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Ictal Behaviors During Nonepileptic Seizures Differ in Patients with Temporal Lobe Interictal Epileptiform EEG Activity and Patients Without Interictal Epileptiform EEG Abnormalities

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Summary: *Purpose:* Ictal behaviors during psychogenic nonepileptic seizures (NES) vary considerably among individuals, and can closely resemble common semiologies of epileptic seizures (ES). We tested the hypothesis that behaviors during NES in patients who have temporal spikes would more closely resemble behaviors during ES in patients with temporal lobe epilepsy than would behaviors during NES in patients who do not have EEG spikes.

Methods: We identified 20 patients who had interictal temporal EEG spikes and EEG-video recorded NES (Study Group), 133 patients with temporal EEG spikes and recorded ES, without NES (Epileptic Group), and 24 patients with recorded NES and no epileptiform EEG abnormalities, without ES (Nonepileptic Group).

Results: The hypothesis was supported with regard to ictal motor behaviors. Motionless staring or complex automatisms occurred mainly during NES in the Study Group and during ES in the Epileptic Group. In contrast, convulsive movements or flaccid falls were most common during NES in the Nonepileptic Group. Duration of unresponsiveness was longer, and there were fewer postictal states in NES both in the Study and Nonepileptic Groups. Unresponsiveness was briefer and postictal states were more consistent in ES in the Epileptic Group, however.

Conclusions: Stereotyped motor activities during NES presumably represent learned behaviors. Processes underlying acquisition of ictal behaviors of NES probably differ in patients with interictal epileptiform EEG abnormalities compared to those without. Prior experiences and temporal lobe dysfunctions that are associated with epilepsy, and psychological characteristics that are unrelated to interictal epileptic dysfunctions, may determine ictal behaviors during NES. **Key Words:** Nonepileptic seizures—Temporal lobe epilepsy—Epileptiform EEG activity.

Epileptic and nonepileptic seizures often manifest similar ictal behaviors (1,2), although bizarre behaviors are more characteristic of psychogenic nonepileptic seizures (NES) than of epileptic seizures (ES). Some patients have both ES and NES (3–5), although most patients with seizures that cause global impairment of awareness have either ES or NES. Ictal recording with long-term EEG-video monitoring (LTM) is essential to exclude NES before epilepsy surgery; an important minority of patients have interictal epileptiform EEG abnormalities and have ES that are fully controlled with medications, but have ongoing NES that mimic ES in ictal behaviors reported by witnesses of the seizures (5). Stereotyped motor activities during psychogenic NES presumably represent learned behaviors. A patient who has temporal spikes on EEG is likely to have experienced complex partial seizures. Such a patient may well have experienced auras preceding complex partial seizures and probably has heard observers' reports of his or her own ictal behaviors during ES. Additionally, a patient with temporal spikes on EEG is likely to have undergone focused questioning by physicians with regard to occurrence of symptoms and behaviors typical of complex partial seizures. Such a patient might have NES with ictal behaviors that have been shaped by these prior experiences. Among patients with NES, cerebral dysfunctions and experiences may well differ between those with interictal temporal epileptiform activity and those without epileptiform EEG abnormalities. Different cerebral dysfunctions and experiences might be reflected in varying ictal behaviors of NES. We hypothesized that behaviors during NES of patients with temporal spikes would more closely resemble behaviors during complex partial seizures than do the NES of patients without interictal epileptiform abnormalities on EEG.

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METHODS

Subject selection

Patients in the Study, Epileptic Control, and Nonepileptic Control Groups were selected consecutively from all patients referred for treatment of medically refractory seizures at the University of Michigan from October 1988 through October 1992. Each patient, managed by his or her referring neurologist, had seizures that resisted control with multiple antiepileptic drugs (AEDs).

None of the referring neurologists suspected that their patients had NES. Each selected patient had the habitual seizures recorded on LTM at our institution, in evaluations for possible epilepsy surgery. None had been given an LTM before this evaluation. None of the patients was considered likely to have recurrent syncope, confusional migraine, or other nonepileptic events, which could be diagnosed by history alone. None of the patients showed evidence of syncope, paroxysmal movement disorders, parasomnias, or other nonpsychogenic (organic) NES during any events recorded on LTM.

Patients assigned to the Study Group met these criteria:

1. Medically refractory seizures for >one year.
2. Absence of moderate or severe encephalopathy on neurologic examination and of moderate or severe generalized slowing on interictal EEG.
3. Pathologic focal spikes or sharp waves with temporal maximum, and pathologic delta frequency, slowing with the same maximum as that of the epileptiform abnormality, on waking scalp EEG.
4. Absence of generalized or extratemporal-maximum focal epileptiform EEG abnormality.
5. Recorded NES (a) that were considered by the patient and the family members or other lay observers to represent the patient's habitual seizures, (b) that featured definite unresponsiveness during the event, (c) for which the patient was amnestic after regaining normal responsiveness following the event, and (d) during which the scalp EEG was well recorded and showed no change from baseline waking activities.

Patients assigned to the Epileptic Group met criteria 1, 2, 3, and 4, as described for the Study Group above. Inclusion in this group required that no NES were recorded during LTM. Additionally, inclusion in the epileptic control group required recording of complex partial or secondarily generalized seizures (a) that were considered by the patient and the family members or other lay observers to represent the patient's habitual seizures, (b) that featured definite unresponsiveness during the event, (c) for which the patient was amnestic after regaining normal responsiveness following the event, and (d) during which the scalp EEG showed ictal electrographic activities typical of complex partial seizures of temporal origin.

Patients assigned to the Nonepileptic Group met criteria 1, 2, 4, and 5, as described for the Study Group. Additionally, inclusion in the Nonepileptic Group required absence of interictal epileptiform EEG abnormality and absence of electrographic seizures during LTM.

Clinical neurologic evaluation

Each patient had a history taken and examination by the authors before LTM. Reports of ictal behaviors also were obtained from a lay observer of the patient's habitual seizures at this initial clinic visit. Seizures were considered habitual if they had occurred on more than five occasions and at least once within the month before evaluation. Each habitual seizure type had been witnessed by the available lay observer on at least one occasion. A comprehensive description of each reported seizure type was synthesized from all available history.

Each reported seizure type that involved unresponsiveness and impaired memory of ictal behaviors was included in this study. Each reported seizure type was characterized by (a) type of ictal motor activity (according to the lay observer), (b) duration of unresponsiveness (according to the lay observer), and (c) presence or absence of behavioral changes after responsiveness resumed (according to the patient or lay observer). Duration of unresponsiveness was classified as brief (estimated at <2 min), medium (2–30 min) or long (>30 min). Motor activities during the period of unresponsiveness were classified as: convulsive (widespread, repetitive, rapid flexion-extension, jerking or shaking movements); hypokinetic (motionless or nearly motionless staring with unchanging posture); hypotonic (sudden falls, or leaning limply onto a bed or other nearby support); automatistic (simple or complex movements that are asymmetric and nonconvulsive); or other (generalized symmetric hypertonia, or inability to classify the predominant motor pattern into one of the first four categories). (In this investigation the category denoted "other" was never required, either to classify lay observers' report of habitual seizures before LTM or to facilitate the investigators' description of seizures recorded with LTM.) If more than one type of behavior occurred, a seizure was categorized by the single predominant semiologic pattern.

Prior medical records were reviewed and each patient and lay observer was questioned about these possible epileptic predispositions and associations: prenatal or perinatal insult, febrile convulsion of infancy or early childhood, developmental delay, head injury of severity sufficient to cause brief or prolonged unconsciousness (or without unconsciousness but with vomiting or more than a day of loss of normal motor or cognitive activity,

when the insults occurred before five years of age), meningitis or encephalitis diagnosed with lumbar puncture, cerebral CT or MRI abnormality, stroke, or undiagnosed acute neurologic deficits, and family history of seizures. Only insults that occurred before onset of the patient's habitual seizures were considered in this study.

Interictal EEG and long-term EEG-videomonitoring

Interictal EEGs were recorded with 19 scalp electrodes in the International 10–20 system of placement, with two ear electrodes, and reviewed with multiple bipolar and referential montages. Interictal recordings included waking, drowsiness, and sleep, and lasted >1 h. Definite pathologic interictal epileptiform abnormalities with focal temporal maximum were required to be present during full waking, to have the same topographic field as polymorphic delta activity that was unassociated with the epileptiform activity, and to occur often enough to permit distinction from confluence of background activities. These criteria permitted distinction of temporal spikes from benign epileptiform transients of sleep, wicket spikes, and other sharply contoured temporal activity (6–8). The authors independently interpreted all epochs of interictal EEG that were reported. There was no disagreement as to presence or absence of pathologic interictal temporal epileptiform activity.

Ictal EEG recordings were performed with at least 16 scalp electrodes, excluding the three midline 10–20 system electrodes, displayed in an anteroposteriorly-oriented (''double banana'') bipolar montage. Most patients also had sphenoidal electrodes recorded for presurgical epilepsy evaluation. We considered only recorded seizures that featured definite ictal unresponsiveness and subsequent amnesia for the event, as well as technically adequate EEG recordings that were associated with technically adequate behavioral testing for distinction of ES and NES. Adequate behavioral testing required that a nurse, an EEG technologist or a lay companion, demonstrate unresponsiveness (by calling the patient's name and touching the patient), demonstrate amnesia for the event (by presenting a two-word phrase and touching the patient during unresponsiveness, and then asking the patient to recall both the phrase and which body part was touched, shortly after resolution of any postictal state) and to interact with the patient following resumption of partial or complete responsiveness. We diagnosed NES by absence of EEG change during unresponsiveness for a minimum of 10 s, without artifactual obscuration of cerebral activity, and with subsequent demonstration of amnesia for verbal and nonverbal stimuli that were presented during the period of unresponsiveness. We diagnosed ES by EEG changes of specific electrographic seizure patterns characteristic of partial seizures (9–11). The authors independently interpreted all epochs of ictal EEG and ictal videotaped behavior that were reported. There was no disagreement as to presence or absence of electrographic ictal discharges during behavioral seizures. One of the two interpreters considered some recorded events equivocal as to unresponsiveness or amnesia for the event; only events considered by both to feature definite unresponsiveness and amnesia were included in the study.

We used AED tapering and sleep deprivation to induce seizures. We did not use hypnosis, saline infusion, or other behavior interventions to induce psychogenic NES. During monitoring, nine of 20 Study Group patients were tapered off AEDs entirely. Each reported habitual seizure type was recorded during LTM for all of the patients in the Epileptic and Nonepileptic Groups. We stopped LTM when all habitual seizure types had been recorded, or after the longest reasonable duration of admission.

Other clinical and laboratory investigations

Neuropsychometric testing was not required for inclusion in these investigations. Nonetheless, all Study and Epileptic Group patients had received either the Wechsler Adult Intelligence Scale (WAIS) or Wechsler Adult Intelligence Scale-Revised (WAIS-R) test. Among Nonepileptic Group patients, 14 (58%) had intelligence quotient (IQ) testing. No other neuropsychometric test was universally included in test batteries administered to those patients who had neuropsychometric testing.

Cranial magnetic resonance imaging (MRI) had been obtained for all patients in the Study and Epileptic Groups, and for 20 (of 24) in the Nonepileptic Group. The other four Nonepileptic Group patients had cranial x-ray computed tomography (XCT) scans, which in each case was normal. Films were reviewed by the first author in all Study and Epileptic Group patients, and in 21 of the Nonepileptic Group patients. Neuroradiologists' reports were used when films were not available.

All of the patients in the Study and Nonepileptic Groups had clinical evaluations performed by a psychiatrist, a clinical psychologist, or a psychiatric social worker. These evaluations often were obtained because of diagnosis of NES with LTM, and were performed by many different clinicians at various institutions, due to variability in medical insurance coverage.

Statistical analysis

Comparisons of the frequency of occurrence of particular seizure types between different groups were tested for significance with the Chi-square test. An intrasubject comparison of seizure duration of NES and ES (in patients who had both NES and ES) was tested for significance with the Wilcoxon matched-pairs signed-ranks test.

RESULTS

General characteristics of subjects

Patient characteristics are summarized in Table 1 for each group. Neurologic examinations were normal for most patients, without considering the mental status examination. In the Study Group, patient 12 had severe Wernicke's aphasia and right faciosomatic spasticity and paresis, four other patients had mild unilateral upper motor neuron dysfunctions, and one had an hysteriform gait disturbance. In the Epileptic Group, 12 patients had mild unilateral upper motor neuron findings, eight had mild cerebellar dysfunction, and one had an hysteriform gait disturbance. In the Nonepileptic Group, two patients had somatic hypesthesia in nonanatomic distributions, and two had hysteriform gait disturbances. All subjects were alert and had normal forward and reverse digit spans. Approximately one-fourth of the patients in each group had mild or moderate difficulty in recalling three two-word phrases after five min, but all subjects recognized each phrase that was not recalled. All Study and Epileptic Group patients had full-scale Intelligence Quotient (FSIQ) >70. Among Nonepileptic Group patients, 14 (58%) had IQ testing and none had FSIQs <70.

Study Group patients were similar to Epileptic Group patients in the incidences of focal cerebral lesions on MRI and overall risk factors for epilepsy (Table 1). Study Group patients were intermediate between the Epileptic and Nonepileptic Groups in gender ratio, mean age at seizure onset, and mean duration of the seizure disorder, and the incidence of febrile convulsions of early childhood. The incidence of a history of significant head injury that preceded onset of seizures was nearly as great in the Nonepileptic Group as in the Study and Epileptic Groups.

Two patients in the Study Group had undergone anterior temporal lobectomy for treatment of medically refractory seizures at 10 and 8 years, respectively, prior to evaluation at the University of Michigan. Neither patient had received LTM before temporal lobectomy. Neuropathology reports indicated hippocampal sclerosis in patient four and no pathologic abnormality in patient 16.

Among the 20 patients in the Study Group, two (10%) had no reported psychopathology, 18 (90%) had depression considered to warrant therapy, five (25%) had anxiety considered to warrant therapy, five (25%) evidenced significant somatization, six (30%) reported childhood sexual abuse, and one had borderline personality disorder (5%); none was considered actively psychotic or suicidal. Among the 24 patients in the Nonepileptic Group, three (13%) had no reported psychopathology, 20 (83%) had depression considered to warrant therapy, five (21%) had anxiety considered to warrant therapy, five (21%) displayed significant somatization, six (25%) reported childhood sexual abuse, and one had antisocial personality disorder (4%); none was considered actively psychotic or suicidal. Psychiatric findings were similar in the Study and Nonepileptic Groups. Psychiatric findings were similar in patients with and patients without any of the particular (hypokinetic, automatistic, convulsive, or hypotonic) ictal behaviors.

Epileptic and nonepileptic seizures in the Study Group

Ten of the 20 Study Group patients had recorded ES, in addition to the recorded NES required by the selection criteria. The described seizure types are listed for the Study Group in Table 2, with notation as to whether each type represented an ES and or an NES. Two patients (nos. 1 and 4) had ES that did not represent their habitual seizures as described in history obtained before LTM (marked as "not described" in Table 2). Each of these ES featured motionless staring. In each case, the patient did not recognize that a seizure had occurred. Eighteen of 20 patients in the Study Group had each reported habitual seizure type recorded during LTM, but patients five and 18 each had one reported seizure type that was not adequately recorded during LTM (Table 2).

The period of unresponsiveness during NES often was

TABLE 1. *Group characteristics*

	Female-male ratio	Mean age at seizure onset[a]	Mean duration of seizure disorder[b]	Mean (range) number of AEDs used over time	Percentage with febrile convulsions	Percentage with head injury	Percentage with focal cerebral MRI or XCT Abnormality	Percentage with no identified epileptic predisposition
Study Group (n = 20)	13:7 (1.9)	18 yrs	11 yrs	3.9 (2–7)	15%	30%	50%	15%
Epileptic Group (n = 133)	62:71 (0.87)	11 yrs	19 yrs	4.2 (3–8)	41%	30%	52%	11%
Nonepileptic Group (n = 24)	19:5 (3.8)	23 yrs	4 yrs	2.3 (2–4)	4%	21%	4%	63%

[a] Age at seizure onset is based on habitual seizures occurring at the time of diagnosis (excluding seizure types that ceased before LTM). Age at onset is determined by the earliest habitual seizure type for patients with multiple types of habitual seizures.

[b] Duration of seizure disorder was calculated by subtracting the age at seizure onset from the age at LTM.

AEDs, antiepileptic drugs; MRI, magnetic resonance imaging; XCT, X-ray computed tomography.

TABLE 2. *Ictal semiology in study group*

Event[a]	LTM[b]	Described ictal behavior[c]	Recorded ictal behavior[c]	Described duration[d]	Recorded durations[d]	Described postictal state[c]	Recorded postictal state[c]
1a	NES	A	A	Brief	740 s	No	No
1b	ES	[n.d.]	A	[n.d.]	60 s	[n.d.]	Yes
2a	NES	M	M	Brief	40 s	Yes	No
2b	ES	A	A	Brief	70 s	Yes	Yes
3a	NES	A	A	Brief	360 s	Yes	No
3b	ES	A	A	Brief	50 s	Yes	Yes
4a	NES	A	A	Brief	150 s	Yes	Variable
4b	ES	[n.d.]	M	[n.d.]	40 s	[n.d.]	Yes
5a	[n.r.]	C	[n.r.]	Brief	[n.r.]	No	[n.r.]
5b	NES	M	M	Brief	435 s	No	No
5c	ES	A	A	Brief	60 s	No	Yes
6a	NES	A	A	Brief	90 s	Yes	Variable
6b	ES	A	A	Brief	50 s	Yes	Yes
7a	ES	C	C	Brief	60 s	Yes	Yes
7b	NES	A	A	Brief	270 s	Variable	No
8a	NES	A	A	Brief	360 s	No	No
8b	ES	A	A	Brief	45 s	Yes	Yes
9a	ES	A	A	Brief	50 s	Yes	Yes
9b	NES	A	A	Brief	110 s	Yes	Variable
10a	ES	M	M	Brief	15 s	No	Yes
10b	NES	A	A	Brief	120 s	No	No
11a	NES	C	C	Brief	480 s	Yes	Yes
11b	NES	A	A	Brief	560 s	Yes	Yes
12a	NES	A	A	Medium	150 s	Yes	Yes
13a	NES	A	A	Brief	1200s	Yes	Yes
14a	NES	A	A	Brief	120 s	Yes	Yes
14b	NES	A	A	Long	960 s	Yes	Yes
15a	NES	M	M	Brief	100 s	No	No
15b	NES	A	A	Brief	190 s	No	No
16a	NES	M	M	Brief	50 s	Yes	No
16b	NES	A	A	Brief	60 s	Yes	Yes
17a	NES	M	M	Brief	90 s	Yes	No
17b	NES	A	A	Brief	780 s	Yes	Variable
18a	NES	M	M	Brief	160 s	Yes	Yes
18b	NES	A	A	Brief	300 s	Yes	Yes
18c	[n.r.]	A	[n.r.]	Medium	[n.r.]	Yes	[n.r.]
19a	NES	A	A	Brief	1260s	Yes	Yes
20a	NES	C	C	Brief	900 s	Yes	Yes
20b	NES	A	A	Brief	120 s	Yes	Yes
20c	NES	M	M	Brief	30 s	Yes	Yes

NES, Nonepileptic seizures; ES, epileptic seizures; n.d., not described; A, automatistic; C, Convulsive; N, hypotonic; M, Motionless (hypokinetic); n.r., none recorded during LTM.

[a] Each patient's seizure types are designated with the patient's study number followed by a letter. Seizure types were determined primarily with patient descriptions (See Methods).

[b] Diagnosis as ES (epileptic seizure) or NES (nonepileptic seizure) by LTM. Patients 1 and 4 each had motionless staring unresponsiveness during an epileptic seizure recorded on LTM, but neither patient was reported to have such seizures before LTM; these evens are listed as [n.d.] (not described).

[c] These columns contain summary information derived from detailed descriptions of each type of event that was described by the patient and nonprofessional witnesses of the patient's seizures ("Described Ictal Behavior" and "Described Postictal State") or from detailed observations of each type of event that was recorded during LTM (Recorded Ictal Behavior and Recorded Postictal State). Postictal states were noted to be present, absent or variably present or absent for each type of event.

[d] Duration is defined as the period of unresponsiveness. When more than one event of a particular type was recorded on LTM, the mean duration of the events is presented.

much longer than that for the ES recorded in the study and supplementary groups (Table 2). Ten patients each had one type of ES and one type of NES recorded on LTM (Table 2). Thus, each of these 10 pairs of recorded NES and ES was produced by one patient. The greater duration of NES in these patients was significant at $p < 0.01$ (Wilcoxon test). Some NES were quite brief, however. In one patient, NES averaged only 30 s in duration. Approximately one-quarter of the NES lasted ≤2 min, placing their duration within the range of unresponsive periods of the ES, while approximately half of the NES demonstrated unresponsiveness for >4 min. The lay observers reported durations of ictal unresponsiveness that often were discordant with recorded ictal behaviors during LTM (Table 2), with a tendency by the lay observers to underestimate the duration of NES.

The bizarre aspects of ictal behaviors were not used to distinguish ES and NES (see definitions of ES and NES

above). Many NES featured behaviors that seemed bizarre to the investigators, but often the lay observers did not consider these to be bizarre. On the other hand, ictal automatisms that appeared typical of ES to the investigators sometimes were reported to be bizarre by the lay observers. Overall agreement, however, was excellent between the lay observers' reports and the investigators' observations concerning the general types of ictal behaviors (Table 2).

Postictal behavioral dysfunction was observed on videorecordings following all ES in Study Group patients. Among 28 recorded types of NES in these 20 patients, 13 types were always followed by postictal behavioral changes, 11 types were always followed by immediate resumption of baseline alert behavior (i.e., no postictal changes), and four types varied on different occasions with regard to presence or absence of postictal changes. Lay observers' reports of postictal behavioral changes often were discordant with postictal behaviors as recorded on LTM (Table 2). Among the 10 patients who each had one recorded type of ES and 1 recorded type of NES, all ES consistently had postictal behavioral changes and all NES sometimes or always lacked postictal behavioral changes.

Comparison of Ictal Behaviors in the Study, Epileptic and Nonepileptic Groups

The distribution of general types of ictal behaviors were similar for ES and NES in the Study Group and ES in the Epileptic Group (Table 3). Hypokinetic and automatistic events predominated, convulsive events were often recorded, and hypotonic events did not occur. All ES in the Study and Epileptic Groups were followed by postictal states.

The distribution of general types of ictal behaviors was grossly different for NES in the Study Group versus those of NES in the Nonepileptic Group (Table 3). Fully one-half of NES in the Nonepileptic Group featured generalized convulsive movements. These events had always been described by lay observers in a fashion entirely consistent with epileptic generalized tonic-clonic seizures, but the electroencephalographers reviewing these events on LTM consistently noted movements that were uncharacteristic of epileptic convulsions. These nonepileptic convulsions often featured jerking that waxed and waned in amplitude, with more than one cycle of jerking during a single period of continuous unresponsiveness. Additionally, one quarter of NES in the Nonepileptic Group had hypotonic behaviors which featured falls or gradual postural declines to limp unresponsiveness, in some cases with arm movements that appeared protective. Such ictal behaviors were not observed during NES or ES of the Study or Epileptic Groups. Motionless or nearly motionless staring only once occurred among NES of the Nonepileptic Group, but was very common in NES of the Study Group. The tendency for patients in the Nonepileptic Group to have hyptonic NES and for patients in the Study Group not to have hypotonic NES was significant (Chi square of 3.86, $p < 0.05$). The tendency for patients in the Nonepileptic Group to have convulsive or hypotonic NES and for patients in the Study Group not to have these types of NES also was significant (Chi square of 12.24, $p < 0.001$).

On the other hand, the duration of unresponsiveness during NES in the Study Group was highly similar to that during NES in the Nonepileptic Group. The mean duration of unresponsiveness during each patient's NES averaged 6.1 min in the Study Group and 7.3 min in the Nonepileptic Group. The duration of unresponsiveness during NES was highly variable in both of these groups. Unresponsiveness lasted ≤2 min during all habitual seizures that were ES in the Study and Epileptic Groups. (Three patients in the Epileptic Group had episodes of complex partial status epilepticus >30 min, which occurred after complete AED discontinuation. These episodes were behaviorally quite different from any events reported to occur habitually.) The association of unresponsiveness lasting ≥2 min with NES in the Study Group versus unresponsiveness for <2 min with ES in the Epileptic Group was significant (Chi square of 127.32, $p < 0.001$).

The presence or absence of postictal states also was quite similar for NES in the Study Group and NES in the Nonepileptic Group. Among 28 recorded types of NES in the 24 Nonepileptic Group patients, 11 types were always followed by postictal behavioral changes, 12 types were always followed by immediate resumption of baseline alert behavior (i.e., no postictal changes), and five types varied on different occasions with regard to presence or absence of postictal changes. All recorded ES in the Study and Epileptic Groups were associated

TABLE 3. *Recorded ictal behaviors during seizures in the Study and Control Groups*[a]

	Hypokinetic	Automatistic	Convulsive	Hypotonic
Nonepileptic seizures of Nonepileptic Group (n = 24)	1 (4%)	8 (33%)	13 (54%)	6 (25%)
Nonepileptic seizures of Study Group (n = 20)	7 (35%)	19 (95%)	2 (10%)	0
Epileptic seizures of Study Group (n = 20)	2 (10%)	7 (35%)	1 (5%)	0
Epileptic seizures of Epileptic Group (n = 133)	25 (19%)	126 (95%)	19 (14%)	0

[a] Numbers (percent figures) in each column indicate the number (percent) of patients in each group that had EEG-videorecorded seizures of that type.

with postictal states. The association of variable or no postictal states with NES in the Study Group versus postictal states with ES in the Epileptic Group was significant (Chi square of 91.03, $p < 0.001$).

Thus, types of ictal behaviors during NES of the Study Group were similar to those of the ES of the Study and Epileptic Groups, but significantly different from those of NES in the Nonepileptic Group. Duration of unresponsiveness and presence or absence of postictal states were similar for NES in the Study Group and NES in the Nonepileptic Group, but were dissimilar from these aspects of ES in the Epileptic Group.

DISCUSSION

Our observations indicate significant differences in motor behaviors of NES in two distinct patient groups, one (the Study Group) with temporal spikes on interictal EEG and the other (the Nonepileptic Group) with no epileptiform abnormalities on interictal EEG. Pathologic temporal spikes on interictal EEG are highly associated with clinical epilepsy. The Study Group probably represents patients with temporal lobe epilepsy who had experienced both ES and psychogenic NES. Although only 10 of the 20 Study Group patients actually had ES recorded during LTM, it is likely that most or all of the other Study Group patients would have demonstrated ES if LTM had continued longer. In each case in which both ES and NES were recorded, the NES occurred earlier during LTM than did the ES. Recorded ES and NES in Study Group patients and recorded ES in Epileptic Group patients usually showed motionless staring or automatisms during periods of unresponsiveness. By contrast, NES in the Nonepileptic Group patients usually demonstrated generalized convulsions or flaccid falls during unresponsiveness. The NES in the Study Group were quite similar to the NES in the Nonepileptic Group with regard to their durations of unresponsiveness and presence or absence of postictal states.

Prior studies have described ictal behaviors and durations of NES in some detail. Duration of NES typically are greater than those for ES durations, although some NES are as brief as ES, in our series and in prior reports (12–16). Types of ictal behaviors during NES are quite variable in these reports. Meierkord and colleagues divided NES behaviors into "attacks of collapse," which are equivalent to our hypotonic NES, and "attacks with prominent motor activity" (14), which are similar to our automatistic and convulsive NES combined. Approximately one-third of their patients and 25% of our Nonepileptic Group patients had hypotonic ictal behaviors, and two-thirds of their patients and 87% of ours had automatistic or convulsive behaviors; they had no patients who stared motionlessly during NES and only one of our Nonepileptic Group patients had this pattern. Motionless unresponsiveness was the most common and hypotonia the second most common NES behavior in one series (17), but these behaviors rarely occurred in other series (15,16,18–20). Diagnosis of NES required unresponsiveness, among other criteria, both in our study and in that of Meierkord (14). Diagnosis of NES required bizarre ictal behaviors and absence of EEG change, with or without unresponsiveness, in other series (15–20). We suspect that much of this variability in reported NES behaviors is due to differences in the patient populations from which the patients were drawn, and to differences in the definition of NES.

In this investigation, we did not induce NES with hypnosis, saline infusion, or other psychologic interventions. Induction of NES may significantly shorten the duration and decrease the expense of LTM (21–23). Atypical events may be induced which do not represent the patient's habitual seizures. It is essential to obtain a detailed description of an individual's habitual seizures before LTM, so that recorded ictal semiology can be compared as objectively as possible with previously acquired descriptions of habitual seizures, whether NES occur spontaneously or with induction. In some cases, patients may have difficulty in accurately comparing habitual seizures with recorded events. Psychologic induction might alter subtle details of ictal behaviors, the duration of unresponsiveness, or the occurrence of postictal states, as compared with spontaneous occurrence of NES. The conclusions of this study are probably stronger because NES were not psychologically induced in our patients.

Reasons for the differences in ictal behaviors during NES in our Study and Nonepileptic Groups are unclear. If these behaviors are learned, the possible determinants of such behaviors might arise from a variety of earlier experiences, including stimuli associated with occurrence of epileptic seizures and with comments made by witnesses of an epileptic seizure after the event, with the interictal state of localization-related epilepsy, and with the questions and comments of physicians (which are likely to be different in the presence versus the absence of interictal EEG spikes). Such learning might be strongly influenced by cognitive and psychologic dysfunction, both in the types of learning that can occur and in experiences in the psychosocial environment. The incidences of particular psychopathologies were similar in our Study Group and in Nonepileptic Group patients. We did not observe associations of particular psychopathologic characteristics with particular ictal behaviors during NES, but the frequencies of particular psychopathologies and the types of psychiatric data in our study were not optimal for detecting such associations. The relatively high incidences of concussive head injury in our Study Group and Nonepileptic Group patients, and the observations of others (24,25), suggest that chronic sequelae of head injury may predispose to NES. Our

Study Group patients frequently revealed a history of febrile convulsions during infancy, which often are associated with hippocampal sclerosis in patients with temporal spikes (26), and frequently had focal temporal lobe MRI abnormality. Thus, prior experiences, psychologic characteristics, and cerebral function, can be abnormal in patients with NES, and factors in any of these areas may influence the types of ictal behaviors that are manifested during NES. Further studies will be required to elucidate the specific bases of different types of ictal behaviors during NES.

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