American Handbook of Psychiatry

EPILEPSY

NEUROPSYCHOLOGICAL ASPECTS

Gilbert H. Glaser

EPILEPSY

NEUROPSYCHOLOGICAL ASPECTS

Gilbert H. Glaser

e-Book 2015 International Psychotherapy Institute

From *American Handbook of Psychiatry: Volume 4* edited by Silvano Arietti

Table of Contents

material of about one second; (2) short-term memory (STM) or primary memory, having a trace of slightly longer but still limited duration (20-30 sec.) and with a slightly larger capacity; and (3) long-term memory (LTM) or secondary memory, in which a stable trace or engram exists and may remain permanently. Evidence exists that the anatomical localization of these memory systems may be different. Thus the amnesic syndrome, characterized by severe LTM loss in the presence of intact immediate and STM and intellect, is thought to be a concomitant of bilateral lesions of the diencephalon, thalamus, and hippocampus structures closely related to the temporal lobe. A situation in which STM, particularly for auditorally presented material, is grossly impaired in the presence of intact LTM has been described. The critical lesion is thought to be in the dominant parietal lobe, in the region of the supra-marginal and angular gyri.

It thus is clear that the temporal lobes are important to the proper functioning of memory in man, as shown by a fairly extensive literature concerning subjects with brain lesions. It is, therefore, surprising that the problem of memory impairment in patients with epilepsy, especially temporal-lobe epilepsy, has not yet been analyzed in the same depth, even given the evidence that lack of any structural damage to the temporal area is not always evident. Milner has pointed out that care must be taken to distinguish between impairment of memory and impairment of attention or vigilance. Thus “absence” in petit mal may be interpreted later as producing

memory loss, and generalised intellectual impairment may appear to the patient as memory loss. Given that such situations exist, there remains a need to study the memory problems that may be associated with epilepsy. Examples of dense amnesia seen after bitemporal lobectomy for epilepsy (H.M.), or in one case after right-temporal lobectomy have been studied. The episodes of deja vu in temporal-lobe epilepsy have been interpreted as abnormal activity in the temporal lobe, giving rise to a false sense of memory, analogous, perhaps, to Penfield's stimulation studies.

There have been studies of memory impairment in epilepsy, and many workers have sought to find both the differentially affected temporal-lobe epileptic, and the predicted laterality effects. Thus, Horowitz and Cohen in a follow-up study of patients after surgery for temporal-lobe epilepsy, did not find any consistent memory impairment (using the Wechsler memory scale and Benton visual retention test, amongst other general tests of intellectual performance such as the WAIS). They do not accept the view that psychologists are able to demonstrate laterality effects, and argue that temporal lobectomy merely leads to impairment of "organization."

Serafetmides and Falconer studied thirty-four patients with right anterior temporal-lobe ablations and showed that only two had some brief postoperative memory impairment; six had persistent memory deficits, but the authors state that "the type of memory deficit did not correlate with the

more formal psychometric test results." They suggest that these six subjects must have had bilateral temporal-lobe dysfunction. Meyer studied similar patients and found that nondominant lobectomies produced no change, and that dominant lobectomies produced auditory verbal learning difficulties. Many studies have made comparisons between various types of seizure patients. Guerrant et al. found no overall significant differences in any of their groups of grand mal, petit mal and psychomotor (temporal-lobe) epileptics, with respect to memory functioning, using the memory span for objects and the Wechsler memory scale.

Mirsky, Primac et al. found no significant group differences on memory tests between subjects with temporal-lobe epilepsy (TLE) of a focal and nonfocal nature. Scott, Moffett et al. tested subjects with and without epilepsy, matched for age and IQ and found no differences in their performance on nonverbal tests in three modalities. Quadfasel and Pruyser predicted a greater impairment in verbal skills and some memory difficulty in patients with TLE, and Fedio and Mirsky and Dennerll demonstrated some laterality effects in TLE patients.

Thus there is some confusion as to the precise nature of the memory impairments in the epileptic patients. Memory tests have not differentiated adequately between STM (short term memory) and LTM (long term memory) components; indeed, there is little indication that very remote memory has

been tested at all. Although some studies have considered laterality effects, more subtle tests have not been used. Thus, the use of tests of nonverbal memory cannot be described as such, unless it is clear that no verbal labels can be applied to the stimulus to be remembered, at least during the time of presentation to the subject. Horowitz is of the opinion that no gross differences between right and left foci in the temporal-lobe epileptic have yet been demonstrated. It has yet to be proved definitively that the lack of differentiation in these studies is a result of test inefficiency, or whether temporal-lobe disturbances in epilepsy really do produce a different type of dysfunction from other types of lesions, where perhaps the disturbance may be more continuous. Lack of direct information about the true origins—i.e., perhaps subcortical—of discharges in many patients with temporal-lobe epilepsy adds to the difficulties.

It has been noted that there is often a discrepancy between the observed clinical findings, the patient's subjective impression of memory impairment, and psychological test findings. Since memory is so vital an element in adequate functioning, good evaluation is important. More discriminating tests, such as have been employed in other memory studies, may improve the evaluation of this function in epilepsy. There is also a need for more careful control of other influences, such as anticonvulsant levels, seizure frequency, and the overall psychological state of the patient (i.e., level of anxiety, depression, etc.).

Interictal psychotic states can develop, especially in certain patients with psychomotor-temporal lobe epilepsy, and may be correlated with long-standing disturbances in intellectual function, particularly in perceptual-cognitive areas. The overall incidence of psychosis is relatively small and difficult to determine, yet significant; if psychotic states in epileptic patients are considered as the starting point of any study of this problem, then it is likely that their coincidence is not just a matter of chance (See references 14, 27, 37, 54, 121, and 152).

A fluctuating episodic behavioral and personality disorder other than actual seizure can exist in a patient. At times an alternation between seizure and overt psychosis can be observed, especially in patients under medication. However, it is often difficult to distinguish an ictal or postictal psychotic episode from an interictal state. Ever since the midnineteenth century, so-called acute epileptic psychotic reactions have been recognized as part of what is now regarded as the psychomotor-temporal-lobe seizure complex, and more prolonged psychotic disturbances with schizophreniclike manifestations have been differentiated from actual seizure in some patients. Epileptic "furor," fugue, twilight and depersonalization phenomena have been described in both settings.

The electroencephalogram has aided somewhat in these considerations. Confusional states have been found to be more common in patients with

bilateral spike-wave discharges and prolonged petit-mal seizures. More complex psychotic disturbances of schizophreniclike qualities in patients with psychomotor seizures have been found with unmodified EEG rhythms, desynchronization of the EEG, “forced normalization” with disappearance of abnormal discharges or a reinforced temporal abnormality.

The interictal psychotic states may appear early in the history of the patient, even at the onset of seizures, but more often some years later varying from six to 14 years. The psychotic episodes may last from one to many days. Reactions are paranoid, depressive, confusional, and hallucinatory along with bizarre behavior. Episodes of self-mutilation have been reported. There usually is little or no occurrence of otherwise goal-directed destructive, violent behavior in these patients and no indications of major withdrawal or atavistic mechanisms. Affect is often warm and appropriate with much reality testing, a major difference from schizophrenic psychosis occurring in other spontaneous circumstances. Affective flattening is unusual. Catatonic disorders appear, but are usually transitory. Religious preoccupations are frequent, as well as related obsessional activities. Impulsive, compulsive eating and drinking may occur. Somnambulism has been reported. In some patients, acute disorganization of verbal productions is present along with bizarre distortions and many somatic delusions. Pregnancy fantasies have existed in some females. Diminished libido and sexual functions are found in some patients with temporal-lobe epilepsy Hypersexuality is unusual. Sexual

deviation, such as fetishism, has been reported in association with temporal-lobe epilepsy, relieved, in one instance, by temporal lobectomy.

Over half the patients have fluctuating memory disturbances with mild to moderate impairment, difficulty in attention and concentration and disorientation to time. Extreme confusion occasionally appears, often lasting several hours and not associated with the usual manifestations of seizure with motor-sensory or visceral components. Partial to complete amnesia, often for the psychosis, suggests subclinical “seizure” activity; in some of the cases with confusion, bilateral EEG discharges suggesting subcortical origin may be correlated.

Psychological testing of such patients requires not only scoring, but also observation of performance and response. There is evidence of loss of trains of association along with word finding and tracking difficulties, vacillation of alertness, and fluctuation in the accuracy of perceptions. Looseness of associations without bizarre content or mode of thought is common, along with indications of concreteness. However, there is usually no clear sign of autism or withdrawal; many patients make continued attempts to be in contact with reality. There are usually no signs of archaic thinking or autistic fantasy elaboration as would be found in more typical schizophrenic subjects.

Mild to moderate memory disturbances are frequent in these patients,

with both retention and recall difficulties in both short- and longterm memory. Mere scoring of IQ levels is not very meaningful. Many patients express concern over problems in the clarity of their thinking and make concerted efforts to control, restrict, and contain emotions and actions in order to become clear, accurate, and realistic. Misperceptions and arbitrary thought processes usually involve relatively benign, neutral content, although themes of religiosity are frequent. A degree of word-finding difficulty is often apparent, and distinct dysphasia is occasionally present (in over 10 percent of Slater's cases). Flor-Henry and others have emphasized the correlation of dominant temporal-lobe focal involvement and schizophreniclike psychosis in these patients. Some patients experience weakness of spatial orientation and fluctuating motor incoordination. Difficulty in arithmetic is sometimes present.

The paranoid elements involve projection of thoughts and feelings, but well-organized delusions of persecution, for example, are relatively uncommon. Indications of contamination and feelings of depersonalization and unreality are frequent. Disturbances of body image involve feelings of being disconnected, fragmented, malformed, awkward, or incomplete.

Most epileptic patients with interictal psychosis are found to have psychomotor temporal-lobe seizure disorders. The classification of the seizure disorder must be on the basis of the clinical signs, not of the EEG,

since the latter might show fluctuating bilaterality of discharge. The onset of the psychotic reaction does not appear to be clearly related to specific psychological triggers in many instances, but often does follow increasing buildup of tension and anxiety. Gradual intellectual disorganization, often subtle at first, may initiate the process. Some patients remain in an impulsive, aggressive, unstable, obsessional state without actual psychotic break. It should be stated that the actuality of a "true" or non-directly related schizophrenia could develop in patients with epilepsy, but the above described schizophrenialike phenomena are qualitatively different.

Taylor has recently emphasized that, from the clinical point of view, the epileptic schizophrenialike psychoses emerge as a group of disorders following largely on psychomotor-temporal-lobe epilepsies involving mainly the left temporal lobe either alone, or as part of a more generalized seizure disorder, emerging mainly in the second and third decades, where mesial temporal sclerosis is an improbable pathological substrate, to which females are more prone, but in whom half the risk to psychosis is past by the twenty-fifth year. Of interest is the increasing evidence that a number of cases of childhood psychosis or "autism" follow episodes of infantile epilepsy, especially of the myoclonic spasm type.

The therapeutic implications of these considerations are yet to be fully realized. It might be expected that a psychotic reaction associated with a

seizure disorder would regress as seizures respond to treatment. Although this does happen, the interictal behavioral disturbance occasionally persists and may increase as seizures are controlled. Anticonvulsant drugs are to be used, and the administration of certain psychotropic drugs such as "alerting" phenothiazines (i.e., flu-phenazine) might be helpful. In selected cases with intractable seizures and well-defined focus, temporal lobectomy has produced some improvement in "schizophrenic" symptoms, but this is unpredictable and does not correlate well with the response of the seizures.

Clinical Evaluation of the Patient

The patient with epilepsy should receive a thorough diagnostic evaluation in order to determine the relative significance of the possible etiologic factors as well as precipitating circumstances. This requires thorough history taking, physical, medical, and neurologic examinations, and selected laboratory investigations with particular reference to blood chemistry studies, cerebrospinal fluid analyses, and electroencephalography; special radiologic studies may be required. The collected data may lead to the diagnosis of either a specific medical illness associated with seizures or a focal cerebral lesion.

History

In order to establish whether recurrent seizures are being experienced, a careful history should contain detailed descriptive material, usually from sources other than the patient. Eye-witness accounts are helpful. As much recollection as possible should be obtained from the patient, particularly of experiences of the aura or the onset of the seizure. The patterning or course of events during and after seizure episodes should be documented with special attention to phenomena which might be of localizing significance. Other information of great importance with regard to treatment concerns the circumstances under which the seizure occurs, e.g., time of day or night, frequency of attacks, and the influence of medication, menstrual cycle, pregnancy, food intake, sound or light stimulation, intake of alcohol, and psychological stress. Additional indications of neurologic disturbance should be described, e.g., headache, hemiparesis, hemisensory symptoms, dysphasia, and visual difficulties, especially loss of acuity and hemianopsia, and vertigo.

A family history may reveal data of importance, particularly with regard to susceptibility to seizure. In a significant number of families a history of febrile seizure in early childhood may be obtained, as well as seizures of both generalized and focal types extending into later life. In addition, since a number of genetically determined cerebral disorders may be associated with seizure as well as other neurologic abnormalities, the family history may include phenomena other than seizures as indications of brain disorder related to structural or metabolic abnormalities.

The general medical history is significant, since seizure may be associated with cardiovascular disease, various blood dyscrasias, and metabolic and endocrine disorders; for example, the history of neoplasm anywhere in the body is important, since a focal seizure may be the first manifestation of a cerebral metastasis.

The past medical and developmental history of the patient is of great significance in attempting to determine etiology; information concerning pregnancy, delivery, the neonatal period, and the developmental neurological milestones should be obtained. The position of the child on the developmental scale should be determined, particularly with regard to motor and intellectual skills. Past history should also include information regarding head injuries, reactions to immunizations, childhood diseases such as measles, mumps, and chickenpox, and any severe illness with delirium or coma that might be considered related to an encephalitis. A history of exposure to toxic substances is important, as well as the possibility of drug intake, particularly in adults suspected of taking barbiturate or tranquilizing drugs.

A detailed survey of the patient's social development and behavior in and out of the family setting is relevant, including an evaluation of intellectual performance at school and vocational performance. Attention should be paid to alteration in any of these phases of existence in relation to seizure

occurrence, as well as between seizures, and also to possible effects of medication on seizure incidence or behavior.

Physical and Neurological Examination

Clinical examination of patients with seizures may not reveal significant physical or neurologic abnormality in 75 percent or more of cases. However, thorough physical examination is necessary to establish whether a general medical disorder is present; even examination of the skin may produce the requisite information for diagnosis of tuberous sclerosis, neurofibromatosis, or cerebral hemangioma. Examination of the lungs may provide the background for consideration of metastatic tumor or abscess; evaluation of the peripheral circulation and blood pressure may give indication of the possibility of the various types of cerebral vascular lesions, or aid in differential diagnosis of syncope and seizure.

The neurological examination serves two functions: (1) to give indication of general cerebral disorder, and (2) to demonstrate whether focal signs are present, indicative of a localized cerebral lesion. Neurological examination at the time of or shortly after a seizure may be important, since hemiparesis and related signs may be revealed. Psychological testing may be useful in the assessment of general intellectual status, possible deterioration from a previously higher level of functioning, and the possibility of focal

cerebral damage. As discussed previously, the WAIS and Wechsler Memory Scale give a very broad idea of the patient's functioning, but more careful evaluation of learning, memory, and perception is needed to distinguish subtler disturbances, as discussed above. The Rorschach and other projective tests have been used to demonstrate both "organicity" and the epileptic personality, but doubt has been cast on the validity of such techniques for this purpose. Attention should be paid to the patient's performance during these tests as well as to the actual scores.

Laboratory Investigations

Each patient with recurrent seizures, regardless of age, should be subjected to selected laboratory investigations at least once during the course of his history, particularly if changes in seizure patterns or neurologic signs develop. There are no routines, but at different age levels certain tests are more apt to produce results leading to specific etiologic diagnosis. In addition, certain studies are necessary for the evaluation of the general health of the patient and in following the effects of medication which may be toxic to various body systems. Aside from electroencephalographic abnormalities, there are no abnormal laboratory findings characteristically associated with the seizure process. Urinalysis is important to determine the state of kidney functioning, which, if abnormal, may preclude the use of certain drugs or may suggest a specific diagnosis. Similarly, a complete blood count is necessary,

particularly if a blood dyscrasis is suspected. Severe seizure states, such as *status epilepticus,* may be associated with proteinuria, leukocytosis, and fever as secondary manifestations. In certain instances, special blood chemistry studies are important, e.g., blood sugar and glucose-tolerance test in the diagnosis of hypoglycemia and in the evaluation of a difficult-to-control diabetic. Determinations of serum calcium are necessary in the evaluation of infants and young children with seizure states, since hypocalcemia may cause generalized seizures, distinct from tetany. Evaluation of serum electrolytes and acid-base balance is extremely important in the study of both children and adults with metabolic encephalopathies and seizures in various disorders of the kidney, liver, heart, and lungs. As yet, no specific patterns of electrolyte distortion are associated with seizures, but at times variations in these can be so correlated. Determination of serum enzymes is mainly important in establishing the presence of general medical disorders, and serologic tests are helpful in the diagnosis of past infectious states.

The cerebrospinal fluid is apt to be normal except in a minority with certain neurological disease. Following severe seizures there may be a slight increase in cerebrospinal fluid protein and white cell counts, but this is usually transitory. In structural neurological disorders with concomitant seizures, the protein or pressure or both may be persistently elevated and the diagnosis is then dependent on other tests, such as contrast radiologic studies. Chronic infection of the nervous system can be associated with

increase in white cell count in the cerebrospinal fluid, and occasionally the presence of cerebral neoplasm may be shown by neoplastic cells in the fluid, diagnosed by cell block and appropriate histologic examination.

Radiologic Studies

All patients should have an X ray of the skull and chest. The plain X-ray film may show abnormal calcifications and shift of the pineal or other signs of increased intracranial pressure. The X ray of the chest is of two-fold importance: (1) in the evaluation of any anomalous cardiopulmonary status in an adult or a child; and (2) to reveal possible primary tumor in an adult.

The so-called contrast radiological studies of the intracranial contents are extremely useful diagnostic procedures, but since they have a certain morbidity they must be selected with great care and be performed when they can be expected to be most informative. Certainly, such procedures must be considered when there is suspicion of a focal intracranial lesion.

If there is increased intracranial pressure, particularly if there may be a lesion involving the posterior fossa, ventriculography may be the procedure of choice; however, this procedure generally gives incomplete information with regard to the subarachnoid spaces. Ordinarily, if the pressure is normal, a fractional pneumoencephalogram gives more information with regard to a lesion occupying space in the brain substance or distorting the ventricular or

subarachnoid system. In addition, the presence of focal brain atrophy may be shown by differential enlargements of specific spaces such as the temporal horns of the ventricles.

Cerebral arteriography is useful in patients with and without evidence of increased pressure, and may give important information, particularly if there are focal or lateralizing signs. Abnormal vascular patterns are found in particular types of tumors, intracranial hematomas, and vascular malformations; the location of vascular occlusions may be found by arteriography as well. There are instances when such studies are negative but reveal a lesion when repeated later; occasionally such tests may be worthwhile in initial base-line investigations of a case.

The use of brain scanning with radioactive isotopes requires more evaluation, but there is increasing regard for these procedures as a means of determining the presence of certain types of tumors, either single or multiple, and of vascular lesions. In some instances a negative brain scan may eliminate the necessity, for the moment, of a contrast radiological procedure. Also, a significantly lateralized pickup in scanning may indicate the preferred side for an arteriogram, an indication which otherwise might not be clear from the neurological evaluation and the EEG.

Electroencephalography

The various electroencephalographic correlates of the different types of seizures have been described above. The EEG, however, must be regarded only as an indicator of a certain kind of cerebral activity determined by the recording method using electrodes upon the scalp. This is important to realize, since the EEG from a patient with known seizures of any type might be normal, as it is the case in a single-sample recording in 25 percent of such patients. Depth electrode recording techniques have shown that, in some of these instances, there may be abnormal discharges in the deeper structures such as the amygdala and hippocampus, while the electrical activity of the cortex shows no change. The EEG; therefore, has limited diagnostic applications, and it must be considered only as a reflection of certain cerebral functions to be correlated with other information obtained from physical and neurological examinations. The electroencephalographic findings are of varying usefulness in the diagnosis of epilepsy, depending on their nature and the circumstances under which they are obtained.

The EEG may be utilized as an aid in the confirmation of the presence of a seizure state, particularly if paroxysmal discharges are recorded during and correlated with a seizure; for example, in the petit-mal absence, up to 85 percent of children have the typical 3 Hz. spike-and-wave discharges both between and during seizures. In addition, these may be precipitated by overventilation and light stimulation. The EEG may merely contain generalized nonspecific slow-wave discharges, which may be considered only

as an indicator of cerebral dysfunction, but not necessarily of a definite seizure disorder. Focal slow-wave abnormality is suggestive of a localized structural lesion and indicates the need for further investigations. In certain forms of focal epilepsy the EEG may show focal discharges of spikes, sharp waves, and complex components indicative of the epileptogenic nature of the focus. However, in some of these instances such abnormality might be transmitted from deeper, even centrally disposed, lesions.

In most laboratories of electroencephalography the procedure includes recordings in the waking state and during hyperventilation. Frequently, however, attempts are made to provoke generalized and focal paroxysmal discharges by means of sleep, sensory stimulation with light or sound, or certain metabolic and pharmacologic adjuvants. The EEG during sleep is useful to demonstrate focal discharges in patients with psychomotor-temporal-lobe epilepsy. Such discharges are increased during sleep in 50-75 percent of adults. The results in children are less definitive; in 25-35 percent of young patients the temporal activity becomes more prominent during sleep. However, in some patients sleep tends to produce increased bilaterality of abnormal temporal discharges. The use of sphenoidal electrodes is occasionally helpful in lateralizing temporal-lobe discharge, particularly when patients are being evaluated for surgery. At times barbiturate-induced fast-wave activity is found to be less marked in the involved temporal lobe. Photic stimulation detects patients with light-sensitive epilepsy and occasionally

evokes lateralized discharges in patients with a sensitive focus.

There have been many attempts to alter the electrical activity of the brain in susceptible patients by inducing metabolic changes, such as hydration, following an injection of vasopressin or the induction of hypoglycemia with small doses of insulin. Various stimulant drugs have been used, e.g., pentylenetetrazol and bemegride. All of these methods, particularly the use of drugs, may precipitate paroxysmal discharges as well as clinical seizures; the latter are usually generalized, but occasionally activation of a focus occurs. Attempts to measure seizure discharge threshold have been largely unsuccessful because of great variability; in addition, many otherwise normal subjects respond to these procedures with seizure activity. For these reasons this approach is not recommended for general use in the diagnosis of an epileptic state. Occasionally, however, it may be desirable to view in detail the clinical phenomena of the seizure and to determine focal components either in the EEG or clinically. At times this can be accomplished by the administration of a controlled dose of a seizure-producing drug.

The degree of electroencephalographic abnormality, especially in its paroxysmal characteristics, may be regarded as an objective indicator of the severity of a particular seizure state in a patient; this may fluctuate with the clinical behavior of the seizure disorder. However, the use of the EEG to follow patients with epilepsy is limited since in many instances some degree

of electroencephalographic abnormality persists even when seizures are controlled. This occurs most often in patients with psychomotor-temporal-lobe epilepsy and least often in children with petit-mal and myoclonic seizures.

Differential Diagnosis

The implications of a diagnosis of an epileptic disorder are so significant both medically and psychologically that the diagnosis must be positive and specific, excluding other disturbances characterized by similar transitory abnormalities of neurological function that are not seizures. Consciousness may be disturbed episodically by limitations of cerebral blood flow, either generally or locally, e.g., in instances of cerebral vascular insufficiency and syncope of various types, particularly the vasodepressor form. Disturbances of cerebral circulation occur frequently in older age-groups; there is usually evidence of hypertension and cerebral arteriosclerosis. Periodic blackouts and general confusional states may result from basilar artery insufficiency; however, there are usually other signs of brainstem and cerebellar dysfunction. Patients with deficient carotid circulation may have transitory hemiparesis and hemisensory disturbances along with dysphasia. Electroencephalographic findings of paroxysmal discharge may suggest the presence of a seizure state; however, rhythmic discharges may be related to lesions of vascular origin in the upper brainstem. The differential diagnosis in

these patients involves careful evaluation of the history and general medical state of the patient; arteriographic confirmation of a vascular lesion may be necessary.

Syncopal episodes may resemble akinetic or minor motor seizure; actually, prolonged syncope can develop into convulsions due to the persistence of cerebral ischemia and hypoxia. The patient with syncope usually has some indication of disturbed vasomotor reactivity with excessive sweating, pallor, and tachycardia. Specific precipitating factors often are present, such as fear or other psychological upset; the confusion, headache, and drowsiness which occur after a generalized seizure do not usually appear. During a simple syncopal episode the EEG consists of diffuse asynchronous slow waves without paroxysmal or focal discharges.

Various disturbances of consciousness, from confusion to coma, may be produced by metabolic disturbances not necessarily leading to seizures. These conditions are important in the differential diagnosis, since in specific instances of metabolic encephalopathy seizures may be only a minor clinical concomitant, and the overall distortion of general cerebral function may be of major concern. These clinical abnormalities appear in hypoglycemia, hyponatremia, kidney failure with uremia, hepatic insufficiency, and pulmonary insufficiency (with hypoxia and hypercarbia). The EEG in these states contains generalized, often intermittent, intermediate (4-7 Hz.) and

very slow waves (1-3 Hz.). Rhythmic components (such as the triphasic complexes in hepatic encephalopathy) may be present, but paroxysmal discharges are unusual unless actual seizures are occurring. Hypocalcemia, as in hypoparathyroidism, may produce tetanic spasms throughout the somatic musculature; occasionally these may be unilateral and suggestive of localized seizure, but consciousness is not lost and actual clonic contractions do not occur. However, as mentioned previously, hypocalcemia may precipitate actual convulsive seizures. Fluctuating distortions in behavior are also characteristic of many endocrine disorders, e.g., hypoadrenalism and hyper-adrenalism, hypopituitarism and hyperpituitarism, and myxedema. In none of these states are seizure disorders particularly prominent.

Certain psychogenic disorders may resemble epileptic states and be difficult to distinguish from them. Hysterical "seizures" may occur independently, but are occasionally seen in patients with known seizures, i.e., so-called liystero-epilepsy. The clinical problem in these patients is often difficult to solve because of the interrelationships between the seizure state and the reactive development of the psychological disturbance. The hysterical seizure is not associated with neurological signs of reflex abnormality; the EEG contains no paroxysmal discharges. The hysterical seizure pattern is bizarre and not a stereotyped tonic-clonic movement sequence, and self-injury does not occur during, or as a result of, the hysterical seizure. The postictal states of confusion, headache, and drowsiness are absent. The

diagnosis of hysterical seizure requires careful psychiatric evaluation because of the deep-seated and severe neurotic process involved. Similarly, certain hysterical or psychotic fugue disturbances and dissociative reactions may need to be distinguished from psychomotor-temporal-lobe seizures.

Treatment

The treatment of a patient with an epileptic disorder must take into account not only the patient and his disorder, but also his family and life situation. Much depends on the diagnostic evaluation and the etiology or precipitating factor. This can be clearly defined where a metabolic disturbance is obvious, e.g., in a hypoglycemic or hypocalcemic patient cured of seizures by administering glucose or calcium. Operable cerebral tumors represent another such situation. However, in many cases of acquired epilepsy the cause of the seizure cannot be treated directly, and symptomatic therapy with anticonvulsant drugs together with the total management of the patient are necessary. This may be true even in certain cases in which the precipitating factor is known, e.g., an anticonvulsant drug may be temporarily necessary in hypocalcemia, since a delayed response to calcium may be present. Seizures may continue even after surgery for a brain tumor due to postoperative scarring or incomplete excision. Immediate specific therapy is not always indicated in patients with acquired epilepsy. Only a limited number of patients with posttraumatic epilepsy are amenable to surgery for a

localized meningo-cerebral scar. For these reasons, only a relatively small number of patients with seizures do not require anticonvulsant drugs and a general psychosocial rehabilitative program.

Medical Therapy with Anticonvulsant Drugs

Drugs commonly used in the treatment of epilepsy are listed in Table 13-2 together with recommended dosage, indications, and toxic effects.

Table 13-2. Medical Therapy in Epilepsy: Anticonvulsant Drugs

Bromides	
Daily dosage	Adults: 1.0-3.0 g. (not recommended for children)
Symptoms	All types of seizures, especially grand mal and psychomotor; may be combined with hydantoins
Toxic effects	Drowsiness, dulling, rash, psychosis; *rarely used now.*
Celontin (methsuximide)	
Dose 0.3 g. capsule	
Daily dosage	Children: 0.6 g.; adults: up to 1.5 g.
Symptoms	Petit mal, psychomotor seizures, myoclonic seizures, massive spasms
Toxic effects	Ataxia, drowsiness, rarely blood dyscrasias, anorexia
Dexedrine (dextroamphetamine)	
Dose 5 mg.	

	tablet; 10 and 15 mg. spansules
Daily dosage	Children: 5-15 mg.; adults: 15-50 mg.
Symptoms	Hyperkinetic behavioral disturbances in children, narcolepsy, to counteract sedative effects
Toxic effects	Anorexia, irritability, sleeplessness

Diamox (acetazolamide)

Dose	250 mg. tablet
Daily dosage	Children: 0.75-1.0 g.; adults: 1.0-1.5 g. Use intermittently, as an adjuvant in all types of seizures, especially those in females related to menstrual cycles; tolerance may develop
Toxic effects	Anorexia, acidosis, drowsiness, numbness of extremities, rare blood dyscrasia

Dilantin (diphenylhydantoin)

Dose	0.03 g. and 0.1 g. capsules; 0.05 g. tablet; 0.25 g./ml. suspension; 0.1 g. in oil capsule; 0.25 g. ampul for parenteral use
Daily dosage	Children: 0. 1-0.3 g adults: 0.3-0.6 g. Effective blood level 10-20 μg/ml.
Symptoms	Grand mal, psychomotor, and focal seizures; most useful in combination with phenobarbital or primidone
Toxic effects	Rash, fever, gum hypertrophy, gastric distress, diplopia, ataxia, hirsutism (in young females); drowsiness uncommon; lymphadenopathy, rare megaloblastic anemia, secondary folate deficiency, “encephalopathy,” hepatitis rare, aplastic anemia, agranulocytosis rare

Gemonil (metharbital)

Dose	0.1 g.
Daily dosage	Children: 0. 1-0.3 g.; adults: 0.3-0.6 g.
Symptoms	Mainly in children with petit mal, myoclonic seizures, massive spasms, occasionally in grand mal
Toxic effects	Drowsiness, rash

Mebaral (mephobarbital)

Dose	0.03 g., 0.1 g. tablets. Demethylated to phenobarbital.
Daily dosage	Children: 0.06-0.3 g; adults: 0.3-0.6 g.
Symptoms	Grand mal, petit mal, psychomotor, focal seizures; most useful in combination with hydantoins
Toxic effects	Drowsiness, irritability, rash

Mesantoin (methylphenylethylhydantoin)

Dose	0.1 g.
Daily dosage	Children: 0.1-0.4 g.; adults: 0.4-0.8 g.
Symptoms	Grand mal, psychomotor, focal seizures
Toxic effects	Rash, fever, drowsiness, ataxia, gum hypertrophy, (less than dilantin), neutropenia, agranulocytosis, aplastic and megaloblastic anemia.

Milontin (methylphenylsuccinimide)

Dose	0.5 g. capsules; 250 mg./4 ml. suspension.
Daily dosage	Children: 0.25-1.5 g.; adults: 2.0-4.0 g.
Symptoms	Petit mal, myoclonic, akinetic seizures, occasionally psychomotor seizures

Toxic effects	Nausea, dizziness, rash, hematuria (may be nephrotoxic)

Mysoline (primidone)

Dose	0.25 g. tablets; 250 mg./5 ml. suspension
Daily dosage	Children: 0.25-1.0 g.; adults: 0.75-2 g. The daily dosage should be built up very slowly. Blood levels: therapeutic range 5-15 /μg/ml.
Symptoms	Grand mal, psychomotor, focal seizures, occasionally petit mal; useful in combination with Dilantin
Toxic effects	Drowsiness, ataxia, dizziness, rash, nausea, leukopenia rare

Paradione (paramethadione)

Dose	0.15-0.3 g. capsules; 0.3 g/ml. solution.
Daily dosage	Children: 0.3-1.8 g.; adults: 1.2-2.4 g.
Symptoms	Petit mal, myoclonic and akinetic seizures, massive spasms, occasionally psychomotor seizures (in children); often useful in combination with Dilantin and phenobarbital; somewhat less effective and less toxic than Tridione
Toxic effects	Rash, gastric distress, visual symptoms (glare, photophobia), neutropenia, agranulocytosis

Peganone (ethylphenylhydantoin)

Dose	0.25-0.5 g. tablets
Daily dosage	Children: 0.5-1.5 g.; adults: 2.0-3 g.
Symptoms	Grand mal, psychomotor, focal seizures
Toxic effects	Similar to Dilantin but less severe; may be substituted for Dilantin, but is generally less effective

Phenobarbital

Dose	0.015, 0.030; 0.060, and 0.1 g. tablets; 4 mg./ml. elixir. Therapeutic blood level 10-30 /μg/ml.
Daily dosage	Children: 0.45-0.1 g.; adults: 0.1-0.3 g.
Symptoms	All seizure states; grand mal, petit mal, psychomotor, and other focal; most useful in limited dosage in combination with other drugs such as Dilantin
Toxic effects	Drowsiness, dulling, rash, fever; irritability and hyperactivity in some children

Phenurone (phenacemide)

Daily dosage	Children: 0.5-2.0 g.; adults: 1.5-3.0 g.
Symptoms	May be effective in all types of seizures, especially focal temporal-lobe or other psychomotor seizures; should be used only in very resistant cases
Toxic effects	A *highly* toxic drug, producing liver damage, agranulocytosis, psychotic reactions, and rashes

Tridione (trimethadione)

Dose	0.15 g. tablet; 0.3 g. capsule; 0.15 g./4 ml. solution
Daily dosage	Children: 0.3-1.8 g.; adults: 1.2-2.4 g.
Symptoms	Petit mal, myoclonic and akinetic seizures, massive spasms, occasionally psychomotor seizures (in children); often useful in combination with Dilantin and phenobarbital
Toxic effects	Rash, gastric distress, visual symptoms (glare, photophobia), neutropenia, agranulocytosis

Zarontin (ethosuximide)

Dose	0.25 g. capsule

Daily dosage	Children: 0.75-1.0 g.; adults: 1.5 g.
Symptoms	Petit mal seizures (the drug of choice, now); use with Dilantin in mixed seizure states
Toxic effects	Blood dyscrasias (pancytopenia, leukopenia), dermatitis, anorexia, nausea, drowsiness, dizziness, euphoria; disturbance of mental functions reported in some patients

The following drugs may be used in the emergency treatment of status epilepticus:

Drug	Dose
Sodium phenobarbital:	0.25-0.50 g., IV
Sodium amytal:	0.25-0.50 g., IV
Paraldehyde:	3.0 -5.0 g., IV diluted in saline, or 10-20 ml. IM
Dilantin sodium: (parenteral prep.)	0.25 g., IV or IM (to 0.5 g./24 hours)
Valium (diazepam):	10 mg., IV

More general anesthetics, such as ether, avertin, and xylocaine, have a limited usefulness in treatment of status epilepticus. Careful nursing and attention to fluid and electrolyte balance, airway, cardiac, and renal functions, and temperature control are essential. Adrenocorticotrophic hormone (ACTH) and adrenocortical steroids are used as anticonvulsants in treating massive spasm epilepsy in infancy associated with the "hypsarhythmic" electroencephalogram. A "ketogenic" diet may be helpful in certain children

and young adults, with intractable seizures.

The basic mechanisms of anticonvulsant drugs are not clearly understood. Most such drugs are neuronal depressants with certain variations in action. The hydantoin drugs have been found to reduce the synaptic activity of posttetanic potentiation; the oxazolidine (trimethadione) drugs decrease transmission during repetitive stimulation. Increased stabilization of excitable neuronal membranes probably takes place by action upon electrochemical characteristics involved in ion permeability and membrane polarization. These stabilizing effects presumably decrease the activity of the abnormal hyperexcitable neuronal aggregates in an epileptogenic focus and, more importantly, generally prevent the spread of discharge through normal neuronal circuits.

While there are many anticonvulsant drugs, none is capable of total seizure control in all patients. However, careful selection and utilization in each individual case often leads to optimal results. Each physician should learn to use a number of these drugs and to recognize disturbing side effects as early as possible. Periodic blood counts, urinalyses, and liver-function tests are necessary during administration of many of these drugs.

The majority of the anticonvulsant drugs are administered to achieve a desired effect and the dosage must be increased to the point of tolerance

without untoward toxic reactions. Blood levels should be followed (see Table 13-2). It is best to start with a drug of choice; however, a single drug does not usually achieve the desired degree of control and a second may be necessary; two drugs may be indicated initially in patients with two different types of seizure, e.g., grand mal and petit mal. The process may require weeks of adjustment and during this time the patient's and family's cooperation in reporting effects on seizure frequency or side reactions is most important. Frequent changing of drugs is to be avoided.

Unfortunately, there is no specific anticonvulsant drug for each type of seizure. However, there is one major therapeutic axiom; the petit-mal absence does require a special anticonvulsant drug, either a succinimide (Zarontin) or an oxazolidine (trimethadione). Ethosuximide (Zarontin) is generally the drug of choice for this seizure state. This group of drugs is not effective in the treatment of major generalized seizures; conversely, the hydantoins are not generally effective in petit mal. Some authors state that the drugs effective in petit mal may worsen a generalized seizure state and vice versa; adequate evidence for this generalization has not been reported to date.

Generalized seizures, grand mal, and minor motor seizures are best treated with diphenylhydantoin sodium and phenobarbital. Initially, either drug may be administered to patients with infrequent attacks, but generally

the combination of diphenylhydantoin and phenobarbital will achieve control of seizure in up to 85 percent of patients. Dosages should vary as indicated in Table 13-2. The average dose of diphenylhydantoin is 0.3-0.4 g. per day, usually administered as 0.2 g. in the morning after breakfast and 0.2 g. after dinner. The use of diphenylhydantoin has been enhanced by the determination of blood levels of the drug. The effective therapeutic range is between 10 and 20 μg/100 ml. Toxic effects usually appear at levels above this. The dosage of phenobarbital is initially 60 mg. at bedtime, with 30-mg. increments during the day if necessary; dosage is limited by its sedative effect.

Patients with psychomotor-temporal-lobe epilepsy are often more difficult to control. In these instances many trials may be necessary; the best results are to be expected with diphenylhydantoin and either phenobarbital or primidone. Although in some clinics the latter two drugs are used together, their sedative effects combine to make such administration difficult. Actually a significant amount of primidone is metabolized into phenobarbital. When employing primidone it is very important to start with doses ranging from 50 to 125 mg. per day, increasing slowly at weekly intervals to a maximum of 0.75 or 1.0 g. per day. If untoward side effects occur with diphenylhydantoin, substitution with the less reactive ethylphenylhydantoin is sometimes successful, although this drug has a weaker anticonvulsant effect. Mephenytoin and phenacemide are useful in difficult cases, but must be

utilized with extreme care because of their high toxicity.

Occasionally, a paradoxical reaction to diphenylhydantoin occurs, at a time when a high or toxic blood level is reached, or, in some instances, even at a level regarded as nontoxic but relatively high for the particular patient. This clinical state is characterized by a lapse of seizure control with actual increase in seizures, worsening of the EEG with increased paroxysmal discharges and background slow waves, and a dulling of perceptual-cognitive functions (with poor school or work performance, for example). Occasionally, focal neurological signs, such as hemiparesis, appear. There may be no usual "toxic" signs of diphenylhydantoin excess such as nystagmus or ataxia. Photic stimulation or other "alerting" stimuli may actually reduce the EEG phenomena. The term "diphenylhydantoin encephalopathy" has been applied to this state, but the mechanism of its production remains unclear. It is clinically significant, and can be treated by reduction of dosage.

Disturbances of intellectual function, along with psychotic states, reported in children treated with ethosuximide have been difficult to evaluate in relation to the seizure process and interictal state.

Certain stimulating drugs such as the amphetamines may be useful adjuncts in the therapy of certain patients, particularly to counteract sedative effects of phenobarbital or primidone without interfering with anticonvulsant

action.

It is of interest that certain drugs interfere with the metabolism of diphenylhydantoin and increase its blood levels; these include dicoumarol, phenylbutazone, disulfiram, *p*-aminosalicylate, and isoniazid.

Acetazolamide is (Diamox) an important adjuvant in some patients with any type of seizure state, since it seems to have a general effect upon hyperexcitable cerebral neurons because of its inhibition of carbonic anhydrase or production of an acidosis. Since tolerance develops, the drug should be administered intermittently; it is occasionally useful, for example, in helping to control seizures occurring prior to or during the menstrual cycle. Under these circumstances acetazoleamide is administered for a week before and during the menstrual period. Some patients require its administration continually; tolerance does not develop in all patients.

The results of drug therapy are difficult to predict. With careful attention to individual details and general patient management, the patient with occasional generalized and psychomotor seizure can achieve effective control of seizure frequency. In children with petit-mal absences, the results are generally quite satisfactory. There are in each group of patients, however, a refractory number with increasing psychological and social problems as the years go by. This is the group which requires frequent changes in drugs and in

which side effects become most troublesome.

Problems relating to drug withdrawal appear when patients achieve complete seizure control for a number of years; after two years the question of drug withdrawal is usually raised. However, in most adults with grand mal and psychomotor epilepsy, continued therapy is necessary. In relatively few patients can drug withdrawal be accomplished even after freedom from seizures for three to five years; seizures usually recur. As has been pointed out, the EEG may remain abnormal in clinically seizure free patients, indicating seizure potentiality; and even in cases in which the EGG reverts to normal, drug withdrawal may be unsuccessful.

However, a calculated risk of drug withdrawal should be considered in some patients, since successful withdrawal could represent an important psychological achievement. Drug withdrawal should be attempted extremely carefully with small decrements over many weeks. Drug withdrawal can be expected to be more successful in children with controlled petit-mal epilepsy, particularly since there is a natural tendency for petit mal to diminish with age and maturity. However, in some of these patients generalized convulsions appear even after the absences have ceased.

Dietary Treatment

In general, there are no dietary restrictions for the patient with

epilepsy, nor is there a specific diet capable of aiding most patients. However, a diet high in fat content producing significant ketosis, i.e., the "ketogenic diet," is occasionally helpful in young children, particularly those with intractable absences and minor motor seizures. Anticonvulsant drugs usually have to be continued and the diet is difficult to maintain because of its lack of appeal.

Psychological Therapy and Sociological Management

Even though drugs may achieve a significant degree of seizure control in individual patients, there are many problems related to the life and adjustment of the patient that need additional management. These are generally less marked when the seizures are under control, and require greater attention when seizures create continued problems. There are certain patients, particularly some children and adults with psychomotor-temporal-lobe seizures, who develop increased personality and behavioral disorders after seizure control; the reasons for this are not clear. In many patients, the coexistence of seizure and personality problems requires a combination of medical anticonvulsant therapy and psychologically oriented management.

Although many anticonvulsant drugs have sedative properties, these usually are not used directly. The so-called tranquilizing drugs have limited usefulness in the management of seizure patients. Chlordiazepoxide and

diazepam may reduce disturbed behavior, particularly in children. The phenothiazine drugs have variable effects; the alerting phenothiazine, fluphenazine, is of some use in controlling abnormal behavior in certain patients with psychomotor seizures. However, other drugs in the chlorpromazine group are known to provoke paroxysmal discharges in the EEG and seizures.

In most patients there is a direct interplay of emotional disturbances with clinical seizure activity; patients in a state of psychological turmoil have increased seizure susceptibility and often require greater amounts of anticonvulsant drugs. The achievement of psychological adjustment often reduces seizure frequency and intensity, and lessens drug requirement. This fact must be considered in relation to the individual patient, the age, family, and social circumstances. Family understanding is of primary importance, since the child with seizures must live, insofar as possible, as a normal individual within home and school settings. A great problem, still to be overcome, is the stigma attached to epilepsy and the lack of understanding which exists not only among people in general but in relation to various restrictive legal and social practices. Most children with seizures can attend schools and vocational programs successfully; most adults with seizures can develop productive careers and engage in activities, such as marriage, childbearing, obtaining an education, driving an automobile, traveling, and working successfully in business and industry; while so engaged they can and

should be protected by insurance and workmen's compensation programs. Only few patients require a protected environment in schools or "colonies" specifically developed for the epileptic. Even these should not be institutions in which many hundreds of epileptic patients are kept under essentially custodial care. Special treatment units or "colonies" in Great Britain, Holland, Denmark, and France are relatively small and homelike; they are designed to provide care for usually small numbers of patients at a time, involved in intensive programs of medical therapy, psychological management, education, and vocational training. From these units increasing numbers of adequately controlled patients are sent out into the general community where they can live well-adjusted and productive lives.

There are only a few occupations contraindicated for patients with a tendency toward seizures; these include activities of potential danger to either the patient or others, e.g., work requiring climbing to great heights, using heavy power equipment, or perhaps dangerous chemical substances; there may be exceptions in individual cases.

There is no medical reason to restrict driving an automobile if the patient has been seizure-free for at least two years. Furthermore, the work records of many patients with a history of seizures show that they are seldom involved in industrial accidents because they realize how important it is to their welfare to be most careful.

In a family situation, therefore, the person with epilepsy must be accepted on as normal a basis as possible; restrictive situations must be minimal, if needed at all, and a regular program of education and vocational planning should be developed. School officials frequently need appropriate orientation; most children and young adults with seizures are accepted without question by their associates.

In individual instances, both informal and formal psychotherapeutic measures can be undertaken in order to reduce emotional disturbances. The role of the family physician is all-important; often he alone can judge the problems in a family, school, or social setting and can, by his guidance and understanding, help the patient and his family overcome the feelings of despair, anxiety, fear, and self-consciousness that interfere with everyone's normal adjustment. It is only when anxieties and depressive tendencies develop into more severe reactions, associated with perhaps paranoid states, increased withdrawal, and excessive obsessional tendencies, that more intensive psychiatric treatment may become necessary. Occasionally, it is found that brief periods of appropriately oriented hospitalization with psychotherapy can help readjust or control such patients. This may also be required to evaluate the intensity of the psychological disturbance and the apparent intellectual difficulties that may be interfering with the patient's performance. Adjustment of drug schedules may be carried out at the same time. With increased experience even the child with epilepsy and behavioral

disorder can be cared for best if he can attend a normal school with an understanding environment and, in addition, be associated with a clinical outpatient service in which the functions, of the physician and social service department work together with the child and the family. It is becoming less necessary to arrange for either home tutoring or placement of such children into special schools or other facilities for the maladjusted.

"Conditioned Inhibition" or "Desensitization" Therapy

There has been much interest, in recent years, in attempting to reduce or control seizures, particularly those triggered by sensory or reflex stimuli, by "desensitization" techniques. Whether these represent "true conditioning" in the Pavlovian sense remains problematic. However the results have sometimes been interesting and therapeutically successful. Olfactory stimuli have been known to arrest uncinate seizures since the time of Jackson, and were studied in detail by Efron. Forster and his group have been involved in a number of "conditioning" therapeutic trials in patients with various kinds of sensory or reflex-induced epilepsies (reading, photic, audiogenic, especially musicogenic). These phenomena have led to experimental studies as well. In specifically selected patients, therefore, such techniques, utilizing the known stimulus in a "desensitization" or "conditioning" paradigm, may lead to effective therapy.

Surgical Therapy

There is no question that a patient with a lesion such as a brain tumor should be considered for operation, regardless of the state of the seizures. Surgical intervention with removal of a focus of abnormal discharge is considered an appropriate treatment for certain patients who have intractable focal epilepsy, after adequate trial of intensive medical care. The evaluation of such a patient, therefore, must consist of careful medical and neurological studies which should include a psychological consideration, since rehabilitation may be affected by the procedure. A focally discharging area should be determined by serial electroencephalographic studies as being fixed, and the region of brain considered for excision must be such that the patient will not be left with a severe speech, memory, or other neurological deficit.

Patients so evaluated often do not have obvious brain tumors, but the epileptogenic region involved as the discharging focus may contain a small tumor, a vascular lesion, or a scar secondary to trauma or previous encephalitis. This approach has been particularly used in patients with focal motor seizures, especially psychomotor-temporal-lobe or limbic seizures. It must be realized that even though many patients are considered for surgical therapy, few are chosen; the number of surgically treated epileptic patients is still only in the hundreds. Yet, the occasional patient carefully selected for

such surgical therapy may achieve significant control of seizures. In some series good results have been reported in up to 50 percent; unfortunately, this means that an equal number are not better controlled postoperatively. In some cases, however, less anticonvulsant medication may be required. Occasionally, generalized seizures appear instead of previous psychomotor-temporal-lobe seizures. In most of these patients it would seem that the regions of brain involved are too widespread for limited excisions to be practicable. A small number of patients have experienced relief from severe personality disturbances, particularly aggressive psychotic behavior, but the surgical intervention usually has not been primarily directed toward this end. Bilateral operations on the temporal lobe have only limited effectiveness and may produce severe memory disturbances. The use of stereotaxic neurosurgical techniques to destroy epileptogenic regions deeply seated in brain, i.e., amygdala and hippocampus, has been recommended, particularly for certain patients with psychomotor-temporal-lobe epilepsy where there is such evidence from depth electroencephalographic studies. In a small number of carefully selected children with severe infantile hemiplegia, intractable convulsions, and behavior disturbance, cerebral hemispherectomy has been performed with improvement in seizure state and behavior despite the persistence of neurologic disability.

Concluding Remarks

Much more must be learned about the natural history of the epileptic in order to evaluate thoroughly the different therapies. The question of treating the young child who has had a single febrile convulsion is typical of the problems involved. There is accumulating evidence that recurring seizures (especially with *status epilepticus*) do produce cerebral damage which may eventually cause clinical neurological dysfunction and further severe seizures. On the other hand, many infants and young children have one or a few seizures and then no more.

Proper medical therapy adequately controls most seizure states in over 60 percent of patients and partially controls an additional 25-30 percent. The drugs involved are decreasingly toxic, although anticonvulsant medication remains essentially nonspecific and broadly directed against mechanisms of neuronal hyperexcitability that are little understood. The remaining intractable patients may be considered for surgical therapy; such procedures are applicable, however as stated, to only a very small selected group. Surgical therapy is effective in only about 50 percent of those chosen. It is hoped that combined physiological and biochemical studies of disturbed cerebral and general bodily functions in epilepsy will lead eventually to more rational and effective therapy.

Bibliography

Abraham, K. and C. Ajmone Marsan. "Patterns of Cortical Discharges and Their Relation to Routine Scalp Electroencephalography," *Electroencephalogr. Clin. Neurophysiol.,* 10 (1958), 447-461.

Alstrom, C. H. "A Study of Epilepsy in its Clinical, Social and Genetic Aspects," *Acta Psychiatr. Neurol. Scand. Suppl.,* 63 (1950), pp. 1-284.

Andermann, F. "Self-Induced Television Epilepsy," *Epilepsia,* 12 (1971), 269-275.

Andermann, K., F. Berman, P. M. Cooke et al. "Self-Induced Epilepsy," *Arch. Neurol.,* 6 (1962), 49-65.

Aretaeus. The Extant Works of Aretaeus, The Cappadocian. Libri Septema. Translated by Francis Adams. London: Sydenham Society, 1856.

Bacia, T. and K. Reid. "Visual and Somato-sensory Evoked Potentials in Man, Particularly in Patients with Focal Epilepsy," *Electroencephalogr. Clin. Neurophysiol.,* 18 (1965), 778.

Baddeley, A. and K. Patterson. "Relation Between Long-term and Short-term Memory," *Br. Med. Bull.,* 27 (1971), 237-242.

Baldwin, M. and P. Bailey, eds. *Temporal Lobe Epilepsy.* Springfield, Ill.: Charles C. Thomas, 1958.

Barrow, R. L. and H. D. Fabing. *Epilepsy and the Law,* 2nd ed. New York: Harper & Row, 1966.

Bergamini, L. and B. Bergamesco. *Cortical Evoked Potentials in Man,* pp. 49-52. Springfield, Ill.: Charles C. Thomas, 1967.

Blumer, D. and A. E. Walker. "Sexual Behavior in Temporal Lobe Epilepsy," *Arch. Neurol.,* 16 (1967), 37-43.

Bingley, T., "Mental Symptoms in Temporal Lobe Epilepsy and Temporal Lobe Gliomas," *Acta Psychiatr. Neurol. Scand. Suppl.,* 120 (1958), 151.

Brierley, J. B. “Neuropathology of Amnesic States,” in C. W. M. Whitty and O. L. Zangwill, eds., *Amnesia,* pp. 150-180. London: Butterworths, 1966.

Bruens, J. H. “Psychoses in Epilepsy,” *Psychiatr. Neurol. Neurochir.*, 74 (1971), 175-192.

Buchanan, R. A. “Ethosuximide Toxicity,” in D. M. Woodbury, J. K. Penry, and R. P. Schmidt, eds., *Antiepileptic Drugs,* pp. 449-454. New York: Raven, 1972.

Cereghino, J. J. and J. K. Penry. “Testing of Anticonvulsants in Man,” in D. M. Woodbury, J. K. Penry, and R. P. Schmidt, eds., *Antiepileptic Drugs,* pp. 63-73. New York: Raven, 1972.

Cèrnacěk, J. and L. Cigànek. “The Cortical Electroencephalographic Response to Light Stimulation in Epilepsy,” *Epilepsia,* 3 (1962), 303-314.

Collins, A. L. and W. G. Lennox. “The Intelligence of 300 Private Epileptic Patients,” *Res. Publ. Assoc. Res. New. Ment. Dis.,* 26 (1947), 586-603.

Courtois, G. A., D. H. Ingvar, and H. H. Jasper. “Nervous and Mental Defects During Petit Mal Attacks,” *Electroencephalogr. Clin. Neurophysiol, Suppl.,* 3 (1953), 87.

Currie, S., K. W. G. Heathfield, R. A. Henson et al. “Clinical Course and Prognosis of Temporal Lobe Epilepsy—A Survey of 666 Patients,” *Brain,* 94 (1971), 173-190.

DallaBarba, G. “Mental Capacities of Epileptics at Intelligence Test 1,” *Arch. Psycol. Neurol. Psychiatr.,* 18 (1957), 459-488.

Davidoff, R. A. and L. C. Johnson. “Paroxysmal EEG Activity and Cognitive-Motor Performance,” *Electroencephalogr. Clin. Neurophysiol.,* 16 (1964), 343-354.

Delay, J., P. Pichot, T. Lamperiere et al. *The Rorschach and the Epileptic Personality.* New York: Logos, 1958.

Dennerll, R. D. “Cognitive Deficits and Lateral Brain Dysfunction in Temporal Lobe Epilepsy,” *Epilepsia,* 5 (1964), 177-191.

Detre, T. and R. G. Feldman. “Behavior Disorder Associated with Seizure States,” in G. H. Glaser,

ed., *EEG and Behavior,* pp. 366-376. New York: Basic Books, 1963.

Dimsdale, H., V. Logue, and M. Piercy. "A Case of Persisting Impairment of Recent Memory Following Right Temporal Lobectomy," *Neuropsychologia,* 1 (1964), 287-298.

Dongier, S. "Statistical Study of Clinical and Electroencephalographic Manifestations of 536 Psychotic Episodes Occurring in 516 Epileptics Between Clinical Seizures," *Epilepsia,* 1 (1960), 117-142.

Drachman, D. A. and J. Arbit. "Memory and Hippocampal Complex," *Arch. Neurol.* list15 (1966), 52-61.

Efron, R. "The Effect of Olfactory Stimuli in Arresting Uncinate Fits," *Brain,* 79 (1956), 267-281.

----. "The Conditioned Inhibition of Uncinate Fits," *Brain,* 80 (1957), 257— 262.

Falconer, M. A. "Some Functions of the Temporal Lobes with Special Regard to Affective Behavior in Epileptic Patients," *J. Psychosom. Res.,* 9 (1967), 25.

Falret, J. "De l'Etat Mental des Epileptiques," *Arch. Gén. Méd.* 16 (1860), 666— 679; 17 (1861), 461-491; 18 (1861), 26-37.

Fedio, P. and A. F. Mirsky. "Selective Intellectual Deficits in Children with Temporal Lobe or Centrencephalic Epilepsy," *Neuropsychologia,* 7 (1969), 287-300.

Fenton, G. W. and E. L. Udwin. "Homicide, Temporal Lobe Epilepsy and Depression: A Case Report," *Br. J. Psychiatry,* 111 (1965). 304-306.

Ferguson, S. M. and M. Rayport. "The Adjustment to Living Without Epilepsy," *J. New. Ment. Dis.,* 140 (1965), 26-37.

Fischer-Williams, M., R. G. Bickford, and J. P. Whisnant. "Occipito-parieto-temporal Seizure Discharge with Visual Hallucinations and Aphasia," *Epilepsia,* 5 (1964), 279-292.

Flor-Henry, P. "Ictal and Interictal Psychiatric Manifestations in Epilepsy: Specific or Non-specific. A Critical Review of Some of the Evidence," *Epilepsia,* 13 (1972). 772-783.

Flynn, J. P., P. D. MacLean, and C. Kim. "Effects of Hippocampal After-discharges on Conditioned Responses," in E. D. Sheer, ed., *Electrical Stimulation of the Brain,* pp. 380-386. Austin: University of Texas Press, 1961.

Flynn, J. P., M. Wasman, and D. Egger. "Behavior During Propagated Hippocampal After-discharges," in G. H. Glaser, ed., *EEG and Behavior,* pp. 134-148. New York: Basic Books, 1963.

Forster, F. M. "Clinical Therapeutic Conditioning in Reading Epilepsy," *Neurology,* 19 (1969). 717-723.

Forster, F. M. and G. B. Campos. "Conditioning Factors in Stroboscopic-induced Seizures," *Epilepsia,* 5 (1964), 156-165.

Freud, S. (1923) "A Seventeenth-Century Demonological Neurosis," in J. Strachey, ed., *Standard Edition,* Vol. 19, pp. 72-105. London: Hogarth, 1955.

----. (1928) "Dostoevsky and Parricide," in J. Strachey, ed., *Standard Edition,* Vol. 21, pp. 177-194. London: Hogarth, 1955.

Gascon, G. G. and C. T. Lombroso. "Epileptic (Gelastic) Laughter," *Epilepsia,* 12 (1971), 63-76.

Gastaut, H. "So-called 'Psychomotor' and 'Temporal' Epilepsy," *Epilepsia,* 2 (1953), 59-96.

Gastaut, H. and H. Colomb. "Etude du comportement sexual chez les epileptiques psychomoteurs," *Ann. Méd. Psychol.,* 112 (1954), 657-696.

Gastaut, H., G. Franck, W. Krolikowska et al. "Phénomènes de Déafferentation sensoriélle spécifique decélés par l'enregis-trement transcranien des potentials évoqués visuels chez des sujets présentant des crises épileptiques visuelles dons leur champ hemianapsique uni-ou bilateral," *Rev. Neurol.* (Paris), 109 (1963), 249.

Gastaut, H. and H. Regis. "Visually Evoked Potentials Recorded Transcranially in Man," in L. D. Proctor and W. R. Adey, eds., *Symposium on the Analysis of Central Nervous System and Cardiovascular Data Using Computer Methods,* pp. 8-34. Washington: NASA, SP72, 1964.

Gastaut, H., J. Roger, R. Soulayrol et al. “Childhood Epileptic Encephalopathy with Diffuse Slow Spike-waves (Otherwise known as “Petit Mal Variant”) or Lennox Syndrome,” *Epilepsia,* 7 (1966), 139-179.

Gastaut, H. and C. A. Tassinari. “Triggering Mechanisms in Epilepsy: The Electroclinical Point of View,” *Epilepsia,* 7 (1966), 85-138.

Gastaut, H. and M. Vigoroux. “Electroclinical Correlations in 500 Cases of Psychomotor Seizures,” in M. Baldwin and P. Bailey, eds., *Temporal Lobe Epilepsy,* pp. 118—128. Springfield, Ill.: Charles Thomas, 1958.

Gibbs, F. “Ictal and Non-ictal Psychiatric Disorders in Temporal Lobe Epilepsy,” *J. Nerv. Ment. Dis.,* 113 (1951), 522-528.

Glaser, G. H. “Visceral Manifestations of Epilepsy,” *Yale J. Biol. Med.,* 30 (1957), 176-186.

----. “The Problem of Psychosis in Psychomotor Temporal Lobe Epileptics,” *Epilepsia,* 5 (1964), 271-278.

----. “Limbic Epilepsy in Childhood,” *J. Nerv. Ment. Dis.*, 144 (1967), 391-397.

----. “Epilepsy and Disorders of Perception,” *Assoc. Res. Nerv. Ment. Dis.*, 48 (1970), 318-333.

----. “Diphenylhydantoin Toxicity,” in D. M. Woodbury, J. K. Penry, and R. P. Schmidt, eds., *Antiepileptic Drugs,* pp. 219-226. New York: Raven, 1972.

Glaser, G. H., R. J. Newman, and R. Schafer. “Interictal Psychosis in Psychomotor-Temporal Lobe Epilepsy. An EEG-psychological Study,” in: G. H. Glaser, ed., *EEG and Behavior,* pp. 345-365. New York: Basic Books, 1963.

Glaser, G. H. and E. C. Zuckermann. “Potassium Accumulation in Extracellular Spaces of Brain as a Possible Cause of Epileptogenic Activity,” in G. Alemà, G. Bollea, V. Floris et al., eds., *Brain and Mind Problems,* pp. 309-329. Rome: Il Pensiero Scientifico, 1968.

Goldensohn, E. S. “EEG and Ictal and Post-ictal Behavior,” in G. H. Glaser, ed., *EEG and Behavior,* pp. 293-314. New York: Basic Books, 1963.

Goode, D. J., J. K. Penry, and F. E. Dreifuss. "Effects of Paroxysmal Spike-wave on Continuous Visual-Motor Performance," *Epilepsia,* 11 (1970), 241-254.

Goodglass, H., M. Morgan, A. T. Folsom et al. "Epileptic Seizures, Psychological Factors and Occupational Adjustments," *Epilepsia,* 4 (1963), 322-341.

Gowers, W. R. (1881) *Epilepsy and other Chronic Convulsive Disorders.* London: Churchill, 1881; reprinted New York: Dover, 1964.

Green, J. B. "Reflex Epilepsy. Electroencephalographic and Evoked Potential Studies of Sensory Precipitated Seizures," *Epilepsia,* 12 (1971), 225-234.

Guerrant, J., W. W. Anderson, A. Fischer et al. *Personality in Epilepsy.* Springfield, Ill.: Charles C. Thomas, 1962.

Guey, J., M. Bureau, C. Dravet et al. "A Study of the Rhythm of Petit Mal Absences in Children in Relation to Prevailing Situations," *Epilepsia,* 10 (1969), 441-451.

Hecker, A., F. Andermann, and E. A. Rodin. "Spitting Automatism in Temporal Lobe Seizures," *Epilepsia,* 13 (1972), 767-772.

Hill, D. "Psychiatric Disorders of Epilepsy," *Med. Press,* 229 (1953), 473-475.

Hippocrates. Translated by J. Chadwick and W. N. Mann. *Medical Works of Hippocrates,* Sect. 15, p. 189. Oxford: Blackwell, 1950.

Hishikawa, Y., J. Yamamoto, E. Furija et al. "Photosensitive Epilepsy: Relationships Between the Visual Evoked Responses and Epileptiform Discharges Induced by Intermittent Photic Stimulation," *Electroencephalogr. Clin. Neurophysiol.,* 23 (1967), 320-334.

Horowitz, M. J. *Psychosocial Function in Epilepsy. Rehabilitation after Surgical Treatment for Temporal Lobe Epilepsy.* pp. 180. Springfield, Ill.: Charles C. Thomas, 1970.

Horowitz, M. J. and F. M. Cohen. "Temporal Lobe Epilepsy. Effect of Lobectomy on Psychosocial Functioning," *Epilepsia,* 9 (1968), 23-41.

Hunter, R., V. Logue, and W. H. McMenemy. "Temporal Lobe Epilepsy Supervening on Longstanding Transvestism and Fetishism," *Epilepsia, 4* (1963), 60.

Hutt, S. J. "Experimental Analysis of Brain Activity and Behavior in Children with 'Minor' Seizures," *Epilepsia,* 13 (1972), 520-534.

Hutt, S. J., P. M. Jackson, A. Belsham et al. "Perceptual-motor Behavior in Relation to Blood Phenobarbitone Level. A Preliminary Report," *Develop. Med. Child Neurol.,* 10 (1968), 626-632.

Hutt, S. J., D. Lee, and C. Ounsted. "Digit Memory and Evoked Discharges in Four Light-Sensitive Epileptic Children," *Develop. Med. Child Neurol.,* 5 (1963), 559-571.

Ives, L. A. "Learning Difficulties in Children with Epilepsy," *Br. J. Disord. Commun.*, 5 (1970), 77-84.

Jackson, J. H. On Epilepsy and Epileptiform Convulsions. Vol. 1, Selected Writings, J. Taylor, ed., London: Hodder and Stoughton, 1931.

Jackson, J. H. and W. S. Colman. "Case of Epilepsy with Tasting Movements and 'Dreamy State' A Very Small Patch of Softening in the Left Uncinate Gyrus," *Brain,* 21 (1898), 580-590.

Jasper, H. H. "Some Physiological Mechanisms Involved in Epileptic Automations," *Epilepsia,* 5 (1964), 1-20.

Jasper, H. H., A. Wards, and A. Pope. eds. *Basic Mechanisms of the Epilepsies.* Boston: Little, Brown, 1970.

Jordan, E. J. "MMPI Profile of Epileptics: A Further Evaluation," *J. Consult. Psychol.,* 27 (1963), 267-269.

Jung, R. "Blocking of Petit-mal Attacks by Sensory Arousal and Inhibition of Attacks by an Active Change in Attention During the Epileptic Aura," *Epilepsia,* 3 (1962), 435-437.

Karagullia, S. and E. E. Robertson. "Psychical Phenomena in Temporal Lobe Epilepsy and the

Psychoses," *Br. Med. J.,* 1 (1955). 748-752.

Kenna, J. C. and G. Sedman. "Depersonalization in Temporal Lobe Epilepsy and the Organic Psychoses," *Br. J. Psychiatry,* 111 (1965), 293-299.

Kimura, D. "Right Temporal Lobe Damage," *Arch. Neurol.,* 8 (1963), 264-271.

----. "Cognitive Deficit Related to Seizure Pattern in Centrencephalie Epilepsy," *J. Neurol. Neurosurg. Psychiatry,* 27 (1964), 291-295.

Kolvin, I., C. Ounsted, and M. Roth. "Cerebral Dysfunction and Childhood Psychoses," *Br. J. Psychiatry,* 118 (1971), 407-414.

Kooi, K. A. and H. B. Hovey. "Alterations in Mental Function and Paroxysmal Cerebral Activity," *Arch. Neurol. Psychiatry,* 78 (1957), 264-271.

Kreindler, A. "Active Arrest Mechanisms of Epileptic Seizures," *Epilepsia,* 3 (1962), 329-337.

Landolt, H. "Serial Electroencephalographic Investigations During Psychotic Episodes in Epileptic Patients and During Schizophrenic Attacks," in A. M. Lorentz De Haas, ed., *Lectures on Epilepsy,* Suppl. 4, pp. 91—133. Amsterdam: Elsevier, 1958.

Lennox, W. G. "Bernard of Gordon on Epilepsy," *Ann. Med. Hist.,* 3 (1941), 372-383.

Lennox, W. G. and M. A. Lennox. *Epilepsy and Related Disorders*. Boston: Little Brown, 1960.

Lockard, J. S., W. L. Wilson, and V. Uhlic. "Spontaneous Seizure Frequency and Avoidance Conditioning in Monkeys," *Epilepsia,* 13 (1972), 437-444.

Lorentz De Haas, A. M. and O. Magnus. "Clinical and Electroencephalographic Findings in Epileptic Patients with Episodic Mental Disorders," in A. M. Lorentz De Haas, ed., *Lectures on Epilepsy,* pp. 134-167. Amsterdam: Elsevier, 1958.

Loveland, W., B. Smith, and F. Forster. "Mental and Emotional Changes in Epileptics on Continuous Anticonvulsant Medication," *Neurology,* 7 (1957), 856-865.

Lugaresi, E., P. Pazzaglia, and C. A. Tassinari. "Differentiation of 'Absence Status' and 'Temporal Lobe Status,"' *Epilepsia,* 12 (1971), 77-87.

MacLean, P. D. "The Limbic System and Its Hippocampal Formation. Studies in Animals and Their Possible Application to Man," *J. Neurosurg.,* 11 (1954), 29-44.

Margerison, J. H. and J. A. Corsellis. "Epilepsy and the Temporal Lobes," *Brain,* 89 (1966), 499-530.

Matthews, C. G. and H. Kløve. "Differential Psychological Performance in Major Motor, Psychomotor, and Mixed Seizure Classifications of Known and Unknown Etiology," *Epilepsia,* 8 (1967), 116-128.

Meyer, V. "Cognitive Changes Following Temporal Lobectomy for Relief of Temporal Lobe Epilepsy," *Arch. Neurol. Psychiatry,* 81 (1959). 299-309.

Meyer, V. and A. Yates. "Intellectual Changes Following Temporal Lobectomy for Psychomotor Epilepsy," *J . Neurol. Neurosurg. Psychiatry,* 18 (1955), 44-52.

Mignone, R. J., E. F. Donnelly, and Sadowsky. "Psychological and Neurological Comparisons of Psychomotor and Non-psychomotor Epileptic Patients," *Epilepsia,* 11 (1970), 345-359.

Milner, B. "Psychological Defect Produced by Temporal Lobe Excision," *Res. Publ. Assoc. Res. Nerv. Ment. Dis*., 36 (1956), 244-257.

----. "Alteration of Perception and Memory in Man: Reflections on Methods," in L. Weiskrantz, ed., *Analysis of Behavioral Change,* pp. 268-375. New York: Harper & Row, 1968.

----. "Interhemispheric Differences and Psychological Processes," *Br. Med. Bull.* 27 (1971), 272-277.

Milner, B., S. Corkin, and H. L. Teuber. "Further Analysis of Hippocampal Amnesic Syndrome: 13 year Follow-up of M.," *Neuropsychologia,* 6 (1968), 215-234.

Mirsky, A. F., D. W. Primac, C. A. Marsan et al. "A Comparison of the Psychological Test

Performance of Patients with Focal and Non-focal Epilepsy," *Exper. Neurol.,* 2 (1960), 75-89.

Mirsky, A. F. and J. L. Tecce. "The Analysis of Visual Evoked Potentials. During Spike and Wave EEG Activity," *Epilepsia,* 9 (1968), 211-220.

Mirksy, A. F. and J. M. Van Buren. "On the Nature of the 'Absence' in Centrencephalic Epilepsy: A Study of Some Behavioral, Electroencephalographic and Autonomic Factors," *Electroencephalogr. Clin. Neurophysiol.,* 18 (1965), 334-348.

Mitchell, W., M. A. Falconer, and D. Hill. "Epilepsy with Fetishism Relieved by Temporal Lobectomy," *Lancet,* 2 (1954), 626-630.

Morocutti, C. and J. A. Sommer-Smith. "Etude des Potentials evoqués visuels dans l'epilepsie," *Rev. Neurol.,* 115 (1966), 93-98.

Naquet, R. "Conditonnement de décharge hypersynchrones epileptiques," in J. F. Delafresnaye, ed., *Brain Mechanisms and Learning,* pp. 625-640. Oxford: Blackwell, 1961.

Newcombe, F. "Memory for Designs Test," *Br. J. Soc. Clin. Psychol.*, 4 (1965), 230.

Ounsted, C. "The Hyperkinetic Syndrome in Epileptic Children," *Lancet,* 2 (1955), 303-311.

Ounsted, C., D. Lee, and S. J. Hutt. "Electroencephalographic and Clinical Changes in an Epileptic Child During Repeated Photic Stimulation," *Electroencephalogr. Clin. Neurophysiol.,* 21 (1966), 388-391.

Ounsted, C, J. Lindsay, and R. Norman. *Biological Factors in Temporal Lobe Epilepsy,* p. 135. London: Heinemann, 1966.

Penfield, W. and H. Jasper. *Epilepsy and the Functional Anatomy of the Human Brain,* p. 896. Boston: Little, Brown, 1954.

Penfield, W. and P. Perot. "The Brain's Record of Auditory and Visual Experience," *Brain,* 86 (1963), 595-696.

Piercy, M. “The Effects of Cerebral Lesions on Intellectual Function: A Review of Current Research Trends,” *Br. J. Psychiatry,* 110 (1964), 310-352.

Pond, D. A. “Psychiatric Aspects of Epilepsy,” *J. Indian Med. Profess.,* 3 (1957), 1441-1451.

----. Psychiatric Aspects of Epileptic and Brain-damaged Children,” *Br. Med. J.,* 2 (1961), 1377-1382, 1454-1459.

----. “Psychological Disorders of Epileptic Patients,” *Psychiatry Neurol. Neurochir.,* 74 (1971), 159.

Prechtl, H. F. R., P. E. Bocke, and T. Schut. “The Electroencephalogram and Performance in Epileptic Patients,” *Neurology,* 11 (1961), 296-304.

Price, J. C. and T. J. Putnam. “The Effect of Intrafamily Discord on the Prognosis of Epilepsy,” *Am. J. Psychiatry,* 100 (1944), 593-598.

Prichard, J. W. and G. H. Glaser. “Cortical Sensory Evoked Potentials During Limbic Seizures,” *Electroencephalogr. Clin. Neurophysiol.,* 21 (1966), 180-184.

Putnam, T. J. and H. H. Merritt. “Dullness as an Epileptic Equivalent,” *Arch. Neurol. Psychiatry,* 45 (1941), 797-813.

Quadfasel, A. F. and P. W. Pruyser. “Cognitive Deficit in Patients with Psychomotor Epilepsy,” *Epilepsia* (Ser. 1), 4 (1955), 80-90.

Rapoport, D., M. Gill, and R. Schafer. *Diagnostic Psychological Testing.* London: University of London Press, 1970.

Raven, J. C. *Guide to Using the Mill Hill Vocabulary Scale with Progressive Matrices.* London: Lewis, 1948.

----.*Guide to Using Progressive Matrices.* London: Lewis, 1949.

Rennick, P. M., C. Perez-Borja, and E. A. Rodin. “Transient Mental Deficits Associated with Recurrent Prolonged Epileptic Clouded State,” *Epilepsia,* 10 (1969), 397-405.

Reynolds, E. H. "Mental Effects of Anticonvulsant Drugs and Folate Metabolism," *Brain,* 91 (1968), 197-214.

Ricci, G., G. Berti, and E. Cherubini. "Changes in Intrictal Focal Activity and Spike-wave Paroxysms During Motor and Mental Activity," *Epilepsia,* 13 (1972), 785-794.

Richer, P. *Etudes Cliniques sur L'Hystéro-épilepsie ou Grande Hystérie.* Paris: Adrien Delahaye et Emile Lecrosnier, 1881.

Robertson, E. G. "Photogenic Epilepsy: Self-Precipitated Attacks," *Brain,* 77 (1954), 232-261.

Rodin, E. A. *The Prognosis of Patients with Epilepsy.* Springfield, Ill.: Charles C. Thomas, 1968.

Rodin, E. A., R. N. DeJong, R. W. Waggoner et al. "Relationship between Certain Forms of Psychomotor Epilepsy and 'Schizophrenia,' " *Arch. Neurol. Psychiatry,* 77 (1957), 449-463.

Rodin, E. A., S. Gonzalez, D. Caldwell et al. "Photic Evoked Responses During Induced Epileptic Seizures," *Epilepsia,* 7 (1966), 202-214.

Rodin, E. A., D. W. Mulder, D. L. Faucet et al "Psychologic Factors in Convulsive Disorders of Focal Origin," *Arch. Neurol. Psychiatry,* 74 (1955), 365-374.

Roger, J., H. Grangeon, J. Grey et al. "Psychiatric and Psychological Effects of Ethosuximide Treatment in Epileptics," *Encephale,* 57 (1968), 407-438.

Roth, M. and M. Harper. "Temporal Lobe Epilepsy and the Phobic-Anxiety Syndrome, Part 2," *Compr. Psychiatry,* 3 (1962), 215-226.

Schwab, R. S. "Method of Measuring Consciousness in Attacks of Petit Mal Epilepsy," *Arch. Neurol. Psychiatry,* 41 (1939), 215-227.

Schwartz, M. L. and R. D. Dennerll. "Neuropsychological Assessment of Children with, without and with Questionable Epileptogenic Dysfunction," *Percept. Mot. Skills.,* 30 (1970), 111-121.

Scott, D. F., A. Moffett, A. Mathews et al. “Effect of Epileptic Discharges on Learning and Memory in Patients,” *Epilepsia*, 8 (1967), 188-194.

Scoville, W. B. “Amnesia after Bilateral Mesial Temporal-lobe Excision: Introduction to Case H.M.” *Neuropsychologia,* 6 (1968), 211-213.

Serafetinides, E. A. “Aggressiveness in Temporal Lobe Epileptics and Its Relation to Cerebral Dysfunction and Environmental Factors,” *Epilepsia,* 6 (1965), 33-42.

Serafetinides, E. A. and M. A. Falconer. “Some Observations on Memory Impairment after Temporal Lobectomy for Epilepsy,” *J. Neurol. Neurosurg. Psychiatry,* 25 (1962), 251-255.

Servit, Z., J. Machek, A. Stercova et al. “Reflex Influences in the Pathogenesis of Epilepsy in the Light of Clinical Statistics,” *Epilepsia,* 3 (1962), 315-322.

Shallice, T. and E. K. Warrington. “Independent Functioning of Verbal Memory Stores: A Neuropsychological Study,” *Q. J. Exp. Psychol.,* 22 (1970), 261-273.

Shimazono, Y., T. Hirai, T. Okuma et al. “Disturbance of Consciousness in Petit Mal Epilepsy,” *Epilepsia,* 2 (1953), 49-55.

Slater, E., A. W. Beard, and E. Glithero. “The Schizophrenia-like Psychoses of Epilepsy,” *Br. J. Psychiatry,* 189 (1963), 95-150.

Small, J. G., V. Milstein, and J. R. Stevens. “Are Psychomotor Epileptics Different?” *Arch. Neurol.,* 7 (1962), 187-194.

Stevens, J. R. “Psychiatric Implications of Psychomotor Epilepsy,” *Arch. Gen. Psychiatry,* 14 (1966), 461-471.

Stevens, J. R., G. H. Glaser, and P. D. MacLean. “The Influence of Sodium Amytal on the Recollection of Seizure States,” *Trans. Am. Neurol. Assoc.,* 79 (1954), 40-45.

Symonds, C. “Excitation and Inhibition in Epilepsy,” *Brain,* 82 (1959), 133-146.

Taylor, D. C. "Aggression and Epilepsy," *J. Psychom. Res.,* 13 (1969), 229-235.

----. "Sexual Behavior and Temporal Lobe Epilepsy," *Arch. Neurol.,* 21, (1969), 510-516.

----. "Ontogenesis of Chronic Epileptic Psychoses: A Reanalysis," *Psychol. Med.,* 1 (1971), 247-253.

----. "Psychiatry and Sociology in the Understanding of Epilepsy," in E. M. Mandelbrote and M. G. Gelder, eds., *Psychiatric Aspects of Medical Practice,* pp. 161-187. London: Staples Press, 1972.

----. "Mental State and Temporal Lobe Epilepsy. A Correlative Account of 100 patients Treated Surgically," *Epilepsia,* 13 (1972), 727-765.

Temkin, O. *The Falling Sickness,* p. 380. Baltimore: The Johns Hopkins Press, 1945.

Tizard, B. and J. H. Margerison. "Psychological Functions during Wave-Spike Discharge," *Br. J. Soc. Clin. Psychol.,* 3 (1963), 6-15.

Walker, A. E. "Murder or Epilepsy?" *J. Nerv. Ment. Dis.,* 133 (1961), 430-437.

Warrington, E. K. "Neurological Deficits," *in P. Mittler, ed., The Psychological Assessment of Mental and Physical Handicaps*, pp. 261-287. London: Methuen, 1971.

Warrington, E. K. and M. James. "Disorders of Visual Perception in Patients with Localized Cerebral Lesions," *Neuropsychologia,* 5 (1967), 253-266.

Warrington, E. K. and P. Rabin. "A Preliminary Investigation of the Relation between Visual Perception and Memory," *Cortex,* 6 (1970), 87-96.

Wechsler, D. *The Measurement of Adult Intelligence,* 3rd ed., Baltimore: Williams & Wilkins, 1944.

Whitty, C. W. M. and O. L. Zangwill, eds. *Amnesia.* London: Butterworths, 1966.

Williams, D. "The Structure of Emotions Reflected in Epileptic Experience," *Brain,* 79 (1956), 29-67.

----. “Man’s Temporal Lobe,” *Brain,* 91 (1968), 639-654.

Yeager, C. L. and J. S. Guehrant. “Subclinical Epileptic Seizures: Impairment of Motor Performance and Derivative Difficulties,” *Calf. Med.,* 86 (1957), 242-247.

Notes

1 The assistance of Helen Sanders Brittain in the preparation of portions of this chapter is gratefully acknowledged.

2 Raven’s matrices consists of a graded series of patterns in which one part is missing and the correct missing part is chosen by the subject from a collection of six (or later in the test eight) alternatives. At its simplest, the task requires only matching a pattern, but at its most complex, the grasp of a subtle relationship between the parts of the system is required.