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Ictal Pleasant Sensations: Cerebral Localization and Lateralization

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Summary: Ictal pleasant feelings are a rare sign of focal epilepsies. The most popular description was performed by Dostojevskij, who reported an aura by Myshken in one of his books. No convincing evidence has been published concerning the cerebral localization of ictal happiness. In this study, the findings of 11 patients with ictal pleasant feelings are described. In eight patients, the origin of the focal epileptic activity was found in the temporal lobe (most often temporal inferior basal); in three patients, frontal or parietal lobe in addition to temporal lobe involvement was found. According to our findings ictal happiness is a localizing sign pointing to the ictal involvement of temporal mesiobasal areas. Lateralization to the right temporal lobe was found in seven and to the left temporal lobe in four patients.
Key Words: Focal epilepsy—Ictal happiness—Mirth—Pleasant ictal feeling—Temporal lobe epilepsy—Localization—Psychic auras.

Reports on ictal pleasant feelings are rare. Most famous is a description of auras from Myshken (1). and Kirillof (2). Myshken experienced during this aura a higher dimension of human being with an "extreme consciousness," highest harmony and beauty, deepest feelings of happiness, and exaltation. Kirillof was sent into ecstasy. Jackson (3) recognized that changes of emotion of fear or even happiness may be related to pathophysiologic changes of affect during a seizure. It was emphasized that pleasant feelings during an epileptic aura may be more often experienced than reported by the patients. Janz (4) also described a patient who had posttraumatic epilepsy. During seizure onset, the patient recognized music increasing intensely and later amalgamated with a peculiar feeling of happiness and satisfaction.

Jackson and Stewart (5) commented on the replacement of pleasurable auras by depression. Wilson (6) referred to three patients who were subject to affective seizures. The first patient described her attacks as a "dream of delight." The second patient said, "I felt that I had been away somewhere in a pleasant dream, which I was enjoying to the full." It is of interest that this patient later had this pleasurable aura replaced by attacks beginning with a feeling of dread or apprehension, thus confirming Jackson's comments on the sequential alterations of affect. Lennox and Cobb (7) noted unpleasant aurae in 5.5% of their patients and pleasant sensations in 1.2%. No definite proof has been found of a possible cerebral localization of ictal happiness, although in single cases, a tumor or EEG abnormalities were found in the temporal lobe (8–11). Presurgical evaluation for epilepsy surgery now offers optimal conditions for the localization of focal epileptic activity and the correlation to behavioral changes including psychic or autonomic ictal signs (12).

Because systematic studies concerning the multimethodologic localization of epileptogenic areas in patients with these auras have not been performed, further studies on other such patients are needed. We collected our patients and analyzed the results of the localization procedures.

METHODS

From our presurgical evaluation data-file documentation (1990–2003), we analyzed 549 patients (302 men, 247 women; age range, 17–62 years; mean, 33 years). Temporal lobe epilepsies were diagnosed in 83% and extratemporal lobe epilepsies in 17%. Findings of 11 patients with ictal pleasant feelings are reported in detail. For the selection of the final 11 patients, only those were considered who had a unifocal pharmacoresistant epilepsy and patient report of ictal happiness. Two patients with ictal myrth and laughter were excluded because this is known as a distinct clinical entity. The patients must have had sufficient evidence of concordant findings of localization

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including interictal and ictal EEG, imaging, etiology, and surgical outcome.

These 11 patients had pharmacoresistant focal epilepsies and were considered possible candidates for epilepsy surgery. Video-EEG long-term monitoring was performed with 32-channel scalp EEG (Glonner neurosys, Munich, Germany) by day and by night (average 7 days), and in six cases before surgery, invasive recordings. Neuroimaging was performed with magnetic resonance imaging (MRI; 11 cases) and single-photon emission computed tomography/positron emission tomography (SPECT/PET; nine cases). Intraoperative electrocorticography was recorded

TABLE 1. *Clinical findings*

No.	Male	Female	Age (yr)	Emotional component	Initial accompanied signs	Etiology	Outcome Engel	Surgical approach
1	+		26	Feeling of happiness 10 S; otherwise depressed	1. Pleasant feeling in head; intimacy feeling 2. Staring gaze	Astrocytoma	Ia	TR H: 30, Gm: 75 Gi: 75, Gs: 60
2	+		56	Pleasant feeling like orgasm	1. Unpleasant smell 2. Hot pleasant feeling in head arising 3. Staring gaze, swallowing	HS	Ic	SR H: 22, Gi: 55 Gm: 55, Gs: 30
3		+	29	Positive; feels like orgasm followed by fear	1. Strange feeling with lightly dozy; feeling of pleasant security "like orgasm" 2. Seeing of letters and signs; after that, fear 3. Loss of consciousness, oral automatism	Oligodendroglio-magyrus occipi-totemporalis left	Ia	TR H: 0 Gi: 35
4	+		36	Pleasant feeling, lucky; interictal depressive	1. Strange, pleasant, rising feeling, mainly by coldness or fever 2. Clouding of consciousness with staring gaze, chewing movement	HS	No surgery	
5	+		36	Pleasant feeling like orgasm	1. By eating of sharp spices and sauces; orgasm-like feeling with prickling in the perineum 2. Loss of consciousness with staring gaze; right arm is rubbing on left arm; ictal speech	HS	Ia	TR H: 25 Gi: 65 Gm: 60
6		+	43	1. Euphoria, safe feeling, flying 2. Fear, cold shiver, depressive	1. Pleasant feeling 2. Staring gaze 3. Oral automatism	Parietal atrophy, bilateral	Ia	TR H: 20, Gi: 65 Gm: 65, Gs: 0
7		+	56	Pleasant feeling in head followed by depression	1. From chest; rising pleasant feeling in head 2. Staring gaze and pain 3. Automatism and postictal aphasia	Cavernoma, temporomesial left	III	SAH H: 10
8	+		60	Pleasant feeling arising from stomach	1. From stomach; in head, rising pleasant feeling 2. Visual field is changing; contortion of face 3. Déja vu experiences, staring gaze, oral automatism	Ganglioglioma, parahippocam-pal + mesial right	Ia	TR H: 25 Gi: 50 Gm: 50 Gs: 25
9		+	58	Happy; otherwise depressive	Dizzy and hot feeling in head with pleasant feeling	Gliosis, temporal right	Ia	SR H: 25, Gi: 62 Gm: 50, Gs:45
10	+		42	Pleasant feeling; interictal depressive	1. Hearing slightly and feels euphoria 2. Staring gaze, oral automatism	Astrocytoma, temporal left	Ia	TR H: 25, Gi: 40 Gm: 40
11	+		36	Pleasant feeling	Epigastric	DNET, temporal right	Ia	TR H: 30, Gi: 75 Gm: 70, Gs: 60

HS, hippocampus sclerosis; TR, tailored resection; SR, standard resection; SAH, selective amygdalohippocampectomy; H, hippocampus; resection [mm]; Gi, gyrus temporalis inferior resection [mm]; Gm, gyrus temporalis medialis resection [mm]; Gs, gyrus temporalis superior resection [mm].

from hippocampus, temporomesiobasal and neocortical areas (gyrus-temporalis superior, medius inferior) in all but one operated-on patients. After surgery, postoperative seizure control was assessed with the Engel outcome scale (13).

All patients were investigated by a standard neuropsychological test battery including an interview concerning experiences and changes of mood. During the preoperative evaluation, in addition to video-EEG long-term monitoring, MRI, SPECT, or PET, and if necessary, the sodium amytal test were performed. Speech lateralization was performed by functional MRI (fMRI) in case 11 (14). The resected brain tissue was examined with histopathologic investigations.

RESULTS

Of 549 patients investigated during the presurgical evaluation for epilepsy surgery, 11 patients were identified as experiencing ictal pleasant feelings (2%). The clinical data are presented in Tables 1 and 2.

The focal epileptic activity of all patients showed involvement of temporal lobe regions. Most of the detected lesions (hippocampal atrophy, five cases; tumors, four cases; cavernomas, two cases) were located in the hippocampal and/or temporal inferior basal areas. In seven patients, the lesion involved hippocampal regions. SPECT or PET showed a change in metabolism or perfusion in all cases within the temporal lobe and in three (cases 2, 3, and 6), temporal and extratemporal parietal. In three (cases 4, 6, and 9) ictal hypoperfusion was shown at the temporal lobe. Invasive electrophysiologic preoperative or intraoperative investigations delineated the most prominent focal epileptic activity in the hippocampal, parahippocampal, and temporal inferior and basal regions (Fig. 1). No clear predominance of left or right foci was seen (seven cases, right, vs. four cases, left). In addition to initial feelings during the seizures of pleasure, happiness, or mirth, postictal depression occurred in three (patients 6, 7, and 9), and in one case, initial fear was followed by pleasant feelings (case 2). The sodium amytal test was performed in seven cases. In all investigated patients, language dominance was found in the left hemisphere; in one patient (case 6), bilateral left more than right. Neuropsychological testing indicated deficits in the temporal lobe in eight patients.

DISCUSSION

The results of our multimethodologic localization in patients with ictal pleasant feelings point to the temporal lobe. The temporal inferior basal region especially was involved in the focal epileptic activity. Most often the temporal lobe was the seizure-onset region. In a few cases, primary extratemporal excitation and spread to the temporal lobe was possible. Because not all patients have been operated on (two patients had only noninvasive recordings, and one had no surgery), the final decision concerning the ictal-onset region and secondary propagated areas cannot be made in these cases. Ictal happiness is not constantly present during the seizures and is most often reported by the patients only in the case history. Auras are rarely documented during video-EEG monitoring. Sufficient evidence exists that the seizure-onset zone in the patients who reported ictal happiness during seizures is temporal. This also could be shown by invasive recordings, even if ictal happiness is not a constant feature. Ictal happiness also may be related to the involvement to additional symptomatic zones. Our data show that the epileptogenic zone in these patients is predominantly temporobasal (Fig. 1A).

TABLE 2. *Localization findings*

No.	EEG: Interictal/ Ictal	Invasive	MRI	SPECT/PET	Neuropsychology/ Sodium amytal test
1	Temporal right	Hi + Tb	Tumor Hi + parahippocampus R	Temporal mes. right ↓	SD L deficit: R temp. mes.
2	Temporal right	Hi + Tb	Hippocampal atrophy R	Temporal + parietal right ↓	SD L deficit: R temp. mes.
3	Temporal posterior left	Gyrus temp. inf + med occipitotemporalis left	Gyrus occipitotemp. left, lesion L	Temporal + parietal right ↓	SD L no deficit: temp. mes.
4	Temporal left	–	Hippocampal atrophy L	Temporal left↑	SD L no deficit: temp. mes.
5	Temporal right	Tb + amygdala right	Hippocampal atrophy R	Temporal pol + basal 1 > l ↓	SD L deficit: R temp. mes
6	Temporal anterior right	Tb + propagation to parietal right	Atrophy parietal R	Temporal + parietal right ↑	SD L deficit: R temp. mes.
7	Temporal left	Tb	Temporomes. left, lesion L	Temporal left ↓	SD L deficit: R temp. mes. + L neocortical
8	Temporal right	Hi + Tb	Parahippocampal lesion R	Temporal mes. right ↑	SD L no deficit: temp. mes., low intellegence
9	Temporal dorsal right → frontal	Tb	Temporal R	Temporal right ↑	SD L deficit: R temp. mes.
10	Temporal mesial left	Tb	Temporal tumor L	Temporal inferior left ↓	SD L deficit L temp. mes.
11	Temporal mes. right	–	Temporal lateral-basal R	–	SD L deficit: bilateral temp. mes.

↑, Hyperperfusion; Tb, temporobasal; ↓, hypoperfusion as hypometabolism; Hi, hippocampus; SD, speech dominance; L, left; R, right.

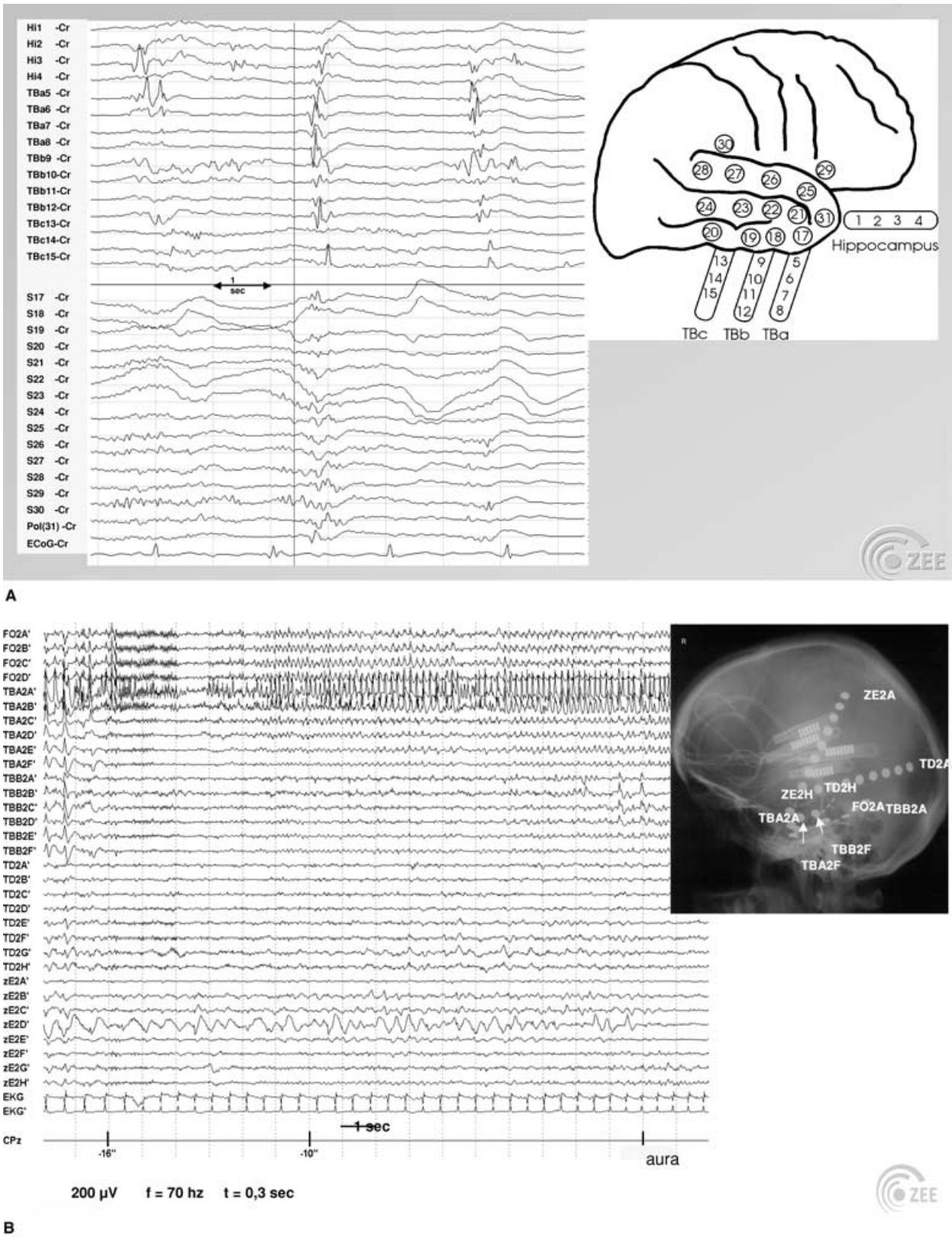

FIG. 1. **A**: Intraoperative electrocorticography (ECoG). Hi, Hippocampus; TBa, temporobasal anterior; TBb, temporobasal medial; TBc, temporobasal posterior; focal epileptic (spike) activity, temporobasal and gyrus temporalis inferior (TBa 6, 7, 8, 12, and later in the hippocampus area). Electrode TBa 8 records from gyrus temporalis inferior. The focal epileptic activity involves temporal basal and neocortical inferior areas (case 2). **B:** Ictal invasive recording seizure onset temporobasal mesial. Fo, foramen ovale electrode; Tb, temporobasal electrode. Ictal invasive recording with electrographic onset temporobasal TBA2/TBB2.

This also is demonstrated by invasive ictal recordings of these patients, of which an example is shown in Fig. 1B.

Often during auras, several sensations can be combined with changes of mood and cognition. Because auras may provide important information for a clinical localization hypothesis of the brain region involved at seizure onset, a dynamic analysis of the succession of the subjective experiences during an aura was performed. The dynamic analysis of the aura characteristics and the following ictal signs was analyzed according to a nucleus shell structure model (15). The change of perception and affect was described as pleasant feeling, a condition of higher harmony, clarity, satisfaction, or euphoria. In no patient was postictal happiness observed. In three patients, pleasant sexual ictal manifestations were reported, whereas unpleasant or neutral sensations in the genitalia were observed during discharges of the postcentral gyrus or the perisylvian region (16,17). Erotically pleasurable, sexual, or orgasm sensations in women were located in the limbic portion of the temporal lobe (18). Cognitive and affective modality–specific processing of humor is expressed in medial ventral prefrontal cortex and in the middle and inferior temporal gyrus (19). The combination with other ictal signs (epigastric aura, déja vu, stare gaze, oral automatism, dystonic posturing) provided information for localization hypotheses in the temporal lobe. The results of the other multimethodologic localizations in our patients with ictal pleasant feelings pointed to the temporal lobe. In all cases, interictal and ictal epileptic activity was found in the temporal lobe, and the temporal lobe was the seizure-onset region (Table 2). Nine patients were investigated by means of scalp and invasive EEG recordings, and two patients only by means of scalp EEG. In one of these patients (case 4), MRI showed hippocampal atrophy, ictal SPECT hypoperfusion temporal and video-EEG-recording interictal and ictal focal epileptic activity temporal left. In the other patient (case 11) a dysembryoplastic neuroepithelial tumor (DNET) was found in the temporolaterobasal region. In three patients, a hypoperfusion in SPECT was found in the temporoparietal area (cases 2, 3, and 6). In these cases, the focal epileptic activity can be located in posterior parts of the temporal lobe or even extratemporally. We had no evidence for secondary propagation to the temporal lobe. Intraoperative electrocorticography in eight patients showed a predominance of focal interictal activity in the basal parts of the temporal lobe (cases 1–3, 5, and 7–10). Electrical stimulation of the human amygdala has been reported to produce mirth, fear, déja vu, and hallucinatory experiences as well as changes in autonomic functioning (20–22). According to Gloor (23), the amygdala represents the key structure in the expression and acquisition of conditioned fear. It contributes emotional aspects to cognitive functions of attention, memory, and perception. Mood disorders are more common in temporal lobe epilepsies, and their presence may be related to impairment involving mesial temporal limbic structures. In particular, the hippocampus and amygdala as well as the orbitofrontal cortex are involved in emotional responses. Wherever the amygdala is more engaged, in cases of danger and threat, the orbitofrontal cortex obviously is less specific. Markowitsch (24) discussed the possibility of an emotional lateralization. The left hemisphere might be responsible especially for positive emotions like "lucky" feelings. Halgren et al. (21) concluded that the occurrence of mental phenomena was more dependent on patients' specific characteristics than on the exact side of stimulation. Gloor et al. (22) emphasized that electrical stimulation studies demonstrate that identical responses often can be elicited in the same individual from multiple medial and lateral cortex locations. They explained these observations by the activation of diffuse neuron matrices rather than a discrete anatomic focus. Concerning pleasant feelings, Arroyo et al. (25) suggested that the emotional content of laughter may be represented in the basal temporal area (fusiform gyrus and/or parahippocampal gyrus). Satow (26) reported findings of electrical cortical stimulation applied to the inferior temporal gyrus producing mirth. These findings are congruent with the findings of our localizations of epileptogenic lesions, interictal irritative, and seizure-onset regions. In our patients, no feeling of mirth and laughter occurred. Therefore "auras of luck" are different from gelastic seizures. Because a close relation of the localization of epileptogenic lesions and electrophysiologic localizations were found in patients with auras (27), it is considered that the temporal inferior basal-mesial area is involved in ictal pleasant changes of affect, regardless of gender and hemispheric lateralization. Lesionectomy of temporolateral and basal areas, sparing hippocampus and amygdala (case 11), controlled ictal pleasant feelings. A mood-related network system may be triggered also by extratemporal (frontoparietal) propagation. Dostojevskij himself had epilepsy. Obviously he expressed, through the reports of Myshkin and Kirillof, his ictal emotional sensations. The fact that Dostojevskij also reported epigastric auras, in addition to pleasant ictal sensations and memory deficits, strongly indicates that he had temporal lobe epilepsy.

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