-Christian, Islamic, Hindu, Buddhist, and Taoist traditions, as well as the writing of mystics unattached to any spiritual tradition, concluded that the hallmark of mystical experience is the conscious recognition of, and experiential union with, ultimate reality or divinity, although that experience may be not as prominent in

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every spiritual tradition, and need not be interpreted in religious terms as union with God (Granqvist, Hagekull, & Ivarsson, 2012).

Stace (1960, p. 61) differentiated two kinds of mystical experience: the "inward way" or "introversion," and the "outward way" or "extroversion": "the extrovertive experience looks outward through the senses, while the introvertive looks inward into the mind. Both culminate in the perception of an ultimate Unity … with which the perceiver realizes his own union or even identity." He further differentiated both kinds of experience from their interpretation, by which he meant "anything which the conceptual intellect adds to the experience for the purpose of understanding it, whether what is added is only classificatory concepts, or a logical inference, or an explanatory hypothesis" (Stace, 1960, p. 37).

Pahnke (1969), building on the work of James (1902) and Stace (1960), delineated nine common traits of mystical consciousness: unity, transcendence of time and space, deeply felt positive mood, sense of sacredness, noetic quality, paradoxicality, ineffability, transiency, and persisting positive changes in attitudes and behaviors. This model was subsequently operationalized by Hood's Mysticism Scale (Hood, 1975), which thus incorporates phenomena described in a wide range of mystical traditions.

Alteration and impairment of consciousness are critical factors in the definition and diagnosis of epileptic seizures. One particular expression of altered consciousness, excessive religiosity, has been recognized as a trait of some patients with epilepsy at least since the nineteenth century (Esquirol, 1838; Maudsley, 1879; Morel, 1860). However, religious experience, though sometimes seen in seizures, is not a common feature: prior studies among patients with epilepsy have cited frequencies of 1% (Kanemoto & Kawai, 1994) and 0.4% (Ogata & Miyakawa, 1998).

Mystical experience in particular has been reported to occur in epileptic auras (Runions, 1979), albeit infrequently. Mystical experiences have been linked theoretically to the temporal lobes (Saver & Rabin, 1997), and that association has been widely accepted. According to Ramachandran and Blakeslee (1998, p. 1975), for example, "every medical student is taught that patients with epileptic seizures originating in this part of the brain can have intense, spiritual experiences during the seizures." However, a survey of patients in an epilepsy clinic found no mystical experiences (Sensky, 1983), and a survey of patients specifically with complex partial seizures found that only 2.3% reported ictal mystical experiences (Devinsky, Feldmann, Bromfield, Emoto, & Raubertas, 1991).

Bradford (2013) has recently argued that a neuropsychological study of mystical experience must rely on traditional concepts of such experiences in order to be meaningful and reliable. Increasing interest in a scientific approach to mystical experiences has led to a variety of quantitative instruments for assessing the content and quality of mystical states of consciousness as described in disparate spiritual traditions (Hill & Hood, 1999; Koenig, King, & Carson, 2012). Hood's Mysticism Scale, which has become the most frequently used measure of mystical experience (Hill & Hood, 1999), operationalizes the common core of phenomenological features in mystical experience: loss of self, perception of oneness, perception of all objects as animate, distortion of time and space, perception of special knowledge or insight, ineffability, experience of peace or bliss, and perception of sacredness or wonder. While the Mysticism Scale has been widely used among various clinical samples and among stratified groups of interest among the general population, it has not yet been used to characterize alterations of consciousness during seizures.

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Objectives

This study was designed to identify and characterize the mystical states of consciousness reported in association with seizure activity through the use of Hood's Mysticism Scale (Hood, 1975), a reliable and valid standardized self-report instrument for assessing content and quality of mystical states of consciousness. We also compared this quantitative analysis of subjective experiences with electroencephalographic (EEG) evidence of seizure focus, in order to increase our understanding of the role of neurophysiological factors in mystical experience.

Methods

Participants

Patients attending the University of Virginia's Comprehensive Epilepsy Program were invited by their neurologists to participate in the study. After providing written informed consent, patients who agreed to participate were interviewed by one of us (B.G. or L.L.D.) regarding their recall of experiences associated with seizures.

We interviewed 100 patients with seizures. Patients were obtained non-consecutively, as those patients who did not have epilepsy (i.e., had psychogenic seizures only), or those with intellectual impairment or psychotic symptoms severe enough to render their responses unreliable, were not invited by their neurologist to participate in the study. We did not track clinic patients who were deemed by their neurologist to be inappropriate for the study and therefore do not know how many were excluded on that basis. However, none of the 100 patients referred by their neurologist for participation in the study refused or was excluded.

After soliciting a spontaneous description of subjective experiences associated with seizures, we administered the Mysticism Scale, modified as described below, to all patients, whether or not they spontaneously recalled subjective experiences associated with their seizures. Of the 100 patients interviewed, only 98 could understand and respond to the items on the Mysticism Scale. Therefore, all analyses were performed on the sample of 98 patients who completed the Mysticism Scale.

Mysticism Scale

The Mysticism Scale is a 32-item Likert-style instrument designed to measure intense experiences characterized by a sense of unity with the outside world and/or with "nothingness," which may or may not be interpreted religiously (Hood, 1975). It has well-documented reliability and validity (Hill & Hood, 1999), but does not include an established cutoff point for experiences to be categorized as mystical. However, the scale's author suggested using an average score for the scale as a whole of 4 or 5 points per item (on a five-point Likert scale) as a criterion for a mystical experience, and a score of 1 or 2 points per item as a criterion for not being a mystical experience (R. Hood, personal communication, April 2, 2012). Although psychometric validation of these criteria has not been published, these are not arbitrary cutoff points but rather the recommendations of the scale's author based on almost four decades and hundreds of studies using the Mysticism Scale.

The Mysticism Scale includes items assessing eight distinct conceptual categories of mystical experience: Ego Loss (losing oneself into a greater unity), Unity (perception of the unity of all things), Inner Subjectivity (perception of an inner awareness in all things), Timelessness/Spacelessness (transcending spatiotemporal limits), Noetic Quality

(sensation of the experience as a source of valid direct knowledge), Ineffability (impossibility of expressing the experience in words), Positive Affect (joy or bliss), and Sacredness (intrinsic holiness of the experience) (Hood, 1975). Statistical analyses of the Mysticism Scale with widely diverse populations have upheld a three-factor model that corresponds generally to Stace's distinction between Introvertive and Extrovertive Mysticism, both distinct from Religious Interpretation (Anthony, Hermans, & Sterkens, 2010; Chen, Yang, Hood, & Wastson, 2012; Hood et al., 2001). This three-factor model has become the preferred solution for use of the Mysticism Scale (Hood, Hill, & Spilka, 2009).

The original Mysticism Scale was developed to investigate whether the respondent had ever had certain experiences over the course of a lifetime. However, applying the scale to a single event requires a slight rewording of the items (Hood, 1977), after which the double negatives in some items can be confusing (MacLean, Leoutsakos, Johnson, & Griffiths, 2012). Because of this confusion, prior researchers have opted to use only the positively worded items (Anthony et al., 2010; Holm, 1982). Indeed, preliminary testing of the Mysticism Scale in our epilepsy clinic established that the negatively worded items proved to be so confusing for this population with some cognitive and linguistic limitations as to produce unreliable answers. We therefore opted to use the modified version of the Mysticism Scale that included only the positively worded items, as prior researchers have done with atypical samples. We report below mean scores per item rather than a total score for the Mysticism Scale, because we used only the 16 positively worded items, and to facilitate comparison with Hood's criterion for a mystical experience.

Neurologic and EEG evaluation

The medical records of participants were examined for data on age of onset and duration of the seizure disorder, seizure frequency, epilepsy etiology, and history of status epilepticus. EEG recordings were examined for evidence of anatomic localization and lateralization of the seizure focus. The International League Against Epilepsy (ILAE) seizure type (Dreifuss et al., 1981) and the ILAE epilepsy syndrome (Commission on Classification and Terminology of the International League Against Epilepsy, 1989) were derived from the medical records.

Analysis of data

We examined statistical correlations in patients with seizures between scores on the modified Mysticism Scale and various facets of their seizures and neurological history, evaluation, and treatment. We included comparisons involving neurophysiological data from the patients' clinic medical records, including their EEG recordings, to ascertain the anatomic focus of the seizure, epilepsy etiology, type of seizure, and specific epilepsy syndrome; and historical data on age of onset and duration of the seizure disorder, maximum number of seizures per month, and history of status epilepticus.

Results

Subjective experiences associated with seizures

Of the 98 patients included in the study, 55 were able to recall some subjective experience associated with their seizures. Of those 55 patients, 29 (53%) reported that they could

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recall more than 10 seizure-associated subjective experiences, 23 (42%) reported between two and 10 seizure-associated experiences, and three (5%) reported that they could recall only one seizure-associated subjective experience. Twenty-nine of these patients (53%) reported that those experiences occurred during an aura immediately before their seizures, 29 (53%) reported experiences during their seizures, and 22 (40%) reported experiences during the postictal period immediately following their seizures. Percentages total more than 100% because some patients attributed their subjective experiences to more than one time period, and some could not determine when the experiences had occurred. For these reasons, it was not possible to distinguish precisely between aural, ictal, and postictal experiences. Most of these reports of subjective experience consisted of only brief, fragmentary sensory impressions rather than coherent narratives.

The kinds of subjective experiences that patients reported tended to be changes in emotional state, cognitive changes, other consciousness alterations, sensory distortions, paresthesias, and other somatic sensations. Emotions reported included feeling scared, anxious, sad, apprehensive, threatened, and feeling pursued; less commonly, patients reported feeling euphoric or "protected." Cognitive changes reported included déjà vu, racing thoughts, indecipherable thoughts, confusion, single words repeating in one's thoughts, and flashbacks to childhood. Other consciousness alterations reported included feeling tired, sleepy, "spacey," dazed, fatigued, exhausted, intoxicated, feeling as if one is "falling into darkness," and "no sense of order."

Sensory distortions reported included seeing flashing lights, wavy lines, insects, geometric colored shapes, and kaleidoscopic vision, monochromatic vision, and seeing as if through a film; hearing music, pulsing noises, "a sound like Rice Krispies," and hearing voices as if from far away or slowed down; smelling sulfur, burning, watermelon, ammonia, and pungent spices; and a bad taste in one's mouth. Paresthesias reported included feeling lightheaded, dizzy, tingling, electric jolts in the body, a stunned sensation like a nerve block, facial numbness, feeling "a sugar rush," "butterflies," waves of energy pulsing through the body, and burning sensations. Other somatic sensations reported included headache, pounding in one's head, tightness in the head, head swimming, nausea, sweatiness, warmth, coldness, palpitations, feeling pulled or twisted, feeling one's energy drained, weakness, and stomach ache.

Mystical experience features

Of the 100 patients interviewed, 98 were able to complete the modified Mysticism Scale with regard to their subjective experiences associated with seizures. The mean score of these 98 patients on the 16-item Mysticism Scale was 1.38 (SD = 0.55), on a Likert scale ranging from 1 to 5. In the subgroup of 55 patients who were able to recall any subjective experience associated with their seizures, the mean score on the Mysticism Scale was 1.66 (SD = 0.60). Table 1 shows the mean scores (taken over the entire group and over the two subgroups) for the modified Mysticism Scale, for each of the three factors (introvertive mysticism, extrovertive mysticism, and interpretation), and for each of the eight conceptual categories. Figure 1 shows the frequency distribution of the 98 individual participants' scores on the modified Mysticism Scale.

No single participant had a score on the Mysticism Scale that averaged 4 or more points per item, the criterion for having had a mystical experience; 85 individual participants (87%) scored 2 points or lower, the criterion for not having had a mystical experience; and the remaining 13 individual participants (13%) scored between 2 and

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Table 1. Mean scores for Mysticism Scale and subcategories (range = 1–5).

Mysticism Scale and subcategories	Patients able to recall any experience (n = 55)	Patients unable to recall any experience (n = 43)	All patients (N = 98)
Total Mysticism Scale	1.66 (SD = 0.60)	1.03 (SD = 0.07)	1.38 (SD = 0.55)
Introvertive Mysticism	2.32 (SD = 1.02)	1.07 (SD = 0.59)	1.78 (SD = 0.99)
Extrovertive Mysticism	1.23 (SD = 0.59)	1.00 (SD = 0.00)	1.13 (SD = 0.55)
Interpretation	1.28 (SD = 0.60)	1.00 (SD = 0.00)	1.16 (SD = 0.47)
Ego Loss (loss of self)	1.67 (SD = 0.93)	1.15 (SD = 0.47)	1.44 (SD = 0.81)
Unity (perception of oneness)	1.35 (SD = 0.89)	1.00 (SD = 0.00)	1.19 (SD = 0.68)
Inner Subjectivity (perception of all as animate)	1.12 (SD = 0.38)	1.00 (SD = 0.00)	1.07 (SD = 0.29)
Timelessness/Spacelessness	2.04 (SD = 1.30)	1.02 (SD = 0.15)	1.59 (SD = 1.10)
Noetic Quality (special knowledge or insight)	1.40 (SD = 0.84)	1.00 (SD = 0.00)	1.22 (SD = 0.65)
Ineffability	3.25 (SD = 1.72)	1.05 (SD = 0.31)	2.29 (SD = 1.70)
Positive Affect (peace or bliss)	1.12 (SD = 0.59)	1.00 (SD = 0.00)	1.07 (SD = 0.44)
Sacredness (sense of wonder)	1.32 (SD = 0.80)	1.00 (SD = 0.00)	1.18 (SD = 0.61)

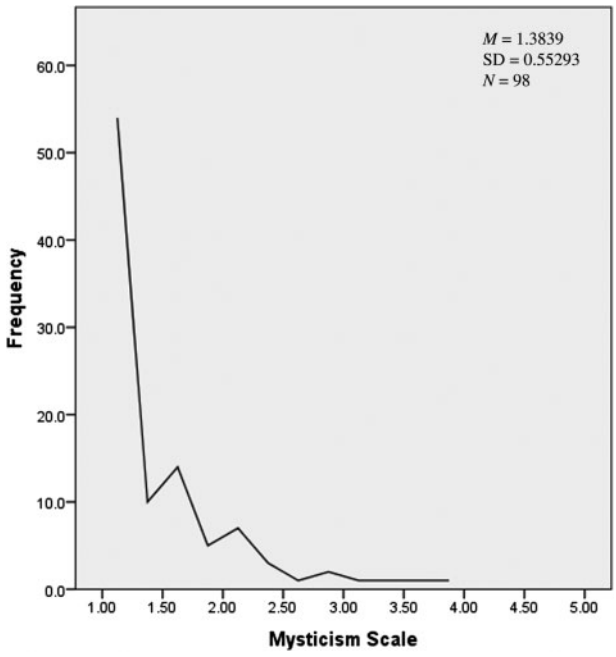

Figure 1. Frequency distribution of individual participants' Mysticism Scale scores.

3.75 points. Therefore, by Hood's criterion, none of the 98 patients described a mystical experience associated with seizures.

Table 2 shows the frequency distribution of individual participants who scored 4 points per item or higher (suggesting a mystical experience), greater than 2 but less than 4, and 2 or lower (suggesting that an experience that was not mystical), for the modified

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Table 2. Distribution of individual scores for Mysticism Scale and its subcategories ($N = 98$).

Mysticism Scale category	Score ≥ 4	Score > 2 and < 4	Score ≤ 2
Total Mysticism Scale	0	13	85
Introvertive Mysticism	4	29	65
Extrovertive Mysticism	0	5	93
Interpretation	1	4	93
Ego Loss (loss of self)	1	19	78
Unity (perception of oneness)	2	5	91
Inner Subjectivity (perception of all as animate)	0	2	96
Timelessness/Spacelessness	8	12	78
Noetic Quality (special knowledge or insight)	2	7	89
Ineffability	27	11	60
Positive Affect (experience of peace or bliss)	1	1	96
Sacredness (sense of wonder)	1	5	92

Mysticism Scale, for each of the three factors, and for each of the eight conceptual categories. Even though no individual participant scored 4 points per item or higher on the Mysticism Scale, four participants did so on the Introvertive Mysticism factor and one did on the Interpretation factor. Thus, the kinds of experiences associated with seizures sometimes had the features of introvertive mysticism but not of extrovertive mysticism, and were not interpreted in religious terms. In terms of specific features, at least one participant scored 4 points per item or higher on seven of the eight conceptual categories, including 27 participants on the Ineffability category and 8 on Timelessness/Spacelessness, both of which contribute to the Introvertive Mysticism factor. These data suggest that even though no individual met the criterion for a mystical experience, some did describe particular features of mystical experiences, particularly of Introvertive Mysticism, most notably difficulty describing their experience and a loss of a sense of time or spatial localization.

Not surprisingly, those patients who were able to recall any subjective experience during their seizures scored higher on the Mysticism Scale than those patients who were unable to recall any experience ($t = 6.84$, df = 96; $p < .001$). Patients who recalled experiences also scored significantly higher than those who did not on four of the eight conceptual categories of mystical experience: Ineffability ($t = 8.34$, df = 96; $p < .001$), Timelessness/Spacelessness ($t = 5.07$, df = 96; $p < .001$), Ego Loss ($t = 3.37$, df = 96; $p = .001$), and Noetic Quality ($t = 3.14$, df = 96; $p = .002$). For the remaining four conceptual categories, the two groups did not differ significantly, using the Bonferroni corrections for the eight simultaneous statistical tests: Unity ($t = 2.55$, df = 96), Sacredness ($t = 2.64$, df = 96), Inner Subjectivity ($t = 2.01$, df = 96), and Positive Affect ($t = 1.32$, df = 96).

Demographics and mystical experience

Age, gender, years of education, and ethnic identification of the patients are shown in Table 3, along with mean scores on the modified Mysticism Scale for genders and ethnic identifications. Those patients who were able to recall any subjective experience and those who were not able to do so did not differ in age ($t = -2.16$, df = 96), in years

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Table 3. Demographic variables of sample.

Variable	Patients able to recall any experience (n = 55)	Patients unable to recall any experience (n = 43)	All patients (N = 98)	Mysticism Scale
Age (yrs)	37.3 (SD = 12.1)	42.8 (SD = 12.9)	39.7 (SD = 12.7)	
Education (yrs)	14.0 (SD = 2.8)	13.0 (SD = 5.6)	13.6 (SD = 4.3)	
Gender				
Female	26 (47%)	23 (54%)	49 (50%)	1.30 (SD = 0.45)
Male	29 (53%)	20 (47%)	49 (50%)	1.47 (SD = 0.63)
Ethnicity				
European American	44 (80%)	38 (88%)	82 (84%)	1.36 (SD = 0.51)
African American	10 (18%)	4 (9%)	14 (14%)	1.54 (SD = 0.79)
Latino American	1 (2%)	1 (2%)	2 (2%)	1.25 (SD = 0.35)

of education (t = 1.15, df = 96), in gender (χ^2 = 0.37, df = 1), or in ethnic identification (χ^2 = 1.57, df = 2). Pearson correlation coefficients did not show significant associations between Mysticism Scale scores and age (r = −0.18) or years of education (r = 0.14). Mysticism Scale scores were not significantly associated with gender (t = 1.47, df = 96) or with ethnic identification (F = 0.72; df = 2, 95).

Seizure history and mystical experience

The mean age at onset of seizures, mean duration of the seizure disorder, mean maximum seizure frequency per month, and history of status epilepticus are presented in Table 4, along with mean scores on the modified Mysticism Scale for those with and without status epilepticus. Those patients who were able to recall any subjective experience and those who were not able to do so did not differ in age of onset (t = −0.64, df = 92), duration of seizure disorder (t = −1.71, df = 92), maximum monthly seizure frequency (t = −0.63, df = 87), or history of status epilepticus (χ^2 = 0.53, df = 1).

Table 4. Seizure history of sample.

Variable	Patients able to recall any experience (n = 55)	Patients unable to recall any experience (n = 43)	All patients (N = 98)	Mysticism Scale
Age of onset (yrs)	18.1 (SD = 12.6)	19.9 (SD = 13.7)	18.9 (SD = 13.1)	
Duration of seizure disorder (yrs)	18.5 (SD = 10.2)	23.1 (SD = 16.1)	20.6 (SD = 13.4)	
Seizure frequency/ month	35.4 (SD = 63.9)	44.7 (SD = 73.8)	39.5 (SD = 68.2)	
Status epilepticus history				
Status	7 (13%)	8 (19%)	15 (16%)	1.41 (SD = 0.63)
No status	48 (87%)	35 (81%)	83 (85%)	1.37 (SD = 0.55)

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Pearson correlation coefficients did not show significant associations between Mysticism Scale scores and age of onset ($r = -0.14$), duration of seizure disorder ($r = -0.02$), or maximum seizure frequency ($r = -0.14$). Mysticism Scale scores were not significantly associated with history of status epilepticus ($t = 0.26$, df = 94).

Seizure characteristics and mystical experience

Epilepsy etiology was unknown for 56 patients. Among the remaining 42 patients, 29 (69%) had seizures related to focal pathology, including focal congenital malformation, mesial temporal sclerosis, chronic localized encephalitis, and benign tumor; and 13 (31%) to generalized or multifocal pathology, including diffuse head injury, generalized congenital malformation, perinatal anoxia, and multiple intracerebral hemorrhages.

Seizure type was classifiable for 95 patients, of whom 70 had complex partial seizures; 10 had simple partial seizures, including focal motor, somatosensory, autonomic, déjà vu, and cognitive seizures; and 15 had generalized seizures, including tonic-clonic, multiple generalized, absence, and myoclonic seizures.

Epilepsy syndrome was classifiable for 93 patients, of whom 82 had a localization-related syndrome, including mesial temporal lobe, frontal lobe, and parietal lobe, as well as nonclassified cryptogenic; and 11 had a generalized epilepsy syndrome, including juvenile myoclonic, juvenile absence, and other idiopathic, as well as nonspecific symptomatic generalized and cryptogenic generalized epilepsy.

Epilepsy etiology, seizure type, and epilepsy syndrome are presented in Table 5, along with mean modified Mysticism Scale scores. Those patients who were able to recall any subjective experience and those who were not able to do so did not differ in epilepsy etiology ($\chi^2 = 2.08$, df = 2), seizure type ($\chi^2 = 4.19$, df = 3), or epilepsy syndrome ($\chi^2 = 1.67$, df = 2).

Table 5. Seizure characteristics of sample.

Variable	Patients able to recall any experience ($n = 55$)	Patients unable to recall any experience ($n = 43$)	All patients ($N = 98$)	Mysticism Scale
Epilepsy etiology				
Focal pathology	18 (33%)	11 (26%)	29 (30%)	1.31 (SD = 0.48)
Generalized pathology	5 (9%)	8 (19%)	13 (13%)	1.43 (SD = 0.56)
Unknown	32 (58%)	24 (56%)	56 (57%)	1.41 (SD = 0.59)
Seizure type				
Complex partial seizure	35 (64%)	35 (81%)	70 (71%)	1.36 (SD = 0.57)
Simple partial seizure	8 (15%)	2 (5%)	10 (10%)	1.37 (SD = 0.31)
Generalized seizure	10 (18%)	5 (12%)	15 (15%)	1.52 (SD = 0.61)
Unclassified seizure	2 (4%)	1 (2%)	3 (3%)	1.42 (SD = 0.55)
Epilepsy syndrome				
Localization-related epilepsy syndrome	45 (82%)	37 (86%)	82 (84%)	1.37 (SD = 0.55)
Generalized epilepsy syndrome	6 (11%)	5 (12%)	11 (11%)	1.62 (SD = 0.80)
Unknown	4 (7%)	1 (2%)	5 (5%)	1.70 (SD = 0.73)

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Table 6. EEG variables of sample.

Variable	Patients able to recall any experience (n = 46)	Patients unable to recall any experience (n = 40)	All patients (N = 86)	Mysticism Scale
Epileptiform discharge localization				
Temporal	15 (33%)	20 (50%)	35 (41%)	1.24 (SD = 0.46)
Other locus	5 (11%)	1 (3%)	6 (7%)	1.61 (SD = 0.37)
Multifocal	11 (24%)	9 (23%)	20 (23%)	1.24 (SD = 0.33)
None	15 (33%)	10 (25%)	25 (29%)	1.57 (SD = 0.65)
Epileptiform discharge lateralization				
Left-sided	16 (35%)	10 (25%)	26 (30%)	1.35 (SD = 0.52)
Right-sided	6 (13%)	5 (13%)	11 (13%)	1.35 (SD = 0.42)
Bilateral	7 (15%)	11 (28%)	18 (21%)	1.17 (SD = 0.29)
Generalized	4 (9%)	6 (15%)	10 (12%)	1.50 (SD = 0.75)
None	13 (28%)	8 (20%)	21 (24%)	1.50 (SD = 0.57)

Mysticism Scale scores were not significantly associated with epilepsy etiology (F = 0.35; df = 2, 95), seizure type (F = 0.37; df = 3, 94), or epilepsy syndrome (F = 1.17; df = 2, 56).

Electroencephalographic data and mystical experience

For the 86 patients for whom EEGs were available, data on localization and lateralization of epileptiform discharges are presented in Table 6, along with scores on the modified Mysticism Scale. Those patients who were able to recall any subjective experience and those who were not able to do so did not differ in discharge localization (χ^2 = 3.47, df = 3) or lateralization (χ^2 = 2.65, df = 4).

Modified Mysticism Scale scores were not significantly associated with discharge localization (F = 3.07; df = 3, 80) or lateralization (F = 1.17; df = 4, 79).

Discussion

Mystical experience and seizures

The finding that none of the patients' descriptions met the criteria for mystical experience corroborates a previous survey performed three decades ago that found no mystical experiences in an epilepsy clinic (Sensky, 1983). There were, to be sure, some features typical of mystical experience among these participants, but no single participant reported enough of these features to meet the criterion for having had a mystical experience. Four participants reported experiences that scored high on Introvertive Mysticism, whereas none reported experiences that scored high on Extrovertive Mysticism.

The characteristics of mystical experience most commonly endorsed by patients in this study, Ineffability and Timelessness/Spacelessness, are by no means unique to mystical experience but are seen in many altered states of consciousness. On the other hand, the more definitive elements of mystical experience, such as Inner Subjectivity, Sacredness, and Unity, were very rarely endorsed in this study. It is not surprising that patients who could recall any experience scored higher on four of the eight conceptual categories of mystical experience. Rather, it is perhaps surprising that the remaining

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categories – Unity, Sacredness, Inner Subjectivity, and Positive Affect – were not reported more frequently by those who could recall any subjective experience.

Features of mystical experience associated with seizures were not associated with any clinical factors in the seizure history, nor with seizure characteristics. However, given the small number of mystical experience features reported by patients and the small number of patients with certain EEG patterns, there may have been insufficient statistical power to evaluate certain of these associations, and any statistical significance found might be of limited clinical relevance.

The widespread assumption that mystical experience is associated with seizures may be due in part to inexact use of the term "mystical" and its general confounding with religiosity (Sensky, 1983). Cardeña and Marcusson-Clavertz (2012) have highlighted the inappropriate use of the label "mysticism" by scholars unfamiliar with the clear and specific connotations of that term in religious studies, psychology, and related disciplines.

Experiences of ecstasy have occurred with complex partial seizures, and these "ecstatic seizures" have some features that have been thought to resemble spontaneous mystical experiences (Cirignotta, Tedesco, & Lugaresi, 1980), although they are rare enough that their study has been largely anecdotal, based on single case reports or small case collections (Hansen & Brodtkorb, 2003). Many of the anecdotal reports of "ecstatic" seizures include feelings of depersonalization or unreality, and feelings of being detached, far away, or "not in this world," "dreamy states," and "a sense that things do not seem real" (e.g., Dolgoff-Kaspar et al., 2011, p. 641), sensations that are not suggestive of mystical experience. In contrast, standard descriptions of mystical experience include a hyper-awake rather than "dreamy" state and a sense that things seem "hyper-real" rather than "not real" (Kelly & Grosso, 2007). Some published examples of purported "ecstatic seizures" involve pleasurable physiologic sensations rather than true ecstasy or mystical experience (e.g., Saver & Rabin, 1997). The common occurrence of centrally mediated orgasmic sensations in "ecstatic" seizures is virtually unknown in traditional mystical experience, and the self-absorption associated with stereotypical ictal affect is contrary to the detachment, nuanced feelings, and important interpersonal structure of mystical experience (Bradford, 2013).

Mystical experience and the temporal lobe

Although speculation regarding the physiological bases of mystical experiences has focused on the temporal lobes, corroborative evidence to support a link between the temporal lobe and mystical experience has been rather sparse (Bradford, 2013; Joseph, 2001; Kelly & Grosso, 2007). The few features of mystical experience that were reported in this study were not associated primarily with temporal lobe function, nor were they lateralized to either the right or left side. These findings support recent clinical and neuroimaging research suggesting a much more complex picture of mystical experience involving extensive neocortical involvement (Bradford, 2013; Devinsky & Lai, 2008).

Studies involving direct electrical or magnetic stimulation of the temporal and limbic cortex have yielded ambiguous evidence of a connection with genuine mystical experience. Of the 520 patients with temporal lobe epilepsy studied by Penfield and Perot (1963), only about 10% reported any experiential phenomena at all, and none of the reported experiences bears any significant resemblance to mystical states of consciousness. Several subsequent studies involving direct electrical stimulation of the temporal lobes and limbic system have found that affective responses of any kind to electrical stimulation are rare and consist almost exclusively of fear and anxiety (Gloor, 1990;

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Gloor, Olivier, Quesney, Andermann, & Horowitz, 1982; Halgren, 1982; Halgren, Walter, Cherlow, & Crandall, 1978).

Despite the persistent assumption of a connection between limbic system dysfunction and religious experience, the complex visual, auditory, and ideation content suggests a more complex picture involving extensive neocortical involvement (Bradford, 2013; Devinsky & Lai, 2008). Neuroimaging studies of mystical experience have reported complex patterns of widespread activation in the cortices, midbrain, and brainstem using functional magnetic resonance imaging (fMRI) imaging (Beauregard & Paquette, 2006), EEG spectral power (Beauregard & Paquette, 2008), positron emission tomography (PET) imaging (Azari et al., 2001), and single-photon emission computed tomography (SPECT) (Newberg, Pourdehnad, Alavi, & d'Aquili, 2003; Newberg et al., 2001, 2010).

Methodological issues

The dearth of mystical phenomena reported by patients in association with their seizures must be interpreted with caution due to postictal retrograde amnesia (Devinsky & Lai, 2008) and the documented unreliability of patients' memories of their seizures (Quigg, 2011). It is possible that interviewing patients immediately after their seizures might have yielded a higher incidence of mystical phenomena.

It is also possible that mystical experiences associated with seizures may be under-reported by patients as a result of reluctance to discuss experiences that may be considered psychopathological (Devinsky & Lai, 2008). However, patients in this study freely and openly discussed their mystical and other anomalous experiences that occurred under circumstances *not* associated with their seizures, and they spontaneously reported *other* unusual experiences, such as out-of-body experiences and precognitive visions, that they associated with their seizures, suggesting that the absence of reported seizure-related mystical experiences was not due to patients' reluctance to acknowledge such events.

Another complicating factor in studies of subjective experiences associated with seizures is the role of comorbid psychiatric disorder in epileptic patients. Interest in mystical states in epilepsy was advanced by Slater and Beard (1963) and Dewhurst and Beard (1970), who specifically studied patients with both epilepsy and comorbid psychosis. Although we included in our sample patients with comorbid psychiatric disorders, we excluded those whose psychotic symptoms precluded a reliable interview. That exclusion may have influenced the frequency of reports of mystical experience in this sample.

Our use of the Mysticism Scale to quantify mystical experience assumes that mystical experience can be measured on a continuous scale. Whether such experiences have a common core, as argued by scholars from James (1902) to Stace (1960), and whether they can be meaningfully classified by "depth" by any measure, are open questions. It may be that mystical experience may be better conceptualized as a family of experiences of differing typology; or that, even within one type of mystical experience, experiential intensity may not be measurable along a continuous scale (Kelly & Grosso, 2007; Wulff, 2013).

It is conceivable that our use of only the positively worded items in the Mysticism Scale may have influenced our findings. As noted above, the modification of the original Mysticism Scale for reference to a single event rather than a lifetime (Hood, 1977) results in confusing double negatives in the negatively worded items (MacLean, Leoutsakos, Johnson, & Griffiths, 2012). We followed the lead of prior researchers sampling atypical populations in opting to use only the positively worded items (Anthony et al., 2010;

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Holm, 1982). The correlation between positively worded items and all items for the entire Mysticism Scale score is greater than 0.90 (Greyson, in press), suggesting that using the positively worded items alone does not significantly alter the outcome.

We relied on scalp EEG, the standard tool for epilepsy diagnosis, for identification of seizure localization and lateralization. However, clinical data from intractable epilepsies suggest that "focal" epilepsy does not necessarily remain focal or static in its pathology (Najm et al., 2013). It is conceivable that correlations that were not evident with EEG measures might become apparent using multimodality neuroimaging employing intracranial EEG, MRI, resting-state fMRI, PET, SPECT, magnetoencephalography (MEG), or diffusion tensor imaging (Olson & Perry, 2013).

It should be noted that this study investigated the incidence specifically of mystical experience associated with seizures, but did not address the incidence of other expressions of hyper-religiosity. It is possible that seizures may be associated with other religious experiences, such as subjectively perceived encounters with spiritual entities, which do not involve the specific features of mystical experience.

Conclusion

Considerable progress has been made in recent decades elucidating the neurobiologic correlates of altered states of consciousness. In particular, there has been considerable suggestive evidence bearing on the evolutionary neurological foundations of religious behavior and mystical experience (Joseph, 2001; Saver & Rabin, 1997). The data from this study add to the accumulating evidence that the temporal lobe is not differentially involved in the generation of mystical states (Bradford, 2013; Devinsky & Lai, 2008; Kelly & Grosso, 2007). Mystical experience does not appear to be associated commonly with seizures, although features of introvertive mysticism are more common than extrovertive; nor does mystical experience appear to be associated with any one particular region of the brain.

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