

Epilepsy and emotion

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Abstract

The introductory comments discuss some conceptual and methodological problems related to the investigation of emotions and the pathogenesis and characteristics of behavioral changes in patients with epilepsy. Some of our own studies illustrate clinical and experimental approaches to the investigation of the anatomo-functional relations of emotional processes. The two studies reported examine the anatomical correlates of rare behavioral alterations we observed in patients with focal lesions. We found that both, the drawing of a smiling face instead of three dots, as well as the sudden onset of a craving for fine food are signs of affective dyscontrol and are highly correlated with lesions involving the right fronto-limbic regions. In another study, we assessed the emotional content of verbal productivity by means of a simple fluency test and found that patients with right frontal lesions produced most items and named mainly "pleasant" events, whereas patients with left frontal lesions named few and predominantly "unpleasant" events. This finding illustrates that patients' verbal output contains important information regarding characteristic emotional changes associated with lesion side. Finally, a lateralized tachistoscopic experiment on patients with surgical seizure treatment (unilateral selective amygdalohippocampectomy) revealed that affective judgments (like/dislike) of facial

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stimuli differ according to the side of the visual field stimulated as well as the side of the operation. While patients with left-sided lesions showed a preference for "like" judgments when stimuli were presented to the left hemisphere, and for "dislike" judgments when they were presented to the right hemisphere, patients with right-sided operations performed inversely, i.e., they made more "like" choices to right hemisphere stimulation and more "dislike" choices to left hemisphere stimulation. We conclude that epilepsy and emotion are indirectly related, since the fronto-limbic areas are dominantly involved in the regulation of emotional processes and are also frequent predilection sites in epilepsy. Moreover, the finding of an association between behavior trait and side of defect is in line with the idea that emotional processes are regulated by complementary hemispheric systems.

Mots clés : Affectivité, latéralité, crises épileptiques limbiques, amygdalo-hippocampectomie.

Key words: Emotion, laterality, limbic seizures, amygdalohippocampectomy.

INTRODUCTION

Although the two nouns, "epilepsy and emotion" are highly familiar, the facts behind these verbal constructs are still scarce. With respect to "epilepsy", neither the pathogenesis nor the mechanisms are well understood. On the other hand, its pathological expression, seizure activity, is one of the few neurological symptoms that is measurable and easy to quantify and qualify. As reflected in the variety of definitions, functions and cerebral mechanisms of "emotion" are even vaguer. The term "emotional knowledge", once used early in this century, may best describe the importance and functional range of affectivity as, for instance, for perception, experience, and action. Consequently, there is no single method for measuring emotion, and there are no adequate procedures available to qualify and quantify emotional functions.

Complex partial seizures (CPS) and temporal lobe epilepsy (TLE) are the most frequent epileptic disorders. CPS commonly originate in the limbic temporal lobe and are accompanied by a large variety of mental symptoms (for an overview see Blumer & Benson, 1975; Trimble & Bowling, 1986). Both the existence of an interictal behavior syndrome and associations of characteristic traits with site of focus are controversial, partly because additional variables (e.g., socialization, age of seizure onset, seizure duration, type of treatment) are difficult to disentangle from the effects of the site of structural damage (Moller & Mombour, 1994; Adamec & Adamec, 1986). Moreover, emotional alterations in epilepsy are typically evaluated by clinical observation or questionnaires, and the findings may be confounded by methodological limitations. Both rely on language, which is known to reflect only the verbally aware emotional experience and displays. Thus, for clinical and experimental investigations of the cortical organization of emotions, more precise terminology and preferably non-verbal methods are required.

Laterality studies with healthy subjects and the systematic observation of an association between site of lesion and kind of behavior alteration in patients suggest hemispheric differences in the perception and expression of emotional meaning. Similarly, evidence from studies with patients suffering from TLE suggest that the limbic-cortical regions are also functionally lateralized and of special importance in the regulation of emotions (Waxman & Geschwind, 1975). For example, Bear (1986) found that side of seizure focus is related to kind of interictal behavior, as assessed by a questionnaire. The specific behavior observed in right-sided TLE was labelled "emotive" (higher level traits such as euphoria, sadness, aggressivity, and altered sexual behavior), that of left-sided TLE "ideative" (religiousness, philosophical interest, sense of personal interest, paranoid ideation, hypergraphia). Other studies suggest that these behavior traits may characterize only a subgroup of patients with TLE or may not even be specific of epilepsy or seizure type (Post, 1986).

We present some of our studies to illustrate clinical and experimental approaches to the investigation of emotional functions and their anatomical correlates. Three studies report subtle clinical signs of emotional dyscontrol that we observed in patients with focal lesions. A tachisto-

scopic study is presented which revealed that the affective preferences of patients with TLE depend upon which hemisphere is stimulated and the side of seizure resection.

DISPLAYS OF EMOTIONAL DYSCONTROL

Neuropsychiatric abnormalities have been primarily associated with structural or functional damage of the limbic and frontal regions. Lesions located in the right anterior cortex more likely result in maniform-like behavior traits and left anterior lesions in depression-like affective displays. To quantify the verbal output reflecting differences in mood, we conducted a simple "affect fluency test" requiring the spontaneous naming of either "pleasant" or "unpleasant" events (Regard & Röhrenbach, 1993). Investigating a patient sample selected for side of lesion and not for mood, we found that patients with right frontal lesions named more items than did patients with left frontal lesions and normals. Moreover, patients with right-sided lesions named more "pleasant" events and patients with left-sided lesions named more "unpleasant" events. Thus, despite the verbal nature of the task, "affect fluency" captures quantitative and qualitative differences in mood associated with the side of anterior lesions.

With the same task we assessed pharmacoresistant patients with CPS who underwent left- or right-sided selective amygdalohippocampectomy (AHE), comprising the excision of the amygdala, the anterior hippocampus, and small parts of the parahippocampal gyrus (Röhrenbach, 1995). We found no laterality differences in our sample of patients with TLE, who were again selected according to side of resected seizure focus. Retrospective analysis revealed that the majority of the patients were seizure-free or had improved seizure status. Perhaps the verbal response mode and the "happy-sad" dichotomy in this task were too insensitive to measure emotional changes, which may be less pronounced in patients with small limbic lesions than in patients with more voluminous temporal resection or frontal lesions.

The following studies illustrate the relationship between size and site of lesion and clinical signs of emotional dyscontrol. In one study, we analyzed the rare observation of copying or recalling the circle with

three dots in the famous Rey complex figure as a smiling face (Regard & Landis, 1994). The finding of a high association with fluctuating or euphoric-like affective displays suggests that the "Smiley" is a graphomotor expression of mood. Lesion location was mostly in the right anterior quadrant, including limbic-frontal and temporal regions.

Furthermore, the analysis of a benign eating disorder, the so-called "Gourmand-Syndrome", consisting of heightened appetite, especially of a craving for fine food, revealed further evidence that the right limbic-cortical area is critical for impulse control (Regard & Landis 1997). Thus, although both the "Smiley" and altered appetite are "soft" signs of disinhibition evoked by right anterior lesions, we seldom observed both signs in the same patient. In the latter case, lesion location was more often or only limbic (in 7 instances, selective AHE). This finding suggests that the postulated modulatory function of amygdalo-fronto-limbic circuits in eating behavior and pleasure is asymmetrically organized.

LATERALIZED AFFECTIVE PREFERENCE

Preference judgments is an established method for studying processes not directly accessible to a person's verbal awareness. We adopted this method to study hemispheric differences in emotional processing because the responses proposed are non-verbal and spontaneous, and thus are believed to reflect the interaction of the perceiver's affective state and the emotional valence of a stimulus. Using bilateral simultaneous tachistoscopic presentations of faces with a strong emotional meaning, we found consistent evidence for hemispheric differences in healthy subjects (Regard, 1991; Röhrenbach, 1995; Gysi, 1996).

Pairs of faces were simultaneously projected, one to each visual field, and subjects had to indicate the side of preference by pressing a key. One run required subjects to indicate which face in a pair they "liked", and the other, which one they "disliked". The analysis revealed an interaction of side of stimulation and kind of choice, namely a left hemisphere dominance for "like" choices and a right hemisphere dominance for "dislike" choices.

We used this method to investigate emotional functions in TLE (Röhrenbach, 1995). Patients with limbic seizure foci were selected according to side of operation. The two groups were comparable with respect to seizure outcome and severity of neuropsychological symptoms, except that their memory performance differed in modality (Regard et al., 1996). We found that patients with left-sided operations performed as did healthy subjects, whereas the right-sided group showed the opposite pattern, i.e., stimuli projected to the left hemisphere were disliked, and those projected to the right hemisphere were liked.

Thus, limbic lesions seem not to impair the ability to make differentiated affective judgments. Moreover, they do not alter emotional concepts as revealed by item classification. However, they may change their hemisphere-dependent affective evaluation: we found that the lesioned hemisphere judges emotional stimuli more positively, while negative choices are made by the healthy side. The finding that the left-sided group performed as did the healthy subjects may indicate that right-sided lesions play a more critical role in altering emotional judgments.

CONCLUSIONS

What is known about "epilepsy and emotion" reflects the understanding of the cerebral organization of mental functions in general, and is specifically related to the problems involved in the investigation of emotional processes. The studies reported here illustrate some of our clinical and experimental attempts to access emotional functions and provide further evidence of the relationship between behavioral alterations and site and size of lesion. We used two different approaches to study this relation, one, the anatomical analysis of behavior changes observed in patients with cortical and limbic lesions, the other, experiments with healthy subjects and patients with unilateral limbic seizure resections. The findings of the retrospective studies illustrate that behavioral changes, even rare or subtle ones, support the diagnostic value of observation. The tachistoscopic studies we conducted with a non-

verbal affective preference paradigm revealed additional evidence of lateral differences in emotional processing.

What conclusions can be drawn about the relationship between epilepsy and emotions? Obviously, this question cannot be answered without further specification of the qualitative and quantitative aspects of emotional functions. The behavior alterations commonly associated with epilepsy mainly correspond to characteristic traits observed in some patients with TLE. Emotional changes in epilepsy primarily depend upon location and etiology of damage, which determine type and frequency of seizures as well as treatment. The limbic temporal region, an area with dense connections to the rest of the brain, is the most vulnerable to CPS. The regulation of emotions depends on anatomofunctional connections which are organized vertically along the ARAS, horizontally in the interconnected hemispheres, and intrahemispherically along the posterior-anterior axis. Along the vertical axis, behavioral aspects related to drive, vigilance, and alertness are regulated. The midbrain filters and modulates internal and external stimuli, which are coordinated in the end in different cortical areas. The lateral organization seems to play a major role, insofar as distinct intrahemispheric subsystems exist, that provide partly complementary processes. In the healthy brain, the left hemisphere dominantly processes verbally and preferably judges stimuli as emotionally pleasant, and the right hemisphere dominantly processes non-verbally and primarily selects stimuli evaluated as negative. In patients, the side of brain damage determines major aspects of emotional alterations. Patients with left-hemispheric lesions more likely display withdrawal behavior, such as reduced drive and mood. In contrast, the behavior of patients with lesions in the right hemisphere is characterized by stimulation-seeking, often associated with addictive behaviors, hyperactivity, or mood fluctuations. These lateral differences are accentuated the most when lesions involve the anterior-limbic cortex. Although we could not find consistent behavioral traits in the epileptic patients, the results revealed lateral differences in affective processing. These lateral differences are consistent with the behavior changes observed in patients with larger hemispheric lesions. We found that limbic resection of seizure focus alters the non-verbal interpretation of affective meaning. Visual stimuli processed by the lesioned hemisphere are more frequently judged as pleasant, while

their emotional appeal seems less pleasant when processed by the healthy hemisphere. This complementary process in the emotional domain may be a biologically relevant separation of attraction and avoidance, curiosity and protection. These results and the observation of an increased desire for fine food ("Gourmand-Syndrome") suggest dysregulation of interhemispheric balance caused by a right limbic lesion.

We conclude that in limbic as well as in cortical lesions, side of lesion is a primary variable determining the kind of emotional changes. Furthermore, the extent of behavior alteration seems to depend on lesion size, which may reflect the regulatory capacities of the remaining tissue. Thus, although emotional changes and epilepsy are correlated, especially in TLE, both are related to a lesion and symptoms determined by lesion location and etiology. As the regulation and experience of emotions requires a complex cerebral system, various factors and mechanisms may disrupt this system and lead to dyscontrol in emotional behavior. Patterns of qualitative and quantitative changes indicate specific dysfunctions of anatomically organized subsystems. The future of a neuropsychology of emotions requires improved concepts and methodological procedures and an interdisciplinary neuroscientific effort.

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RÉSUMÉ

Après une introduction discutant les difficultés conceptuelles et méthodologiques liées à l'investigation des émotions chez des patients épileptiques, cet article présente quelques résultats de travaux illustrant les approches clinique et expérimentale dans l'étude des relations entre processus anatomo-fonctionnels et émotionnels. Dans une première étude, une tendance, dans la figure de Rey, à transformer le "rond avec

trois points" en visage "sourire", ainsi qu'une modification des goûts culinaires, sont décrites comme des signes de modification affective en rapport avec des lésions fronto-lobiques droites. Une deuxième étude a montré que, dans un test de fluence affective verbale, l'évocation d'événements heureux est liée à des lésions frontales droites. Enfin, une épreuve tachistoscopique latéralisée à laquelle ont été soumis à des patients avec amygdalo-hippocampectomie sélective unilatérale pour cause d'épilepsie, a mis en évidence des différences dans le jugement affectif (j'aime, je n'aime pas), qui dépendent du côté de l'opération mais également du champ visuel stimulé. Les patients avec résection droite avaient une tendance à aimer les stimuli présentés à leur hémisphère droit et à ne pas aimer les stimuli présentés à l'hémisphère gauche, alors que les patients avec une résection gauche donnaient un jugement inverse, comme les sujets normaux. L'article conclut à une relation indirecte entre épilepsie et émotion, étant donné l'implication des aires fronto-lobiques dans des processus émotionnels et des crises épileptiques. De plus, la mise en évidence d'une association entre les traits comportementaux et le côté de la lésion appuie l'idée que les processus émotionnels sont modulés par des systèmes hémisphériques complémentaires.

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