NUMINOUS-LIKE AURAS AND SPIRITUALITY IN PERSONS WITH FOCAL SEIZURES

by

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ABSTRACT

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Background and Rationale: Religion and spirituality have been associated with epilepsy for thousands of years, yet the nature of this association remains elusive. This study addressed this topic by seeking a relationship between aura symptoms that are reminiscent of spiritual experiences ("numinous-like auras", or NLAs) and spirituality of an unconventional form. It was hypothesized that seizure patients with greater frequencies of NLAs would have increased ictal and interictal spirituality as measured by the Experiential Phenomenological Dimension (EPD) and Paranormal Beliefs (PB) factors of the Expressions of Spirituality Inventory Revised (ESI-R), compared to patients with fewer NLAs and compared to a reference population. No differences were expected among the groups on ESI-R measures related to traditional religiosity.

Methods: Thirty-eight patients with focal seizures filled out the ESI-R for both their ictal and interictal experiences/beliefs, as well as the MMPI-2 to assess psychopathology. Patients were divided into Low and High NLA groups for comparisons. Sixteen introductory psychology students comprised the reference population.

Results: As hypothesized, patients in the High NLA group had significantly greater ictal and interictal EPD and PB scores compared to the Low NLA group ($p < .05$). The High group also had significantly greater EPD scores, and a statistical trend of greater PB scores compared to the reference population ($p < .05$ and $p < .1$, respectively). There were no differences between the Low NLA group and the reference group. Additionally, there were no differences among the groups on the other ESI-R measures.

Conclusions: The results show that patients with high frequencies of NLAs have increased paranormal beliefs and spiritual experiences both ictally and interictally. The findings support a conception of epileptic spirituality as personalized, experiential and distinct from traditional, culturally-based religiosity. The enhanced spirituality observed in this study may be attributed to over-activation of the limbic system, as it underlies most of the NLAs. Interictal spiritual experiences may be related to potentiation of select limbic-cortical circuits that underlie numinous-like experiences. Frequent NLAs may be key because they indicate sufficient activation to produce this potentiation. The relationship between spiritual experiences and accompanying paranormal beliefs is likely reciprocal, and is an interesting topic for future research.

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Background

Epilepsy: Prevalence, Definitions and Classifications

An Introduction to Epilepsy

Epilepsy is one of the most prevalent neurological disorders. It affects approximately 50 million people worldwide, and accounts for 1% of diseases overall (WHO, 2005). The number of new cases per year in developed countries is 24-53 per 100,000 people (WHO, 2005). In the United States, approximately 2 million people have epilepsy, and lifetime prevalence for the general population is 3% (Annegers, 2001). Although it is a neurological disorder, it has physical, psychological, social and occupational consequences. This project focuses on the experiential aspects of seizures, however, a brief overview of key definitions and classifications of epilepsy will be provided first.

The International League Against Epilepsy (ILAE) and the International Bureau for Epilepsy (IBE) have made considerable efforts to define the terms *seizure* and *epilepsy* (Fisher et al., 2005). While these terms have been used widely for many years, the need to clarify their definitions as recently as 2005 indicates their ambiguity and the lack of consensus in their usage. Table 1 (adapted from tables in Fisher et al., 2005) provides definitions of these key terms and their core elements. The following text provides an elaboration on the definitions provided by Fisher et al. (2005).

Table 1

International League Against Epilepsy (ILAE) and International Bureau for Epilepsy (IBE) Definitions of Epileptic Seizure and Epilepsy (adapted from Fisher et al., 2005)

A. Epileptic Seizure
Definition:
An epileptic seizure is a transient occurrence of signs and/or symptoms due to abnormal excessive or synchronous neuronal activity in the brain.

Elements in the Definition:
Mode of onset and termination
Clinical Manifestations
Abnormal enhanced synchrony

B. Epilepsy
Definition:
Epilepsy is a disorder of the brain characterized by an enduring predisposition to generate epileptic seizures and by the neurobiologic, cognitive, psychological, and social consequences of this condition. The definition of epilepsy requires the occurrence of at least one epileptic seizure.

Elements of the Definition:
History of at least one seizure
Enduring alteration in the brain that increases the likelihood of future seizures
Associated neurobiologic, cognitive, psychological, and social disturbances

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Epileptic seizures are generally short-lived, with a demarcated onset and termination that can be observed both clinically and with electroencephalography (EEG). Status epilepticus is an exception, in which seizures are prolonged or rapidly recurring. Additionally, peri-ictal states (periods before and particularly after seizures, or *ictus*) may obscure the precise boundaries of the seizure. The presence of clinical manifestations such as signs and symptoms is required in the definition of a seizure. Thus, EEG activity that resembles a seizure, but has no clinical manifestation, does not qualify as a seizure. However, it may be that the clinical manifestation is too subtle for detection by the observer and not recognized by the patient. Another key component of a seizure is the presence of underlying aberrant neuronal firing. This firing is generally orderly and

relatively stereotyped; enhanced synchrony of firing is common. Seizures may involve both excitation and inhibition, and do not necessarily involve greater excitation than inhibition (Fisher et al., 2005).

Epilepsy is an umbrella term that includes a variety of different disorders that involve an enduring predisposition to have epileptic seizures (Shneker & Fountain, 2003). This may include a focal brain insult such as a lesion, or a genetic trait such as an ion channel abnormality, which leads to the occurrence of future seizures. The most frequently reported etiologies of epilepsy worldwide are: trauma, central nervous system infections, perinatal risk factors, cerebrovascular disease, idiopathic origin, tumors, congenital origin, and parasitic infections (WHO, 2005). Only one seizure is required for a diagnosis of epilepsy, however it must be an epileptic seizure. A single seizure in a normal brain (e.g. due to alcohol withdrawal) would not qualify as epilepsy. Additionally, multiple seizures due to multiple (non-epileptic) etiologies in a person would not qualify. The presence of psychological, cognitive and social symptoms is also included in the definition of epilepsy (Fisher et al., 2005). These factors may greatly reduce the quality of life of patients. The psychological symptoms of epilepsy will be explored at length in the following chapter.

The ILAE has worked to create a classification system of epileptic seizures and syndromes since 1970, with the most recent version published in 1989 (Commission, 1989). This latest version has been criticized, and changes have been suggested, but a formal replacement has not occurred due to the widespread usage of the 1989 system, and the lack of a better system (Engel, 2001a; Engel, 2006). The categorization of seizure types is found in Engel (2001a) and has been adapted here (Table 2). The two main

categories of self-limiting seizure types are generalized seizures and focal seizures (previously termed partial seizures, and localization-related seizures). While some conditions fall between these categories (e.g. diffuse hemispheric abnormalities, multifocal abnormalities and bilaterally symmetrical localized abnormalities) (Engel, 2001a), the distinction is still useful.

Table 2

International League against Epilepsy (ILAE) Classification of Epileptic Seizure Types and Precipitating Stimuli for Reflex Seizures (from Engel, 2001a)

Self-limited seizure types

Generalized seizures

- Tonic-clonic seizures (includes variations beginning with a clonic or myoclonic phase)
- Clonic seizures
  - Without tonic features
  - With tonic features
- Typical absence seizures
- Atypical absence seizures
- Myoclonic absence seizures
- Tonic seizures
- Spasms
- Myoclonic seizures
- Eyelid myoclonia
  - Without absences
  - With absences
- Myoclonic atonic seizures
- Negative myoclonus
- Atonic seizures

Focal Seizures

- Focal sensory seizures
  - With elementary sensory symptoms (e.g., occipital and parietal lobe seizures)
  - With experiential sensory symptoms (e.g., temporo parieto occipital junction seizures)
- Focal motor seizures
  - With elementary clonic motor signs
  - With asymmetrical tonic motor seizures (e.g. supplementary motor seizures)
  - With typical (temporal lobe) automatisms (e.g., mesial temporal lobe seizures)
  - With hyperkinetic automatisms
  - With focal negative myoclonus
  - With inhibitory motor seizures
- Gelastic seizures

Hemiclonic seizures
Secondary generalized seizures

Continuous seizure types

Generalized status epilepticus

Generalized tonic-clonic status epilepticus
Clonic status epilepticus
Absence status epilepticus
Tonic status epilepticus
Tonic status epilepticus
Myoclonic status epilepticus

Focal status epilepticus

Epilepsia partialis continua of Kojevnikov
Aura continua
Limbic status epilepticus (psychomotor status)
Hemiconvulsive status

Precipitating stimuli for reflex seizures

Visual stimuli
Flickering light: color to be specified when possible
Patterns
Other visual stimuli
Thinking
Music
Eating
Praxis
Somatosensory
Proprioceptive
Reading
Hot water
Startle

Generalized and focal seizures occur in the context of various epilepsy syndromes. The ILAE classification system of the epilepsies is found in Sirven (2002) and has been adapted here (Table 3). Both focal and generalized seizures are organized by etiology – idiopathic, symptomatic or cryptogenic. Idiopathic syndromes are usually inherited and have no identifiable structural cause. Here, seizures are caused by abnormalities in neuronal transmission (anatomical, neurochemical or both) (Shneker & Fountain, 2003). Symptomatic syndromes are associated with a known or suspected

brain lesion or pathology. Syndromes that are secondary to a brain injury, but where the injury is unknown are labeled cryptogenic (Sirven, 2002). In general, idiopathic syndromes have better prognoses than the symptomatic syndromes. The following sections review generalized and focal seizures and syndromes in greater detail, with more attention spent on focal epilepsy, as that is the population investigated in this study.

Table 3

International League against Epilepsy (ILAE) Classification of the Epilepsies (Sirven, 2002, based on 1989 system)

1. Localization related (focal, partial)

   A. Idiopathic
      i. Benign childhood epilepsy with centrotemporal spikes
      ii. Childhood epilepsy with occipital paroxysms
      iii. Primary reading epilepsy

   B. Symptomatic
      i. Temporal lobe epilepsy
      ii. Frontal lobe epilepsy
      iii. Parietal lobe epilepsy
      iv. Occipital lobe epilepsy
      v. Chronic progressive epilepsia partialis continua of childhood

   C. Cryptogenic defined by
      i. Seizure type
      ii. Clinical features
      iii. Etiology
      iv. Anatomic localization

2. Generalized

   A. Idiopathic
      i. Benign neonatal familial convulsions
      ii. Benign neonatal convulsions
      iii. Benign myoclonic epilepsy in infancy
      iv. Childhood absence epilepsy
      v. Juvenile myoclonic epilepsy
      vi. Epilepsies with grand mal
      vii. Seizures on awakening
      viii. Other generalized idiopathic epilepsies

B. Cryptogenic or symptomatic
   i. West syndrome
   ii. Lennox-Gastaut syndrome
   iii. Epilepsy with myoclonic-astatic seizures
   iv. Epilepsy with myoclonic absences

C. Symptomatic
   i. Nonspecific etiology
   ii. Early myoclonic encephalopathy
   iii. Early infantile epileptic encephalopathy with suppression bursts
   iv. Other symptomatic generalized epilepsies

3. Undetermined epilepsies
   A. Generalized and focal seizures
      i. Neonatal seizures
      ii. Severe myoclonic epilepsy in infancy
      iii. Epilepsy with continuous spike wave during slow wave sleep
      iv. Acquired epileptic aphasia

4. Special syndromes
   A. Situation-related seizures
      i. Febrile convulsions
      ii. Isolated seizures or isolated status epilepticus
      iii. Seizures occurring only when there is an acute or toxic event due to factors such as alcohol, drugs, eclampsia, nonketotic hyperglycemia

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Generalized Epilepsy

Generalized seizures are characterized by seizure activity in all, or most of, the brain. Broad subtypes include: absence, myoclonic, tonic, atonic, clonic, tonic-clonic and unclassified seizures (Table 2) (Browne & Holmes, 1997). Primary generalized seizures are believed to begin simultaneously throughout the brain (Chang and Lowenstein, 2003). Many types of primarily generalized seizures are idiopathic, with a strong genetic component. Most have a complex inheritance pattern, but a few have a simple Mendelian pattern of inheritance, which involves a single gene that in most cases codes for ion-channel proteins (Chang & Lowenstein, 2003). Generalized seizures may have a motor component, such as generalized tonic-clonic seizures, or they may have no or minimal

motor involvement, such as absence seizures (Browne & Holmes, 1997). Brief descriptions of these two seizure types are provided as examples of primary generalized seizures.

Generalized tonic-clonic seizures are the most severe kind of seizure (Sirven, 2002) and involve loss of consciousness, autonomic activation sometimes with urinary incontinence and convulsions. There is increased muscle tone and rigid posturing (tonic phase), followed by bilateral, synchronous rhythmic jerks (clonic phase). The patient awakens by passing through stages of coma, confusion and drowsiness (Browne & Holmes, 1997). Generalized tonic-clonic seizures occur with equal frequency across the lifespan (WHO, 2005). While such seizures have traditionally been thought to involve aberrant neuronal activity throughout the entire brain, recent research using single photon emission computed tomography (SPECT) during electroconvulsive shock therapy (ECT) suggests that generalized tonic-clonic seizures may actually involve only certain regions of the brain – in particular, the prefrontal, parietal and temporal association cortices – while sparing others (Blumenfeld et al., 2003).

Absence seizures involve rapid onset and resolution of impaired consciousness and responsiveness. There are two types of absence seizure – typical and atypical – seen in epilepsies of idiopathic and symptomatic (respectively) origin. In typical absence seizures, there is a lapse of consciousness that usually lasts between 1-10 seconds. Patients cease activity and appear to stare blankly for several seconds, however there are often subtle signs and symptoms such as clonic movements, changes to postural tone, automatisms and autonomic changes. The clonic movements often involve the eyelids, such as rapid blinking. Automatisms may include facial movements or rocking (Sirven,

2002). Patients then return to baseline, with no postictal symptoms or memory of the event; they may, however, notice gaps in time (Chang & Lowenstein, 2003). Atypical absence seizures usually last 10-25 seconds, and often produce motor signs such as changes in tone (Sirven, 2002). Unlike typical absence seizures, there may be postictal symptoms such as confusion. Absence seizures are most common in children 5-10 years old (childhood absence epilepsy) (WHO, 2005) and involve an alteration in the circuitry between the thalamus and cerebral cortex (Chang & Lowenstein, 2003).

Focal Epilepsy

Focal seizures involve only an isolated region of the brain, although they can become generalized to involve the whole brain (secondary generalization). The broad subtypes of focal seizures include focal sensory seizures, focal motor seizures, gelastic seizures, hemiclonic seizures and secondarily generalized seizures (Table 2) (Engel, 2001a). Focal seizures were previously categorized in terms of consciousness: seizures with impairments in consciousness were termed complex partial seizures, and seizures with no impairment were termed simple partial seizures (Browne & Holmes, 1997). These terms are no longer recommended, as consciousness is an ambiguous term and has no localizing value (Engel, 2006), however, they are still in wide use. For the purposes of this paper, the term focal seizure will be used unless a cited study uses the older terms. Focal seizure syndromes are categorized by their location in the brain and their etiology, if known (e.g. frontal lobe epilepsy, mesial temporal lobe epilepsy with hippocampal sclerosis, etc.) (Table 3). Focal seizures are predominantly symptomatic disorders, caused by brain insults such as lesions, tumors or strokes (Annegers, 2001). However, in

some cases, the insult is never identified (cryptogenic). Less commonly, focal seizures may have genetic etiologies, as in the case of autosomal dominant nocturnal frontal lobe epilepsy, which involves a single-gene mutation (idiopathic) (Chang & Lowenstein, 2003). Focal seizures are the most prevalent seizure type in adults, accounting for over half of all seizures (WHO, 2005).

The most common type of focal epilepsy (and epilepsy in general) is temporal lobe epilepsy (TLE) (Engel, 2001b, Chang & Lowenstein, 2003). There are two types of TLE – mesial TLE and lateral, or neocortical TLE (Sirven, 2002). The more common type is mesial TLE, with seizures arising from the mesial limbic structures of the temporal lobe, usually the hippocampus, amygdala and adjacent parahippocampal cortex (Chang & Lowenstein, 2003). The most common pathology is hippocampal sclerosis (scarring) (Engel, 2001b). It is unclear if this pathology is a cause, or an effect, of seizures (Chang & Lowenstein, 2003). Mesial temporal lobe seizures usually present with an aura, such as an epigastric rising sensation, olfactory or gustatory hallucinations or experiential symptoms such as depersonalization or déjà vu (these experiential symptoms will be explored extensively in the next chapter). They may then progress to include loss of awareness and automatisms such as lip-smacking (Kotogal, 1991), constituting what was previously termed a complex partial seizure. Seizures generally last between 1-3 minutes, and are often accompanied by postictal confusion; secondary generalization is relatively rare (Sirven, 2002). Mesial TLE is poorly controlled by antiepileptic medications; surgery is an effective treatment option for persons who do not respond to medications. Risk factors include a history of febrile seizures or other insults such as intracerebral infections or head trauma in early childhood (up to age 5). There is

also some evidence for a genetic predisposition towards mesial TLE (Engel, 2001b). Neocortical temporal lobe epilepy is not as common or as well-defined as mesial TLE. It is also associated with auras and automatisms, but may have more frequent secondary generalization than mesial temporal seizures (Sirven, 2002). Both mesial TLE and neocortical TLE are associated with interictal EEG abnormalities such as unilateral or bilateral asynchronous spikes or sharp waves (Sirven, 2002).

Frontal lobe epilepsy (FLE), parietal lobe epilepsy (PLE), occipital lobe epilepsy (OLE) and chronic progressive epilepsia partialis continua of childhood are the other forms of symptomatic focal seizure syndromes (Table 3). The signs and symptoms associated with these epilepsies reflect the functions of the specific regions involved. FLE is the second most common form of focal epilepsy after TLE (Sirven, 2002). FLE may include a wide variety of symptoms, depending on the regions involved. Seizures involving the hand area of the primary motor cortex will produce contralateral clonic hand movements (Shneker & Fountain, 2003). Seizures involving Broca's area will have speech arrest, while orbitofrontal or cingulate seizures may involve olfactory, psychic or emotional auras as well as complex automatisms (Sirven, 2002). EEG may show unilateral or bilateral interictal spiking in the frontal region, although temporal spikes may also be present (Sirven, 2002). PLE usually involves sensory symptoms such as numbness, tingling and pain. OLE can involve a variety of visual symptoms; simple visual hallucinations arise from involvement of the primary visual cortex, while complex hallucinations reflect involvement of the association cortex (Sirven, 2002). FLE, PLE and OLE seizures may involve preserved or impaired consciousness (i.e. simple or complex seizures) and may become secondarily generalized (Shneker & Fountain, 2003).

Chronic progressive epilepsia partialis continua of childhood involves selective motor cortex activation. Symptoms include continuous arrhythmic myoclonic jerking of one or more muscle groups (Sirven, 2002).

The Psychological Symptoms of Epilepsy

Epilepsy is categorized as a neurological disease, but there are many psychological manifestations as well. These manifestations may range from transient mental experiences that occur during seizures, to significant cognitive disabilities, to posited long-term personality alterations that may be unrelated to epilepsy (Manchanda, 2002). Some psychological phenomena seen in epilepsy, such as depression and anxiety, are common psychiatric disturbances in the general population, while other phenomena, such as hypergraphia, are unusual behaviors that have aroused much debate (Devinsky & Najjar, 1999). One of the main objectives of research on the psychological symptoms of epilepsy is to determine their etiology. Neuropathology (e.g. anatomical site, laterality, nature of the pathology, and number of lesions) and parameters of epileptic discharges (e.g. ictal, interictal, subclinical, area and pattern of spread, frequency, status epilepticus, age of onset, and duration) may differ among patients – even those with the same diagnosis – to produce different psychological manifestations (Kwan & Brodie, 2001). Psychosocial factors (e.g. public attitudes, self-esteem, educational opportunities, employment status and marital status) as well as antiepileptic medications (e.g. number of medications, dosage, and concentration) and other interventions (e.g. surgery) may also impact psychological symptoms (Kwan & Brodie, 2001). Certainly, unrelated life events and/or medical conditions may also determine the expression of psychological symptoms.

One way that researchers have attempted to sort through the variety of psychological symptoms in epilepsy, and to determine the etiology of symptoms, is to categorize them by their temporal proximity to seizures (ictus). Psychological symptoms are thus categorized as ictal, peri-ictal (including pre-ictal and postictal) and interictal. The benefits of this nomenclature have been recognized since the 19th century in the writings of Gowers and Hughlings-Jackson (Kanner, 2006). Despite this lengthy history, the boundaries among these categories remain somewhat ambiguous. It can be difficult to distinguish the ictal and peri-ictal states, both clinically and with EEG. Nevertheless, this categorization system is widespread, and will be employed in the current discussion. As this project assesses both ictal and interictal psychological symptoms, those symptom categories will be the focus of this discussion, although peri-ictal symptoms will also be reviewed.

Pre-Ictal Symptoms

Pre-ictal clinical symptoms have received little systematic investigation, although they have been recognized since the time of the Babylonians, who believed that various symptoms predicted the severity of the seizure that would follow (Wilson & Reynolds, 1990, as cited in Boylan, 2002). Cognitive difficulties and mood disturbances such as irritability are the most commonly reported pre-seizure symptoms. In children, it is common to see motor hyperactivity, irritability, impulsive behavior and poor frustration tolerance (Kanner, 2006). In one of the only systematic prospective studies of pre-ictal symptoms, subjects reported dysphoric mood that began approximately 3 days before a seizure, and worsened as the seizure approached (Blanchet & Frommer, 1986). Another

study found symptoms of irritability, depression, headache, “funny feeling”, and confusion in patients with focal seizures, which began at least 30 minutes before seizure onset (Hughes, Devinsky, Feldmann & Bromfield, 1993). Survey results show that 63-92% of seizure patients report stress, fatigue, depression and menstruation as common states that precede, and perhaps precipitate, seizures (as reviewed by Boylan, 2002). Recent research has identified pre-ictal changes in EEG that can be detected hours before seizures occur (Protopopescu, Hively & Gailey, 2001).

Postictal Symptoms

Postictal symptoms are symptoms that occur in the hours to weeks following seizures. The amount of time that constitutes the postictal period has not been firmly established. It has been defined as up to 3 days after a seizure (Kanner, Soto & Gross-Kanner, 2004), although sometimes it lasts up to 4 weeks (Kanner, 2006), or even 3 months after a seizure (Logsdail & Toone, 1988). Symptoms include a variety of cognitive and psychiatric manifestations that may occur individually or in clusters. Postictal symptoms are very common; Kanner et al. (2004) found that only 14% of patients reported no cognitive or psychiatric symptoms after seizures.

Postictal cognitive symptoms are often characterized by confusion and clouded thinking, with specific deficits in attention, concentration, short-term memory and verbal skills, among others (Fisher & Schachter, 2000). Deficits are generally greatest in patients with generalized tonic-clonic seizures, followed by patients with absence seizures, and then patients with focal seizures (Dodrill & Willensky, 1992). Generalized tonic-clonic seizures are usually followed by periods of unresponsiveness and

occasionally, unconsciousness, which may last hours to days (Fisher & Schachter, 2000). In patients with focal seizures, postictal cognitive symptoms may include more specific deficits that are associated with the location and lateralization of the seizure. Helmstaedter, Elger & Lendt (1994) found that verbal and visual recognition memory was impaired after temporal, but not frontal lobe seizures. Additionally, the results showed lateralization effects – verbal deficits occurred after seizures in the dominant hemisphere, and visual deficits occurred after seizures in the non-dominant hemisphere. Other specific postictal neuropsychological deficits include aphasia, apraxia, hemineglect and nonverbal memory difficulties (Boylan, 2002). In terms of prevalence, Kanner et al. (2004) showed that 14% of refractory partial epilepsy patients reported at least one postictal cognitive symptom, which generally lasted one to several hours.

Postictal psychiatric manifestations include symptoms of depression, anxiety and psychosis. Kanner, Stagno, Kotagal & Morris (1996) reported postictal psychiatric episodes in 7.9% of patients undergoing video-monitored EEG. In a more recent study, 74% of patients with refractory seizures reported at least one type of postictal psychiatric symptom (Kanner et al., 2004). The postictal psychiatric symptoms that were reported were depression, anxiety (including panic, agoraphobia symptoms and compulsions), psychosis, hypomania and vegetative symptoms, and generally lasted one to several days. Depression is likely the most common postictal psychiatric symptom, however, it is often not recognized in patients (Kanner, 2006). Kanner et al. (2004) found that 48% of refractory partial seizure patients reported postictal symptoms of depression, with a median duration of 24 hours for most symptoms (Kanner & Barry, 2001).

The postictal symptom that has been most studied is postictal psychosis (PIP) (Boylan, 2002). PIP is generally characterized by mood changes and positive psychotic symptoms such as paranoid delusions, and less frequently, auditory, visual and sensory hallucinations (Lancman, 1999). Suicide, aggression and violence towards others have also been observed (Boylan, 2002). Kanner et al. (2004) summarize common characteristics of postictal psychotic episodes as the following: 1) delay between the onset of symptoms and the last seizure, 2) relatively short-lasting, 3) affective symptomatology, 4) delusional and affective-like clusters of symptoms, 5) secondarily generalized tonic-clonic seizures frequently precede onset, 6) most patients have had seizures for at least 10 years, and 7) prompt response of psychosis to low-dose neuroleptic medications or benzodiazepines (Kanner & Barry, 2001). Prevalence estimates of postictal psychosis range from 6-10% of persons with epilepsy (Lancman, 1999). Postictal psychosis may be more likely to occur after periods of frequent seizures, particularly when anti-epileptic drugs (AEDs) are lowered for EEG monitoring (Lancman, 1999; Savard, Andermann, Olivier & Remillard, 1991). Kanner et al. (1996) found that of 13 patients with postictal psychiatric episodes during video-monitored EEG, 10 had postictal psychosis.

Ictal Symptoms

Psychological ictal symptoms (psychological auras) are clinical manifestations of seizures, thus they are generally sudden and short-lived. Such symptoms usually occur during focal seizures without impaired consciousness (SPS), but may also occur during seizures with impaired consciousness (e.g. complex partial or absence seizures) (Kanner,

2006). In nonconvulsive status epilepticus, symptoms may be more prolonged (Shorvon, 1994, as cited in Boylan, 2002). Auras may also be followed by impairments in consciousness (i.e. simple partial seizures elaborate into complex partial or generalized tonic-clonic seizures), in which case the psychological symptoms may not be remembered due to retrograde amnesia.

Classification systems of auras.

Psychological auras include a variety of cognitive, sensory and affective alterations and have been grouped in various ways in different aura classification systems. Gupta, Jeavons, Hughes & Covanis (1983) classified auras into four categories based on that of the International League Against Epilepsy, including, 1) auras with motor signs, 2) specific sensory symptoms (visual, auditory, olfactory, gustatory, vertiginous and somatosensory), 3) psychic symptoms (dysphasic, dysmnesic [e.g. déjà vu], cognitive [e.g. dreamy states, distortions of time], affective [e.g. fear, anger] illusions [e.g. macropsia], and structural hallucinations [e.g. music, scenes]), and 4) autonomic signs or symptoms (epigastric sensation, pallor, sweating, flushing, piloerection, papillary dilation, cardiovascular and genitourinary). Palmini and Gloor (1992) classified auras into nine categories, including: 1) somatosensory phenomena (tingling, numbness, or pain in a limb or on one side of the body), 2) elementary visual phenomena or ocular sensations (flickering sensation, acute loss or diminution of vision, “electric feelings” in the eyes, or a sensation of the eyes being pulled to one side), 3) elementary auditory hallucinations (ringing in the ears), 4) vicero-sensory phenomena (epigastric sensations such as rising sensation, nausea, abdominal pressure or butterflies; chest sensations such

as pressure, palpitation; and, throat feelings such as choking), 5) cephalic sensations (nonvertiginous dizziness, lightheadedness, inflation of the head, and pressure on the head), 6) vertigo (spinning sensation), 7) diffuse warm sensations (ascending from feet to waist or chest to head), 8) conscious confusion (subjective experience of confusion or mixed up thoughts), and, 9) experiential phenomena (fear, déjà vu, feelings of strangeness, visual and auditory illusions, complex auditory and visual hallucinations, and olfactory and gustatory hallucinations). The aura symptoms relevant to the current project fall into Gupta and colleagues' "psychic symptoms" category, or Palmini and Gloor's "experiential phenomena" category. Those symptoms will be the focus of this discussion, with particular emphasis placed on the auras targeted in this study, including depersonalization, derealization, dreamy states, ecstasy and autoscopy (out of body experiences).

Experiential aura symptoms.

The term *experiential* comes from the 1930s, when Penfield and Kristiansen electrically stimulated the cortices of conscious patients undergoing brain surgery and produced perceptual, mnemonic and affective experiences (Penfield & Kristiansen, 1951, as cited in Hansen & Brodtkorb, 2003). One typical form of experiential aura involves an alteration of one's mental state that is difficult to describe in words. *Dreaminess*, *depersonalization* and *derealization* are related terms that have been used to describe such ineffable states. The Diagnostic and Statistical Manual of Mental Disorders, 4th Edition defines depersonalization as, "an alteration in the perception or experience of the self so that one feels detached from, and as if one is an outside observer of, one's mental

processes or body". Derealization is defined as, "an alteration in the perception or experience of the external world so that it seems strange or unreal" (e.g. people may seem unfamiliar or mechanical) (American Psychiatric Association, 1994). Depersonalization and derealization are similar concepts, and have been combined under the umbrella term of depersonalization (Sierra & Berrios, 1998). These states have also been termed "a feeling of strangeness" (Palmini & Gloor, 1992). Dreaminess may be a less extreme form of depersonalization or derealization. In the late 19th century, Hughlings-Jackson wrote about the existence of such auras, and called them "intellectual auras", or "dreamy states", which he described as "elaborate or "voluminous" mental states (Hughlings-Jackson, 1888, as cited in Hogan & Kaiboriboon, 2003). However, his "dreamy state" actually corresponded to memory alterations, which he described as "a sense of familiarity, or reminiscence". Déjà vu (the sense that an experience has happened before) and jamais vu (the sense that the familiar is unfamiliar) are now acknowledged as typical mesial temporal lobe auras. A related aura is the altered sense of time, in which time seems to either slow down or speed up.

Of the affective auras, fear or anxiety is the most common. Williams (1956) found that 61/100 patients with emotional auras had fear. Ictal fear may resemble panic attacks, and their differentiation has received attention in the literature (Sazgar, Carlen & Wennberg, 2003; Biraben et al., 2001). Depression is the second most common affective aura; Williams (1956) found that 21/100 patients had ictal depression. Depressive symptoms may include anhedonia, guilt and suicidal ideation (Kanner, 2003). A less frequent emotional aura is pleasure, including ecstasy, contentment, and joy. Patients with pleasurable seizures have reported the feeling to be unique, with no equivalent

human experience (Hansen & Brodtkorb, 2003). Prevalence estimates of pleasure in patients with affective auras have ranged from 9% (Williams, 1956) to 23% (Daly, 1958). The most famous case of ecstatic seizures is the writer and epileptic, Fyodor Dostoevsky. He based the epileptic experiences of a character in his novel, "The Idiot", on his own ecstatic seizures. He wrote:

> There was always one instant just before the epileptic fit...when suddenly in the midst of sadness, spiritual darkness and oppression, his brain seemed momentarily to catch fire, and in an extraordinary rush, all his vital forces were at their highest tension. The sense of life, the consciousness of self, were multiplied almost ten times at these moments which lasted no longer than a flash of lightning. His mind and his heart were flooded with extraordinary light; all his uneasiness, all his doubts, all his anxieties were relieved at once; they were all resolved in a loft calm, full of serene, harmonious joy and hope, full of reason and ultimate meaning (Dostoevsky, trans. 1956).

There have been multiple case studies of ictal ecstasy (Amancio, Zymberg & Pires, 1994; Naito & Matsu, 1988), the largest of which included 11 patients consecutively recruited (Hansen & Brodtkorb, 2003). This study localized the experience to the temporal lobe in 4/11 patients (two right, two left); the site of seizure onset could not be localized in the remaining 7/11 patients. The majority of patients welcomed their seizures; five patients were able to self-induce them, and four lowered their AED levels to permit their pleasurable auras, while preventing generalized tonic-clonic seizures.

Sensory alterations may involve any modality (visual, auditory, olfactory, gustatory and somatosensory) and may include illusions (distorted perception of real

sensory information) or hallucinations (perception of unreal sensory information). Examples of visual illusions are micropsia (stimuli appear smaller) or macropsia (stimuli appear larger) (Kotogal, 1991). Simple (or elementary) hallucinations consist of single elements of a given sensory modality (e.g. flashing light, buzzing, ringing sound, etc.), and are not generally categorized as experiential or psychic auras (see above). Complex (or structural) hallucinations are those that consist of a unified, formed percept. For example, complex visual hallucinations may consist of formed objects or people, while complex auditory hallucinations may consist of music or speech. The former involves the visual association areas and the posterior temporal neocortex, while the latter has been localized to the superior temporal gyrus and opercular region (Weinand, Labiner & Ahern, 2001). Hallucinations may also include more than one sensory modality.

Autoscopy is a visual hallucination of oneself. It can be either an out-of-body experience, where one "leaves" one's body and views it from an external perspective, or, a mirror-like experience, where one sees a double of oneself floating in space from an internal perspective. In this latter case, the viewed self may include the whole body, or just the head and torso (Blanke, Landis, Spinelli & Seeck, 2004). A third variety, heautoscopy, is when perspective is split between two bodies, with the sense of inhabiting both (Blanke & Arzy, 2005). Autoscopy may occur during simple partial, complex partial, or generalized tonic-clonic seizures; incidence has been estimated to be 6.3% of patients with seizures (Devinsky, Feldmann, Burrowes & Bromfield, 1989). However, lifetime prevalence in the healthy population has been estimated to be as high as 10% (Blackmore, 1982, as cited in Blanke & Arzy, 2005). Recent research on autoscopy in epilepsy patients and other populations has localized the phenomenon to the

temporoparietal junction (Blanke & Arzy, 2005; Blanke et al., 2004). Studies with epilepsy patients have implicated seizure foci in the right parietal region (Maillard, Vignal, Anxionnat, Taillandier & Vespignani, 2004), as well as left or right temporal lobes (Devinsky et al., 1989). A less extreme, but related aura is body-part illusion/distortion, for example, the sense that one's limb is shorter than it actually is, or that it is moving when it is stationary (Blanke & Arzy, 2005).

Most experiential auras are associated with seizures originating in the temporal lobe, although they have also been associated with frontal or occipital seizures. In the latter case, seizures likely spread to temporal structures (Palmini & Gloor, 1992). A study utilizing depth electrodes to record spontaneous and evoked seizures warrants special review. Gloor, Olivier, Quesney, Andermann & Horowitz (1982) found that stimulated and spontaneous seizures of the temporal lobe were associated with a variety of experiential symptoms, including perceptual (visual or auditory) hallucinations or illusions, memory flashbacks, illusions of familiarity, forced thinking, emotions, sensed presence, far-away feelings, floating sensations, dreaminess, bodily distortions, and strange, indescribable mental feelings. They found involvement of the limbic system to be essential in the occurrence of all of these symptoms, even those typically associated with neocortex. They reasoned that the limbic system adds an affective or motivational dimension to information (e.g. percepts) processed in the neocortex. This endows the information with experiential qualities, and thereby brings it into consciousness. Stimulation or discharge involving the amygdala produced the most experiential symptoms, followed by the hippocampus, and then the parahippocampal gyrus. The type of experiential symptom varied in different individuals, even though they were stimulated

in the same region. Furthermore, not everyone had experiential symptoms. These findings led the authors to propose that the particular experiential manifestations depend more on *whom* is stimulated than *where* in the limbic system the stimulation occurs. As the temporal lobe and limbic system functions to encode individuals' life histories, activation of these areas may produce different responses in different individuals. In this way, personal factors, such as life experience and personality may influence the manifestation of seizures. An alternate possibility is that the epileptic discharge produces both aura symptoms and personality characteristics. These possibilities will be explored in later sections.

Interictal Symptoms

Interictal symptoms occur between seizures. They are generally longstanding symptoms that may not be obviously related to epilepsy. Of the different kinds of psychological symptoms of epilepsy reviewed here, interictal symptoms are the most difficult to relate to seizures because of the temporal disconnect between seizures and symptoms. Another difficulty is that interictal symptoms that are observed in epilepsy may be similar to symptoms and traits seen in persons without seizures (Kanner & Barry, 2001). Etiological ambiguity is particularly relevant to interictal psychiatric and personality alterations; cognitive symptoms are more readily accepted as being epilepsy-related. Nevertheless, it appears that persons with epilepsy may have greater incidences of psychological symptoms than the general population (Whitman, Hermann & Gordon, 1984).

Interictal cognitive symptoms.

The most common interictal cognitive symptoms are memory impairment, mental slowing, and attentional deficits (Dodrill & Wilensky, 1992). The extent of impairment may depend on factors such as seizure type, severity and frequency, age of onset, and antiepileptic drug treatment (Brown, 1991). Another potential etiological factor is the presence of interictal epileptiform EEG discharges, which may result in "transient cognitive impairments" (Aldenkamp & Arends, 2003). Focal seizure disorders are often associated with greater cognitive impairment than idiopathic epilepsies such as benign rolandic and juvenile myoclonic epilepsy (Motamedi & Meador, 2003). Patients with secondarily generalized seizures are also at greater risk for cognitive impairment (Dodrill, 1986). Prevey, Delaney, Cramer, Mattson & VA Epilepsy Cooperative Study (1998) found that patients with secondarily generalized seizures performed significantly worse on verbal fluency, concentration and mental flexibility than patients with complex partial seizures. Both groups were impaired compared to controls on tests of motor speed/integration and memory. Of note, this study was performed in newly diagnosed patients, who had not been treated with AEDs. Another pre-AED-treatment study also documented cognitive deficits (visual motor tasks, mental flexibility and memory) in patients with partial and generalized seizures (Pulliainen, Kuikka & Jokelainen, 2000). These findings indicate that cognitive deficits can be directly related to epilepsy, rather than side effects of AED treatment. Other studies have demonstrated stable cognitive skills in patients with AED-controlled seizures over extended time periods (Dodrill & Wilensky, 1992; Brown, 1991).

Focal seizures may result in selective deficits, which are related to the brain region that is affected. A study of 273 patients with intractable TLE revealed deficits in full scale IQ (low average), verbal memory (borderline to impaired range), and language (borderline range). Results showed average scores in higher executive functions, reading abilities and visual memory function. Lateralization effects were also present – patients with left-sided TLE scored significantly lower on verbal intelligence, general intelligence, attention span and expressive language functioning than those with right-sided TLE (Moore & Baker, 2002). Cognitive impairments in patients with FLE may resemble frontal lobe dysfunction in general (Upton & Thompson, 1996). Helmstaedter, Kemper & Elger (1996) found deficits in psychomotor speed/attention, motor coordination, working memory and response inhibition in patients with FLE. Compared to patients with TLE, patients with FLE had greater deficits in motor skills and response inhibition.

Interictal psychiatric symptoms.

The most common interictal psychiatric disturbances are depression, anxiety, psychosis, and personality disorders. Prevalence estimates for psychiatric disturbances in epilepsy range from 20 to 50%, with estimates generally lowest in community-based samples, and highest in specialty clinics (Manchanda, 2002). Psychiatric disturbances are more common in persons with epilepsy than in the general population. Lifetime prevalence estimates of depression range from 6 to 30% in population-based patient studies, and up to 50% of patients in tertiary centers (Kanner, 2003). In contrast, prevalence estimates of lifetime major depressive disorder in a community-based US

population ranged from 10.4 to 17.9% in various ethnic groups (Williams et al., 2007). Psychotic disorders are present in 2.5 to 9% of patients with epilepsy, compared with 1% in the general population (Manchanda, 2002; Kanemoto, Tsuji & Kawasaki, 2001). In a general population based study, Pariente, Lepine and Lellouche (1991) found that 21% of persons with epilepsy reported a history of panic attacks, compared to only 3% of persons without. However, this study did not control for epilepsy-related behavioral disturbances that may have conflated panic symptomatology. Some studies also show mildly increased prevalence of interictal psychopathology compared to persons with other chronic illnesses (Paraiso & Devinsky, 1997, as cited in King et al., 2002), although findings have been mixed (Manchanda, 2002; Whitman et al., 1984). These studies suggest that the increased interictal psychopathology seen in epilepsy is not simply a reaction to having a chronic illness, and implicates a biological etiology. Other research has further found that patients with temporal lobe seizures have greater frequencies of psychiatric disturbances than patients with generalized seizures, as well as those with other types of focal seizures. For example, Helmstaedter (2001) found that patients with mesial TLE showed a trend of poorer mood, as well as significantly increased anxiety than patients with FLE. Kanemoto et al. (2001) found that interictal psychoses are much more prevalent in TLE than in other focal or generalized epilepsies. However, other studies have not found seizure type to predict psychopathology (as reviewed by King et al., 2002).

A common assessment instrument of psychopathology is the Minnesota Multiphasic Personality Inventory-2 (MMPI-2) (Butcher, Dahlstrom, Graham, Tellegen & Kraemer, 1989). It consists of ten clinical scales assessing various psychiatric and

personality characteristics, as well as three validity scales. The MMPI-2 has been found to be valid and reliable in the epilepsy population, however, minor corrections for neurological symptoms are recommended in select cases (Derry, Harnadek, McLachlan & Sontrop, 1997; Derry et al., 2002). This research group found that the mean scale scores of a population of patients with refractory epilepsy (n=100) were below clinically significant levels (T<65), even before the corrections (Derry et al., 1997). Their group found similar sub-clinical means for the ten clinical scales in a later study (Derry et al., 2002). However, King et al. (2002) found clinical elevations (T >= 65) in 81/93 (87%) of patients with intractable epilepsy (they looked at individual elevations rather than the overall population means). The most commonly elevated scales were: Schizophrenia (n=51, 54.8%), Depression (n=48, 51.6%), Hypochondriasis (n=51.6%) and Hysteria (n=36, 38.7%). These scales, along with Psychasthenia, have been found to be elevated in other neurological populations due to the number of items that contain common cognitive and somatic symptoms which these patients experience (Gass & Russell, 1991; Gass, 1996). King et al. (2002) additionally found three clusters of MMPI-2 profiles in their epilepsy population: 1) minimal psychological complaints (45%), 2) generalized clinical elevations (30%), and 3) intermediate elevations with a tendency to emphasize somatic complaints and/or depression (24%). They did not apply data correction techniques to attempt to control for seizure symptoms, which may have exaggerated scale scores. However, they note that even though the symptoms may be related to epilepsy rather than psychopathology, they are nevertheless distressing and incapacitating.

Temporal lobe epilepsy interictal personality syndrome.

Interictal psychological symptoms may also include more subtle personality alterations, although this is controversial. In 1974, Norman Geschwind proposed the existence of a collection of behavioral changes in persons with TLE, that has been coined the "TLE interictal personality syndrome" and includes long-term changes in sexual behavior, religiosity, increased writing and drawing, viscosity (stickiness, tendency to repeat), circumstantiality (loquacious, pedantic and peripheral) and emotionality (deepening of all emotions) (Waxman & Geschwind, 1975). Bear and Fedio (1977) extended the alleged syndrome to a total of 18 traits including affective changes, humorless sobriety, dependence, obsession and enhanced sense of the personal, among others. Research regarding the presence of clustered personality traits has been mixed. Devinsky and Najjar (1999) review findings from multiple research groups using the Bear-Fedio Inventory (BFI) with TLE and a variety of controls (generalized epilepsy, psychiatric and healthy). Overall, the findings and conclusions of the various studies are inconsistent. Some studies confirm the presence of all traits (Bear & Fedio, 1977; Rodin, 1973), others find none (Swanson, Grafman, Salazar & Kraft, 1995), others find a seizure focus or lateralization effect (Brandt, Seidman & Kohl, 1985; Nielsen & Kristensen, 1981), and most groups confirm the presence of only some traits (Hermann & Reil, 1981; Swanson et al., 1995). However, in general, three broad trends emerge: 1) behavioral traits in TLE patients are generally distinguished from normal volunteers, but not from other psychiatric groups and not always from generalized epilepsy patients, 2) when there is a difference between TLE and generalized epilepsy groups, TLE patients generally score higher, and 3) there may be a left-TLE effect (patients with left-sided foci generally score higher than those with right-sided foci (Devinsky & Najjar, 1999).

The discrepancies in the literature may reflect the vast methodological differences in the various studies. These studies often had non-uniform subject variables including different seizure foci and frequencies, durations of seizure disorder or pharmaceutical treatment, as well as different comparison groups. Furthermore, many of these studies are relatively old, and relied on outdated techniques to localize and characterize seizure type. A recent study (Trimble & Freeman, 2006) found that persons with TLE who identified themselves as religious scored higher on all 18 traits of the BFI, compared to non-religious persons with TLE. Perhaps this study had significant results because it formed comparison groups by behavioral (i.e. religious versus non-religious) rather than seizure characteristics. It suggests there is a subset of patients with TLE who display the alleged behavioral syndrome, but that diagnostic and seizure characteristics are not sufficient in identifying them. Some researchers note that psychiatric scales and personality inventories (the BFI as well as others) often fail to reflect epilepsy-related changes in personality that appear obvious to the examiner (Helmstaedter, 2001). Studies utilizing more detailed evaluations than the BFI may be more useful (Devinsky & Najjar, 1999).

Studies have also investigated personality alterations in non-temporal focal seizures. Helmstaedter (2001) concluded that extensive personality disorders in persons with FLE are uncommon. However, he described mild behavioral alterations in hyperactivity, conscientiousness, obsession and addiction. Changes that are characteristic in persons with TLE, such as depression, anxiety, neuroticism, cognitive (memory) impairment and social limitations are less commonly observed in patients with FLE.

The Relationship Between Ictal and Interictal Symptoms

Association of auras and interictal traits.

Several studies have documented associations between experiential auras and interictal psychological traits. Manchanda, Freeland, Schaefer, McLachlan & Blume *(*2000) found that epilepsy patients with an experiential aura (fear, déjà vu, feelings of strangeness, visual and auditory illusions and complex sensory hallucinations) were significantly more likely to have a psychiatric diagnosis than those without. Mendez, Engebrit, Doss & Grau (1996) demonstrated an association between cognitive auras (forced thinking or intrusive thoughts, dreamy states and feelings of derealization or depersonalization) and depressive traits. Silberman, Sussman, Skillings, & Callanan (1994) did not find an association between ictal psychosensory phenomena and psychopathology, however, they did find significant correlations between *interictal* psychosensory phenomena and psychopathology. Other studies have looked at specific kinds of auras and corresponding psychiatric manifestations. The most frequently replicated association is between fear auras and mood/anxiety disorders. Hermann and Chhabria (1980) noticed that two patients with ictal fear also had seemingly random interictal episodes of fear. In a controlled study of the topic, their group found increased psychopathology in patients with TLE and fear auras compared to patients with TLE and no fear auras, as well as patients with generalized epilepsy, as measured by the MMPI and number of psychiatric hospital admissions (Hermann, Dikmen, Schwartz & Karnes, 1982). More recently, Mintzer and Lopez (2002) found an association between ictal fear and panic disorder. Kohler, Carran, Bilker, O'Connor and Sperling (2001) found that of patients who had received temporal lobectomies, those who had fear auras had a higher

incidence of mood/anxiety disorders post-operatively than those who did not have fear auras. Associations have also been found between dreamy state auras and epileptic psychosis (Sengoku, Toichi & Murai, 1997).

Kindling: a possible explanation.

If interictal personality traits are associated with ictal events, what is the nature of this association? One possible explanation comes from studies of kindling. Kindling is a neuronal process related to long-term-potentiation that involves the strengthening of synaptic connections through activation. This activation may lead to the development of seizures, and thus provides a model of epileptogenesis. Kindling in animals has been demonstrated to occur following low-level stimulation to various limbic structures such as the hippocampus and amygdala, which then leads to permanent increases in seizure vulnerability. Low-level electrical or chemical stimulation that initially does not produce seizures can come, over time, to elicit full-blown motor seizures (Gilbert, 2001).

Kindling experiments in animals have demonstrated that behavioral changes are associated with seizure elicitation. Mallanby et al. (1981) found that after hippocampal kindling, rats had changes in their responses to handling, their interactions with new rats, and their stature in social hierarchies. Interestingly, although observable seizures ceased approximately 2 weeks after stimulation was stopped, the behavioral changes were long-lasting. Amygdala-kindled cats have been found to have greater interictal defensiveness and mood lability (Adamec, 1990). Similarly, limbic-kindled rats have displayed profound changes in fearful and defensive behavior, which lasted for at least 2 months

after the final stimulation (Kalynchuk, 2000). These animal studies have been proposed as models for interictal affective disturbances in persons with epilepsy (Adamec, 1990).

Long-term paroxysmal limbic discharges are found in kindled animals, suggesting that the term *interictal* may be a misnomer given that there is continuous abnormal electrographic activity. Similarly, long-term paroxysmal discharges are found in patients with focal seizures. Spiers, Schomer, Blume & Hochandel (1992) argue that if a patient with epilepsy has frequent paroxysmal discharges it would be difficult to define the interictal period. Persons with epilepsy have been found to have more interictal aura-like symptoms than healthy subjects (Silberman, Post, Nurnberger, Theodore & Boulenger, 1985). As Silberman et al. (1994) stated, it may be that these experiences are in fact manifestations of aberrant neuronal activity, even though no electrographic activity is detected on EEG. In the same vein, people presumed to be seizure-free may have abnormal electrographic activity that is not detected because there are no observable ictal symptoms. Aura symptoms may go unrecognized in seizure patients for many years because the patients do not recognize the symptoms as pathological. Hansen and Brodtkorb (2003) described patients who had pleasurable auras for over 25 years before receiving a diagnosis of epilepsy. It is likely that there are mild cases where seizures remain undiagnosed. It may be that seizure-like activity in the brain is a continuum, with the low end being neurologically healthy individuals and the high end being persons with generalized epilepsy syndromes (Persinger, 1983; Persinger & Makarec, 1993). The interesting area of the continuum is the gray area, where presumed non-epileptic individuals may have occasional focal spiking, or a focal seizure, and accompanying aura-like symptoms that are never diagnosed as such.

Religiosity and Spirituality in Epilepsy

> I am about to discuss the disease called "sacred". It is not, in my opinion, any more divine or more sacred than any other diseases, but has a natural cause…Its origin, like that of other diseases, lies in heredity…The fact is that the cause of this affection…is the brain... (Hippocrates, trans. 1923, as cited in Riggs & Riggs, 2005).

Hippocrates wrote his decree against a metaphysical etiology of epilepsy in 400 BC, nevertheless, an association between seizures and supernatural phenomena persists today. This association is no longer based on superstition, but is found in medical and scientific literature. Since the 19th century physicians and researchers have observed the presence of abnormal religiosity/spirituality in some persons with epilepsy. Such reports are found in the works of Esquirol, Morel, Boven, Mabille, Echeverria, Clouston, Howden and Kraepelin, among other early 19th and 20th century writers (Dewhurst & Beard, 1970; Trimble & Freeman, 2006). In the 1960s and 70s the topic was taken up by Geschwind and Gastaut, within the context of a broader epilepsy personality syndrome (Trimble & Freeman, 2006). Mixed findings resulted in a lull in interest until it was recently rekindled through the new field of neurotheology. Several forms of epileptic religiosity/spirituality have been described over the years, with experiences and beliefs occurring ictally, postictally and interictally. This chapter reviews epileptic religiosity in its various forms, and presents predominant theories regarding the mechanism underlying this phenomenon.

Interictal Religiosity and Spirituality

There have been numerous reports of persons with epilepsy who have excessive preoccupation with religion and metaphysical topics (Bear & Fedio, 1977; Roberts & Guberman, 1989; Hansen & Brodtkorb, 2003; Ogata & Miyakawa; 1998; Trimble & Freeman, 2006) as well as religious conversions (Dewhurst & Beard, 1970; Roberts & Guberman, 1989). As described above, Waxman and Geschwind (1975) proposed an interictal behavioral syndrome of TLE, in which religiosity/spirituality was a key trait. They reported this religiosity/spirituality to be distinct from traditional religious behaviors and beliefs. They wrote:

> The preoccupations of the patients often have a cosmic or global flavor, and may transcend the limits of established religions; we have seen a patient who, when asked if he were religious replied that he was "beyond religion" and that he was a "cosmic minister to the world".

Two recent studies showed that the religions of choice of patients with epilepsy with accompanying hyperreligiosity were not the predominant religions of their communities. Ogata and Miyakawa (1998) found that Japanese patients with hyperreligiosity did not solely believe in Buddhism (the predominant religion), but rather subscribed to a combination of Buddhism and Shintoism, new Christian sects, contemporary Japanese religions and/or other folk beliefs. Trimble and Freeman (2006) found that patients in the United Kingdom reported non-mainstream religions (not Roman Catholic or Church of England). The term *hyperreligiosity* may be a misnomer, because the construct that Geschwind first described appears more akin to individualized metaphysical beliefs, which may not fit within organized religions.

Bear and Fedio (1977) expanded Geschwind's TLE interictal behavioral syndrome to include 18 traits (see chapter 2). Of these traits, three appear to be related to religiosity/spirituality: sense of personal destiny (events given highly charged, personal significance; divine guidance ascribed to many features of a patient's life); philosophical interest (nascent metaphysical or moral speculations, cosmological theories); and, religiosity (holding deep religious beliefs, often idiosyncratic; multiple conversions, mystical states). These traits appear consistent with Waxman and Geschwind's description of TLE religiosity/spirituality as distinct from traditional religious practice that is generally within the context of cultural upbringing.

Subsequent research assessing the Waxman/Geschwind/Bear/Fedio constructs of religiosity/spirituality using the Bear Fedio Inventory (BFI) had mixed results. Of 13 studies reviewed by Devinsky and Najjar (1999), 6 reported the presence of one or more of the three traits (sense of personal destiny, philosophical interest and religiosity) in their comparisons. The mixed findings may be due to the use of different comparison groups (for example, left vs right TLE; TLE vs generalized epilepsy, medical or psychiatric). The lack of significant results in some studies suggests that the alleged trait of religiosity/spirituality may not be present in all patients with TLE, as was initially proposed (Tucker, Novelly & Walker, 1987). Dodrill (1985, as cited in Tucker et al., 1987) suggested that perhaps these traits were only present in a subset of the TLE population. However, it remains unclear what might characterize this subset.

Researchers have looked for a laterality effect, but results have been mixed. Bear & Fedio (1977) originally proposed a preponderance of TLE traits in persons with a left-side focus, which has had some support (Csernansky, Leiderman, Mandabach & Moses,

1990). More recently, Trimble and Freeman (2006) found that religiosity was associated with bilateral cortical involvement, which they interpreted as being associated with postictal psychosis, compared to patients with left or right foci. Another recent study found smaller right hippocampi volumes on MRI in religious compared to non-religious refractory TLE patients (Wuerfel et al., 2004). These findings highlight the need to identify focal seizure groups based on criteria other than seizure localization or lateralization.

A recent study using the BFI compared two TLE groups that were formed based on known interest in religion (hyperreligious patients and non-religious patients) and compared these groups to neurologically-healthy religious individuals (Trimble & Freeman, 2006). On the BFI, the hyperreligious group had elevations in religiosity, philosophical interests and personal destiny (among other traits) compared to the non-religious patient group. Compared to the healthy religious group, the hyperreligious patient group reported more phenomenological experiences, such as awareness of an external being. There were no significant differences between the two groups in regard to churchgoing behavior, religious rituals or strength of religious beliefs.

Using the appropriate construct is crucial when studying religiosity/spirituality. Negative findings of interictal religiosity/spirituality may in part be due to inaccurately defining and assessing the construct of hyperreligiosity. Two studies failing to document increased religiosity in patients with TLE utilized assessments that targeted traditional forms of religious beliefs and behaviors rather than the “cosmic” form described by Waxman and Geschwind. Tucker et al. (1987) used the Wiggins Religiosity Scale to assess the degree of religious fundamentalism, types of religious beliefs and extent of

participation in religious activities. Willmore, Heilman, Fennell and Pinnas (1980) assessed religious beliefs (e.g., I believe in God and a life hereafter), practices (e.g., I attend church at least one to two times a week), philosophy (e.g., Religious education only belongs in church), ethics and morality (e.g., People do bad things because they do not know and love God), healing (e.g., When you are sick only your belief in God will heal you) and changes in attitudes (e.g., I have always been as religious as I am now). Both of these studies failed to demonstrate hyperreligiosity in patients with focal seizures compared to patients with generalized seizures as well as other populations. In contrast, Roberts and Guberman (1989) made an effort to discriminate between normal and abnormal religious behavior, the latter including unusual metaphysical topics such as occultism. They found that 60% of patients with epilepsy had abnormal religious interests, which was associated with the presence of psychopathology and religious conversions. These studies highlight the importance of targeting the appropriate construct – namely, abnormal, or cosmic spirituality rather than traditional religiosity – with a valid, reliable instrument.

Postictal Religiosity and Spirituality

Many cases of epileptic spirituality have occurred in the context of postictal psychosis (Dewhurst & Beard, 1970; Marchetti, Tavares, Gronich, Fiore & Ferraz, 2001; Ogata & Miyakawa, 1998; Trimble & Freeman, 2006). This psychosis generally occurs within 1 week after a period of seizure exacerbation. The psychotic state is generally characterized by elevated mood and feelings of grandiosity (Kanemoto, Kawasaki & Kawai, 1996). Dewhurst and Beard (1970) described six patients with intense religious

experiences and conversions, five of which occurred shortly after an isolated seizure or a cluster of seizures (Devinsky, 2003). Trimble & Freeman (2006) found that patients with TLE who were identified as hyperreligious were significantly more likely to have had postictal psychosis than patients with TLE who were non-religious. They found that patients with religious experiences during postictal psychosis were influenced by these experiences for years after their psychosis had resolved; some had incorporated their religious experiences into their belief systems. Ogata and Miyakawa (1998) identified hyperreligiosity in 3 of 234 Japanese patients with epilepsy; all 3 of these patients had TLE with postictal psychosis. Within only the postictal population, the incidence of hyperreligiosity was 27.3% (3/11). Another Japanese study found the incidence of religiosity in postictal psychosis to be 23% (Kanemoto et al., 1996). The religiosity that occurs in epileptic psychosis may be specific to the postictal period – Kanemoto et al. found religiosity in only 3% of patients with acute interictal psychosis and 0% of patients with chronic interictal psychosis. Religiosity in postictal psychosis appears more likely to occur in TLE than in generalized epilepsy (Ogata & Miyakaa, 1998).

Ictal Religiosity and Spirituality

As previously described, auras may include symptoms such as illusions and hallucinations, memory alterations, strong emotions, alterations in sense of place or time, depersonalization, derealization and autoscopy (Gupta et al., 1983; Palmini & Gloor, 1992). In combination, these experiences can be very powerful and strikingly reminiscent of spiritual revelations. A case report of such an experience follows:

> I always know when I am going to have this "turn". A moment or two after I cease seeing my flashes and stars, I feel very queer: everything seems to be so far away, so unimportant, so odd and so unreal. My body is like an empty shell. Then, all at once, I see and feel how my "shadow" or "my other me" steps out of me, and my earthly body. He makes two or three steps, then stops, and turns his head to me… he is like a photograph or like old films, with no color at all… I can almost see through him… like through a fog or mist… I feel how my soul and my life leave my body and enter him. Soon he is the real me, and what is left of the "old" me is only "my outer body", just like an empty shell after the chick has hatched. (Daly, 1975)

Case reports also describe overtly religious experiences during ictus, where a seizure manifests in a supernatural form, such as hearing the voice of God, or sensing a divine presence (Dewhurst & Beard, 1970; Ogata & Miyakawa, 1998; Hansen & Brodtkorb, 2003; Landtblom, 2006). The incidence of overtly religious ictal experiences is unclear, but appears to be rare. Ogata and Miyakawa (1998) found such experiences in only 1/137 patients with TLE. It may be more common in patients with ecstatic seizures – 5/11 Norwegian patients with focal epilepsy and ecstatic seizures had spiritual or religious overtones (Hansen & Brodtkorb, 2003). Two of these patients reported contact with an "indescribable phenomenon" or a "divine power" and three reported that they received deep messages in their seizures. Seizure-induced spiritual experiences may be indistinguishable from accounts of "authentic" spiritual revelations from historical texts. Both may include hallucinations, feelings of depersonalization or derealization and strong emotions. It has been proposed that the spiritual epiphanies of many important religious

figures – including Saint Paul, Muhammad, Joseph Smith and Joan of Arc – were actually seizures (see reviews by Dewhurst & Beard, 1970 and Saver & Rabin, 1997).

Theories of Epileptic Religiosity and Spirituality

A psychosocial reaction to a chronic illness?

There have been several hypotheses proposed to explain the religiosity/spirituality observed in epilepsy. One theory is that it is a psychosocial reaction to having a chronic illness. In this case, persons with epilepsy turn to religion for solace and support in dealing with their health issues, or perhaps as a means of understanding their misfortune. In the late 19th century, Howden wrote, "it is a craving for sympathy (which) finds a deep response in the highest development of hope-religion" (Roberts & Guberman, 1989). However, the observation that this trait is more common in patients with TLE than other forms of epilepsy (Bear & Fedio, 1977; Trimble & Freeman, 2006) suggests there is a biological component. Most contemporary researchers agree that epileptic religiosity is not simply a psychosocial reaction to dealing with a chronic illness (Roberts & Guberman, 1989; Ogata & Miyakawa, 1998; Trimble & Freeman, 2006).

An expression of other forms of psychopathology?

Some researchers have explored epileptic religiosity within the context of psychopathology. Roberts & Guberman (1989) made an effort to define the construct of epileptic religiosity as pathological, involving morbid interests that often included occult topics. They found associations among "abnormal" religiosity and current or past psychopathology as well as religious conversions. As described above, psychiatric

disturbances such as depression, anxiety and psychosis have been found to be more common in persons with epilepsy than in other populations (Lancman, 1999; Whitman et al., 1984). It was questioned whether epileptic religiosity/spirituality could be a manifestation of this increased psychiatric disturbance. Religiosity has been associated with several non-epileptic psychiatric disorders, including schizophrenia, mania and obsessive-compulsive disorder (Previc, 2006). As the first two are relevant to epileptic religiosity, they will be reviewed here.

Religious delusions are a known characteristic of schizophrenia, with prevalence estimates ranging from 3.2% (WHO, 1979, as cited in Saver & Rabin, 1997) to 37.5% (Cothran & Harvey, 1986). Studies also show that persons with schizophrenia have stronger religious beliefs and more religious experiences than persons without (Previc, 2006). Bear, Levin, Blumer, Chetan & Ryder (1982) found comparable levels of religiosity in persons with TLE and persons with schizophrenia. As reviewed above, religiosity in persons with epilepsy often occurs in the context of postictal psychosis. These cases have some resemblance to the religiosity observed in persons with schizophrenia. Both forms may involve positive symptoms such as hallucinations and delusions of a religious character. Furthermore, both epileptic and schizophrenic religiosity has been described as taking a mystical or cosmic flavor. Jaspers (1964, as cited in Previc, 2006) wrote:

> The cosmic experience is characteristic of schizophrenic experience. The end of the world is here, the twilight of the gods. A mighty revolution is at hand in which the patient plays a major role. He is the center of all that is coming to pass. He has immense tasks to perform, vast powers. Fabulous distant influences,

> attractions, and obstructions are at work. "Everything" is always involved: all the peoples of the earth, all men, all the gods, etc. The whole of human history is experienced at once. The patient lives through infinite millennia. The instant is an eternity to him. He sweeps through space with immense speed, to conduct mighty battles; he walks safely by the abyss.

Schizophrenic and epileptic postictal psychoses differ in that the latter are known to have greater affective components and less negative symptoms (Kanemoto et al., 1996). Another obvious difference is that unlike schizophrenia-like psychoses, postictal psychosis is transient, usually resolving within several days (Leutmezer et al., 2003). After this period, patients display no residual psychopathology, although they may report being influenced by their experiences. Trimble and Freeman (2006) found that some persons with TLE who had postictal religious experiences reported being strongly influenced by those experiences, even well after the psychosis had resolved. It may be that religious experiences that occur during periods of postictal psychosis resemble those seen in schizophrenia, but then when the psychosis resolves, the experiences are integrated into patients' rational belief systems. This latter form of epileptic religiosity is likely quite distinct from that seen in active psychosis.

It is noteworthy that acute and chronic interictal psychoses are not as strongly associated with religiosity as postictal psychosis. Kanemoto et al. (1996) found that patients with postictal psychosis had more grandiose and religious delusions, often in the setting of strong mood elevations and mystic fusion of the body with the universe, compared to patients with acute and chronic interictal psychosis. They also had the hypomanic trait of pressed speech. Grandiose religious delusions are also common

during manic states in primary mood disorders (reviewed by Saver & Rabin, 1997). One study found that 90% of patients with bipolar disorder reported manic religious delusions and hallucinations (Brewerton, 1994). Persons with bipolar mania also have more religious conversions compared to persons without (Gallemore, Wilson & Rhoads, 1969, as cited in Previc, 2006). Thus, perhaps there is an association between the mood elevations observed in postictal psychosis and religious experiences in that state. While psychosis and mood elevations do seem to play a role in some forms of epileptic religiosity – namely, that which occurs during postictal psychosis – there are many cases of epileptic religiosity without associated psychosis (Bear & Fedio, 1977; Trimble & Freeman, 2006). Thus, those forms of psychopathology cannot explain epileptic religiosity in all cases.

Religiosity and the temporal lobe.

Bear and Fedio (1977) theorized that epileptic religiosity is driven by affect. They proposed that repeated seizure activity strengthens limbic and neocortical connections and results in enhanced emotionality for previously neutral stimuli, events or concepts. This emotionality is hypothesized to underlie all of the behavioral changes observed in their alleged interictal behavioral syndrome, including religious and philosophical interest. Their proposed mechanism is akin to kindling. As reviewed above, kindling-induced behavioral changes have been observed in animals. Other support for this theory is found in a study by Kanemoto et al. (1996). They found that patients with postictal psychosis (which is closely associated with TLE) had two traits that are reminiscent of the enhanced emotionality described by Bear and Fedio, including,

1) excessive emotional responses to trivial external stimuli, and 2) a tendency to attach abnormal significance to actual undistorted perceptions with no cause understandable in rational or emotional terms. One glitch in Bear and Fedio's theory is that it predicts that the limbic-cortical strengthening and associated behavioral changes occurs in all persons with TLE (Tucker et al., 1987). However, research suggests that only a subset of patients with TLE display behavioral changes such as hyperreligiosity (Trimble & Freeman, 2006).

Saver and Rabin (1997) proposed a related theory of spirituality, which they termed a "limbic marker" hypothesis. Their theory is similar to Bear and Fedio's in that they identified the limbic system as having a role in imbuing otherwise neutral phenomena with special qualities. However, it differs from Bear and Fedio's theory in that the tagging is not isolated to affective qualia. They proposed that the limbic system can mark events and experiences as: 1) depersonalized or derealized, 2) crucially important and self-referent 3) harmonious – indicative of a connection or unity between disparate elements, and 4) ecstatic – profoundly joyous. They noted that these features are among the core features of spiritual experiences. They further argued that this limbic involvement explains the ineffable quality of spiritual experiences. Similar to emotions, spiritual experiences cannot be fully explained in words, because it is the very qualitative (and thus innately ineffable) aspects of the experience that characterizes them.

Michael Persinger presented a third theory of spirituality involving the temporal lobe (Persinger, 1983; 1984; 1993; Persinger & Makarec, 1993). He stated that mystical experiences are produced by transient, electrical microseizures within deep structures of the temporal lobe. Differences in temporal lobe stability and electrical activity produce a

range in the intensity and frequency of such experiences in different people, while cultural and religious beliefs shape the content of these experiences. He reasoned that this continuum of temporal lobe stability results in a continuum of spiritual experiences in all people, with persons with epilepsy at the high end of the spectrum.

A study by MacDonald and Holland (2002) offers support to the idea that the temporal lobe underlies mystical experiences in all people. They assessed the prevalence of phenomena typically thought of as auras in the TLE population – termed "complex partial epileptic-like signs" and included dissociative experiences, alterations in sense of time, etc. – in persons without a diagnosis of TLE. Individuals with these signs were found to have enhanced spirituality, but not religiosity, compared to people without these signs. The specific aspects of spirituality found to be greater were: paranormal beliefs, existential well-being, and experiential/phenomenological aspects of spirituality. These individuals would likely fall in the middle of Persinger's temporal lobe continuum – below temporal lobe epileptics, but above persons with more "stable" temporal lobes who do not experience these mild complex partial epileptic-like signs.

Making sense of one's experiences.

An alternate, but related theory of religiosity in epilepsy is that patients are attempting to make sense of their bizarre and metaphysical-like experiences (Saver & Rabin, 1997). This theory is related to attribution theory, which states that people interpret events based on their cognitive expectations, even for physiologically neutral events (Schachter & Singer, 1962). Research shows that individuals with strong religious beliefs are more likely to interpret anomalous experiences (such as delusions) as religious

(as reviewed by Previc, 2006). Similarly, persons with epilepsy who have strong religious beliefs may interpret their seizure symptoms as religious. Evidence supporting this process is found in the study by Ogata and Miyakawa (1998). They found that of three patients with ictus-related (ictal and/or postictal) religious experiences, all had a prior history of devout religious life.

Researchers agree that the temporal lobe – in particular the limbic system – underlies particular qualitative experiences, such as depersonalization, derealization and strong emotions (Gloor et al., 1982), which are often associated with spirituality (Saver & Rabin, 1997; Persinger, 1983; 1993). It is plausible that these experiences, which comprise the qualitative aspects of spiritual experience, could be interpreted in a religious or spiritual fashion even in persons without strong prior religious convictions. Saver and Rabin (1997) argued that some aura symptoms, including depersonalization, derealization, dreamy states, autoscopy and ecstasy are particularly likely to foster religious interpretations. This idea forms the basis of the current investigation.

Rationale of Present Study and Specific Aims

Rationale of Present Study

Despite numerous anecdotal associations of hyperreligiosity in epilepsy patients – ictally, postictally and interictally – empirical studies seeking to identify a particular subpopulation with this trait have been inconclusive. Negative findings may have been partially due to difficulties in defining and assessing the construct of hyperreligiosity. Waxman and Geschwind (1975) originally conceived of epileptic hyperreligiosity as distinct from normal religious beliefs and behaviors. However, as reviewed above, some

key studies (e.g. Tucker et al., 1987; Willmore et al., 1980) assessing this trait nevertheless targeted traditional forms of religious beliefs and behaviors. Of note, this research had negative findings. In contrast, studies that distinguished normal and abnormal religious behaviors (e.g. Roberts & Guberman, 1989) had positive findings. Together, this research highlights the importance of targeting the intended construct – namely, abnormal or cosmic spirituality, rather than traditional religiosity – with a valid, reliable instrument. Previous research using the BFI – which assessed the broader constructs of philosophical interest, sense of personal destiny and religiosity (often idiosyncratic) – also had mixed findings. These mixed results may have been due to the use of inappropriate control groups, or may indicate that the alleged trait of increased spirituality/religiosity is not present in all TLE patients, but rather is present in only a subset of patients. It is unclear what traits characterize this subset.

The current study approached the question of epileptic religiosity from a different angle, taking inspiration from recent research that revealed associations between experiential auras and interictal psychological traits. This research demonstrated associations between aura symptoms and interictal traits of the same form, such as ictal fear and interictal anxiety disorders (Mintzer & Lopez, 2002). No known empirical studies have assessed a relationship between experiential auras and heightened interictal religiosity/spirituality, although such a relationship has been noted in case studies (Ogata & Miyakawa, 1998; Hansen & Brodtkorb, 2003). It was reasoned that patients with auras that are suggestive of metaphysical phenomena, where their sense of self or the world around them is altered, might interpret their experiences in supernatural terms and adopt such beliefs to explain their unworldly experiences. Saver and Rabin (1997) identified

several experiential auras – including depersonalization, derealization, dreamy states, out-of-body experiences and ecstasy – as particularly likely symptoms to elicit mystical interpretations. In the present study, such auras were termed "numinous-like auras" or NLAs; these auras do not necessarily have overt religious content, but may comprise the elements of spiritual/religious experiences. It was predicted that patients with increased NLAs would have increased spirituality of an unconventional, cosmic form, as measured by the Experiential Phenomenological Dimension (EPD) and the Paranormal Beliefs (PB) factors of the Expressions of Spirituality Inventory Revised (ESI-R) (MacDonald, 1997).

Specific Aims 1-4

Aim 1. To determine whether patients with greater frequencies of numinous-like auras have increased ictal spirituality of an unconventional, cosmic form (Experiential Phenomenological Dimension and Paranormal Beliefs, Expressions of Spirituality Inventory-Revised, ictal score), compared to patients with fewer numinous-like auras.

The concept of NLAs was based on the idea that certain experiences are particularly likely to elicit mystical interpretations. Saver and Rabin (1997) listed such aura symptoms as including depersonalization, derealization, dreamy states, out-of-body experiences and ecstasy. While these experiences are not in themselves mystical, it was theorized that they constitute some of the elements of mystical experiences. If this reasoning were accurate, then it would be expected that persons who report high numbers of NLAs would also score high on an assessment of the experiential aspects of spirituality, as measured by the EPD subscale of the ESI-R. Thus, it was predicted that

patients with high NLA scores would also score high on the EPD scale for their experiences that occurred during their seizures (ictal measure).

As an extension of this reasoning, it was expected that patients who scored high on an experiential measure of spirituality would have beliefs that corresponded to their spiritual experiences. The measure of spiritual beliefs utilized in this study was the PB factor of the ESI-R. Thus, it was expected that persons with high NLA scores would additionally have high scores on the ictal measure of PB.

Aim 2: To determine whether patients with greater numinous-like auras have increased interictal spirituality of an unconventional, cosmic form (Experiential Phenomenological Dimension and Paranormal Beliefs, Expressions of Spirituality-Revised, interictal score), compared to those with fewer numinous-like auras and a reference population.

The primary study hypothesis posited that there is an association between ictal experiences and interictal traits of the same form. This hypothesis was based on previous literature that showed such an association for other traits (e.g. ictal fear/interictal anxiety disorders (Mintzer & Lopez, 2002)). It was predicted that patients with high NLA scores would have high scores on measures of spirituality for their experiences and beliefs in general, not only when they were having seizures. Thus, it was predicted that patients with high NLA scores would also have high scores on the EPD and PB factors of the ESI-R for their experiences/beliefs when they were *not* having seizures (i.e. interictally). High scores on the PB factor would suggest that patients maintain general supernatural beliefs that correspond to their supernatural-like experiences that occur during seizures.

High scores on the EPD factor would suggest that patients are predisposed to having mystical experiences even when they are not having seizures.

A reference group of introductory psychology students was included in this analysis to provide a comparison to the patient groups. As this study was based on the theory that increased NLAs predicts increased spirituality, it was expected that the reference group would differ only from patients with high NLA scores. No differences were expected between patients with low NLAs and the reference group because neither of these groups have frequent spiritual-like experiences (i.e. NLAs).

Aim 3: To determine whether the two numinous-like aura groups and the reference group differ on the other Expressions of Spirituality-Revised subscales that were collected (Cognitive Orientation to Spirituality, Religiosity and Existential Well-being, Expressions of Spirituality Inventory-Revised, interictal score). It is hypothesized that there are no differences among the groups.

As reviewed above, Waxman and Geschwind (1975) originally described epileptic religiosity as being distinct from traditional religiosity, in that it often takes a cosmic, or global flavor that may transcend the limits of traditional religious practices and beliefs. Research studies that targeted traditional religious beliefs and practices did not find elevations in TLE populations compared to other populations (Tucker et al., 1987; Willmore et al., 1980). In contrast, studies that assessed abnormal religiosity/spirituality (as characterized by bizarre interests such as black magic) did document this trait in the epilepsy population (Roberts & Guberman, 1989). For this reason, it was predicted that there would be no differences among the groups in

traditional measures of religiosity (Cognitive Orientation to Spirituality (COG) and Religiosity (REL) factors of ESI-R). MacDonald (1997) describes the COG factor as capturing the beliefs, attitudes and perceptions regarding the nature and significance of spirituality, and the REL factor as capturing religious beliefs and practices, particularly of a Judeo-Christian orientation. The Existential Well-Being factor, which is a measure of wellness, was deemed extraneous to the primary study hypotheses.

Aim 4: To determine whether the two numinous-like aura groups and the reference group differ on measures of psychopathology (ten clinical scales, Minnesota Multiphasic Personality Inventory, 2nd Edition).

Previous literature has shown an association between religiosity and psychopathology, particularly psychosis and mania (Previc, 2006). In epilepsy, hyperreligiosity has often occurred in the context of postictal psychosis (Dewhurst & Beard, 1970, Ogata & Miyakawa, 1998; Kanemoto et al., 1996). Some researchers have found that persons with epilepsy and hyperreligiosity have higher incidences of psychiatric diagnoses than those without (Roberts & Guberman, 1989). To explore the potential relationship between psychopathology and the spirituality targeted in this study, the two patient groups and the reference group were compared on the ten clinical scales of the Minnesota Multiphasic Personality Inventory, 2nd Edition (MMPI-2): Hypochondriasis (HS), Depression (D), Hysteria (HY), Psychopathic Deviate (PD), Masculinity/Femininity (MF), Paranoia (PA), Psychasthenia (PT), Schizophrenia (SC), Hypomania (MA) and Social Introversion (SI). It was expected that both patient groups would display increased psychopathology compared to the reference group, as had been

previously demonstrated (various studies cited by Whitman et al., 1984). There were no specific predictions regarding comparisons of the two patient groups on the MMPI-2 clinical scales.

Method

This study received approval from the Institutional Review Boards at Queens College of the City University of New York, Long Island Jewish Medical Center and Weill-Cornell New York Presbyterian Hospitals.

Participants

Consecutive patients who received treatment from either Long Island Jewish Medical Center or Weill-Cornell New York Presbyterian Hospital were recruited for study participation (n = 50). Subjects were receiving video-monitored EEG for epilepsy characterization at the time of recruitment. Patients ages 18-65 were included in the study if they had a diagnosis of focal seizures and/or focal seizures with secondary generalization. Patients with only non-epileptic seizures or generalized seizures were excluded (i.e. patients with these seizures in addition to focal seizures were permitted). Diagnoses were made by an epileptologist based on all available clinical information, including video-monitored EEG results, neuroimaging findings, clinical history and response to anti-epileptic medications. Additionally, a small sample of Queens College psychology 101 students was included as a reference population (N = 16; age 18-65). This population was recruited through the psychology department research pool, and subjects received credit for participation. Exclusion criterion for the reference population was the presence of seizure history.

Numinous-Like Auras and Group Formation

Numinous-Like Auras

Auras were categorized as NLAs based on Saver and Rabin's (1997) list of aura symptoms that they identified as being particularly likely to elicit mystical interpretations, including depersonalization, derealization, dreamy states, out-of-body experiences and ecstasy. Thus, the specific NLAs that patients were queried about were: dreamy state/feeling of detachment; feeling of leaving body; sense that things do not seem real; sense that time has sped up/slowed down; bodily distortion; other depersonalizing/derealizing feelings; pleasurable feelings. Patients verbally reported their NLAs through use of a general aura checklist that had nine categories of aura symptoms including: emotions, depersonalization/derealization, hallucinations, sensory distortions, time/memory distortions, somatosensory symptoms, epigastric sensations, vestibular sensations and other symptoms (Appendix A). Subjects endorsed a score of 0-4 (0=symptom never occurs, 1=rarely occurs, 2=occurs during some seizures, 3=occurs during most seizures, 4=occurs every seizure) for each possible NLA for each seizure type. If subjects reported the same NLA in more than one seizure type (e.g. focal and focal with secondary generalization), the greater score was used. Scores for each symptom were then added to get a total NLA score.

Formation of Numinous-Like Aura Groups

Positive relationships between NLAs and spirituality could have been demonstrated by examining the patient group as a whole (i.e. using correlation or regression). However, this method would not have permitted identification of a subpopulation of patients with focal seizures with enhanced spirituality, or reveal the number/frequency of NLAs that are characteristic of these patients. Furthermore,

breaking the population into two groups – Low NLAs and High NLAs – allowed for investigation of other factors such as demographic and seizure variables as well as psychopathology, which potentially distinguished patients with enhanced NLAs and spirituality from those without. This strategy also allowed for comparison of the targeted patient population with a reference population.

While there were benefits to forming two patient comparison groups, there was no prior example of how to form such groups, as the concept of NLAs is novel. Other studies assessing relationships between auras and interictal traits formed groups in various ways. Hermann et al. (1982) compared patients with ictal fear to those without this aura type. Manchanda et al. (2000) compared patients with 0-1 experiential auras to those with 2 or more. These studies indicate that there is no standard for aura quantification in the formation of groups. Furthermore, prior studies did not account for the frequency of various auras. The current study assessed both the presence of NLAs and the frequency of their occurrence, as it was reasoned that both factors could be influential (e.g. multiple autoscopic experiences may have more weight than a single one).

In forming patient comparison groups for this study, the data were first examined for the presence of overall positive correlations of NLAs with spirituality. The finding of robust correlations indicated that there was a positive relationship between the independent and dependent variables. Thus, it provided rationale for splitting the patient population into groups for further comparisons. The distribution of NLAs was visually inspected for a natural break in NLA scores that showed clustering and had conceptual

merit. Low and High NLA groups were then formed, which reflected both the number of different types of NLAs and the frequency of their occurrence.

Assessments

Expressions of Spirituality Inventory-Revised

The Expressions of Spirituality Inventory-Revised (ESI-R) (MacDonald, 1997; 2000) (Appendix B) is a comprehensive and psychometrically sound self-report instrument that was designed to capture the diverse nuances of religiosity/spirituality in five separate factors: Experiential/Phenomenological Dimension of Spirituality (EPD), Paranormal Beliefs (PB), Religiousness (REL), Cognitive Orientation Towards Spirituality (COG), and Existential Well-Being (EWB). It has 32 questions (six questions per factor and two validity questions), rated on a Likert scale ranging from 0-4. Of the five ESI-R factors, EPD and PB appear to be the most closely related to the form of unconventional, cosmic spirituality described by Waxman and Geschwind (1970). The EPD factor assesses the experiential aspect of spirituality, with questions such as, “I have had an experience in which all things seemed divine”. The PB factor captures paranormal beliefs of either a psychological or supernatural quality with questions such as, “I think psychokinesis, or moving objects with one’s mind, is possible”.

The REL and COG factors – which are highly related statistically – appear to be associated with traditional social and cultural aspects of religion. MacDonald (1997) describes the COG factor as capturing the beliefs, attitudes and perceptions regarding the nature and significance of spirituality, and the REL factor as capturing religious beliefs and practices, particularly of a Judeo-Christian orientation. The EWB factor, a measure

of wellness, was deemed extraneous to the primary study hypothesis. Patients were instructed to fill out the ESI-R two times – once for their feelings, beliefs and experiences that *did not* occur during seizures, and once for their feelings, beliefs and experiences that *did* occur during seizures. This provided an estimate of interictal and ictal spirituality, respectively. The reference group filled out the ESI-R only once, as they do not have seizures.

Minnesota Multiphasic Personality Inventory, 2nd Edition

All subjects filled out the Minnesota Multiphasic Personality Inventory, 2nd Edition (MMPI-2) (Butcher et al., 1989). The MMPI-2 is a widely used assessment of personality traits and psychiatric symptoms. The first 370 questions – which yield ten clinical scales and three validity scales – was administered. Each participant's MMPI-2 profile was assessed for validity using the criterion described by Derry et al. (2002). The authors report that this technique is relatively conservative. Thus, MMPI-2 profiles with F, VRIN and TRIN T scores less than 75, and less than 15 items omitted, were considered valid and included in the analyses. Patient profiles were corrected for epileptic symptomatology by using the correction method outlined by Derry et al. (1997). This involved subtracting 5 T scores on the Hypochondrias scale, and 4 T scores on the Schizophrenia scale, in select cases when patients endorsed 8 or more of 19 items that their group identified as epilepsy-related symptoms. The two NLA groups and the reference group were then compared on the ten clinical scales of the MMPI-2: Hypochondriasis (HS), Depression (D), Hysteria (HY), Psychopathic Deviate (PD), Masculinity/Femininity (MF), Paranoia (PA), Psychasthenia (PT), Schizophrenia (SC),

Hypomania (MA) and Social Introversion (SI). Clinical elevations were set at the standard level of T >= 65 (Derry et al., 1997; 2002).

Overview of Statistical Procedures

All statistical analyses were completed using the Statistical Package for the Social Sciences (SPSS) version 11.5. Descriptive statistics (frequency or mean, standard deviation, standard error and range) were calculated for patient and reference group demographics (age, education, gender, race and religion) and patient seizure variables (localization and lateralization). Independent and dependent variables were analyzed for skewness and kurtosis using the method outlined by Field (2005) at the level of $p<.01$ (skewness and kurtosis z-scores not greater than the absolute value of 2.58). Correlations were performed to look for relationships in the data as a whole on the primary outcome measures (ictal and interictal EPD and PB). As robust correlation statistics were found, Low and High NLA groups were then formed for further analyses.

To look for differences in demographic factors among the groups, the Low and High NLA groups and the reference group were compared on the demographic variables listed above, using ANOVAs for continuous variables or chi-squares for categorical variables. These analyses were done at an alpha level of .05. When significant relationships or differences were found, those measures were compared on the outcome variables (using T-tests or ANOVAs, depending on the number of groups being compared) to determine whether the demographic variable(s) were included as covariate(s) for the relevant primary analyses.

The primary analyses consisted of MANOVAs. For each primary analysis, data were first reviewed for outliers (as defined as equal to, or greater than, two standard deviations from the mean), and removed from the dataset. Post-hoc tests were performed using the method of Least Significant Differences. The p-values were reported for each analysis, although results were considered to be significant at $p < .05$.

Specific Methods: Aims 1-4

Aim 1. To determine whether patients with greater frequencies of numinous-like auras have increased ictal spirituality of an unconventional, cosmic form (Experiential Phenomenological Dimension and Paranormal Beliefs, Expressions of Spirituality Inventory-Revised, ictal score), compared to patients with fewer numinous-like auras.

The Low and High NLA patient groups were compared on the EPD and PB scales of the ESI-R (ictal measure). This analysis consisted of a MANOVA comparing the two groups on the two outcome variables.

Aim 2: To determine whether patients with greater frequencies of numinous-like auras have increased interictal spirituality of an unconventional, cosmic form (Experiential Phenomenological Dimension and Paranormal Beliefs, Expressions of Spirituality-Revised, interictal score), compared to those with fewer numinous-like auras and a reference population.

The Low and High NLA patient groups and the reference group were compared on the EPD and PB scales of the ESI-R (interictal measure). This analysis consisted of a MANOVA comparing the three groups on the two relevant scales.

Aim 3: To determine whether the two numinous-like aura groups and the reference group differ on the other Expressions of Spirituality-Revised subscales that were collected (Cognitive Orientation to Spirituality, Religiosity and Existential Well-being, Expressions of Spirituality Inventory-Revised, interictal score). It is hypothesized that there are no differences among the groups.

The Low and High NLA patient groups and the reference group were compared on the COG, REL and EWB scales of the ESI-R. This analysis consisted of a MANOVA comparing the three groups on the three relevant scales.

Aim 4: To determine whether the two numinous-like aura groups and the reference group differ on measures of psychopathology (Ten clinical scales, Minnesota Multiphasic Personality Inventory, 2nd Edition).

Given the high number of scales in this analysis (ten), there was increased probability that patients had an outlier on one of the subscales. Thus, to preserve our sample size and our ability to use the MANOVA for analysis, patients with two or more outliers were removed from the dataset, while patients with only one outlier were retained. A MANOVA was performed comparing the two patient groups and the reference group on the ten clinical scales of the MMPI-2.

Results

Data Overview

Participants

A total of 50 patients were interviewed about their auras and subsequently completed study questionnaires. Seven patients with generalized epilepsy and five patients who were suspected of psychogenic non-epileptic seizures or with ambiguous diagnoses were excluded from the study. The final patient population (N=38) consisted of 18 patients with focal seizures, 17 patients with focal seizures with secondary generalization and 3 patients with focal seizures and generalized tonic-clonic seizures. Localization and lateralization of seizures was determined though video-monitored EEG results, and was based on recorded seizure events, interictal spiking, and/or focal slowing. Seizure localization included the following: temporal (N = 22), frontotemporal (N = 8), extratemporal (N = 2), unclear localization (N = 6: no telemetry reports available N = 2; no events or interictal EEG abnormalities occurred during monitoring N = 2, or no EEG component to recorded events N = 2). Seizure lateralization included the following: left (N = 17), right (N = 9), both (N = 5), and unclear (N = 7: 6 as above, and 1 with sharp complexes with a broad field, consistent with seizure disorder of possible frontal lobe origin, lateralization unspecified). There were 34 right-handed patients and 4 ambidextrous patients. Patient diagnostic information is listed in Table 4. The reference population consisted of 16 introductory psychology students who participated as part of their course. Demographic information for the patient and reference groups is summarized in Table 5.

Table 4

Patient Diagnostic Information (N=38)

Seizure Diagnosis	**N**	**%**
Focal Seizures	18	47.3
Focal with Secondary Generalization	17	44.7
Focal and Generalized Tonic-Clonic Seizures	3	7.9

Localization	**N**	**%**
Temporal	22	57.9
Frontotemporal	8	21.0
Extra-temporal	2	5.3
Unclear	6	15.7

Note. Unclear: no telemetry report available (N = 2); no events or interictal EEG abnormalities occurred during monitoring (N = 2), or no EEG component to recorded events (N = 2)

Lateralization	**N**	**%**
Left	17	44.7
Right	9	23.7
Both	5	13.2
Unclear	7	18.4

Note. Unclear: six as above, one patient had sharp complexes with a broad field, consistent with partial seizure disorder of possible frontal lobe origin, lateralization unspecified

Table 5

Patient and Reference Group Demographic Information

	Group			
	Reference		Patient	
Demographic Variable	**N**	**%**	**N**	**%**
Gender				
Male	9	56.3	18	47.4
Female	7	43.8	20	52.6
Race				
Caucasian	3	18.8	25	65.8
Non-Caucasian/ Hispanic	13	81.2	13	34.2
Religion				
Christian	9	56.3	24	44.7
Jewish	2	12.5	5	13.2
Other	1	6.3	1	2.6
Agnostic or atheist	3	18.8	8	21.1

Demographic Variable	**Group**	**N**	**Range**	**Mean**	**SD**	**SE**
Age (years)						
	Reference	16	19-52	27.44	9.09	2.27
	Patient	38	18-65	38.03	13.11	2.13
Education (years)						
	Reference	16	13-16	14.63	1.15	0.29
	Patient	38	9-21	14.32	2.52	0.41

Expressions of Spirituality Inventory-Revised

Patients filled out the ESI-R two times, once for their ictal experiences/beliefs and once for their interictal experiences/beliefs. However, the ictal ESI-R assessment was not available for all patients due to a combination of two factors. First, the EPD section of the ESI-R was added midway through the study as an ictal measure of spirituality, and was then expanded to include the entire ESI-R as an ictal assessment. Therefore, patients participating in the study before these additions did not complete the ictal measure. Second, some patients declined to fill out the ictal ESI-R assessment because they denied awareness during their seizures. Thus, the sample size for ictal EPD was 23, and ictal PB was 17. All 38 patients completed the interictal ESI-R assessment. Additionally, 16 reference participants filled out the ESI-R.

Minnesota Multiphasic Personality Inventory, 2nd Edition

A total of 34 patients and 16 reference group participants filled out the MMPI-2 (4 patients did not return the completed questionnaire). Each participant's MMPI-2 profile was assessed for validity using the criterion described by Derry et al. (2002). Six patients and one reference participant had F scores above T = 75, and one patient omitted more than 15 items, thus, these scores were removed from the dataset. Patient profiles were corrected for epileptic symptomatology by using the correction method outlined by Derry et al. (1997). Seven patients endorsed eight or more epilepsy-related items, and thus had adjustments made to their Hypochondriasis and Schizophrenia scale scores (subtractions of 5T and 4T, respectively).

Testing for Normality

The independent variable (NLAs) and the dependent variables (ESI-R: EPD ictal, PB ictal, EPD interictal, PB interictal, COG, REL and EWB; MMPI-2: HS, D, HY, PD, MF, PA, PT, SC, MA and SI) were analyzed for skewness and kurtosis using the method outlined by Field (2005) at the level of $p < .01$. All kurtosis and skewness scale scores were found to be within normal limits (z scores not greater than the absolute value of 2.58), except for the Hypochondriasis kurtosis score ($z = 2.83$). Of note, when statistical outliers were removed from the Hypochondriasis dataset (see specific results, aim 4 below), this score reached the normal range (kurtosis $z = 1.44$). Thus, parametric statistics were used throughout this study.

Group Formation and Comparisons

Correlations of Numinous-Like Auras with Ictal and Interictal Spirituality

To look for overall correlations between the independent variable (NLAs) and the primary outcome variables (ictal and interictal EPD and PB), a Pearson's correlation matrix was performed. The matrix revealed significant positive correlations between NLAs and ictal EPD ($r(21) = .650$, $p = .001$), ictal PB ($r(15) = .623$, $p = .008$) and interictal PB ($r(36) = .345$, $p = .034$). There was also a positive statistical trend between NLAs and interictal EPD ($r(36) = .301$, $p = .066$). These robust correlations showed that greater NLAs were associated with increased spirituality as measured by the EPD and PB scales of the ESI-R. This finding provided support for dividing the patients into groups (see rationale in methods section). This allowed for exploration of potential

characteristics of patients with varying frequencies of NLAs and accompanying spirituality.

Numinous-Like Aura Group Formation

In order to form NLA groups, the NLA distribution was visually inspected for natural breaks in the NLA scores. Four potential breaks were noted in the distribution, as no patients reported NLA scores of 1, 5, 10 and 13/14 (Table 6). Breaking the groups at NLA = 10 or 13/14 would have created groups with insufficient sizes (7 and 2, respectively). In addition, these break points would have populated low NLA groups with patients reporting three or more NLAs, which seemed inappropriate for the definition of low NLAs. Thus, these break points were disregarded, and the patients were broken into three groups at the points NLA = 1 and NLA = 5. Thus, the groups were: 1) NLA = 0 (N = 17), 2) NLA = 2 - 4 (N = 9) and 3) NLA = 6 - 16 (N = 12). This division of patients was also conceptually satisfying, as the second NLA group, by definition, could have no more than one NLA that occurred with great frequency, and no more than two that occurred sometimes.

Table 6

Numinous-Like Auras by Patient

Coding: 0=never, 1=rarely, 2=sometimes, 3=most of the time, 4=all the time

Total NLA score	ID	Type
16	12	dreamy (4); feeling of leaving body (4); things don't seem real (4); time sped up/down (4)
15	36	dreamy (3); feeling of leaving body (1); things don't seem real (4); time sped up/down (4); bodily distortion (3)
12	8	feeling of leaving body (4); things don't seem real (4); bodily distortion (4)
12	14	dreamy (4); things don't seem real (4); time sped up/down (4)
12	17	dreamy (4); feeling of leaving body (2); things don't seem real (2); time sped up/down (4)
12	38	dreamy (4); things don't seem real (4); time sped up/down (4)
11	30	dreamy (4); feeling of leaving body (1); things don't seem real (4); bodily distortion (1); pleasure (1)
9	18	dreamy (4); feeling of leaving body (1); time sped up/down (4)
8	10	things don't seem real (4); time sped up/down (4)
7	20	dreamy (3); other (slow/fast motion) (4)
6	3	dreamy (4); time sped up/down (2)
6	37	dreamy (4); feeling of leaving body (2)
4	13	dreamy (4)
4	26	dreamy (4)
4	35	dreamy (4)
4	16	things don't seem real (4)
4	5	dreamy (2); feeling of leaving body (2)
4	15	feeling of leaving body (2); other (felt soul being taken from body) (1); pleasure (1)

Total NLA score	ID	Type
3	23	dreamy (3)
2	9	things don't seem real (2)
2	22	feeling of leaving body (2)
0	1, 2, 4, 6, 7, 11, 19, 21, 24, 25, 27, 28, 29, 31, 32, 33, 34	

These three groups and the reference group were compared on interictal EPD and PB with a MANOVA. Ictal measures were not compared due to an insufficient sample size for the three groups. The overall F statistic (Wilks' Lambda) was significant, $F(6, 98) = 2.820$; $p = .014$, as was the EPD scale (EPD: $F(3, 50) = 5.494$; $p = .002$). Patients with 6-16 NLAs had significantly greater EPD scores than the other three groups, which were not different from each other. The PB scale was not significant (PB: $F(3, 50) = 1.852$; $p = .150$), although patients with 6-16 NLAs had a trend of increased PB scores compared to the other three groups ($p < .1$), which did not differ from each other. These results are summarized in Figure 1.

Figure 1

A Comparison of the Reference Group and Three Potential Patient Groups on the Interictal Experiential Phenomenological Dimension (EPD) and Paranormal Beliefs (PB) Factors of the Expressions of Spirituality Inventory-Revised (ESI-R)

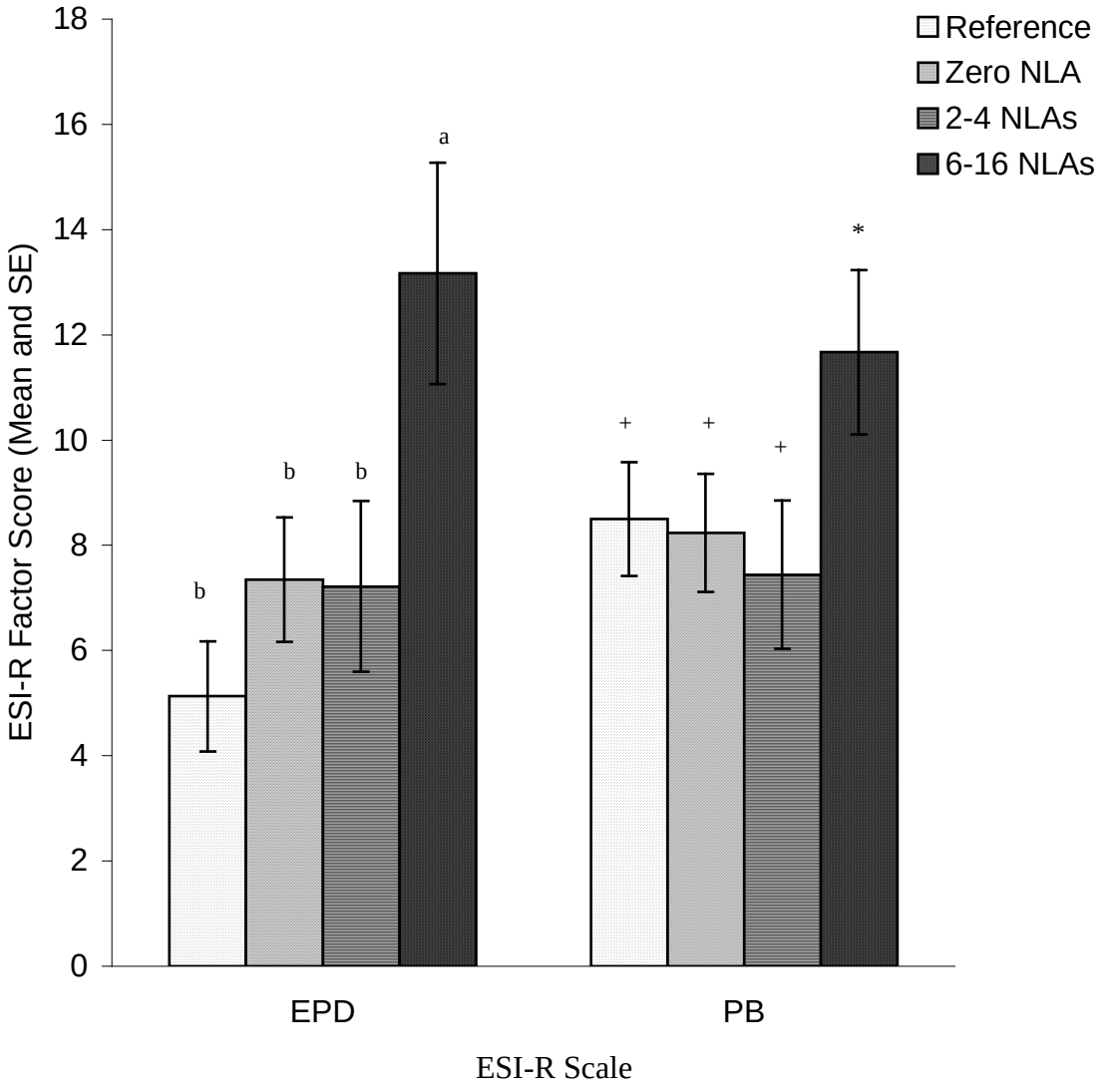

Figure 1. Mean ESI-R factor score (+/-SE) for the reference group and three potential patient groups. Means with different letter subscripts are statistically different from one another ($p < .05$). Means with different symbol subscripts have a statistical trend of difference from one another ($p < .1$). Of note, the 0 and the 2-4 NLA groups were not different from each other, or from the reference group on either scale.

Given that the 0 NLA group and the 2 - 4 NLA group did not differ from each other on these measures, they were collapsed into one group for all future analyses. Thus, two groups – Low NLAs and High NLAs – were formed. Patients with NLA scores of 0 - 4 constituted the Low NLA group (N = 26). This included patients with no NLAs, patients with one or two NLAs that occurred occasionally, or patients with one NLA that occurred all the time. The High NLA group consisted of patients with an NLA score of 6 - 16 (N = 12). This included patients with at least one NLA that occurred all the time, plus at least one other NLA. That is, no patient could score in the high NLA range unless they had at least two NLAs, neither of which occurred infrequently.

Demographic Comparisons: A Comparison of the Two Patient Groups and the Reference Group

ANOVAs and chi-squares were completed comparing the Low NLA, High NLA and reference groups on age, education, race and gender. Descriptive statistics for each group on these demographics are listed in table 7. For education, no significant differences were found among the groups ($F(2, 53) = .964$; $p = .388$). For age, the overall F statistic was significant ($F(2, 53) = 4.457$; $p = .016$). Post-hoc tests revealed that the reference group was younger than the two patient groups. This age difference was statistically significant for the reference group compared to the Low NLA Group ($p = .005$), and was a statistical trend when reference group participants were compared to the High NLA Group ($p = .065$). The two patient groups were not statistically different from each other in age. A follow-up Pearson's correlation revealed that age was not correlated

with either the ESI-R or MMPI-2 outcome variables ($p > .05$), thus, no adjustments for age were required in the primary analyses.

Table 7

Reference, Low and High Group Demographics

	Group					
	Reference		Low NLA		High NLA	
Demographic Variable	**N**	**%**	**N**	**%**	**N**	**%**
Gender						
Male	9	56.3	16	61.5	2	16.7
Female	7	43.8	10	38.5	10	83.3
Race						
Caucasian	3	18.8	15	57.7	10	83.3
Non-Caucasian/ Hispanic	13	81.2	11	42.3	2	16.7

Demographic Variable	**Group**	**N**	**Range**	**Mean**	**SD**	**SE**
Age (years)						
	Reference	16	19 - 52	27.44	9.09	2.27
	Low	26	18 - 65	38.85	13.63	2.67
	High:	12	20 - 56	36.25	12.29	3.55
Education (years)						
	Reference	16	13 - 16	14.63	1.15	0.29
	Low	26	9 - 19	14.00	2.48	0.49
	High:	12	12 - 21	15.00	2.56	0.74

For race, the chi-square statistic was significant (chi-square (2) = 12.15; $p < .05$). The reference group had significantly more non-Caucasian persons than the Low NLA group and the High NLA group (81.2%, 42.3% and 16.7%, respectively). The Low NLA group had a trend of increased non-Caucasian persons compared to the High NLA group (chi-square (1) = 3.346; $p < .1$). A follow-up T-test comparing Caucasian and non-Caucasian participants on the outcome variables revealed no differences on ESI-R scores. However, Caucasian participants had significantly higher MMPI-2 scores on Hypochondriasis, Hysteria, Psychasthenia, Schizophrenia and Hypomania (although the mean scores for both groups were below clinical levels of T = 65).

Literature on racial differences in MMPI-2 scores reveals that this finding is not typical. Timbrook and Graham (1994) found no evidence of ethnic differences in the MMPI-2 normative sample, which was comprised of community participants. While some ethnic differences have been noted in various studies, these differences are not consistent across studies and populations (Munley, Morris, Murray & Baines, 2001), and are not similar to the current findings. The observed differences in this study are more likely due to the fact that the reference group had significantly more non-Caucasian participants than the patient group *overall*, resulting in racial groups that were not matched by subject type (i.e. the Caucasian group was comprised of more patients, and the non-Caucasian group was comprised of more reference participants). A subsequent analysis comparing only the patient population revealed no racial differences on MMPI-2 scores. Thus, for race, prior studies – which did not show consistent ethnic differences in MMPI-2 scores – are given more weight than the current findings. This issue is not relevant to the other demographic analyses because no significant differences were

revealed, suggesting that neither subject type nor the specific demographic were related to the dependent variables.

For gender, the chi-square statistic was significant (chi-square (2) = 6.97; $p < .05$). The High NLA group had significantly more women than the Low NLA group and the reference group (83.3%, 38.5 % and 43.8%, respectively). Follow-up T-tests comparing males and females on the outcome variables revealed that females and males had significant differences on the Masculinity-Femininity scale of the MMPI-2 ($p = .046$), as was expected. There were no other gender differences on MMPI-2 or ESI-R scales, thus, no adjustments were required for the primary analyses.

Overall, it appears that the two patient groups and the reference group were not ideally matched in terms of demographics – differences were present in age, race and gender. However, the general lack of relationships between these variables and the outcome variables suggests that they did not contribute to any observed differences between the groups on the outcome measures. Race and select MMPI-2 scores may have been an exception, although prior research did not support the current findings. It is also interesting that there were more women in the High NLA group than the other two groups. While women did not differ from men in general on the outcome measures (suggesting gender did not impact the primary explored relationships), their prevalence in the High NLA Group is noteworthy, and will be explored in the discussion section.

Seizure Variable Comparisons: Low Numinous-Like Aura Group versus High Numinous-Like Aura Group

In order to explore potential neuroanatomical correlates with NLAs, the Low and High NLA groups were compared on seizure localization and lateralization using chi-squares. They were also compared on duration of seizure onset using a T-Test. For localization (temporal versus frontotemporal) there was no significant difference between the High NLA group (T = 5; FT = 4) and the Low NLA group (T = 16; FT = 5) (chi-square (1) = 1.28; p = .29). For lateralization (left versus right versus both) there was also no significant difference between the High NLA group (L = 7; R = 1; B = 1) and the Low NLA group (L = 10; R = 8; B = 4) (chi-square (2) = 2.82; p = .24). As there were no left-handed participants, a dominant versus non-dominant analysis was not completed. For duration of seizure onset (years), there was also no difference between the High NLA group (mean = 12.38; SD = 14.61) and the Low NLA group (mean = 9.83; SD = 12.51) (T(36) = .522; p = .61). The lack of significant findings indicates that these seizure variables, as measured in this study, did not differentiate the Low and the High NLA groups.

Specific Results

Aim 1. To determine whether patients with greater frequencies of numinous-like auras have increased ictal spirituality of an unconventional, cosmic form (Experiential Phenomenological Dimension and Paranormal Beliefs, Expressions of Spirituality Inventory-Revised, ictal score), compared to patients with fewer numinous-like auras.

Data were reviewed for outliers and none were identified. The Low and High NLA groups (N = 8 and N = 9, respectively) were then compared on the EPD and PB scales of the ESI-R (ictal measure) using a MANOVA. The overall F statistic (Wilks'

Lambda) was significant, $F(2, 14) = 6.143$; $p = .012$, as were both the EPD and PB scale scores (EPD: $F(1, 15) = 6.29$; $p = .024$; PB: $F(1, 15) = 8.90$; $p = .009$). As hypothesized, the High NLA group was found to have significantly greater ictal spirituality as measured by the EPD and PB scales of the ESI-R. These findings are summarized in Figure 2.

Figure 2

A Comparison of the Low and High Numinous-Like Aura (NLA) Groups on the Ictal Experiential Phenomenological Dimension (EPD) and Paranormal Beliefs (PB) Factors of the Expressions of Spirituality Inventory (ESI-R)

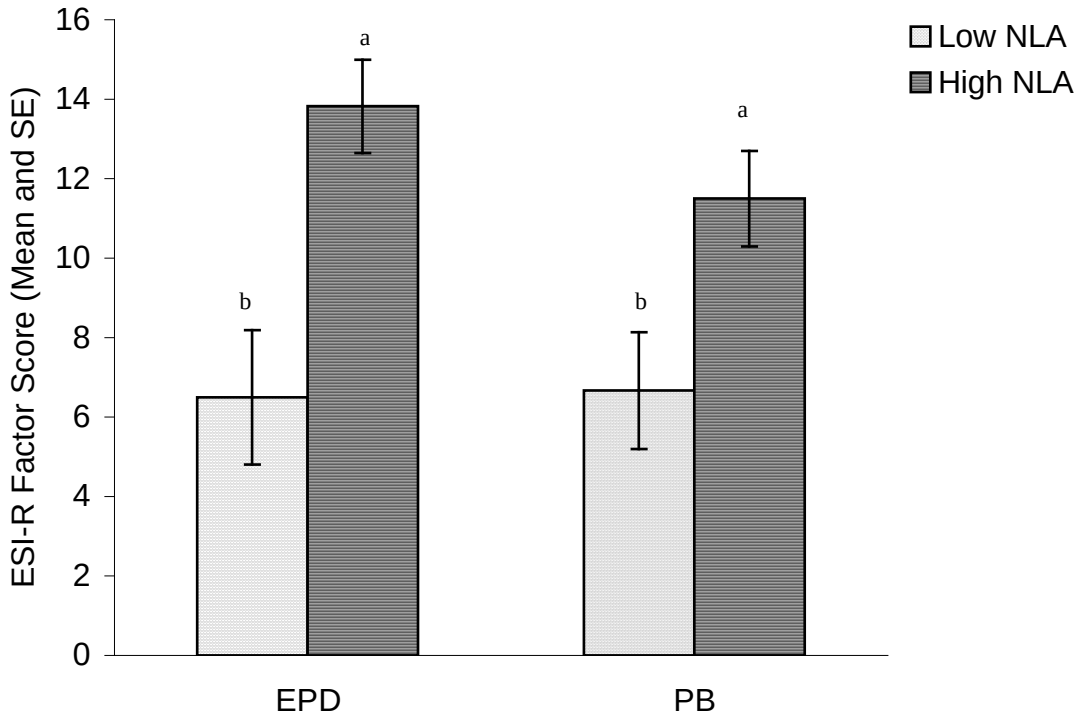

Figure 2. Mean ESI-R factor score (+/-SE) for the Low and High NLA groups. For EPD and PB, bars with different subscripts are statistically different from one another ($p < .05$).

Aim 2: To determine whether patients with greater frequencies of numinous-like auras have increased interictal spirituality of an unconventional, cosmic form (Experiential Phenomenological Dimension and Paranormal Beliefs, Expressions of Spirituality-Revised, interictal score), compared to those with fewer numinous-like auras and a reference population.

Data were reviewed for outliers, and 2/108 data points were removed (resulting in one patient from the Low group and one reference participant being removed from this analysis). The Low and High NLA groups and the reference group (N = 25, N = 12 and N = 15, respectively) were compared on the EPD and PB scales of the ESI-R (interictal measure) using a MANOVA. The overall F statistic (Wilks' Lambda) was significant ($F(4, 96) = 5.225$; $p = .001$) as were both the EPD, ($F(2, 49) = 9.948$; $p = .000$) and PB ($F(2, 49) = 3.444$; $p = .040$) scales. Post-hoc analyses revealed that for EPD, the High NLA group had significantly greater scores than the both Low NLA group ($p = .001$) and the reference group ($p = .000$). The Low NLA group and the reference group were not significantly different from one another. For PB, the High group again had significantly greater scores than the Low group ($p = .012$), and trended toward increased scores compared to the reference group ($p = .072$). The Low NLA group and the reference group were not significantly different from one another. These findings are summarized in Figure 3. Thus, the results support the hypothesis that the High NLA group differs from the Low NLA group and the reference group on these interictal measures of spirituality. It is also noteworthy that the Low NLA group and the reference group had comparable scores, indicating that the Low NLA group was more similar to the reference group than the High NLA group, in terms of the spirituality measured in this study.

Figure 3

A Comparison of the Reference, Low and High Numinous-Like Aura (NLA) Groups on the Interictal Experiential Phenomenological Dimension (EPD) and Paranormal Beliefs (PB) Factors of the Expressions of Spirituality Inventory-Revised (ESI-R)

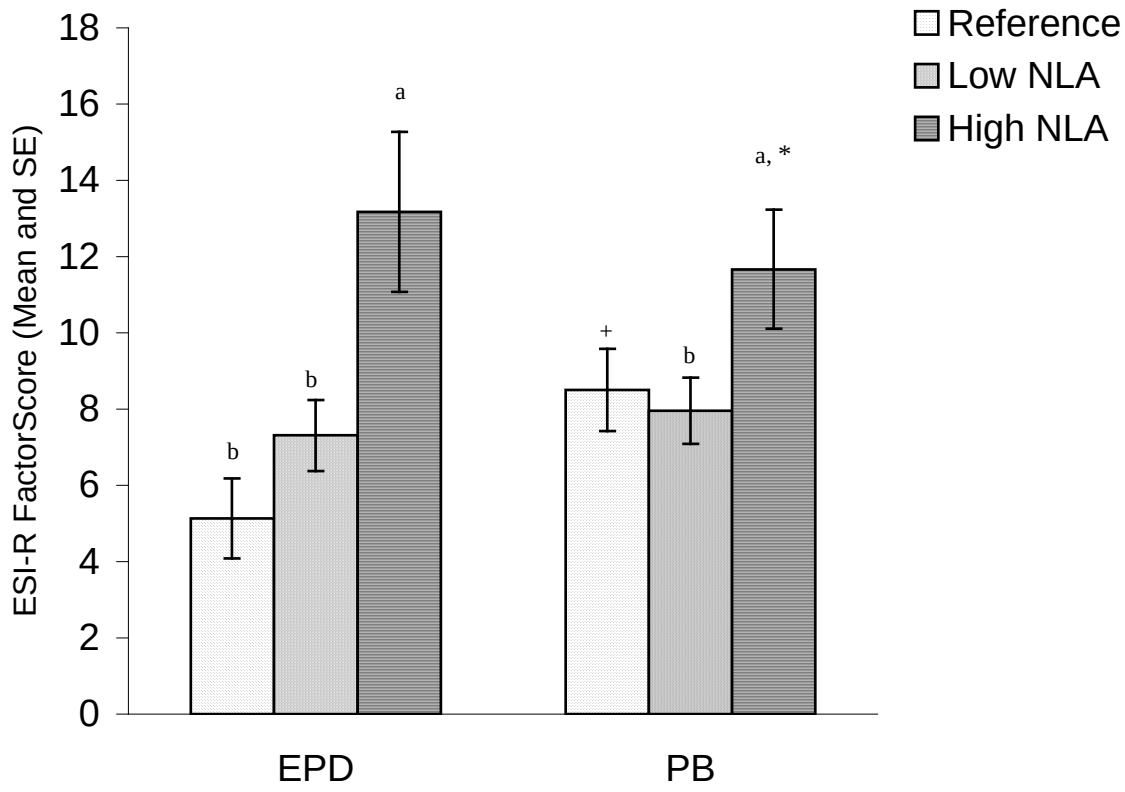

Figure 3. Mean ESI-R factor score (+/-SE) for the Low and High NLA groups and the reference group. For EPD and PB, bars with different letter subscripts are statistically different from one another ($p < .05$). Bars with different symbol subscripts have a statistical trend of difference from one another ($p < .1$).

Aim 3: To determine whether the two numinous-like aura groups and the reference group differ on the other Expressions of Spirituality-Revised subscales that were collected (Cognitive Orientation to Spirituality, Religiosity and Existential Well-being, Expressions of Spirituality Inventory-Revised, interictal score). It is hypothesized that there are no differences among the groups.

Data were reviewed for outliers, and 4/162 data points were removed (resulting in two patients from the Low group and one reference participant being removed from this analysis). The Low and High NLA groups and the reference group (N = 24, N = 12 and N = 15, respectively) were compared on the COG, REL and EWB scales of the ESI-R (interictal measure) using a MANOVA. The overall F statistic for the MANOVA was not significant ($F(6, 92) = 1.046$; $p = .401$), nor were the scale scores for COG, REL and EWB ($p = .805$, $p = .387$ and $p = .149$, respectively). These findings support the hypothesis that the two patient groups and the reference group do not differ significantly on measures of traditional religiosity. These findings are summarized in Table 8.

Table 8

Descriptives for Other Expressions of Spirituality-Revised (ESI-R) Scales: Cognitive Orientation To Spirituality (COG), Religiosity (REL) and Existential Well-Being (EWB)

ESI-R Factor	Group	N	Mean	SD	SE
COG					
	Reference	15	14.20	6.27	1.61
	Low NLA	24	15.29	5.86	1.20
	High NLA	12	15.67	6.77	1.96
REL					
	Reference	15	12.40	6.59	1.68
	Low NLA	24	15.08	5.90	1.24
	High NLA	12	14.71	5.53	1.60
EWB					
	Reference	15	17.47	4.42	1.14
	Low NLA	24	14.46	5.61	1.12
	High NLA	12	16.92	4.25	1.23

Aim 4: To determine whether the two numinous-like aura groups and the reference group differ on measures of psychopathology (Ten clinical scales, Minnesota Multiphasic Personality Inventory, 2nd Edition).

Data were reviewed for outliers, and 20/450 data points were identified as outliers, resulting in five cases (three patients in the Low Group and two reference

participants) being removed from this analysis. A MANOVA was performed comparing the Low and High NLA groups and the reference group (N = 13, N = 16 and N = 9, respectively) on the ten clinical scales of the MMPI-2. The overall F statistic (Wilks' Lambda) was not significant ($F(20, 52) = 1.639$; $p = .078$), though it did show a statistical trend. This trend likely resulted from the finding that two factor scales, Hypochondriasis ($F(2, 35) = 7.343$; $p = .002$) and Hysteria ($F(2, 35) = 5.449$; $p = .009$), were significantly different for the three groups. For Hypochondriasis, post-hoc analyses revealed that the High NLA group had significantly greater scores than both the Low NLA group ($p = .006$) and the reference group ($p = .001$). The High NLA group also had significantly greater scores on the Hysteria scale compared to both the Low NLA group ($p = .004$) and the reference group ($p = .008$). The Low NLA group and the reference group were not significantly different from one another on either the Hypochondriasis or the Hysteria scales. Additionally of note, for both scales, the High NLA group mean was above the clinical cut-off score of T = 65 (T = 67 and T = 65.67, respectively). There was also a statistical trend on the Social Introversion scale ($F(2, 35) = 3.122$; $p = .057$). Post-hoc tests revealed that the High NLA group had significantly lower scores than both of the other groups ($p < .05$). As this result was only a trend, and all scores were in the non-clinically significant range, this finding will not be discussed further. Group means for each of the MMPI-2 scales are summarized in Table 9.

Table 9

Descriptives for the Ten Clinical Scales of the Minnesota Multiphasic Personality Inventory, 2nd Edition (MMPI-2)

MMPI-2 Scale	Group	N	Mean	SD	SE
Hypochondriasis					
	Reference	13	54.5	7.48	2.07
	Low NLA	16	57.56	7.39	1.85
	High NLA	9	67.00	8.46	2.82
Depression					
	Reference	13	55.08	8.69	2.41
	Low NLA	16	59.88	9.52	2.38
	High NLA	9	60.44	9.42	3.14
Hysteria					
	Reference	13	52.85	7.83	2.17
	Low NLA	16	52.06	10.34	2.58
	High NLA	9	65.67	13.92	4.64
Psychopathic Deviate					
	Reference	13	58.92	8.28	2.30
	Low NLA	16	54.94	10.95	2.74
	High NLA	9	56.11	8.37	2.79
Masculinity-Feminity					
	Reference	13	56.23	9.76	2.71
	Low NLA	16	57.19	10.38	2.60
	High NLA	9	55.67	10.01	3.34

	Group	N	Mean	SD	SE
Paranoia					
	Reference	13	51.38	11.51	3.19
	Low NLA	16	50.69	13.02	2.58
	High NLA	9	51.67	8.89	2.96
Psychasthenia					
	Reference	13	52.15	7.01	1.94
	Low NLA	16	53.63	9.19	2.30
	High NLA	9	55.67	4.47	1.49
Schizophrenia					
	Reference	13	54.15	5.06	1.40
	Low NLA	16	57.50	10.30	2.58
	High NLA	9	57.78	4.89	1.63
Hypomania					
	Reference	13	55.08	6.42	1.78
	Low NLA	16	56.31	9.90	2.47
	High NLA	9	56.11	9.20	3.07
Social Introversion					
	Reference	13	50.62	6.91	1.91
	Low NLA	16	51.31	5.67	1.42
	High NLA	9	44.33	9.19	3.06

Discussion

The results of the investigation support the study hypotheses by demonstrating that patients with increased NLAs have increased spirituality of a personalized, non-traditional form, both ictally and interictally. The High NLA group had enhancements on the EPD and PB scales, but not the other ESI-R scales, compared to the Low NLA group and the reference group. Importantly, the Low NLA group and the reference group had comparable scores on all ESI-R factors, suggesting that the enhanced spirituality in the High NLA group is unique to that group, and is associated with the high frequency of NLAs, rather than focal seizures. These findings, along with potential differences between the Low and High NLA groups in regard to demographics, seizure variables and psychopathology will be explored in the following sections. A theory about the epileptic spirituality observed in this study, in relation to prior theories of behavioral changes in epilepsy, will also be presented.

Ictal Spirituality

The results support a positive relationship between high frequencies of NLAs and ictal EPD and PB. These findings indicate that persons with greater frequencies of auras that are thought to comprise the elements of spiritual experiences (NLAs) report more spiritual experiences (EPD) and paranormal beliefs (PB) during their seizures. These results may appear somewhat tautological, considering that NLAs and ictal EPD both target the experiential aspects of spirituality. In fact, this analysis was not initially included in the study for this reason. However, midway through the study it was decided that this comparison could be useful in providing some validity to the construct of NLAs.

NLAs were selected based on their apparent similarities to the elements of mystical experiences (Saver & Rabin, 1997). However, this assumption had never been formally tested, and it was unknown if NLAs actually do share qualitative features with spiritual experiences. If no positive association could be found between NLAs and ictal EPD, the results would suggest that NLAs do not have spiritual-like qualities, and that perhaps other kinds of experiences underlie mystical experiences. The positive findings for ictal EPD suggest that NLAs are a valid construct and that they may comprise the elements of mystical experiences. Other auras, such as complex visual and auditory hallucinations (Ogata & Miyakawa, 1998), as well as the sensation that a being is present (Landtblom, 2006), have been identified as religious auras. While these experiences were not included as NLAs, one could argue that they should also be categorized as such. Perhaps future investigations could explore this topic.

The current findings were also significant for NLAs and ictal PB, indicating that patients who report high frequencies of NLAs also have accompanying paranormal beliefs that match their metaphysical-seeming experiences during seizures. One NLA assessed in this study (feeling of leaving the body) is directly addressed on the PB scale (Question 29: It is possible to leave your body). It is understandable that persons who experience an event first-hand may come to believe that such events are possible. Alternatively, it is plausible that persons who maintain certain beliefs (e.g. that it is possible to leave the body) would be more likely to interpret ambiguous experiences in accordance with their expectations (attribution theory) (Schachter & Singer, 1962). One of the most interesting questions that arises from this study is whether the experiences inspire the beliefs or the beliefs inspire the experiences. It is most likely that there is no

right answer – certainly the relationship may be reciprocal and/or different in different in individuals.

No patients in this study reported overtly religious ictal experiences (with religious content based on a particular belief system). Overtly religious ictal experiences are rare: Ogata and Miyakawa (1998) found such experiences in only 1/137 patients with TLE. In this study, several patients had experiences that were metaphysical, but without overt religious content. Patient #15 reported a seizure in which he felt and saw his soul being taken from his body. He reported that this was a very relaxing and positive experience, and that there was a "force" helping him, however he did not describe this as a religious experience. Similarly, Landtblom (2006) described a patient who had a metaphysical-seeming aura (a sensed presence), but who did not interpret the experience as religious. Whether patients interpret metaphysical-like experiences as being religious may depend on their prior religious beliefs. Of note, in the study by Ogata and Mikayawa (1998), of the three patients with ictal-related religious experiences (one ictal and two postictal), all had a long history of devout religious life. Furthermore, the content of their religious experiences was based on the beliefs of the religions they had faith in.

Interictal Spirituality

The results show that patients who reported higher frequencies of NLAs also reported increased *interictal* spiritual experiences and paranormal beliefs compared to patients with fewer NLAs, and compared to a reference population. Interestingly, the two latter groups had comparable scores on these measures, suggesting that epilepsy itself did

not contribute to interictal spiritual experiences. Additionally, the results reveal that there were no differences among the three groups on other ESI-R factors related to religiosity/spirituality. These findings support the hypothesis that persons who have increased NLAs also have increased spirituality of a personalized, non-traditional (i.e. mystical or cosmic) form, and suggest that the presence of particular aura symptoms, not seizures in general, underlie this type of enhanced spirituality.

The interictal EPD results indicate that patients with increased NLAs are inclined to have spiritual experiences even when they are not (reportedly) having seizures. The ictal EPD results are easy to interpret as being seizure-related, however, in the case of interictal EPD, the patients specifically reported that these experiences did not occur during their seizures. One possible explanation for this interictal finding is that the experiences were in fact seizure-related, but the patients did not recognize them as such. Focal seizures can be elusive – symptoms may be identical to non-seizure experiences (e.g. déjà vu), and it may be difficult to distinguish experiences without the aid of EEG. Even with EEG it can be challenging. Silberman et al. (1985) found that persons with epilepsy have more interictal aura-like symptoms than healthy subjects. As these authors state, it may be that these experiences are manifestations of aberrant neuronal activity, even though no electrographic activity is detected on EEG and the experiences are not interpreted as being seizure-related. In any case, it is noteworthy that patients may *believe* these experiences are not associated with their seizures and attribute them to divine or supernatural mechanisms. Interestingly, one patient reported supernatural experiences, such as having a cat speak to her, which she claimed were not seizure-related. She noted that she began having paranormal-like experiences after she had brain

surgery (clipping of an aneurysm). She was not psychotic, and it is likely that these experiences were associated with seizure activity even though she did not believe them to be. On the other hand, many people who are apparently seizure-free report similar spiritual or supernatural experiences.

The significant interictal PB results, similar to the significant ictal results for this measure reviewed above, show that patients with increased NLAs have paranormal beliefs that match their seemingly metaphysical experiences. Whether patients adopt paranormal beliefs to explain their NLAs, or NLAs are an expression of preexisting beliefs, is beyond the scope of this study. Although this question cannot be answered here, one patient's profile provides support for the first scenario. This patient had a long-standing history of recurrent experiences of intense déjà vu and derealization during which she believed she could predict the future. She knew these experiences were abnormal, but came to believe that she was psychic, not ill. At the time of interview, she had recently had her first grand mal seizure, and learned that her psychic experiences were in fact focal seizures due to a tumor in her right temporal lobe. She reported feeling relieved yet somewhat disappointed by the knowledge that these experiences were disease-induced. It would be interesting to see if and how her supernatural beliefs changed with this knowledge. Exploring the relation of beliefs and experiences is an interesting topic for future research.

It is noteworthy that the High NLA group differed from the other groups on EPD and PB, but not the other ESI-R measures. The EPD and PB factors were selected to capture unconventional, cosmic spirituality rather than traditional religiosity/spirituality (which the REL and COG factors appear to assess). The results of the study fit with

those of Roberts and Guberman (1989), who documented the presence of abnormal spiritual interests (such as black magic and the occult) in epilepsy patients. The results are also consistent with those of Tucker et al. (1987) and Willmore et al. (1980) who failed to document elevations in traditional religious beliefs and practices in the TLE population. Additionally, two different research groups noted that their hyperreligious patients subscribed to atypical belief-systems for their communities (Ogata & Miyakawa; 1998; Trimble & Freeman, 2006). Trimble and Freeman (2006) furthermore found that epileptic religiosity was characterized by intense spiritual experiences, but not traditional religious measures (e.g. churchgoing behavior, religious rituals or strength of religious beliefs) when compared to a healthy religious group. Their findings are consistent with the current finding of increased EPD scores, but not COG or REL scores in the High NLA group. Trimble and Freeman did not assess paranormal beliefs, so it is unclear how their groups differed in this regard. Together, the findings of these various research groups suggest that the term, *hyperspirituality* may be a more appropriate term than *hyperreligiosity*, in that epileptic religiosity/spirituality appears to be more experientially-based and individualized than traditional religiosity, which is likely more related to cultural upbringing.

What's Different About the High Numinous-Like Aura Group?

Hyperreligiosity has been associated with TLE by many research groups (Waxman & Geschwind, 1975; Bear & Fedio, 1977; Trimble & Freeman, 2006). However, inconsistent findings suggest that only a subset of patients with TLE display this trait, and it is unclear what characterizes this subset (Dodrill, 1985, as cited in Tucker

et al, 1987). Some studies have implicated a history of postictal psychosis (Trimble & Freeman, 2006; Ogata & Mikawa, 1998), or ecstatic auras (Hansen & Brodtkorb, 2003). The current findings suggest that focal seizure patients with high frequencies of NLAs may be one subpopulation of patients with enhanced spirituality. It was further explored whether patients with high frequencies of NLAs differed in other regards, including demographics, seizure variables or psychopathology.

Demographics

Demographic comparisons of the reference and two patient groups revealed that the High NLA group was comprised of more Caucasian participants and more females than either of the other two groups. These findings were unexpected and may have been due to the relatively small sample sizes. Follow-up analyses led to the conclusion that gender was not contributing to the observed differences in the dependent variables. Nevertheless, the fact that there were significantly more women in the High NLA group than in either of the other groups is noteworthy. Considering that the construct of NLAs is novel, it is not known whether women have higher incidences of NLAs than men. In general, auras are not discussed in terms of gender, and are assumed to occur equally across the sexes. However, one study found that 83% of patients with ictal fear were female (Mintzer & Lopez, 2002). It is also not known if Caucasian persons have more NLAs than non-Caucasian persons (our analysis revealed that the High NLA group had a statistical trend of more Caucasian persons than the Low NLA group). In this study, follow-up analyses on racial differences revealed that race did not contribute to the observed group differences in EPD and PB. Prior research suggests that the racial

differences uncovered in select MMPI-2 scores were likely an artifact of unmatched groups by subject type (the Caucasian group had more patients than the non-Caucasian group). It would be interesting to see if future studies produced similar findings, or whether these results were due to chance.

Seizure Variables

The High and Low NLA groups did not differ in localization (temporal versus frontotemporal, lateralization or duration of epilepsy. It should be noted, however, that the localization and lateralization criteria utilized in this study were somewhat liberal (for example, including focal slowing as a localization/lateralization criterion). Seizure foci are more accurately identified when stricter criteria are utilized (such as limiting the classification to data collected during a recorded seizure), but that is often not possible in standard clinical practice, as was available in this study. The technological ability to identify detailed and accurate seizure localization and lateralization is limited, and is part of the reason we avoided forming groups based on these criteria.

Previous research has implicated epileptic religiosity as being associated with TLE as opposed to other forms of focal epilepsy (such as FLE, PLE or OLE) (Bear & Fedio, 1977; Trimble & Freeman, 2006; Ogata & Miyakawa, 1998). However, there were not enough subjects in these latter categories to perform a temporal versus extra-temporal comparison. The localization comparison that was performed may not have been useful in this regard, because both categories involved the temporal lobe. Furthermore, such specific differences (temporal versus frontotemporal) are especially difficult to distinguish reliably with standard EEG. Previous research on religiosity and

lateralization has been mixed, with some finding an association with a left-side focus (Csernansky et al., 1990), bilateral focus (Trimble & Freeman, 2006), or with right-sided structural changes (Wuerfel et al., 2004). The lack of a laterality effect in this study was consistent with these mixed findings.

Psychopathology

The MMPI-2 group comparison on the clinical scales was not significant overall. Considering that ten scales were included in the MANOVA, it is likely that if fewer scales had been assessed (e.g. if there were specific hypotheses) there would have been more power in the analysis. Therefore, in an exploratory fashion, it is useful to look at the results from specific scale scores even though the overall MANOVA only approached significance ($p = .07$). Previous literature has shown that religiosity has been associated with two forms of psychopathology that are relevant to epilepsy – mania and psychosis (Previc, 2006). It is noteworthy that there were not significant differences among the groups on these scales. However, it is questionable whether the MMPI-2 is useful in assessing these forms of psychopathology in epilepsy, which may occur in the postictal state and are thus transient (literature could not be found on this topic). Unfortunately, postictal psychosis was not specifically assessed in this study.

Despite the lack of overall significance, two scale scores – Hypochondriasis and Hysteria – were significantly elevated. For both scales, the High NLA group had significantly higher scores than both the Low NLA group and the reference group, who had comparable scores. It is interesting that the pattern of these results mirrors the findings for EPD and PB (the High NLA group differs from both of the other two groups,

who are not different from each other). Also of interest is the fact that the mean High NLA group scores for both Hypochondriasis and Hysteria were above the clinical cut-off of T = 65 (T = 67 and T = 65.67, respectively).

Care was taken to ensure the validity of the MMPI-2 in this population by discarding invalid profiles and making corrections for epilepsy-related symptoms using the method outlined by Derry and colleagues (1997; 2002). However, the two scales that had elevations – Hypochondriasis and Hysteria – are known to be frequently elevated in neurological populations, because the questions in these scales tap real neurological symptoms (Derry et al., 1997; 2002; Gass, 1996; Gass & Russell, 1991). Therefore, these results should be interpreted with some caution as it is unclear whether the elevations on the Hypochondriasis and Hysteria scales are due to seizure-related symptoms, or reflect true psychopathology. Considering that the High NLA group was selected based on their increased experiential symptoms, it is plausible that they would endorse more neurologically-related symptoms, which are actually related to their seizures. A closer look at the number of corrections required reveals that 3/9 (33%) of patients in the High group required corrections because they endorsed high numbers of neurological symptoms, while 4/19 (21%) of patients in the Low group required corrections. It is not known whether this difference could have impacted the comparisons.

It is nevertheless useful to explore the potential implications of these findings with the assumption that the results are meaningful. The Hypochondriasis scale was created to measure preoccupation with the body, as well as fears about physical illness and disease (Graham, 1993). The questions that contribute to this scale deal with general physical competence and specific physical concerns. Persons with bona fide physical

problems tend to score approximately T = 60. The High NLA group mean score was T= 67, compared to the Low NLA group score of T = 57.56 and reference score of T = 54.54. Graham (1993) writes that medical patients who are high scale scorers may have a psychological component to their illness.

The Hysteria scale was developed to capture hysterical reactions to stress (Graham, 1993). The questions that contribute to this scale include a general denial of physical health, denial of emotional or psychological difficulties, as well as endorsement of specific physical complaints such as headaches, fitful sleep and nausea. Of importance, high raw scores are much more common in women than in men in both normal and psychiatric populations. It is not know if this difference is also found in epilepsy populations, however, the current analyses did not reveal any differences between male and female participants on this scale. Once again, patients with bona fide medical problems often score at about T = 60. Thus, the finding that patients in the High NLA group (who were comprised of more women than the other groups, and who had a medical illness) had a mean score of T = 65.67 is of questionable clinical significance (note that no correction was made on this scale). For comparison purposes, the two other groups scored approximately T = 52.

For both scales, the finding that the High NLA group scored T = 10 and T = 13 (for Hypochondriasis and Hysteria, respectively) points more than the Low NLA group suggests some clinically meaningful differences between the groups. How these findings may relate to NLAs or spirituality is unclear. One interpretation is that these patients tend to exaggerate their symptoms, and thus are more likely to endorse a variety of

experiences, including NLAs. This possibility, and the general significance of the Hysteria and Hypochondriasis elevations, is an interesting topic for future research.

A Theory of Spirituality in Epilepsy

There are many forms of religiosity and spirituality – it is one of the most complex human constructs. The measure utilized in this study identified five such forms. Certainly persons with epilepsy have all of these forms, to different extents, based on a variety of personal, cultural and psychiatric/medical factors. This study did not attempt to account for all of the combinations of factors that might lead to different expressions of religiosity/spirituality. Only one such pathway was investigated – the presence of epilepsy-induced experiences that appear to mimic spiritual experiences, and associated spirituality of a personalized, non-traditional form. It was reasoned that people who have auras that are suggestive of metaphysical phenomena would have supernatural beliefs that correspond to their unworldly experiences. The present findings support the study hypotheses, and reveal a positive relationship between the high frequency of NLAs and spirituality. The direction of the relationship remains unclear – it may be that persons with preexisting paranormal beliefs interpret ambiguous experiences in supernatural terms, or that persons who have paranormal-seeming experiences come to have beliefs that accommodate their experiences.

Similar to the conclusions of other investigators, the current results support a role for the temporal lobe – in particular, the limbic system – in the spirituality measured in this study. The results implicate this region of the brain because it underlies most of the NLAs included in this study. Depersonalization, derealization, bodily distortion and

pleasure have been associated with limbic activation (Gloor et al., 1982; Palmini & Gloor, 1992; Sierra & Berrios, 1998), while the sense of leaving the body and body illusions/distortions have been associated with the temporal-parietal junction (Blanke et al., 2004; Blanke & Arzy, 2005). It is significant that most of the focal seizure patients in this study had temporal involvement in their seizures, but only the High NLA group had enhanced spirituality. This emphasizes the importance of the experiential aspects of temporal activation; involvement of temporal regions without accompanying numinous-like experiences was not sufficient. It is proposed that this difference accounts for the finding that only some patients with TLE display enhanced spirituality.

Other temporal lobe theories of epileptic religiosity have proposed that the limbic system excessively marks otherwise neutral phenomena with special qualities. Bear and Fedio (1977) argued that this limbic tagging was based in emotional qualia, while more recently, Saver and Rabin (1997) argued that the tagging could be with depersonalization/derealization, harmony, joy, or with the feeling that events are crucially important/self-referent. This over-activation of the limbic system interictally may occur through strengthening of limbic-cortical connections (Bear & Fedio, 1977). In the cat, repeated amygdala seizures have been shown to produce a lasting hyperactivity of circuits that participate in response to threat, as well as hypoactivity of circuits that antagonize response to threat (Adamec, 1990). It seems plausible that similar potentiation of pathways underlying numinous-like experiences could occur through repeated seizures that elicit these symptoms. The current finding – that persons with increased NLAs have greater spiritual experiences interictally – supports this possibility, because it indicates that persons with more limbic-mediated numinous-like experiences

during seizures also have more (presumably) limbic-mediated numinous experiences interictally.

A criticism of Bear and Fedio's TLE interictal behavioral syndrome (and by extension, Saver and Rabin's theory) is that it predicts behavioral alterations in all patients with TLE, while research shows such alterations in only some patients. If limbic-cortical potentiation is the mechanism of enhanced interictal limbic functioning, this discrepancy suggests that potentiation occurs only in some patients. The current finding, that the Low NLA group did not have as many numinous experiences interictally, suggests that only the High group had this potentiation of circuits. Perhaps interictal spiritual experiences are related to potentiation of select limbic-cortical pathways that underlie numinous-like experiences. In this case, frequent NLAs are key because their presence indicates sufficient limbic activation of select circuits to produce potentiation of these circuits, which then results in parallel experiences occurring interictally. The findings of other research groups, which show associations between other limbic-mediated auras and parallel psychiatric manifestations (e.g. ictal fear and interictal anxiety disorders), suggest that this mechanism may occur for a variety of symptoms. While this line of reasoning is very tentative, it offers a possible explanation for why only some TLE patients display particular interictal traits.

The current findings appear to implicate select limbic-cortical circuits underlying numinous-related experiences, however, there is also the possibility that the proposed limbic hyperfunctioning was more general. If this were the case, it would predict other interictal behavioral alterations, such as those outlined by Bear and Fedio (1977). The High NLA group was not found to have other forms of interictal limbic-mediated

behaviors (e.g. depression and anxiety). However, the finding of increased Hysteria and Hypochondriasis scores in the High NLA group could be interpreted as an exaggerated response to stress. This interpretation would suggest that the limbic hyperfunction in the High NLA group resulted in both increased spiritual experiences as well as exaggerated responses to stress. This is an intriguing possibility, and a good topic for future research.

The views in this paper are aligned with those of Persinger (1983; 1984; 1993; Persinger & Makarec, 1993): that limbic activity may underlie spiritual experiences in all persons, not only persons with epilepsy. It is furthermore argued that numinous-like experiences, such as depersonalization, derealization and autoscopy, are likely to foster spiritual interpretations whether they are induced by seizures or by other mechanisms. These other mechanisms could include psychedelic drugs, psychosis, near-death experiences, or high elevations. Many reports of spiritual experiences have been documented in these conditions (Previc, 2006; Britton & Bootzin, 2005; Arzy, Idel, Landis & Blanke, 2005). Numinous-like experiences also occur in healthy persons, under normal conditions, to varying degrees. Persinger has termed these experiences "complex partial epileptic-like signs" (Persinger & Makarec, 1993). MacDonald & Holland (2002) found an association between such signs and enhanced spirituality in a large population of college students.

While the current results support prior limbic theories of epileptic religiosity, they do not support other theories of epileptic religiosity. There is no evidence that the patients in this study with enhanced spirituality adopted their beliefs/experiences as a coping mechanism for dealing with a chronic illness. This is concluded because patients in the Low NLA group, who were also dealing with a chronic illness, did not show the

observed spiritual enhancement. Additionally, the results do not support a role of psychopathology, such as psychosis or mania, as underlying the enhanced spirituality found in this study. The High NLA group did not have increased scores on the schizophrenia or hypomania scales, compared to the Low NLA group or the reference population. The finding of increased Hysteria and Hypochondriasis scores is interesting, but does not fit within the context of prior literature on psychopathology and religiosity. It may be that patients with high frequencies of NLAs tend to exaggerate their symptoms, but it is unclear how this may relate to the relationship between NLAs and spirituality.

Caveats and Directions for Future Research

This study is exploratory and thus should be interpreted with caution. Nevertheless, the positive findings suggest that future endeavors on this topic are worthwhile. The novelty of this study resulted in some methodological drawbacks – for example, there was no prior example of how to form NLA groups. Additionally, it was not clear whether the auras that were selected were the most numinous-like, or whether other aura symptoms, such as complex hallucinations, or a sensed presence, should additionally have been included. However, considering the positive findings, future studies could draw on the methodology utilized here. Additionally, other studies may limit their population to patients with EEG-documented seizures, rather than relying on other EEG indices (such as interictal spiking or focal slowing), to help delineate potential localization or lateralization effects. Future studies would also benefit from having better-matched populations in terms of demographics. Finally, other studies could

include additional measures of spirituality. While the ESI-R is a reliable and valid measure, it would bolster the findings to observe these effects with different instruments.

An interesting follow-up study would be to assess spirituality in persons who are exposed to high elevations (i.e. mountain climbers or jet-pilots). High elevations have been associated with many numinous-like experiences, similar to those observed in TLE (Arzy et al., 2005). Arzy and colleagues posit that these elevation-induced numinous-like experiences are the reason that many religious revelations have occurred on mountaintops. The proposed follow-up study could be designed similarly to the current study, comparing persons with high frequencies of numinous-like experiences to those with those with low frequencies of numinous-like experiences, on various measures of spirituality. In this case, the "ictal" and "interictal" measures would be for experiences during and not during expeditions (e.g. mountain-climbing or flying). Positive results would provide support to the theory that numinous-like experiences – no matter the condition in which they manifest – may foster spiritual interpretations.

Conclusions

The findings of this study support a positive relationship between aura symptoms that resemble the elements of spiritual experiences and enhanced spirituality. The results show that patients with high frequencies of numinous-like experiences during seizures have increased paranormal beliefs and spiritual experiences both ictally and interictally. This finding held when compared to a reference group of college students, as well as when compared to patients with lower frequencies of NLAs. The findings support a conception of epileptic spirituality as being personalized, experiential and distinct from

traditional, culturally-based religiosity. It is acknowledged that the spirituality investigated here may be only one form of religiosity/spirituality that is found in persons with epilepsy. The enhanced spirituality observed in this study is attributed to an over-activation of the limbic system, as it underlies most of the numinous-like auras. Interictal spiritual experiences may be related to potentiation of select limbic-cortical circuits that underlie numinous-like experiences. Frequent NLAs may be key because they indicate sufficient activation to produce this potentiation. The relation of spiritual experiences and accompanying paranormal beliefs is likely reciprocal, and is an interesting topic for future research.

Appendix

Appendix A

Aura Questionnaire

ID:_____ Date:_____

Seizure/Aura Types

1) Main Seizure Type:

_____

_____

Frequency: number per month:_____

2) Second Main Seizure or Aura Type:

_____

_____

Frequency: number per month:_____

HAVE YOU EXPERIENCED ANY OF THE FOLLOWING SYMPOMS BEFORE OR DURING A SEIZURE?

CODING:
Frequency: 0=never, 1=rarely, 2=sometimes, 3=most of the time, 4=all of the time

1) Emotions –

	Seizure Type 1	**Seizure Type 2**
Fear	_____	_____
Pleasure	_____	_____
Sadness	_____	_____
Anxiety	_____	_____
Peacefulness	_____	_____
Panic	_____	_____
Embarrassment	_____	_____

**specify whether reactive (R) or not

Description_____

_____

_____

2) Depersonalization/Derealization –

Dreamy state (detachment)	_____	_____
Feeling of leaving body	_____	_____
Things don't seem real	_____	_____
Time sped up/down	_____	_____
Bodily distortion	_____	_____
Other	_____	_____

Description_____

_____

_____

3) Hallucinations –

Sight	_____	_____
Smell	_____	_____
Touch	_____	_____
Sound	_____	_____
Taste	_____	_____

Description_____

_____

_____

4) Visual/Auditory distortions –

Things look:

unusual	_____	_____
closer/farther	_____	_____
smaller/larger	_____	_____
Things sound:	_____	_____
closer/farther	_____	_____
Echo	_____	_____

Description_____

_____

_____

5) Somatosensory –

Tingling _____ _____

Numbness _____ _____

Goose bumps _____ _____

Heat or cold _____ _____

Description_____

_____

_____

6) Time and memory distortions

Déjà vu _____ _____

Jamais vu _____ _____
(when a familiar place looks unfamiliar)

Description_____

_____

_____

7) Epigastric sensation

"Butterflies"
in stomach _____ _____

Nausea _____ _____

Rising sensation _____ _____

Description_____

_____

_____

8) vestibular sensation –

Floating _____ _____

Vertigo _____ _____

Dizziness _____ _____

Description_____

_____

_____

9) Other –

Recurrent
thoughts _____ _____

Other _____ _____

Appendix B

Expressions of Spirituality Inventory- Revised (ESI-R) (© Douglas A. MacDonald, 2000)

This is a questionnaire which concerns your experiences, attitudes, beliefs and lifestyle practices pertaining to spirituality. Below are several statements. Read each statement carefully. Using the five point scale described below, rate the extent to which you agree with each statement as it applies to you and put your response in the space provided. There are no right or wrong answers. Please respond to every statement and respond as honestly as possible.

0----------1----------2----------3----------4

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

_____ 1. Spirituality is an important part of who I am as a person

_____ 2. I have had an experience in which I seemed to be deeply connected to everything

_____ 3. It always seems that I am doing things wrong

_____ 4. It is possible to communicate with the dead

_____ 5. I believe that going to religious services is important

_____ 6. Spirituality is an essential part of human existence

_____ 7. I have had an experience in which I seemed to transcend space and time

_____ 8. I am not comfortable with myself

_____ 9. I believe witchcraft is real

_____ 10. I feel a sense of closeness to a higher power

_____ 11. I am more aware of my lifestyle choices because of my spirituality

_____ 12. I have had a mystical experience

_____ 13. Much of what I do in life seems strained

_____ 14. It is possible to predict the future

_____ 15. I see myself as a religiously oriented person

_____ 16. I try to consider all elements of a problem, including its spiritual aspects, before I make a decision

_____ 17. I have had an experience in which I seemed to merge with a power or force greater than myself

_____ 18. My life is often troublesome

_____ 19. I do not believe in spirits or ghosts

_____ 20. I see God or a Higher Power present in all the things I do

_____ 21. My life has benefited from my spirituality

_____ 22. I have had an experience in which all things seemed divine

_____ 23. I often feel tense

_____ 24. I think psychokinesis, or moving objects with one's mind, is possible

_____ 25. I practice some form of prayer

_____ 26. I believe that attention to one's spiritual growth is important

_____ 27. I have had an experience in which I seemed to go beyond my normal everyday sense of self

_____ 28. I am an unhappy person

_____ 29. It is possible to leave your body

_____ 30. I believe that God or a Higher Power is responsible for my existence

_____ 31. This questionnaire appears to be measuring spirituality

_____ 32. I responded to all statements honestly

Items Contributing to Each Dimension:

Experiential/Phenomenological Dimension (EPD): 2, 7, 12, 17, 22, 27

Paranormal Beliefs (PB): 4, 9, 14, 19, 24, 29

Cognitive Orientation Towards Spirituality (COG): 1, 6, 11, 16, 21, 26

Religiousness (REL): 5, 10, 15, 20, 25, 30

Existential Well-Being (EWB): 3, 8, 13, 18, 23, 28

References

Adamec, R. (1990). Does kindling model anything clinically relevant? *Biological Psychiatry, 27,* 249-279.

Aldenkamp, A. & Arends, J. (2003). Effects of epileptiform EEG discharges on cognitive function: is the concept of "transient cognitive impairment" still valid? *Epilepsy & Behavior, 5,* S25-S34.

Amancio, E., Zymberg, S. & Pires, M. (1994). Temporal lobe epilepsy and aura with happiness and pleasure: report of two cases and review of the literature. *Arquivos de neuro-psiquiatria, 52(2),* 252-259.

American Psychiatric Association (1994). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington DC: American Psychiatric Press.

Annegers, J. (2001). The epidemiology of epilepsy. In E. Wyllie (Ed.), *The Treatment of Epilepsy* (3rd ed.) (pp. 131-138). Philadelphia: Lippincott Williams & Wilkins.

Arzy, S., Idel, M., Landis, T. & Blanke, O. (2005). Why revelations have occurred on mountains? Linking mystical experiences and cognitive neuroscience. *Medical Hypotheses, 65,* 841-845.

Bear, D. & Fedio, P. (1977). Quantitative analysis of interictal behavior in temporal lobe epilepsy. *Archives of Neurology, 34,* 454-67.

Bear, D., Levin, K., Blumer, D., Chetan, D. & Ryder, J. (1982). Interictal behavior in hospitalized temporal lobe epileptics: relationship to idiopathic psychiatric syndromes. *Journal of Neurology, Neurosurgery and Psychiatry, 45,* 481-488.

Biraben, A., Taussig, D., Thomas, P., Even, C., Vignal, J., Scarabin, P. et al. (2001). Fear as the main feature of epileptic seizures. *Journal of Neurology Neurosurgery and Psychiatry, 70,* 186-191.

Blanchet, P. & Frommer, G. (1986). Mood change preceding epileptic seizures. *Journal of Nervous and Mental Disease, 174(8),* 471-476.

Blanke, O. & Arzy, S. (2005). The out-of-body experience: disturbed self-processing at the temporo-parietal junction. *The Neuroscientist, 11(1),* 16-24.

Blanke, O., Landis, T., Spinelli, L. & Seeck, M. (2004). Out-of-body experience and autoscopy of neurological origin. *Brain, 127(2),* 243-258.

Blumenfeld, H., Westerveld, M., Ostroff, R., Vanderhill, S., Freeman, J., Necochea, A. et al. (2003). Selective frontal, parietal, and temporal networks in generalized seizures. *NeuroImage, 19,* 1556-1566.

Boylan, L. (2002). Peri-ictal behavioral and cognitive changes. *Epilepsy & Behavior, 3,* 16-26.

Brandt, J., Seidman, L. & Kohl, D. (1985). Personality characteristics of epileptic patients: a controlled study of generalized and temporal lobe cases. *Journal of Clinical and Experimental Neuropsychology, 7,* 25-38.

Brewerton, T. (1994). Hyperreligiosity in psychotic disorders. *The Journal of Nervous and Mental Disease, 182(5),* 302-304.

Britton, W. & Bootzin, R. (2004). Near-death experiences and the temporal lobe. *Psychological Science, 15(4),* 254-258.

Brown, E. (1991). Interictal cognitive changes in epilepsy. *Seminars in Neurology, 11,* 1678-174.

Browne & Holmes. (1997). *Handbook of Epilepsy.* Philadelphia: Lippincott-Raven Publishers.

Butcher, J., Dahlstrom, W., Graham, J., Tellegen, A. & Kraemer, B. (1989). *Manual for administration and scorin the Minnesota Multiphasic Personality Inventory-2: MMPI-2.* Minneapolis: University of Minnesota Press.

Chang, B. & Lowenstein, D. (2003). Epilepsy. *The New England Journal of Medicine, 349,* 1257-1266.

Commission on Classification and Terminology of the International League Against Epilepsy. (1989). Proposal for revised classification of epilepsies and epileptic syndromes. *Epilepsia, 30(4),* 389-399.

Cothran, M. & Harvey, P. (1986). Delusional thinking in psychotics: Correlates of religious content. *Psychological Reports, 58,* 191-199.

Csernansky, J., Leiderman, D., Mandabach, M. & Moses, J. (1990). Psychopathology and limbic epilepsy: relationship to seizure variables and neuropsychological function. *Epilepsia, 31,* 275-80.

Daly, D. (1958). Ictal affect. *American Journal of Psychiatry, 115,* 97-108.

Daly, D. (1975). Ictal manifestations of Complex Partial Seizures. In J. Penry and D. Daly (Eds.) *Advances in Neurology: Vol. 11: Complex Partial Seizures and their Treatment.* New York: Raven Press.

Derry, P., Harnadek, M., McLachlan, R., Sontrop, J., Blume, W. & Girvin, J. (2002). A longitudinal study of the effects of seizure symptoms on the Minnesota Multiphasic Personality Inventory-2 (MMPI-2) Clinical Interpretation. *Journal of Clinical Psychology. 58(7),* 817-826.

Derry, P., Harnaked, M. McLachlan, R. & Sontrop, J. (1997). Influence of seizure content on interpreting psychopathology on the MMPI-2 in patients with epilepsy. *Journal of Clinical and Experimental Neuropsychology. 19(3),* 396-404.

Devinsky, O. (2003). Religious experiences and epilepsy. *Epilepsy & Behavior, 4,* 76-77.

Devinsky, O., Feldmann, E., Burrowes, K., & Bromfield, E. (1989). Autoscopic phenomena with seizures. *Archives of Neurology, 46,* 1080-1088.

Devinsky, O. & Najjar S. (1999). Evidence against the existence of a temporal lobe epilepsy personality syndrome. *Neurology, 53(2),* S13-S25.

Dewhurst, K. & Beard, A. (1970). Sudden religious conversions in temporal lobe epilepsy. *The British Journal of Psychiatry, 117,* 497-507.

Dodrill, C. (1986). Correlates of generalized tonic-clonic seizures with intellectual, neuropsychologial, emotional and social function in patients with epilepsy. *Epilepsia, 27,* 399-411.

Dodrill, C. & Wilensky, A. (1992). Neuropsychological abilities before and after 5 years of stable antiepileptic drug therapy. *Epilepsia, 33,* 327-334.

Dostoevsky, F. (1956). *The Idiot.* (C. Garnett, Trans.). New York: The Heritage Press. (Original work published 1869)

Engel Jr., J. (2001a). A proposed diagnostic scheme for people with epileptic seizures and with epilepsy: report of the ILAE Task Force on classification and terminology. *Epilepsia, 42(6),* 796-803.

Engel Jr., J. (2001b). Mesial temporal lobe epilepsy: what have we learned? *The Neuroscientist, 7(4),* 340-352.

Engel Jr., J. (2006). ILAE classification of epilepsy syndromes. *Epilepsy Research, 70(1),* S5-10.

Field, A. (2005). *Discovering statistics using SPSS* (2nd ed.). London: Sage Publications Ltd.

Fisher, R., van Emde Boas, W., Blume, W., Elger, C., Genton, P., Lee, P., et al. (2005). Epileptic seizures and epilepsy: definitions proposed by the International League Against Epilepsy (ILAE) and the International Bureau for Epilepsy (IBE). *Epilepsia, 46(4),* 470-472.

Fisher, R. & Schachter, S. (2000). The postictal state: a neglected entity in the management of epilepsy. *Epilepsy & Behavior, 1,* 52-59.

Gass, C. (1996). MMPI-2 interpretation and stroke: Cross-validation of a correction factor. *Journal of Clinical Psychology, 52(5),* 569-572.

Gass, C. & Russell, E. (1991). MMPI profiles of closed head trauma patients: Impact of neurologic complaints. *Journal of Clinical Psychology, 47(2),* 253-260.

Gilbert, M. (2001). Does the kindling model of epilepsy contribute to our understanding of multiple chemical sensitivity? *Annals of the New York Academy of Sciences, 933,* 68-91.

Gloor, P., Olivier, A., Quesney, L., Andermann, F. & Horowitz, S. (1982). The role of the limbic system in the experiential phenomena of temporal lobe epilepsy. *Annals of Neurology, 12,* 129-144.

Graham, J. (1993). *MMPI-2 Assessing Personality and Psychopathology* (2nd ed.). Oxford: Oxford University Press.

Gupta, A., Jeavons, P., Hughes, R. & Covanis, A. (1983). Aura in temporal lobe epilepsy: clinical and electroencephalographic correlation. *Journal of Neurology, Neurosurgery and Psychiatry, 46,* 1079-1083.

Hansen, A. & Brodtkorb, E. (2003). Partial epilepsy with "ecstatic" seizures. *Epilepsy & Behavior, 4,* 666-773.

Helmstaedter, C. (2001). Behavioral aspects of frontal lobe epilepsy. *Epilepsy & Behavior, 2,* 384-395.

Helmstaedter, C., Elger, C. & Lendt, M. (1994). Postictal courses of cognitive deficits in focal epilepsies. *Epilepsia, 35,* 1073-1078.

Helmstaedter, C., Kemper, B. & Elger, C. (1996). Neuropsychological aspects of frontal lobe epilepsy. *Neuropsychologia, 34(5*), 399-406.

Hermann, B. & Chhabria, S. (1980). Interictal psychopathology in patients with ictal fear: examples of sensory limbic hyperconnection? *Archives of Neurology, 37,* 667-668.

Hermann, B., Dikmen, S., Schwartz, M. & Karnes, W. (1982). Interictal psychopathology in patients with interictal fear: a quantitative investigation. *Neurology, 32,* 7-11.

Hermann, B. & Riel, P. (1981). Interictal personality and behavioral traits in temporal lobe and generalized epilepsy. *Cortex, 17,* 125-128.

Hogan, E. & Kaiboriboon, K. (2003). The "dreamy state": John Hughlings-Jackson's ideas of epilepsy and consciousness. *American Journal of Psychiatry, 160(10),* 1740-1747.

Hughes, J., Devinsky, O., Feldmann, E. & Bromfield, E. (1993). Premonitory symptoms in epilepsy. *Seizure, 2(3),* 201-203.

Kalynchuk, L. (2000). Long-term amygdala kindling in rats as a model for the study of interictal emotionality in temporal lobe epilepsy. *Neuroscience and Biobehavioral Reviews, 24(7),* 691-704.

Kanemoto, K., Kawasaki, J. & Kawai, I. (1996). Postictal psychosis: a comparison with acute interictal and chronic psychoses. *Epilpesia, 37,* 454-467.

Kanemoto, K., Tsuji, T. & Kawasaki, J. (2001). Reexamination of interictal psychoses based on DSM IV psychosis classification and international epilepsy classification. *Epilepsia, 42(1),* 98-103.

Kanner, A. (2006). Peri-ictal psychiatric phenomena: clinical characteristics and implications of past and future psychiatric disorders. In A. Ettinger, & A.M. Kanner (Eds.), *Psychiatric Issues in Epilepsy, 2nd Edition* (pp. 321-345). Philadelphia: Lippincott Williams & Wilkins.

Kanner, A. (2003). Depression in epilepsy: prevalence, clinical semiology, pathogenic mechanisms, and treatment. *Biological Psychiatry, 54,* 388-398.

Kanner, A. & Barry, J. (2001). Controversies in epilepsy and behavior: is the psychopathology of epilepsy different from that of nonepileptic patients? *Epilepsy & Behavior, 2,* 170-186.

Kanner, A., Soto, A. & Gross-Kanner, H. (2004). Prevalence and clinical characteristics of postictal psychiatric symptoms in partial epilepsy. *Neurology, 62,* 708-713.

Kanner, A., Stagno, S., Kotagal, P. & Morris, H. (1996). Postictal psychiatric events during prolonged video-electroencephalographic monitoring studies. *Archives of Neurology 53*, 258–263.

King, T., Fennell, E., Bauer, R., Crosson, B., Dede, D., Riley, L. et al. (2002). MMPI-2 profiles of patients with intractable epilepsy. *Archives of Clinical Neuropsychology, 17*, 583-593.

Kohler, C., Carran, M., Bilker, W., O'Connor, M., & Sperling, M. (2001). Association of fear auras with mood and anxiety disorders after temporal lobectomy. *Epilepsia, 42(5),* 674-81.

Kotagal, P. (1991). Seizure symptomatology of temporal lobe epilepsy. In H.O. Luders (Ed.) *Epilepsy Surgery* (pp. 143-156). New York: Raven Press, Ltd.

Kwan, P. & Brodie, M. (2001). Neuropsychological effects of epilepsy and antiepileptic drugs. *The Lancet, 357*, 216-222.

Lancman, M. (1999). Psychosis and peri-ictal confusional states. *Neurology, 53(Suppl 2),* S33-S38.

Landtblom, A. (2006). The "sensed presence": An epileptic aura with religious overtones. *Epilepsy & Behavior, 9*, 186-188.

Leutmezer, F., Podreka, I., Asenbaum, S., Pietrzyk, U., Lucht, H., Back, C. et al. (2003). Postictal psychosis in temporal lobe epilepsy. *Epilepsia, 44(4),* 582-590.

Logsdail, S.J. & Toone, B.K. (1988). Postictal psychoses: a clinical and phenomenological description. *British Journal of Psychiatry, 152*, 246-252.

MacDonald, D. (1997). *The development of a comprehensive factor analytically derived measure of spirituality and its relationship to psychological functioning.* Unpublished doctoral dissertation. University of Windsor, Windsor, Ontario, Canada.

MacDonald, D. (2000). Spirituality: Description, measurement, and relation to the five factor model of personality. *Journal of Personality, 68(1),* 153-197.

MacDonald, D. & Holland, D. (2002). Spirituality and complex partial epileptic-like signs. *Psychological Reports, 91,* 785-792.

Mallanby, J., Strawbridge, P., Collingridge, G., George, G., Rands, G., Stroud, C. et al. (1981). Behavioral correlates of an experimental hippocampal epileptiform syndrome in rats. *Journal of Neurology Neurosurgery and Psychiatry, 44,* 1084.

Maillard, L., Vignal, J., Anxionnat, R., Taillandier, L, Vespignani, H. (2004). Semiologic value of ictal autoscopy. *Epilepsia, 45(4),* 391-394.

Manchanda, R. (2002). Psychiatric disorders in epilepsy: clinical aspects. *Epilepsy & Behavior, 3,* 39-45.

Manchanda, R., Freeland, A., Schaefer, B., McLachlan, R., & Blume, W. (2000). Auras, seizure focus, and psychiatric disorders. *Neuropsychiatry, Neuropsychology, and Behavioral Neurology, 13(1),* 13-9.

Marchetti, R., Tavares, A., Gronich, G., Fiore, L., Ferraz, R. (2001). Complete remission of epileptic psychosis after temporal lobectomy: case report. *Arquivos de neuro-psiquiatria, 59(3-B),* 802-805.

Mendez, M., Engebrit, B., Doss, R. & Grau, R. (1996). The relationship of epileptic auras and psychological attributes. *Journal of Neuropsychiatry, 8(3),* 287-292.

Mintzer, S. & Lopez, F. (2002). Comorbidity of ictal fear and panic disorder. *Epilepsy & Behavior, 3,* 330-337.

Moore, P. & Baker, G. (2002). The neuropsychological and emotional consequences of living with intractable temporal lobe epilepsy: implications for clinical management. *Seizure, 11(4),* 224-230.

Motamedi, G. & Meador, K. (2003). Epilepsy and cognition. *Epilepsy & Behavior, 4,*S25-S38.

Munley, P., Morris, J., Murray, D. & Baines. (2001). A comparison of African American and white American veteran MMPI-2 profiles. *Psychological Assessment, 8,* 1-10.

Naito, H. & Matsui, N. (1988). Temporal lobe epilepsy with ictal ecstatic state and interictal behavior of hypergraphia. *Journal of Nervous and Mental Disease, 176(2),* 123-124.

Nielsen, H. & Kristensen, O. (1981). Personality correlates of sphenoidal EEG-foci in temporal lobe epilepsy. *Acta Neurologica Scandinavica, 64,* 289-300.

Ogata, A. & Miyakawa, T. (1998). Religious experiences in epileptic patients with a focus on ictus-related episodes. *Psychiatry and Clinical Neurosciences, 52,* 321-325.

Palmini, A. & Gloor, P. (1992). The localizing value of auras in partial seizures: A prospective and retrospective study. *Neurology, 42,* 801-808.

Pariente P., Lepine, J. & Lellouche, J. (1991). Lifetime history of panic attacks and epilepsy: an association from a general population survey. *Journal of Clinical Psychiatry, 52,* 88-89.

Persinger, M. (1983). Religious and mystical experiences as artifacts of temporal lobe function: a general hypothesis. *Perceptual Motor Skills, 57,* 1255-1262.

Persinger, M. (1984). People who report religious experiences may also display enhanced temporal-lobe signs. *Perceptual Motor Skills, 58,* 963-975.

Persinger, M. (1993). Paranormal and religious beliefs may be mediated differentially by subcortical and cortical phenomenological processes of the temporal (limbic) lobes. *Perceptual Motor Skills, 76,* 247-251.

Persinger, M. & Makarec, K. (1993). Complex partial epileptic signs as a continuum from normals to epileptics: normative data and clinical populations. *Journal of Clinical Psychology, 49(1),* 33-45.

Prevey, M., Delaney, R., Cramer, J., Mattson, R., & VA Epilepsy Cooperative Study 264 Group. (1998). Complex partial and secondarily generalized seizure patients: cognitive functioning prior to treatment with antiepileptic medication, *Epilepsy Research, 30(1),* 1-9.

Previc, F. (2006). The role of the extrapersonal brain systems in religious activity. *Consciousness and Cognition, 15(3),* 500-539.

Protopopescu, V., Hively, L. & Gailey, P. (2001). Epileptic event forewarning from scalp EEG. *Journal of Clinical Neurophysiology, 18*, 223-245.

Pulliainen, V., Kuikka, P. & Jokelainen, M. (2000). Motor and cognitive functions in newly diagnosed adult seizure patients before antiepileptic medication. *Acta Neurologica Scandinavica, 101,* 73-78.

Riggs, A. & Riggs, E. (2005). Epilepsy's role in the historical differentiation of religion, magic and science. *Epilepsia, 46(3),* 452-453.

Roberts, J. & Guberman, A. (1989). Religion and epilepsy. *Psychiatric Journal of the University of Ottawa, 14,* 282-6.

Rodin, E. (1973). Psychomotor epilepsy and aggressive behavior. *Archives of General Psychiatry, 28,* 210-213.

Savard, G., Andermann, F., Olivier, A. & Remillard, G. (1991). Postictal psychosis after partial complex seizures: a multiple case study. *Epilepsia, 32(2),* 225-31.

Saver, J. & Rabin, J. (1997). The neural substrates of religious experience. *Journal of Neuropsychiatry and Clinical Neurosciences, 9(3),* 498-510.

Sazgar, M., Carlen, P. & Wennberg, R. (2003). Panic attack semiology in right temporal lobe epilepsy. *Epileptic Disorders, 5(2),* 93-100.

Schachter, S. & Singer, J. (1962). Cognitive, social, and physiological determinants of emotional states. *Psychological Review, 69,* 379-399.

Sengoku, A., Toichi, M. & Murai, T. (1997). Dreamy states and psychoses in temporal lobe epilepsy: mediating role of affect. *Psychiatry and Clinical Neuroscience, 51(1),* 23-6.

Shneker, B. & Fountain, N. (2003). Epilepsy. *Disease-a-Month, 49(7),* 426-478.

Sierra, M. & Berrios, G.E. (1998). Depersonalization: neurobiological perspectives. *Biological Psychiatry, 44,* 898-908.

Silberman, E., Post, R., Nurnberger, J., Theodore, W. & Boulenger, J. (1985). Transient sensory, cognitive and affective phenomena in affective illness. A comparison with complex partial epilepsy. *The British Journal of Psychiatry, 146,* 81-89.

Silberman, E., Sussman, N., Skillings, G. & Callanan, M. (1994). Aura phenomena and psychopathology: a pilot investigation. *Epilepsia, 35(4),* 778-84.

Sirven, J. (2002). Classifying seizures and epilepsy: A synopsis. *Seminars in Neurology, 22(3),* 237-246.

Spiers, P., Schomer, D., Blume, H. & Hochandel, G. (1992). The behavioral alterations in temporolimbic epilepsy. In T. Bennett (Ed.), *The Neuropsychology of Epilepsy* (pp. 97-138). NY: Raven Press.

Swanson, S., Grafman, J., Salazar, A. & Kraft, J. (1995). The relationship between seizure subtype and interictal personality. Results from the Vietnam Head Injury Study. *Brain, 118(pt1),* 91-103.

Timbrook, R. & Graham, J. (1994). Ethnic differences on the MMPI-2? *Psychological Assessment, 6,* 212-217.

Trimble, M. & Freeman, A. (2006). An investigation of religiosity and the Gastaut-Geschwind syndrome in patients with temporal lobe epilepsy. *Epilepsy & Behavior, 9,* 407-414.

Tucker, D., Novelly, R. & Walker, P. (1987). Hyperreligiosity in temporal lobe epilepsy: redefining the relationship. *Journal of Nervous and Mental Disease, 175(3),* 181-184.

Upton, D. & Thompson, P. (1996). Epilepsy in the frontal lobes: neuropsychological characteristics. *Epilepsy Research, 23(2),* 169-177.

Waxman, S. & Geschwind, N. (1975). The interictal behavior syndrome of temporal lobe epilepsy. *Archives of General Psychiatry, 32,* 1580-1586.

Weinand, M., Labiner, D. & Ahern, G. (2001). Integration of perceptual and mnemonic dysfunction: sensory auras are associated with left hemispheric memory impairment. *Epilepsy & Behavior, 2,* 423-432.

Whitman, S., Hermann, B. & Gordon, A. (1984). Psychopathology in epilepsy: how great is the risk? *Biological Psychiatry, 19,* 213-237.

Williams, D. (1956). The structure of emotions reflected in epileptic experiences. *Brain, 79(1),* 29-67.

Williams, D., Gonzalez, H., Neighbors, H., Nesse, R., Abelson, J., Sweetman, J. et al. (2007). Prevalence and distribution of major depressive disorder in African Americans, Caribbean blacks, and non-Hispanic whites: results from the National Survey of American Life. *Archives of General Psychiatry, 64(3),* 305-315.

Willmore, L., Heilman, K., Fennell, E. & Pinnas, R. (1980). Effects of chronic seizures on religiosity. *Transactions of the American Neurological Association, 105,* 85-87.

World Health Organization (2005). Atlas: Epilepsy Care in the World. http://www.who.int/mental_health/neurology/epilepsy_atlas_introduction.pdf

Wuerfel, J., Krishnamoorthy, E., Brown, J., Lemieux, L., Koepp, M. Tebartz van Elst, L. et al. (2004). Religiosity is associated with hippocampal but not amygdala volumes in patients with refractory epilepsy. *Journal of Neurology Neurosurgery and Psychiatry, 74(4),* 640-642.