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THE PERIPHERAL PATHWAY FOR PAINFUL SENSATIONS *

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Claude Bernard's observation of the pain produced by stimulation of the anterior roots and the failure of section of the posterior roots to relieve the pain of gastric crises, herpes zoster or causalgia have given rise to doubt of the validity of the Bell-Magendie law. In 1911, Leonard Kidd proposed that pain could be conducted antidromically over the anterior roots. In recent years this theory has been supported by Lehmann (Breslau), 1920; Foerster, 1920; Lehmann (Göttingen), 1920; Shawe, 1922, and Wartenburg, 1926. Lehmann and Shawe stated that the anterior roots regularly convey deep sensibility. Foerster and Wartenburg believed that the sensory fibers carried by the anterior roots are only auxiliary ones which transmit a particular type of deep sensation, and function chiefly when the posterior roots are interrupted. We do not propose to enter into a discussion based on the observations of others or to present a complete bibliography of such observations. The clinical data on which the validity of the Bell-Magendie law is questioned has been analyzed carefully, and a complete bibliography has been given in the excellent article of Wartenburg.[1]

Lehmann [2] described two personal cases. In one there was section of the fifth cervical to the first dorsal posterior roots and in another the fourth to the eighth cervical posterior roots were severed. In both of these cases total cutaneous anesthesia occurred only over the ordinary

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1. Wartenburg, R.: Klinischen Studien zur Frage der Geltung des Bell-Magendieschen Gesetzes, Ztschr. f. d. ges. Neurol. u. Psychiat. **113**:518, 1928.

2. Lehmann, W.: Zur Frage der Wurzelresektion bei gastrischen Krisen, Zentralbl. f. Chir. **2**:1558, 1920.

distribution of the ulnar nerve. Shawe [3] has referred to the cases of Hey Groves, Thorburn, Bennett, Knapp, Kilvington, and Abbe. Because they are generally quoted by others, it is of interest to note the character of these cases. The first case reported by Hey Groves [4] was that of a patient with tabes dorsalis on whom section of the third lumbar to the third sacral posterior roots was performed. This produced such a complete loss of sensation that a subsequent excision of the knee joint was performed painlessly without an anesthetic. Despite this, the preexisting shooting pains returned. The second case was that of a patient with a painful indolent ulcer over the tibia on whom section of the fourth lumbar to the third sacral posterior roots was performed. Little loss of sensation followed, and at a second operation it was found that some of the nerve filaments had been left to each divided root. Curiously enough, after complete section of these fibers cutaneous analgesia resulted up to a hand's breadth below the groin. Nevertheless, pain returned in the area of the ulcer. Thorburn [5] reported a case of rupture of the brachial plexus. At the operation, which was performed because of pain in the extremity, the fifth cervical to the first dorsal posterior roots were severed. They had been found matted together and adherent to the arachnoid, so that only the sixth cervical root was well defined. The preexisting pain returned, and deep sensibility was present everywhere. In two other cases, deep sensibility was conserved in the thoracic wall after section of the fifth to the ninth and the fifth to the eighth dorsal posterior roots, respectively.

Bennett [6] reported a case in which it was found at autopsy that the first to the fifth lumbar and the first to the second sacral posterior roots had been divided, although a rapid restoration of sensation had been observed. Knapp [7] resected the sixth to the eighth cervical posterior roots for a painful amputation stump, but there was subsequently a return of pain. Kilvington [8] resected the sixth cervical to the first dorsal posterior roots extradurally for relief from a painful amputation neuroma, and in addition severed the anterior roots. The pain disappeared permanently. Abbe [9] resected the fifth cervical to the first dorsal

3. Shawe, R. C.: The Gastric Crises of Tabes Dorsalis and Their Surgical Treatment, Brit. J. Surg. **9**:450, 1922.

4. Groves, E. W. H.: On the Division of the Posterior Spinal Nerve Roots, Lancet **2**:79, 1911.

5. Thorburn, W.: Rhizotomy, Brit. J. Surg. **2**:229, 1914-1915.

6. Bennett, William: Case 46.—Painful Amputation Stumps, Brit. J. Surg. **2**: 234, 1914.

7. Knapp, P. C.: Division of the Posterior Spinal Roots for Amputation Neuralgia, Boston M. & S. J. **158**:149, 1908.

8. Kilvington, quoted by Knapp (footnote 7).

9. Abbe, Robert: Intradural Section of the Spinal Nerves for Neuralgia, Boston M. & S. J. **135**:329, 1896.

posterior roots and the sixth cervical to the first dorsal anterior roots for relief from pain referred into the region of a previously amputated athetoid arm.

It may be said from the character of these few cases that the assumption of the existence of antidromic sensory fibers in the anterior roots was based: (1) on the observations that all sensation did not disappear from an expected area following section of the posterior roots; (2) that pain was not relieved, or returned, after section of the posterior roots, and (3) that pain did disappear permanently after section of the anterior and posterior roots.

Wartenburg [1] carefully analyzed the material collected from reported cases. He called attention to the fact that the pathologic process may spread to other roots, and that there is a possibility that the pain may originate central to the root section. He called attention also to changes at a distance in the spinal cord, to possible regeneration, to the changes due to trauma and hemorrhage at the operation, to the fact that overlap may occur over as many as five segments and to the fact that at autopsy in many cases only a few of the supposedly large number of roots have been found severed. He also described cases in which an operation was performed for gastric crises. We believe that it is unnecessary to refer to them because the pathogenesis of such pain is unknown. In addition to the cases already referred to, he noted a number of others in which section of the posterior roots was performed for relief from "neuralgia" without a satisfactory result. Among these are the cases of Elsberg and Beer, Chauvanauz, Jacoby, Lehmann (Breslau), Hildebrandt, Sargent and Sicard. After reading the original reports, we are of the opinion that the latter cases fall into four groups. In the first group are those in which an insufficient number of roots have been cut. In the second are cases in which the patient was operated on for relief from pain caused by an amputation neuroma; of course, these cases do not permit of an adequate sensory examination. In the third class are cases in which the pathogenesis of the pain is unknown, for example, postherpetic pain or that which accompanies syphilitic neuritis and arachnoiditis. Finally, there is a group of cases in which the subsequent loss of sensation occupied an area less extensive than was expected. Unless controlled by autopsy or judged in relation to the known existence of wide overlap, the last group of cases seems to us to be valueless.

Wartenburg referred to cases that he observed personally in Foerster's clinic. Many of these cases were described in Foerster's own publications. Among these descriptions were those of patients who had preservation of deep sensibility over the thoracic wall after section of the thoracic posterior roots. Serious objections may be made to these

observations because the underlying pectoral, serratus magnus and latissimus dorsi muscles are supplied by the cervical segments of the spinal cord. In other patients, deep sensibility was present after several, but not all, of the posterior roots which supply the part were sectioned. His conclusions, which are in general accord with Foerster's, were that after section of the posterior roots it is likely that a special kind of deep sensibility of the subcutaneous structures travels over the anterior roots to a varying degree in individual cases.

The opinion of Foerster [10] and the reports of the cases on which he based his opinion deserve careful consideration. However, it is futile to argue from his observations, and a dissenting interpretation would only confuse the issue. In his monograph, Foerster referred to the fact that in 1920 he described a case of spastic torticollis in which the first to the fourth cervical posterior and the second to the third cervical anterior roots were severed. In this patient, electrical stimulation of the occipitalis minor, auricularis magnus and cutaneous colli nerves produced pain. He repeated this experiment in another case in which the first to the fifth cervical posterior and the first to the third cervical anterior roots were resected with the same result. In a case in which the second lumbar, third lumbar, fifth lumbar to the first sacral and the second sacral posterior roots were resected, stimulation of a deep branch of the tibialis nerve produced a severe pain in the sole. Foerster also described the retention of deep sensibility in two cases of section of the sixth to the tenth dorsal posterior roots. In two cases in which the second lumbar, third lumbar, fifth lumbar to the first sacral and the second sacral posterior roots were severed, cutaneous sensibility was lost over the little toe, and deep sensibility was diminished to a great extent but was not entirely lost. In one of these cases in which the second lumbar, third lumbar, fifth lumbar to the first sacral and the second sacral posterior roots were sectioned on both sides, the anterior roots of the first and second sacral nerves were also cut on the left side. Although deep sensibility was completely absent in the left fourth and fifth toes, it was conserved on the right.

In 1924, Foerster [11] formulated his ideas concerning the transmission of painful impulses. He believed that the anterior, as well as the posterior, root contain afferent fibers. The posterior roots subserve the chief sensory system, and when a sufficient number of roots are severed a sensory defect results. The anterior roots subserve only an

10. Foerster, O.: Die Leitungsbahnen des Schmerzgefühls und die chirurgische Behandlung der Schmerzzustände, Berlin, Urban & Schwarzenberg, 1927.

11. Foerster, O., quoted by Wartenburg: Verhandl. d. Gesellsch. Deutsch. Nervenärtzte, 1924.

auxiliary function in that their isolated interruption never is followed by a sensory defect; only when the chief pathway, through the posterior roots, is interrupted do they function in varying individual degrees. Foerster stated that this vicarious function of the anterior roots deals chiefly with deep sensibility, but that cutaneous fibers also travel over the anterior roots.

In a more recent contribution, Foerster, Altenburger and Kroll [12] noted an observation which to them seemed to prove the existence of afferent fibers in the anterior roots. In one patient the thoracic sympathetic chain was resected from the sixth to the tenth ganglion. During this operation the ninth thoracic nerve was ligated close to its exit from the intervertebral foramen. This produced severe pain. At the same time the adjacent intercostal artery was ligated. At a subsequent operation, the seventh to the eleventh dorsal posterior roots were resected. Despite these procedures, the pain continued. Since the sympathetic chain had been resected, they stated that the pain could have entered into the spinal cord only through the anterior roots. They did not believe that it was possible for the pain to have been transmitted through the sixth or twelfth posterior roots, because a plexiform structure of the thoracic nerves in this region cannot be considered.

Foerster has observed a case, verified at operation, of a rupture of the brachial plexus from the fourth cervical root downward and distal to the entrance of the rami communicantes. The intercostohumeral nerve was also injured. This patient retained a residue of deep-seated pain in the upper extremity, although it was completely paralyzed and anesthetic. Hard pressure on the fingers produced a dull pain. According to Foerster, the only afferent pathway that was intact was by way of the periarterial plexuses of the branches of the subclavian artery which end in the sympathetic ganglionic chain. He also cited a case of total interruption of the three lower roots of the brachial plexus, the seventh and eighth cervical and the first dorsal, distal to the entrance of the rami communicantes. This patient had a total anesthesia of the skin of the third, fourth and fifth fingers and of the ulnar half of the hand, forearm and arm. Hard pressure on the little finger still produced a definite pain. When the nervi digitalis volaris proprius ulnaris of the little finger was exposed and stimulated with a faradic current, no pain ensued. However, when the digital artery was so stimulated, the patient felt a definite sticking pain in the little finger. In this instance, Foerster believed that the sensory impulses were conducted through the periarterial plexus directly into the sympathetic chain. He

12. Foerster, O.; Altenburger, H., and Kroll, F. W.: Ueber die Beziehungen des vegetativen Nervensystem zur Sensibilität, Zschr. f. d. ges. Neurol. u. Psychiat. **121**:140, 1929.

believed that in the upper extremity some of the afferent fibers are sympathetic and in part reach the sympathetic chain through the rami communicantes of the spinal nerves from the arms and partly through the vascular plexus of the subclavian artery and its branches. In either case they reach the sympathetic ganglion and from there travel through the upper thoracic roots first to fifth dorsal into the spinal cord.

What is true for the upper extremity he thought is also true for the lower. In a case of a gunshot wound of the cauda equina, associated with severe pain, the twelfth dorsal to the fifth sacral posterior roots and the first to the fifth lumbar anterior roots were resected. The pain was not relieved, and, what is more important, the patient felt pressure in the leg, and a diffuse pain could be produced. In this case afferent impulses could pass only through the rami communicantes of the lumbosacral nerves or by the periarterial network of the tibial, popliteal, femoral and iliac arteries and the aorta, to end directly in the sympathetic ganglionic chain. From there he believed that they enter the spinal cord by way of the thoracic roots.

This brief abstract outlines the clinical evidence for the assumption of an antidromic sensory pathway in the anterior roots. The experimental evidence began with the observation of Claude Bernard that stimulation of the anterior roots produced pain. Since then there have been but few important contributions to the literature on this subject.

Recently, Lehmann [13] noted that section of the posterior roots in dogs did not destroy visceral sensibility. He concluded that the sensory fibers of the splanchnic nerves travel over the anterior roots. Later, he severed the anterior fifth to the eighth dorsal roots and found no visceral sensibility. Kodama's [14] experiments supported this conclusion. Shawe [15] found that section of the fourth to the seventh lumbar and the first and second sacral posterior roots, with a transverse section of the cord at the second sacral segment, resulted in a retention of deep sensibility in a certain number of animals. On the other hand, after resection of the fourth cervical to the second dorsal posterior roots in the upper extremities and eleventh dorsal to the fifth sacral posterior roots to the lower extremities, Meyer [16] found that all sensation, superficial and deep, was destroyed.

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13. Lehmann, W.: Ueber die sensiblen Fasern der vorderen Wurzeln, Klin. Wchnschr. **3**:1895, 1924.

14. Kodama, Sakuji: A Further Report on the Effect of Stimulation of the Sensory Nerves Upon the Rate of Liberation of Epinephrine from the Suprarenal Glands, Zentralbl. f. d. ges. Neurol. u. Psychiat. **39**:255, 1925.

15. Shawe, R. C.: A Study of Intractable Pain Relative to Rhizotomy and Spinal Section, Brit. J. Surg. **11**:648, 1923.

16. Meyer, A. W.: Ueber die fraglichen sensiblen Fasern der vorderen Wurzeln, Deutsche Ztschr. f. Chir. **199**:38, 1926.

We shall describe the complete loss of all sensibility that resulted from section of all of the posterior roots to an upper extremity in man and shall present experimental evidence that we believe further supports the Bell-Magendie law.

REPORT OF CASE

History.—A young man suffering from the sequelae of epidemic encephalitis in the form of a parkinsonian state applied to us for help. The rigidity was so great as to make life unbearable. Despite the administration of large and sustained

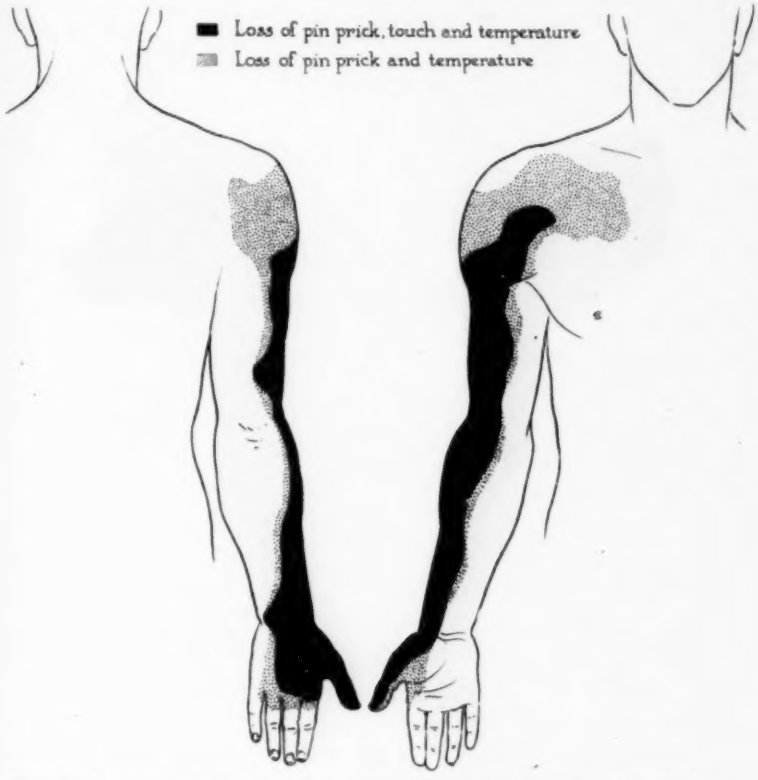

Fig. 1.—Loss of sensation after section of the right fourth, fifth, sixth, seventh and eighth cervical posterior roots on Dec. 14, 1928.

doses of scopolamine, he was often unable to assist himself in the simplest wants. We thought that it was justifiable to section the posterior roots that supplied the right upper extremity, which was the more rigid, in the hope that if the rigidity disappeared, subsequent muscle reeducation would make the limb serviceable.

Operations and Results.—On Dec. 14, 1920, under local anesthesia, a laminectomy was performed on the third, fourth, fifth and sixth cervical vertebrae. The fourth, fifth, sixth, seventh and eighth cervical posterior roots on the right side were ligated and sectioned. The sensory loss, as illustrated in figure 1, occupied chiefly the areas ordinarily attributed to the fifth, sixth and part of the seventh cervical segments. Therefore, on Jan. 9, 1929, again under local anesthesia, a

laminectomy was performed on the seventh cervical and on the first, second and third dorsal vertebrae. The first, second, third and fourth right dorsal posterior roots were sectioned. Sensory examination at this time showed complete loss of pain, touch and temperature sense over the entire right upper extremity and the upper part of the thoracic wall extending downward to the nipple line. The area of loss of touch slightly exceeded this border, and the loss of cold was slightly more extensive than the loss of touch. Passive movement of the segments about the joints of the fingers, wrist and elbow were not recognized. Vibration sense was absent over the elbow, wrist, fingers and thumb, and he was unable to describe

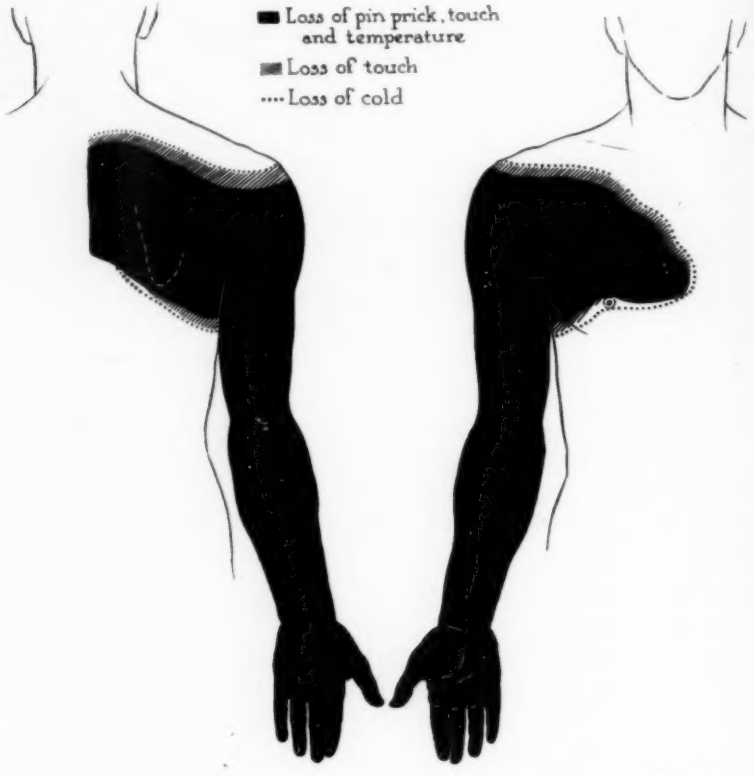

Fig. 2.—Loss of sensation after section of the right first, second, third and fourth thoracic posterior roots in the same patient on Jan. 9, 1929.

the position passively imposed on the extremity. Deep pin prick and piercing the skin were not felt on the forearm, lower part of the arm, wrist or fingers. Pinching with an artery forceps did not produce pain, and piercing the median basilic vein, scratching its intima and lacerating it produced no pain. No sensation was experienced on the prolonged application of a distended cuff of a sphygmomanometer, and its release was not accompanied by any sensation. Compressing a segment of a vein and distending it with physiologic solution of sodium chloride produced no pain. Piercing the radial artery, distending a segment of it with saline solution and lacerating it produced no sensation. The upper border of the loss of deep sensation and pressure pain was not outlined at this time (fig. 2).

Reexamination.—On April 7, 1930, the patient was reexamined. The upper level of pressure sensation was bounded by a line 1½ inches (3.7 cm.) below the loss of touch. The loss of deep pressure pain sense, with a 6 Kg. stimulus, was bounded by a line about 2 inches (5 cm.) below the loss of touch. It is of interest that deep pressure pain could not be elicited over the upper part of the chest, because the supply to the pectoral, serratus magnus and latissimus dorsi muscles had been interrupted (fig. 3). The most severe twisting and pinching of the skin

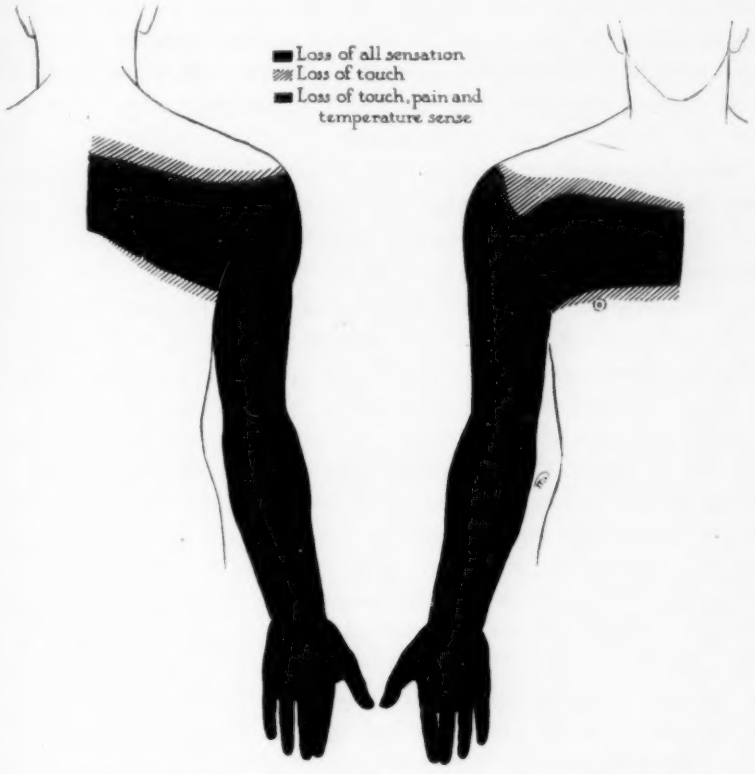

Fig. 3.—Loss of sensation in the same patient on April 7, 1930.

was not felt, and transfixing the skin with a hypodermic needle did not evoke any sensation. About 1 cc. of a solution of neoarsphenamine was injected about the median cephalic vein, and, although inflammatory changes were produced, no sensation was felt. The radial artery was transfixed by a needle electrode, and no sensation was felt on stimulation by a strong faradic current.

COMMENTS

Conclusions drawn from observations of one case ordinarily may not carry much weight. If we were eliciting some positive facts it, alone, would be worthless, but we are determining loss of function.

Therefore, we think that we are justified in assuming that if all of the posterior roots to an upper extremity are sectioned, all sensation, cutaneous and deep, will be lost.

It is notable that the decerebrate animal is particularly sensitive to all forms of stimuli. Such a preparation reacts not only to cutaneous painful stimuli, but also to touch and particularly to those sensations that travel over the proprioceptive system. The positive Stütz reactions described by Schoen and Pritchard and the ipsolateral extensor thrust may be evoked by the mildest pressure. Ipsolateral flexion and rebound phenomena and contralateral thrusts are readily and constantly evoked by nociceptive stimuli such as pricking or pinching the toes with a forceps. When it is necessary to expose a nerve or vessel in an extremity, to separate muscles in a fascial plane or to sever the fascia, a tremendous muscular reflex movement is produced. Faradic stimulation of an exposed artery produces an ipsolateral flexion and a contralateral extension.

It was thought that such a preparation would be admirable for the purpose of studying the effect of posterior root section and denervation of the extremities. The roots of the brachial plexus were cut distal to the rami communicantes in six cats. No sensation was felt in the extremities of any of these animals on touching, pricking, piercing the skin, transfixing the skin, subcutaneous tissue and muscles, scraping the periosteum or crushing the toes. Some time later, these animals were decerebrated by the anemic method. Stimulation of the denervated extremity by pinching, cutting the skin, stimulation of the arterial walls and nerves, cutting the aponeurosis, stripping the periosteum or crushing the bones did not produce any crossed reflexes in the normally innervated opposite upper extremity. It is obvious that had any sensation been present contralateral thrusts would have been evoked promptly. In seven other cats the fourth cervical to the sixth dorsal posterior roots to the right fore leg were sectioned intradurally. No evidence of pain was elicited by pinching or piercing the skin or by transfixing the subcutaneous tissue and muscles of the right upper extremity in any of these animals. They had only an attitude of awareness due to movement of the insensitive extremity which was transmitted to the body.

At later dates these cats were decerebrated by the anemic method. The insensitive extremity participated in the rigidity assumed by the other legs. It reacted normally to tonic neck and labyrinthine reflexes. Crossed extension was produced in it by flexor responses to painful stimuli applied to the opposite upper extremity. Not a single reflex movement on the same or opposite side could be elicited by any form of stimulation of the affected extremity. Pricking the skin, pushing

against the foot pad, incising the skin or the aponeurosis, fascia, muscle or nerves, stimulating the vessels and nerves with a faradic current, scraping the periosteum and crushing the bones all failed to produce the slightest motor response. Of particular interest is the following observation, which was seen in all of the animals at times. When the brachial artery was stimulated with the faradic current, some overflow of the current resulted, and a contraction of the locally stimulated muscles of the affected extremity occurred. Never was there any contralateral reflex movement such as constantly occurs when sensory impulses from the stimulated extremity are not interrupted.

CONCLUSIONS

1. Section of the posterior roots that supply the upper extremity in cats interrupts all forms of sensation, superficial and deep, that would evoke any reflex response.

2. Section of the brachial plexus in decerebrated cats prevents any contralateral reflexes from any form of cutaneous or deep stimulation of the denervated extremity.

3. No evidence of a sensory pathway through the sympathetic nervous system was found in decerebrated cats.

4. Section of the posterior roots that supply the upper extremity in man interrupts all form of superficial or deep sensation.

ABSTRACT OF DISCUSSION

Dr. William G. Spiller, Philadelphia: One of the most thorough studies on the effect of division of the posterior roots on sensation has been made recently by Wartenburg. I know him to be a careful observer. He spent several months in my department at the University of Pennsylvania a few years ago. In his exhaustive critical study of the literature and of his own cases, he comes to the conclusion that the observations are contradictory. The explanation of this may be found in the difficulties attending testing of sensation. Much depends on the attention, the power of concentration, the exhaustibility, the intelligence and the cooperation of the patient. The investigator may deceive himself. He may have a preconceived idea of what he is going to find. Many of the published reports are incomplete, and in some cases all forms of sensation have not been tested. The tests have not been invariably made by those familiar with neurologic technic. In some cases portions of posterior roots have been overlooked, or the posterior roots have not been accurately recognized. Foerster acknowledged that at first he found the technic difficult. It is not permissible to brush aside as unimportant the conclusion of such a master diagnostician as Foerster and to question the correctness of his observations, although it is allowable to be reserved regarding the acceptance of their interpretation.

The work of Davis and Pollock is a valuable contribution to this disputed subject. It shows that in their one case in man and in their experimental work on cats they were able to abolish the afferent impulses in the parts concerned in the operation, but have they nullified the dissimilar observations of other

careful investigators? It does not appear to me that they have done so. We have to consider the transmission of sensation in some way through the sympathetic system as advocated by Foerster and his colleagues, by Mixter and White and by Fay. As the sympathetic fibers from the neck enter the spinal cord through the upper thoracic roots, these roots may not have been cut in the attempt to relieve pain by operation on the roots of the brachial plexus.

I cannot believe that the presence of sensory fibers in anterior roots has been satisfactorily determined. I am willing to believe that a certain variation in sensory tracts in different persons may be possible. Can it be possible that some persons may have afferent fibers in motor roots and others not have them? It seems to me improbable that it should be so, and yet I know that motor tracts do show a marked variation.

In *Brain*, in 1899, and later in the *Neurologisches Centralblatt* in 1902, I published the description of a previously unknown tract coming from the pyramidal tract in the pons, which I could trace down into the ventrolateral portion of the upper part of the spinal cord, and this direct ventrolateral pyramidal tract has been accepted by Ziehen in his work on anatomy.

A sharp distinction must be made in the value of persistent objective disturbance of sensation and persistent subjective pain after operation. The latter may originate in the spinal cord or brain and be referred to definite peripheral parts of the body. I have seen pronounced subjective disturbance of sensation referred to the feet produced by a lesion in the upper thoracic part of the cord. I have published studies on central pain produced by lesions in the spinal cord or elsewhere in the central nervous system, and so have other investigators.

Dr. Mills reported a case in the *Therapeutic Gazette*, in 1911, which I had the opportunity of studying with him, in which the anterior and posterior sixth, seventh and eighth cervical roots were torn out by a blow on the shoulder. Dr. Frazier operated and cut the posterior fifth cervical and first thoracic roots. Twenty-seven days after this operation the patient still had spontaneous pain in the arm, but it was more bearable, and a burning sensation or hyperalgesia in the distribution of the fourth cervical and the second thoracic segments had in large measure disappeared. It had been present before that. The patient had a referred pain excited in the arm by stroking the hyperalgesic area on the chest, that is, touch of the left side of the trunk above the nipple produced sharp pain on the inner side of the left arm.

The interpretation of that seems to me to be that the pain was a referred one, and this was the interpretation which Dr. Mills gave at that time. Frazier and Skillern later also reported the case, in an elaborate form.

Dr. Charles H. Frazier, Philadelphia: The subject which Dr. Davis and Dr. Pollock have presented is of scientific interest and real practical importance. I well remember the original communication of Leonard Kidd when it appeared in the *British Medical Journal* in August, 1911, and reviewed Lehmann's contribution when it came out in 1921. These were confined, however, to the part played by the anterior roots in the sensation of the visceral organs. In our own clinic either Dr. Grant or myself has had an opportunity to section the posterior roots for one reason or another in over thirty cases, for a variety of painful conditions: carcinoma or sarcoma of the spine or neck, gunshot wounds of the plexuses, painful stump, herpes zoster and several other lesions. I have not had an opportunity to extract or to digest all the material from that series which might be germane to this discussion, but I have assembled enough information to enable me to make a few general statements.

Without going into detail, I may say that the outstanding impression gathered from this varied experience has been this: the extraordinary variation in the results on the one hand as to the relief from pain, and, on the other, as to the extent of anesthetic loss. Because of this variation of the results in a considerable number of cases, I have been wondering whether one is justified in dogmatizing on the basis of a single observation, striking as it is, such as that reported by the authors of the paper we are discussing. We must admit, of course, what is generally conceded, that in certain cases we have not cut a large enough number of roots.

To illustrate the variation in results, I may cite briefly one or two examples. In two cases of gastric crises the same number of roots were sectioned, the seventh, eighth, ninth and tenth posterior thoracic roots. In the one case there was a band of anesthesia from the ninth costal cartilage to the umbilicus with complete relief from pain; in the other, there was a limited zone of anesthesia with no relief. And again, in a third case there was relief for three months followed by recurrence.

I might recite an experience similar to that of Lehmann's in which the section of five roots was followed by a limited zone of anesthesia.

More recently, influenced by the agitation as to the efferent fibers as carriers of pain, I planned an operation on a woman who was suffering intolerable pain from a carcinomatous invasion of the axilla, following an inoperable carcinoma of the breast. In that case I crushed the second, third, fourth, fifth, sixth, seventh, eighth cervical and first thoracic fibers of the posterior roots and the fifth, sixth, seventh, eighth cervical and first thoracic fibers of the anterior roots. While the patient was able to abandon the use of drugs altogether, she still complained bitterly of pain, and the result was most disappointing.

Whether or not the efferent fibers carry the impulses of deep sensibility, as proposed by Lehmann, Foerster and others, I have observed in certain instances that all forms of sensation were lost but deep sensibility conserved.

In many instances it is difficult to draw conclusions, because after months of intense suffering the patients' morale is broken, a number are morphine addicts, and, although there may be a well defined area of anesthesia in the zone to which pain is referred, the patient may continue to complain of pain.

That the efferent system carries sensory impulses has been demonstrated in both man and lower forms of life. In the amphibian, the facial, acoustic and vagus nerves each has a large sensory function.

Reference has been made by the authors to the uncertainty of results in the neuralgia of herpes. Of all lesions, the results in herpes have been the most disappointing, in fact, so disappointing that I have declined to operate again in any case of herpetic neuralgia; this applies not only to the herpes of the distribution of the intercostal zone, but to that in the trigeminal zone as well, where resection of the supra-orbital nerve, for example, is disappointing in its results.

These scattering observations do not prove or disprove the essayists' contentions, but may be accepted only as emphasizing the confusion if not the chaos that prevails at the present time in the interpretation of the results of rhizotomy. The subject is one which will bear further investigation. A larger series of observations must be made, contrasting a series in which only efferent fibers have been cut with a series in which both afferent and efferent fibers have been cut.

Dr. Andrew H. Woods, Iowa City: I demonstrated a patient before the Philadelphia Neurological Society in 1920, in whom there were several features that still leave questions unanswered even after we have given full weight to the

observations set forth so clearly by Dr. Davis and Dr. Pollock. There was sufficient evidence that the sensory root of the trigeminus on the right side had been cut by one of the best known surgeons. At a still earlier operation another surgeon had dissected out the anterior half of the gasserian ganglion. These operations had been done in an effort to remedy what had been considered trigeminal neuralgia. The paroxysms of pain had commenced about four years before I saw the patient. They followed a compound fracture of the right mandible with ensuing sepsis and necrosis.

The whole area of the right trigeminus was anesthetic to light touch, light pressure and to small differences in temperature. But pricking, light scratching and all suddenly applied stimuli were followed by severe paroxysms of pain. The patient described this: "I don't feel you touch me, but I get a shot of pain and then know you must have touched me." In the process of a sensory examination, the instant one passed from the trigeminal area over into the cervical dermatomes all forms of sensation were perceived in the ordinary way.

In this man, the element of surprise or fear appeared to make available some unusual route for afferent impulses. Many of us have noted this phenomenon in cases of causalgia.

I asked the Philadelphia Neurological Society whether this condition could be explained on any other basis than that afferent impulses aroused by certain forms of stimulation entered the brain by the perivascular sympathetic fibers. At that time we discussed the possibility that the afferent route for these impulses was in the centripetal fibers of the seventh, ninth or tenth nerves.

Since 1920, I have seen two other cases which showed the same peculiarities. All three of these patients suffered from neuralgia-like paroxysms of pain after inflammatory lesions in the region of the trigeminal nerve.

I am aware that without autopsy to demonstrate that all the sensory fibers of the trigeminal root have been cut, one cannot exclude the trigeminus itself as the afferent pathway for the impulses in these patients that aroused the paroxysms of pain.

In referring to these cases, however, I speak of "afferent impulses" and not "sensory impulses," for in them no sensory discrimination was made. Some form of impulse aroused in the skin of the face traveled to the brain and started an explosion of pain. This pain was referred to the trigeminal area. We are not in position to claim that the afferent pathway was through the perivascular sympathetic fibers, but the evidence thus far seems to me to leave a presumption in favor of that as the route.

Dr. Byron Stookey, New York: Dr. Davis and Dr. Pollock pointed out an important fact when they said that in cutting dorsal roots one must be sure of the location of the lesion that is producing the pain. If one does not know what the pain is or what is causing it, it is possible that the dorsal roots may be cut successfully and still the pain be present.

Dr. Frazier called attention to the fact that no success is obtained in cutting the supra-orbital nerve in herpes of the trigeminal nerve, but I believe that the dorsal roots should be sectioned. Furthermore, there are, as Dr. Spiller has pointed out, definite variations, not only as to the course which the afferent system takes, but definite variations in the innervation of both the upper and lower extremity. We know that there is no such thing as a normal brachial plexus and a normal sacral plexus. We always think of a plexus for either the upper or lower extremity as being either prefixed or postfixed. There is no way that I know of determining whether one is dealing with a prefixed or postfixed

brachial or lumbar plexus. Therefore it is necessary, if one is going to cut the dorsal roots successfully, to cut sufficiently wide in order to take in this overlap or rather this variation in the segment.

The paper by Dr. Davis and Dr. Pollock is conclusive, because they have a definite entity in this particular experiment and in their clinical work. They have cut successfully the dorsal roots without any residual afferent impulses going through. I believe that if these cases are followed carefully and only the cases in the literature reviewed in which it is certain that all the roots are cut, and in which the pathologic process is known, the results will conform with those of Davis and Pollock.

Dr. Sidney I. Schwab, St. Louis: As I understand it, this was a postencephalitic residual condition. What kind of a sensory subject in the writer's experience is one with a postencephalitic residual condition?

Dr. E. A. Spiegel, Vienna: We have made some experiments on fibers in the roots. We sectioned from the eighth cervical down to the fourth thoracic segment and found no pain reactions either from the aorta or from the stellate ganglion after cutting these roots. It is always difficult to know whether one stimulates the peripheries, the skin or the muscle, or whether one has not forgotten some form of reaction.

Dr. Wilder G. Penfield, Montreal: Have Dr. Pollock and Dr. Davis been able to conclude what the mechanism of sympathetic pain is? Of course, they do not deny there is sympathetic pain. Do the sympathetic afferents simply enter the posterior roots and go directly into the cord as Head and McKenzie believe, or is there a reflex, and does the posterior root feel the sympathetic pain at the periphery?

Dr. Pollock: I wish to thank those members who have so ably discussed our paper and at the same time to express a regret that some sight has been lost of the purpose of the communication. As we stated in the paper, which was not read in full, we had no intention to review critically the clinical observations of other men, and we felt it exceedingly hazardous to draw any conclusions from the work of others. What we wished to do was to present further experimental proof in animals that we were unable to find any residue of cutaneous or deep sensibility in such animals after deafferention of an extremity or denervation of the extremity. It so happens that we had one case in man which illustrated this point, and we felt that as this extremity was completely deafferented it was a positive indication in support of the Bell-Magendie law.

We stated that in regard to the opinion of Foerster and his reports of cases that they deserve exceedingly careful consideration, and that it is futile to argue from his observations and a dissenting interpretation would only confuse the issue.

It is, however, as Dr. Spiller has pointed out, probably permissible to scrutinize somewhat the character of the cases on which this dissenting idea of the validity of the Bell-Magendie law has been again brought forth. His earlier cases deal chiefly with section of the posterior roots or section of the posterior and anterior roots of the upper cervical roots with pain about the face or about the neck and so on.

It seems to us that the overlap from all of the other nerves, cranial as well as spinal, would make these cases unsuitable for experimental purposes.

Dr. Spiller refers to a number of cases in which there is a conservation of deep sensibility over the chest after section of the posterior root of the dorsal nerves. It is exceedingly striking that attention has not been called to the fact

that the underlying muscles in the thoracic region receive their nerve supply from the cervical roots and not from the dorsal, noting as we do the wide distribution of the infraspinal portion of the trapezius, the serratus, the pectorals, etc.

We feel in relation to gastric crises that they are not permissible from the standpoint of experimental interpretation because no one knows where the pain originates. We feel that it is not enough to state that a pain does not disappear after section of the posterior roots. We think that the criterion of whether a painful sensation is carried by a certain tract is dependent on our ability to demonstrate the absence or preservation of sensibility in the area so supplied.

In my personal experience with lesions of peripheral nerves, I have never seen a case of complete section of the ulnar nerve or of the brachial plexus in which the ulnar nerve distribution has been interrupted and resection and suture done so that one might determine that the nerve is interrupted, in which any sensibility exists in the terminal phalanges of the little finger.

In regard to Dr. Frazier's cases, I am familiar with some of them, most of those that have been published, and I am sure that his observations are correct. It is on such observations that the validity of the Bell-Magendie law has been called into question. If one cuts the seventh, eighth, ninth and tenth dorsal roots, certainly not many roots have been cut. The underlying muscles and the aponeuroses still receive their innervation from the cervical segments. Limited zones of analgesia have been found after five roots have been cut. That only means, then, either that insufficient roots were cut, as will be found at autopsy, or that in this particular case the overlap was greater. There has been no evidence that cutting any anterior root in addition to a posterior root, however few or many have been cut, has ever increased the area in which cutaneous sensibility had existed.

That the cranial motor nerves carry sensory fibers, of course, we well know, and Dr. Davis pointed out the existence of the sensory pathway in the seventh nerve. Sensory fibers do run with the motor nerve, but I do not think that that is comparable at all to a spinal root.

In regard to Dr. Woods' discussion, all the sensibility in the face has not been interrupted by section of the fifth nerve because the seventh nerve remains intact.

We consider a patient suitable for sensory examination who has a degree of alertness sufficient to permit him to reply to questions, who on comparison of the two sides gives responses that are definitely critical, who feels with a reasonable amount of accuracy, epicritic sensibility and who is unable to feel any type of sensibility to crushing of periosteum or other things noted by Dr. Davis. Our case, of course, is of no great importance in itself.

Finally, we wish to call attention to these facts: that the decerebrate animal is an exquisite preparation for the determination of responses to sensory stimulation; that the slightest stimulus will elicit a muscular reaction, and that there has been no evidence to show that any reflex response occurs after section of the posterior roots or destruction of the brachial plexus.

CEREBRAL BLOOD FLOW

I. THE EFFECT OF INTRAVENOUS ADMINISTRATION OF HYPERTONIC AND HYPOTONIC SOLUTIONS ON THE VOLUME FLOW OF BLOOD THROUGH THE BRAIN *

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The series of studies, of which this is the first, is concerned with the effect of certain changes produced in the brain and its surroundings on the volume of flow of blood through the brain and through the body as a whole. The discovery in the dog of two large venous sinuses which apparently drain a considerable portion of the blood from the brain and which are readily accessible offered a means of approach to the first point.

These venous channels have been called the "occipitovertebral sinuses," and their course and the method of obtaining blood from them have been described in detail elsewhere (Pilcher [1]). They arise from the transverse sinus on each side, course outside the dura overlying the cerebellum and make their way into the vertebral canal. Their point of greatest accessibility is just superior to the arch of the atlas. Experimental evidence has been presented to show that the direction of blood flow in these sinuses is from the transverse sinuses downward, and that a large amount of blood from the brain returns through them.

The oxygen content of venous blood as an index to local volume of flow of the blood has been employed by many investigators (Lundsgaard,[2] Harrop,[3] Blalock,[4] Harrison and Pilcher [5]). If the consumption of oxygen of a given part is assumed to remain constant, the volume of flow of blood varies inversely with the arteriovenous oxygen difference

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1. Pilcher, C.: A Note on the Occipito-Vertebral Sinus of the Dog, Anat. Rec. **44**:363, 1930.

2. Lundsgaard, C.: Studies of Oxygen in the Venous Blood, J. Exper. Med. **27**:179, 199 and 217, 1918.

3. Harrop, G. S.: The Oxygen and Carbon Dioxide Content of Arterial and of Venous Blood in Normal Individuals and in Patients with Anemia and Heart Diseases, J. Exper. Med. **30**:256, 1919.

4. Blalock, A.: Oxygen Content of Blood in Patients with Varicose Veins, Arch. Surg. **19**:898 (Nov.) 1929.

5. Harrison, T. R., and Pilcher, C.: Studies in Congestive Heart Failure: I. The Effect of Edema on Oxygen Utilization, J. Clin. Investigation **8**:259 (Feb.) 1930. Blalock, A.; Pilcher, C., and Harrison, T. R.: Blood Flow Through Edematous Extremities, Am. J. Physiol. **89**:589, 1929.

(utilization of oxygen). The factor of consumption of oxygen will be discussed later.

The present report deals with the oxygen contents of arterial blood and of blood from the occipitovertebral sinus before and after the intravenous administration of hypertonic and hypotonic solutions. The variations in cerebrospinal fluid pressure produced by such solutions have been well known and they have been widely used clinically since the original publications of Weed and McKibben [6] and Weed and Hughson.[7] Further, these solutions have been employed in studies of the cerebral circulation. Wolff and Forbes [8] observed, photographed and measured the vessels of the pia mater through a window in the skull before and after the intravenous injection of hypertonic solutions. They found that such injections caused (after a brief period of fluctuation) a constriction of the pial vessels, which was maintained for at least forty-five minutes. (The same authors [9] observed a dilatation of the pial vessels after increasing the cerebrospinal fluid pressure through a needle in the cisterna magna.) Kubie and Hetler,[10] using color photography of the cortex through a similar window in the skull, observed a heightened intensity of color (i. e., a vascular dilatation) after intravenous administration of hypertonic solutions and a diminished intensity of color after hypotonic solutions. They also observed the same reaction as described by Wolff and Forbes in the pial vessels, and suggested that while hypertonic solutions caused a constriction of arterioles and venules in the pia, they also caused a dilatation of the capillaries of the brain. Hence they believed that the volume of blood in the brain probably increased as the cerebrospinal fluid pressure (and volume) diminished. Cushing [11] observed, but did not measure, the same phenomena in ani-

6. Weed, L. H., and McKibben, P. S.: Pressure Changes in the Cerebro-Spinal Fluid Following Intravenous Injection of Solutions of Various Concentrations, Am. J. Physiol. **48**:512, 1919; Experimental Alteration of Brain Bulk, ibid. **48**:531, 1919.

7. Weed, L. H., and Hughson, W.: Systemic Effects of the Intravenous Injection of Solutions of Various Concentrations, with Especial Reference to the Cerebro-Spinal Fluid, Am. J. Physiol. **58**:53, 1921; The Cerebro-Spinal Fluid in Relation to the Bony Encasement of the Central Nervous System as a Rigid Container, ibid. **58**:85, 1921.

8. Wolff, H. G., and Forbes, H. S.: The Cerebral Circulation: IV. The Action of Hypertonic Solutions, part 1, Arch. Neurol. & Psychiat. **20**:73 (July) 1928.

9. Wolff, H. G., and Forbes, H. S.: The Cerebral Circulation: V. Observations of the Pial Circulation During Changes in Intracranial Pressure, Arch. Neurol. & Psychiat. **20**:1035 (Nov.) 1928.

10. Kubie, L. S., and Hetler, D. M.: The Cerebral Circulation: IV. The Action of Hypertonic Solutions; part II. A Study of the Circulation in the Cortex by Means of Color Photography, Arch. Neurol. & Psychiat. **20**:749 (Oct.) 1928.

11. Cushing, H.: Some Experimental and Clinical Observations Concerning States of Increased Intracranial Tension, Am. J. M. Sc. **124**:375, 1902.

mals with increased intracranial pressure. Weed and McKibben [12] demonstrated a diminution in the bulk of the brain following intravenous injection of hypertonic solutions, but believed that this was due to shrinkage of the brain substance itself as a result of increased osmotic pressure of the blood and independent of changes in blood volume.

Wolff and Blumgart [13] studied the velocity of flow of blood through the brain, using a modification of the radium-emanation method of Blumgart and Yens [14] before and after increasing the cerebrospinal fluid pressure through a needle in the cisterna magna. They observed that "if through an increase in intracranial pressure, the arterio-venous pressure difference becomes small, the velocity of the intracranial blood-flow is slowed." However, they believed that, "through cerebral vasodilatation, the flow, though slowed, is increased in volume and the circulation remains adequate." The latter concept, though in accord with the observations of Wolff and Forbes on pial vessels, is contrary to those of Kubie and Hetler, who observed that a marked pallor of the cortex resulted from the increased cerebrospinal fluid pressure which followed the injection of hypotonic solutions.

The present study throws more direct light on the subject of volume of flow.

METHODS

Dogs were used in the twenty-one experiments performed. Twelve were given sodium barbital, 0.3 Gm. per kilogram of body weight intravenously. The remaining nine were given morphine sulphate, approximately 0.015 Gm. per kilogram of body weight subcutaneously. No experiment was begun until the animal had had morphine at least two and one-half hours or barbital at least one hour. The occipito-atlantoid ligament was then exposed by a midline incision and separation of the muscles. From twenty to thirty minutes later, the first sample of blood was drawn from the occipitovertebral sinus. In nine experiments a sample of arterial blood was also obtained from the left ventricle or femoral artery. This was not done in all instances, because the degree of change in arterial oxygen content was not found to be sufficiently great to affect significantly the change in arteriovenous oxygen difference.

The oxygen content of samples of blood was determined in duplicate in the Van Slyke-Neill [15] constant volume apparatus. Approximately one-half hour after the first samples were drawn, a second control determination was done. The solution selected was then injected slowly into a femoral vein, and in eight experiments samples of blood were drawn immediately after the injection. In all experi-

12. Weed and McKibben (footnote 6, second reference).

13. Wolff, H. G., and Blumgart, H. L.: The Cerebral Circulation: VI. The Effect of Normal and of Increased Intracranial Cerebrospinal Fluid Pressure on the Velocity of Intracranial Blood Flow, Arch. Neurol. & Psychiat. **21**: 795 (April) 1929.

14. Blumgart, H. L., and Yens, O. C.: Studies on the Velocity of Blood Flow: I. The Method Utilized, J. Clin. Investigation **4**: 1, 1927.

15. Van Slyke, D. D., and Neill, J. M.: The Determination of Gases in Blood and Other Solutions by Vacuum Extraction and Manometric Measurement, J. Biol. Chem. **61**: 525, 1924.

ments another determination was done after the lapse of from one to one and one-half hours, and further determinations were made two or more hours after the injection in six experiments.

The hypertonic solutions injected were 50 per cent dextrose, approximately 16 cc. per kilogram of body weight, and 30 per cent sodium chloride, 10 cc. per kilogram. Distilled water, 20 cc. per kilogram, was injected to obtain hypotonic effects. In two control experiments isotonic saline solution of comparable volume (20 cc. per kilogram) was injected intravenously and its effect determined.

The effects of these solutions on the blood pressure and cerebrospinal fluid pressure have been studied by Wolff and Forbes,[8] Weed and Hughson [16] and Hamm and Pilcher,[17] among others, and were not determined in these experiments.

RESULTS

Since control determinations made approximately one-half hour apart in no instance varied more than 0.5 per cent by volume, it can reasonably be assumed that the animals were in a constant basal state. Average figures for these determinations are given in the tables.

TABLE 2.—*The Effect of Intravenous Injection of 50 Per Cent Dextrose on the Oxygen Utilization of the Brain*

		Average Control			1 Hour After Injection			
Dogs*	Weight, Kg.	Arterial Oxygen Content, per Cent by Volume	Occipito-vertebral Sinus Oxygen Content, per Cent by Volume	Oxygen Utilization, per Cent by Volume	Arterial Oxygen Content, per Cent by Volume	Occipito-vertebral Sinus Content, per Cent by Volume	Oxygen Utilization, per Cent by Volume	Change in Oxygen Utilization from Control, per Cent by Volume
H9	6.2	15.24	11.40	3.84	12.08	7.92	4.16	+0.32
H11	6.7	15.24	11.28	3.96	15.72	10.08	5.64	+1.68
H12	6.2	15.79	10.94	4.85	14.70	7.78	6.92	+2.06
H13	7.3	15.40	12.13	3.27	15.76	9.22	6.54	+3.27

* All the animals received barbital.

Effect of Hypertonic Solutions.—Eleven experiments were done with 50 per cent dextrose and two with 30 per cent sodium chloride. In four of the former and both of the latter an arterial blood sample was obtained and analyzed with each venous sample.

The results following intravenous injection of dextrose are given in tables 1 and 2. Immediately after the injection there was a marked fall in both arterial and occipitovertebral sinus oxygen contents, with a moderate diminution in utilization of oxygen. Within thirty minutes, however, the circulation became stabilized, and the observations were approximately the same for several hours thereafter.

The arterial oxygen content, except in one instance (dog H9, table 1), showed no great change. The oxygen content of the blood from the

16. Weed and Hughson (footnote 7, second reference).

17. Hamm, L., and Pilcher, C.: Cerebral Blood Flow: The Effect of Hypertonic and Hypotonic Solutions on the Cardiac Output of the Dog, to be published.

occipitovertebral sinus diminished appreciably in every instance, the average diminution being 2.89 per cent by volume. The utilization of oxygen increased in all experiments in which the arterial oxygen content was determined.

TABLE 2.—*The Effect of Intravenous Injection of 50 Per Cent Dextrose on the Occipitovertebral Sinus Oxygen Content*

Dog	Weight, Kg.	Anesthetic*	Average Control: Occipitovertebral Sinus Oxygen Content, per Cent by Volume	30 Minutes After Injection: Occipitovertebral Sinus Oxygen Content, per Cent by Volume	30 Minutes After Injection: Change from Control, per Cent by Volume	1 to 1½ Hours After Injection: Occipitovertebral Sinus Oxygen Content, per Cent by Volume	1 to 1½ Hours After Injection: Change from Control, per Cent by Volume	Additional Data
H1	4.5	M	9.07	9.86	+0.79	.....	.....	50 cc. distilled water intravenously; occipitovertebral oxygen then 6.01 per cent by volume
H2	9.2	M	10.29	9.87	−0.42	9.33	−0.96	
H3	7.6	M	12.39	.....	.....	8.99	−3.40	Later determinations, 9.84 and 8.87 per cent by volume
H4	9.7	M	13.56	12.47	−1.09	12.23	−1.23	
H5	6.4	M	9.69	.....	.....	8.48	−1.21	
H7	9.3	B	12.62	4.81	−7.81	4.81	−7.81	Later determination, 4.21 per cent by volume
H8	8.0	B	17.43	13.76	−3.67	13.88	−3.55	Immediately after injection, 10.7 per cent by volume

* In this column, M indicates morphine and B, sodium barbital.

TABLE 3.—*The Effect of Intravenous Injection of 30 Per Cent Sodium Chloride on the Oxygen Utilization of the Brain*

Dog	Weight, Kg.	Anesthetic*	Average Control: Arterial Oxygen Content, per Cent by Volume	Average Control: Occipitovertebral Sinus Oxygen Content, per Cent by Volume	Average Control: Oxygen Utilization, per Cent by Volume	1 Hour After Injection: Arterial Oxygen Content, per Cent by Volume	1 Hour After Injection: Occipitovertebral Sinus Oxygen Content, per Cent by Volume	1 Hour After Injection: Oxygen Utilization, per Cent by Volume	1 Hour After Injection: Change in Oxygen Utilization from Control, per Cent by Volume
E1	5.4	B	16.65	13.79	2.86	15.46	8.79	6.67	+3.81
E2	6.4	B	14.62	11.41	3.21	14.27	9.63	4.64	+1.43

* In this column, B indicates sodium barbital.

Thirty per cent sodium chloride was given intravenously in two experiments for comparison with the effects of dextrose. The changes found were essentially the same as with the former solution (table 3).

Effect of Hypotonic Solutions.—Distilled water was given intravenously in eight experiments (tables 4 and 5). In three the arterial oxygen contents, as well as the oxygen contents of blood from the

occipitovertebral sinus, were determined. In two of the three there was no significant change in arterial oxygen content, and in the third the diminution found was not sufficiently great to make the change in utilization of oxygen differ qualitatively from those found in the other animals (dog T7, table 4). Changes occurring immediately after the injection were variable and cannot be considered as significant, since there are obviously rapid changes in the fluid balance of blood and tissues.

TABLE 4.—*The Effect of Intravenous Injection of Distilled Water on the Oxygen Utilization of the Brain*

			Average Control			1 Hour After Injection			
Dog	Weight, Kg.	Anesthetic*	Arterial Oxygen Content, per Cent by Volume	Occipitovertebral Sinus Oxygen Content, per Cent by Volume	Oxygen Utilization, per Cent by Volume	Arterial Oxygen Content, per Cent by Volume	Occipitovertebral Sinus Content, per Cent by Volume	Oxygen Utilization, per Cent by Volume	Change in Oxygen Utilization from Control, per Cent by Volume
T6	7.2	B	23.16	19.26	3.96	23.04	15.72	7.32	+3.36
T7	8.0	B	19.92	15.84	4.08	16.56	9.96	6.60	+2.52
T8	9.6	B	11.93	10.14	1.79	11.93	10.50	1.43	−0.36

* In this column, B indicates sodium barbital.

TABLE 5.—*The Effect of Intravenous Injection of Distilled Water on the Occipitovertebral Sinus Oxygen Content*

			Average Control: Occipitovertebral Sinus Oxygen Content, per Cent by Volume	Immediately After Injection: Occipitovertebral Sinus Oxygen Content, per Cent by Volume	½ to 1 Hour After Injection		Later	
Dog	Weight, Kg.	Anesthetic*			Occipitovertebral Sinus Oxygen Content, per Cent by Volume	Change from Control, per Cent by Volume	Occipitovertebral Sinus Oxygen Content, per Cent by Volume	Change from Control, per Cent by Volume
T1	10.0	B	14.42	4.68	11.30	−3.12	11.30	−3.12
T2	12.0	B	15.20	15.08	13.39	−1.81	13.39	−1.81
T3	9.3	B	14.96	10.01	12.18	−2.78	13.63	−1.39
T4	9.0	B	13.68	13.19	12.59	−1.09	.....	.....
T5	8.7	B	9.13	7.69	6.49	−2.64	6.49	−2.64

* In this column, B indicates sodium barbital.

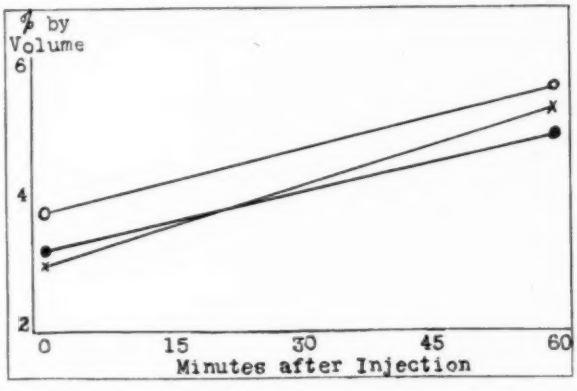
After thirty minutes, however, a period of stability lasting several hours was reached. With a single exception, the occipitovertebral sinus oxygen content diminished from 1.09 to 5.88 per cent by volume; in the one exception (dog T8) there was a rise of 0.36 per cent. The average change was a fall of 2.55 per cent by volume. The utilization of oxygen increased 3.36 and 2.52 and diminished 0.36 per cent by volume, respectively, in the three experiments in which arterial oxygen was determined. Later determinations showed a persistence of the same changes.

The average changes occurring after the administration of all three solutions are shown graphically in the accompanying chart.

Following intravenous injection of isotonic saline solution there was an immediate temporary slight diminution in utilization of oxygen (probably a blood dilution effect), but the values for arterial and venous oxygen contents quickly returned to and were maintained at a normal level.

COMMENT

As previously mentioned, any interpretation of these observations in terms of volume of flow of blood depends on the assumption of a constant, or almost constant, consumption of oxygen by the tissues concerned. Such an assumption seems justifiable in these experiments for several reasons. First, dextrose, which might be expected to influence consumption of oxygen because it is readily oxidized in the tissues, had precisely the same effect on utilization of oxygen as did hypertonic sodium chloride, a substance that does not undergo oxidation. Further,



The close quantitative relationship produced by 50 per cent dextrose, 30 per cent sodium chloride and distilled water. The chart represents average values for determinations of utilization of oxygen before and one hour after the injections.

these two substances have the same effect on consumption of oxygen by the body as a whole, namely, an inconstant rise, usually very slight (Hamm and Pilcher [17]). There is no reason to suppose that changes in intracranial pressure cause a local alteration in consumption of oxygen.

If it is assumed then that in these experiments the consumption of oxygen of the brain is relatively constant, they indicate a decrease in volume of flow of blood through the brain following the intravenous administration of both hypertonic and hypotonic solutions.

Since the total capillary volume is far greater than that of the larger vessels, it is probable that the changes in capillaries (i. e., in the intensity of the color of the cortex) observed by Kubie and Hetler [10] are of greater significance in the estimation of changes in the volume of the

brain's vascular bed at a given time than are the changes in arterioles and venules of the pia observed by them and by Wolff and Forbes.[8] Therefore, it is probable that intravenous injection of hypertonic solutions results in a dilatation, and injection of hypotonic solutions in a constriction of the capillaries of the cortex and in an increase and decrease, respectively, in the volume of blood in the brain at any given time.

If this is true and if the volume of flow of blood is diminished after injection of both hypertonic and hypotonic solutions (as reported herein), one would expect the velocity of intracranial flow to be diminished by both types of solution. The observations of Wolff and Blumgart [13] are suggestive evidence in confirmation of this hypothesis.

The changes reported in this paper may be due to the alterations in intracranial pressure produced by the solutions injected, or to the effects of these solutions on the cerebral vessels or on the circulation as a whole. Further experiments bearing on the mechanism of such changes are in progress.

SUMMARY

The oxygen content of arterial blood and of blood from the occipitovertebral sinuses, which drain a large amount of the blood flowing through the brain, has been studied before and after the intravenous injection of 50 per cent dextrose, or 30 per cent sodium chloride and of distilled water.

The blood, variable in its oxygen content immediately after the injections, reached a point of stability within thirty minutes and this was maintained for several hours.

After thirty minutes there was rarely any significant change in arterial oxygen content, but the oxygen content of blood from the occipitovertebral sinus was invariably diminished markedly after the injection of both hypertonic and hypotonic solutions. The arteriovenous oxygen difference (utilization of oxygen) increased after injection of both types of solutions.

It is thought that these results indicate probably a diminution in volume flow of blood through the brain after intravenous injection of both hypertonic and hypotonic solutions.

CEREBRAL BLOOD FLOW

II. THE EFFECT OF INTRAVENOUS INJECTION OF HYPERTONIC AND HYPOTONIC SOLUTIONS ON THE CARDIAC OUTPUT AND BLOOD PRESSURE *

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In the first paper of this series [1] it was reported that both hypertonic and hypotonic solutions, when injected intravenously, caused an increase in the oxygen utilization of the brain, and this is believed to indicate a diminished volume flow of blood through the brain. To determine whether these changes were the result of the variations in cerebrospinal fluid pressure produced by the solutions injected or of a more general effect of the solutions on the circulation as a whole, two types of investigation seemed indicated, namely, determination of the effect of these solutions on the general circulation and of the effect of increased intracranial pressure produced by other means. The present report deals with the effects of intravenous injection of hypertonic and hypotonic solutions on the cardiac output and blood pressure.

METHODS

Eighteen experiments were done, dogs being used in all experiments. Twelve of the animals were given morphine sulphate (approximately 0.015 Gm. per kilogram of body weight) three hours before the experiment was begun and were placed on the table one-half hour before the experiment was started. In five experiments, the animals were given sodium barbital (0.3 Gm. per kilogram of body weight) intravenously at least one hour before the beginning of the experiments. In all instances except one the animals were quiet throughout the experiments. In this instance the animal struggled, and the experiment was discarded. Duplicate control determinations of cardiac output were made approximately one-half hour apart, and control blood pressure tracings were made at the same intervals. If the control determinations were not in close agreement with each other, they were repeated. (This was necessary in only one instance.)

After control determinations were made, the solution selected was slowly injected into a femoral vein. A blood pressure tracing was made during and for a short time after the injection. The cardiac output and blood pressure were again

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1. Pilcher, C.: Cerebral Blood Flow: I. The Effect of Intravenous Administration of Hypertonic and Hypotonic Solutions on the Volume Flow of Blood Through the Brain, Arch. Neurol. & Psychiat., this issue, p. 899.

determined one hour after the end of the injection. This interval was chosen because at its end the oxygen consumption and blood oxygen contents had reached a constant level. Other determinations were made two hours after the injection in seven experiments.

The solution injected was 50 per cent dextrose (10 cc. per kilogram of body weight), 30 per cent sodium chloride (5 cc. per kilogram) or distilled water (20 cc. per kilogram).

The cardiac output was determined according to the principle of Fick:[2]

$$\frac{\text{Total cc. oxygen consumed per minute}}{\text{Arteriovenous blood oxygen difference per cc.}} = \text{cc. of blood passing through the lungs per minute.}$$

The oxygen consumption was determined with the Benedict-Roth spirometer, the animal being attached to it by means of the Blalock[3] mask. Mixed venous blood was drawn under oil from the right ventricle and arterial blood from the left ventricle or femoral artery. The oxygen content of the blood was determined in the Van Slyke-Neill[4] constant-volume apparatus.

The mean blood pressure was recorded by means of a mercury manometer connected with a cannula in the femoral artery.

RESULTS

The Effects of 30 Per Cent Sodium Chloride.—This solution was injected intravenously with strikingly consistent results (table 1.) One hour after injection, the consumption of oxygen had increased somewhat in four experiments, showed no significant change in two and had diminished 29.2 per cent in one. The average change was an increase of 8.6 per cent. The utilization of oxygen had increased in all experiments, the average increase being 47 per cent. The change almost invariably resulted from a diminution in the oxygen content of the mixed venous blood, the arterial oxygen content rarely showing any significant change. The cardiac output had diminished in all instances, the smallest decrease being 7 per cent, the greatest 66.3 per cent and the average 23.1 per cent.

In two experiments (dogs F_3 and F_4) determinations were made two hours after the injection. In both the oxygen consumption tended to return toward normal, but the changes in oxygen utilization and in cardiac output were slightly greater than those found one hour after the injection.

At the time of injection the blood pressure usually underwent a short sharp fall, only to rise gradually to a point well above the initial

2. Fick, A.: Ueber die Messung des Blutquantums in der Herzventrikeln, Verhandl. d. phys.-med. Gesellsch. zu Würzb. **2**:16, 1870.

3. Blalock, A.: A Rubber Mask for the Determination of the Oxygen Consumption of the Dog, J. Lab. & Clin. Med. **12**:378, 1927.

4. Van Slyke, D. D., and Neill, J. M.: The Determination of Gases in Blood and Other Solutions by Vacuum Extraction and Manometric Measurement, J. Biol. Chem. **61**:525, 1924.

level toward the end of the injection. This was followed by a fall to a level slightly above the normal, and here it remained for at least one hour (table 1).

The Effects of 50 Per Cent Dextrose.—Six experiments were done (table 2). In one (dog L_3) only oxygen consumption and blood pressure were determined. At the end of one hour, the oxygen consumption had increased in four animals and diminished slightly in two. The average change was an increase of 12.7 per cent. The arteriovenous oxygen difference had increased in four of the five experiments in which it was determined, the average change being an increase of 26.5 per cent. The cardiac output had diminished somewhat in four experi-

TABLE 1.—*The Effect of Intravenous Injection of 30 Per Cent Sodium Chloride on the Cardiac Output and Blood Pressure*

		Average Control				1 Hour After Intravenous Injection of 30% Sodium Chloride				2 Hours After Injection				
Dog No.	Weight, Kg.	Oxygen Consumption, Cc. per Min.	Oxygen Utilization, per Cent by Volume	Cardiac Output, Cc. per Min.	Blood Pressure, Mm. of Mercury	Oxygen Consumption, Cc. per Min.	Oxygen Utilization, per Cent by Volume	Cardiac Output, Cc. per Min.	Blood Pressure, Mm. of Mercury	Oxygen Consumption, Cc. per Min.	Oxygen Utilization, per Cent by Volume	Cardiac Output, Cc. per Min.	Blood Pressure, Mm. of Mercury	Blood Pressure During Injection, Mm. of Mercury
F_1	10.0	90.7	3.07	2,920	134	64.2	5.54	1,160	182	.....	....	.....	...	0*-180
F_2	6.4	85.7	7.53	1,140	...	81.5	7.70	1,060	...	.....	....	.....	...	.....
F_3	8.6	89.4	3.96	2,260	134	113.1	7.18	1,570	140	105.8	7.78	1,360	132	70-114
F_4	7.0	45.1	3.94	1,220	104	52.3	4.54	1,150	118	46.3	4.18	1,110	116	96-142
F_5	8.9	65.3	6.91	940	110	76.8	11.38	670	110	.....	....	.....	...	30-130
F_6†	6.2	57.6	5.95	970	110	83.9	9.48	880	104	.....	....	.....	...	94-130
F_7†	9.6	84.3	5.55	1,520	...	84.3	6.99	1,210	...	.....	....	.....	...	.....

* This animal stopped breathing during the injection and required artificial respiration for three minutes.

† These two dogs were given morphine. The others were given sodium barbital.

ments, the average diminution being 16 per cent, and had increased 57.9 per cent in one experiment (dog L_2). The blood pressure usually fell somewhat at the beginning of the injection but quickly returned to and remained at a level slightly above normal.

At the end of two hours after the injection, determinations were done in three experiments, only oxygen consumption and blood pressure being determined in one of these (dog L_3). In all three the oxygen consumption remained above the control level, although lower than at one hour after injection in two of the three animals. The oxygen utilization, however, was either as high as (dog L_4) or higher than (dog L_6) the values obtained one hour after injection, and in both instances it was well above the control level. In both animals, the cardiac output had undergone a further marked diminution (decreases of 37.6 and 27.6 per cent, respectively, from control determination).

The Effects of Distilled Water.—Four experiments were done. The results are shown in table 3. One hour after the intravenous injection of distilled water, the oxygen consumption showed no significant change in two experiments and had increased 10.9 and 26.6 per cent, respectively,

TABLE 2.—*The Effect of Intravenous Injection of 50 Per Cent Dextrose on the Cardiac Output and Blood Pressure*

		Average Control				1 Hour After Injection of 50% Dextrose				2 Hours After Injection				
Dog No.*	Weight, Kg.	Oxygen Consumption, Cc. per Min.	Oxygen Utilization, per Cent by Volume	Cardiac Output, Cc. per Min.	Blood Pressure, Mm. of Mercury	Oxygen Consumption, Cc. per Mm.	Oxygen Utilization, per Cent by Volume	Cardiac Output, Cc. per Min.	Blood Pressure, Mm. of Mercury	Oxygen Consumption, Cc. per Min.	Oxygen Utilization, per Cent by Volume	Cardiac Output, Cc. per Min.	Blood Pressure, Mm. of Mercury	Blood Pressure During Injection, Mm. of Mercury
L1	18.5	108.2	7.24	1,350	110	126.5	11.33	1,120	115	....	....	...	...	110-120
L2	7.6	68.8	4.37	1,570	95	50.5	2.43	2,440	110	....	....	...	...	64-124
L3	8.2	68.2	†	†	104	79.3	†	†	110	84.8	†	†	96	110-126
L4	8.0	62.6	4.82	1,300	110	70.0	6.76	1,030	132	68.2	8.44	810	128	106-140
L5	13.5	111.9	5.94	1,885	104	108.4	7.45	1,455	112	....	....	...	...	100-112
L6	8.2	48.5	4.32	1,120	80	71.8	6.70	1,070	74	53.8	6.62	810	80	80

* Morphine was used in all experiments.
† Blood-gas analyses could not be checked in this experiment, hence the cardiac output was not calculated.

TABLE 3.—*The Effect of Intravenous Injection of Distilled Water on the Cardiac Output and Blood Pressure*

		Average Control				1 Hour After Intravenous Injection of Distilled Water				2 Hours After Injection				
Dog No.*	Weight, Kg.	Oxygen Consumption, Cc. per Min.	Oxygen Utilization, per Cent by Volume	Cardiac Output, Cc. per Min.	Blood Pressure, Mm. of Mercury	Oxygen Consumption, Cc. per Min.	Oxygen Utilization, per Cent by Volume	Cardiac Output, Cc. per Min.	Blood Pressure, Mm. of Mercury	Oxygen Consumption, Cc. per Min.	Oxygen Utilization, per Cent by Volume	Cardiac Output, Cc. per Min.	Blood Pressure, Mm. of Mercury	Blood Pressure During Injection, Mm. of Mercury
K1	7.2	75.9	8.65	880	76	77.7	10.29	750	104	.....	....	.....	...	80-110
K2	10.2	83.4	4.30	1,940	104	92.5	4.70	1,970	130	115.0	5.90	1,950	130	90-140
K3	9.4	90.8	6.65	1,380	110	115.0	7.07	1,630	120	89.0	8.15	1,090	116	108-130
K4	8.3	75.6	5.17	1,460	80	73.0	5.77	1,260	84	.....	....	.....	...	75-94

* Morphine was used in all experiments.

in the remaining two, the average change being an increase of 9.3 per cent. The oxygen utilization had increased slightly in all experiments, the average increase being 11.5 per cent. The cardiac output remained practically unchanged in one experiment, had increased 18.1 per cent in one and had diminished 14.8 and 13.7 per cent in the remaining two. The blood pressure usually fell during the first part of the injection

(particularly if the injection was made more rapidly than usual), but quickly returned to a level somewhat higher than normal and remained elevated throughout the experiment (table 3).

In two experiments further studies were made two hours after the injections. In one of these (dog K_2) the cardiac output showed no significant change (it had shown an increase of 1.5 per cent at one hour after injection). In the other experiment (dog K_3) the cardiac output, which had increased 18.1 per cent at the end of one hour, had diminished to 21 per cent below the control level. This suggests that the true effect of the injection of distilled water in most cases is to diminish the cardiac output. This seems especially likely to be true in view of the fact that the increase in the output of dog K_3 one hour after the injection occurred as a result of a rise in oxygen consumption and in spite of an increase in oxygen utilization (table 3).

TABLE 4.—*A Comparison of the Results Obtained One Hour After Intravenous Injection of Hypertonic and Hypotonic Solutions*

Solution Injected	Oxygen Utilization of the Brain,* Average Percentage Change	Oxygen Utilization of the Body as a Whole, Average Percentage Change	Oxygen Consumption of the Body as a Whole, Average Percentage Change	Cardiac Output, Average Percentage Change
30% sodium chloride	+86.5	+47.0	+ 8.6	—23.1
50% dextrose	+51.5	+26.5	+12.7	—16.0†
Distilled water	+56.0	+11.5	+ 9.3	— 2.2‡
				—12.0

* The values in this column are averages derived from the tables in the preceding paper of this series.

† In calculating this value, the observations on Dog L_2 (table 2), the only atypical experiment in the group, were arbitrarily omitted.

‡ The value 2.2 per cent represents all determinations one hour after injection. The value 12 per cent substitutes the result two hours for that one hour after injection in Dog K_3 (table 3). The latter value seems to represent more correctly the true effect of the injection (see text).

COMMENT

Final conclusions cannot be drawn from a statistical study of so few experiments. The observations, however, are not without interest. In table 4 are shown the average percentage changes found in the experiments reported previously [1] and in this paper. It is seen that the changes in oxygen utilization of the whole body and in cardiac output are not sufficiently great in these experiments to account for the changes in oxygen utilization of the brain. Similarly, the changes in total oxygen consumption fail to account for the difference. It seems probable, therefore, that the changes in oxygen utilization of the brain are due, in part, to a specifically local effect. Whether this is the effect known to be produced by these solutions on cerebrospinal fluid pressure or a specific effect on cerebral vessels cannot be stated without further evidence.

SUMMARY

The cardiac output and blood pressure have been studied in dogs before and after the intravenous administration of hypertonic and of hypotonic solutions.

In most experiments the cardiac output was diminished after the injection of both types of solution, although individual variations occurred.

The oxygen consumption was usually increased and so also was the oxygen utilization by the injection of both hypotonic and hypertonic solutions.

The mean blood pressure varied during the injection, but thereafter was increased slightly in all experiments.

The average diminution found in cardiac output and the average increase in oxygen consumption do not seem to be sufficiently great to account for the increase previously found in oxygen utilization of the brain following injection of hypertonic and hypotonic solutions. This suggests that the latter changes are the result of direct effects of the solutions on the brain or its vessels.

THE CEREBELLUM

THE INFLUENCE OF THE CORTICAL REACTIONS ON THE CLASSIFICATION AND THE HOMOLOGY OF THE LOBES AND FISSURES IN THE CAT, MONKEY AND MAN *

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For the last thirty-five years, widely varying opinions have been expressed on: questions of cerebellar nomenclature, the positions of such fundamental lines of division as the secondary fissure and the prepyramidal sulcus, and the arrangement and the homology of the lobes. As it appears certain that an answer to these questions will not be found in further comparative anatomic investigations, their solution must be looked for in the discovery of new facts which, by establishing a fresh point of view, will make it possible to approach these problems from a different angle.

During the past four years I have been presenting papers at neurologic meetings both in America and abroad on the response of the cerebellar cortex to stimulation.[1] As these reactions of the individual lobes, which were obtained in the cat, rabbit and monkey, supply such important information regarding function, it should be of interest to consider what bearing they have on these various points of dispute.

It is doubtful whether there is any real appreciation of the great confusion that exists in cerebellar nomenclature. For as each school adopted and modified a classification that met with its anatomic requirements, function not being considered, practically any nomenclature was satisfactory. The diversity of views is rather astonishing, and is well illustrated in table 1.

Examination of table 1 shows that the primary fissure in the vermis is situated posterior to the culmen monticuli and lobus 4, and anterior to the declive, lobus medius anterior, lobus simplex, first lobule and the clivus. In the hemisphere it is found posterior to lobus 4, lobus

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1. Mussen, A. T.: Experimental Investigations on the Cerebellum, Brain **50**:313, 1927; The Cerebellum: A New Classification of the Lobes Based on Their Reactions to Stimulation, Arch. Neurol. & Psychiat. **23**:411 (March) 1930.

lunatus anterior, culminis, lobus anterior and the lobus quadratus, and anterior to the lobus quadratus, pars lunatus, lobus simplex and the first lobule. Fortunately, this confusion is only apparent and is due to the disturbing habit of employing different names for similar structures. The position of the fissure is clearly established.

In the grouping of the lobes there is still greater uncertainty. According to the Basle Nomina Anatomica and Elliot Smith classifications,[2] the cerebellum is divided into anterior, middle and posterior lobes by the primary and secondary fissures. But Schäfer and Symington, Tilney and Riley, and Winkler considered that the cerebellum is com-

TABLE 1.—*The Position of the Fissura Prima*

Authority	Sulcus	Vermis	Hemisphere
Basle Nomina Anatomica.....	Fiss. prima	Culmen monticuli Declive	 Lobus quadratus
Elliot Smith.....	Fiss. prima	Lobus culminis Lobus medius anterior	 Pars lunatus
Bolk.....	Fiss. prima	Lobus 4 Lobus simplex	Lobus 4 Lobus simplex
Horsley and Clark.....	Fiss. prima	Lobus culminis First lobule	 First lobule
Schäfer and Symington.....	Fiss. prima	Lobus monticuli Clivus monticuli	Lobus lunatus anterior Lobus lunatus posterior
Ingvar.....	Fiss. prima	Lobus culminis Lobus simplex	Lobus culminis Lobus simplex
Tilney and Riley.....	Fiss. prima	Lobus culminis Lobus clivi	Lobus lunatus anterior Lobus lunatus posterior
Kuhlenbeck.....	Fiss. prima	Lobus culminis Declive	Lobus anterior Lobus simplex
Winkler.....	Fiss. prima	Lobus culminis Declive	Lobus quadratus anterior Lobus quadratus posterior
Mussen.....	Fiss. prima	Lobus culminis Lobus simplex	Lobus culminis Lobus simplex

posed of an upper and an under surface divided by the sulcus horizontalis magnus. Ingvar held to the earlier view of anterior, middle and posterior lobes divided by the primary fissure and the prepyramidal sulcus. Riley in a later paper followed Bolk's classification of an anterior and a posterior lobe, and Tilney favored this view on the ground that the inclusion of a middle lobe does not appear to be necessary. As most of these opinions are founded on comparative anatomic investigations of the mammalian cerebellum, it is interesting to note that they not only differ from each other, but also disagree with the classification of Ingvar based on the study of reptiles, birds and mammals. The difficulty of comprehending these various views is due partly to the

2. The various classifications mentioned in the text will be found in Mussen (footnote 1, second reference).

different terminology made use of, but particularly to the fact that the positions of the prepyramidal sulcus and the secondary fissure in the hemisphere have never been definitely settled.

According to the Basle Nomina Anatomica and Ingvar classifications, the prepyramidal sulcus in the hemisphere divides the lobus semilunaris superior from the lobus semilunaris inferior. Elliot Smith agreed with this but referred to these lobes as the pars pteroidea superior and inferior. But if lobes having similar actions are to be grouped together, this position cannot be accepted, for it divides two lobes the functions of which are associated, the semilunaris superior being related to the lateral muscles of the neck and the semilunaris inferior to the antero-lateral muscles of the neck.

TABLE 2.—*The Position of the Sulcus Prepyramidalis*

Authority	Sulcus	Vermis	Hemisphere
Basle Nomina Anatomica	Sulc. prepyramidalis	Tuber vermis	Lobus semilunaris superior
		Lobus pyramis	Lobus semilunaris inferior
Elliot Smith.....	Sulc. prepyramidalis	Lobus medius posterior Lobus pyramis	Pars pteroidea superior Pars pteroidea inferior
Schäfer and Symington; also Tilney and Riley	Sulc. prepyramidalis	Tuber valvulae Lobus pyramis	Lobus gracilis Lobus biventralis
Ingvar.....	Sulc. prepyramidalis	Lobus medius posterior Lobus pyramis	Lobus semilunaris superior Lobus semilunaris inferior
Kuhlenbeck.....	Sulc. prepyramidalis	Tuber vermis Lobus pyramis	Lobus semilunaris inferior Lobus gracilis
Winkler.....	Sulc. prepyramidalis	Tuber vermis Lobus pyramis	Lobus lunatus inferior Lobus biventralis
Mussen.....	Sulc. prepyramidalis	Lobus medius posterior Lobus pyramis	Lobus semilunaris inferior Lobus gracilis

Schäfer and Symington, Tilney and Riley, and Winkler placed the prepyramidal sulcus between the lobus gracilis and the biventralis, the gracilis being referred to by Winkler as the lobus lunatus inferior. This position is again contrary to the results of stimulation, for it divides the gracilis which is related to movements of the shoulder from the biventralis which is concerned with the reactions in the upper arm. Kuhlenbeck is the only authority to hold the view that this sulcus in the hemispheres divides the semilunaris inferior from the gracilis. As this agrees with the results of my own observations and has established a precedent, it has been incorporated in the proposed classification.

Opinions as to the position of the secondary fissure in the hemisphere also show considerable variation. The Basle Nomina Anatomica, Elliot Smith, Bolk, and Ingvar classifications place it between the semilunaris inferior and the gracilis. On the other hand, Schäfer and Symington, Tilney and Riley, and Winkler hold that it lies between

the biventralis and the tonsil. This is in accord with my investigations on the cat and the monkey as well as with numerous observations on the anatomic arrangement of the lobes in the human cerebellum.

Having briefly compared the views of the authorities mentioned on the position of these fissures, drawing attention to their differences and showing how the cerebellar reactions are helpful in such disputes, I shall examine the character of the cortical responses and see in what manner they may be of assistance in deciding how the lobes should be grouped.

In a diagrammatic presentation of the lobes and their reactions, already published,[3] it will be observed that the arrangement of these

TABLE 3.—*The Position of the Fissura Secunda*

Authority	Sulcus	Vermis	Hemisphere
Basle Nomina Anatomica	Fiss. secunda	Lobus pyramis Lobus uvulae	Lobus semilunaris inferior Lobus biventralis
Elliot Smith	Fiss. secunda	Lobus pyramis Lobus uvulae	Pars pteroidea superior Lobus gracilis
Bolk	Fiss. secunda	C. I. b.	Crus II Lobus gracilis
Horsley and Clarke	Fiss. secunda	Fourth lobule Lobus uvulae	Lobus flocccularis
Schäfer and Symington	Fiss. secunda	Lobus pyramis Lobus uvulae	Lobus biventralis Tonsilla
Ingvar	Fiss. secunda	Lobus pyramis Lobus uvulae	Lobus semilunaris inferior Lobus gracilis
Tilney and Riley	Fiss. secunda	Lobus pyramis Lobus uvulae	Lobus biventralis Lobus tonsillaris
Winkler	Fiss. secunda	Lobus pyramis Lobus uvulae	Lobus biventralis Lobus tonsillaris
Mussen	Fiss. secunda	Lobus pyramis Lobus uvulae	Lobus biventralis Lobus tonsillaris

activities is very precise. But when one considers the importance of the head and neck reflexes on posture, the extraordinary number of neck muscles involved, and that the function of the cerebellum is to synergize these various reflexes with those of the limbs and trunk, it does not seem possible that the grouping of these localizations could be too exact.

According to these stimulations, the activities of the cerebellum fall into three main groups: (1) those related to the movements of the lips, tongue, throat, larynx and pharynx, found in the ventral lobes of the vermis, the uvula, nodule and the lingula; (2) those related to the extremities and the back as obtained in the paraflocculus and the paramedian lobes, and (3) those related to the movements of the head and neck; these are located in the anterior median and posterior vermis, and in the middle lobes of the hemispheres.

3. Mussen (footnote 1, second reference, p. 451).

This means that all the lobes of the cerebellum, except those forming the ventral regions of the vermis and the hemispheres (i. e., the uvula, nodule, lingula, the paraflocculus and the paramedian), are concerned with the reactions of the neck muscles. In support of these contentions it is interesting to call attention to the work of a small group of investigators, for in their researches reactions were obtained which in every case agreed with those reported in the diagram.

Flourens,[4] in 1864, showed by localized destruction that the anterior vermis was concerned in maintaining forward balance, and that the posterior vermis was associated with the preservation of backward balance. Ferrier,[5] in 1886, confirmed these observations and demonstrated that stimulation of the middle lobe produced movements of the head and eyes to the side excited.

Bolk,[6] from his comparative anatomic studies, was the first to consider that the possible location of the laryngeal center was in the anterior vermis. Later, Katzenstein and Rothmann [7] showed that lesions of the anterior cerebellar lobe in the region of the centralis disturbed the function of barking.

In one of my control experiments the dorsal lobule of the paramedian lobe was destroyed by a 3 by 2 mm. lesion just beneath the surface of the cortex. The lobule had first been stimulated and movements in the shoulder observed. The day following the lesion there was incoordination in the shoulder movements, the leg being raised too high, advanced too far forward and brought too suddenly to the floor. This disturbance confirmed the observations of Thomas, Rothmann and Durupt that a lesion of the cerebellar cortex does not produce paralysis but results in incoordination.

Further evidence in support of the correctness of these localizations, and the view that the responses to stimulation indicate the functional activity of the lobes is to be found in Riley's extraordinarily interesting paper on the mammalian cerebellum. If a comparison is made between the cerebella of those mammals, in which certain reactions are highly developed, with the cerebella of others in which the same reactions play a very minor part, it will be observed that the lobe which stimulation has shown to be responsible for these specialized movements is highly organized in those animals in which the particular activity is well

4. Flourens: Recherches expérimentales sur les propriétés et les fonctions du système nerveux, Paris, Crevot, 1842.

5. Ferrier, D.: Functions of the Brain, London, Smith Elder & Company, 1876.

6. Bolk, Louis: Over de physiologische Beteekensis van het Cerebellum, Haarlem, de erven F. Bohn, 1903.

7. Katzenstein and Rothmann: Zur Lokalization der Kehlkopfinnervation in der Kleinhirnrinde, Beitr. z. Anat., Physiol. u. Therap. d. Ohres **5**:380, 1912.

developed and poorly organized in those in which the reaction is unimportant. In table 4 certain of these reactions are examined and the lobes responsible for them are compared.

From these various investigations, which include experimental lesions, stimulations and comparative anatomic studies, it will be seen that in every instance the results obtained are entirely in accord with the localizations that are here reported. The work of numerous other investigators has not been mentioned, because in all of their experiments the lesions have been too extensive to give localized reactions.

The homology of the cerebellar lobes remains to be considered. In the case of the cat and the monkey it would appear that these are fairly

TABLE 4.—*Associations Between Function, Special Development and Reactions to Stimulation in Different Cerebella* *

Lobes Considered	Reactions to Stimulation (Mussen)
Lobus medius posterior	Head and eyes to side stimulated
Lobus uvulae and noduli	Movements in lips and tongue
Lobus paraflocculus anterior	Movements in hindlimbs and tail
Head and Eye Movements	
Very Active	**Very Sluggish**
Reindeer, anteater, calf	Sloth
Lobus medius posterior: Development very good	Development very poor
Lips and Tongue Movements	
Actively Prehensile	**Very Inactive**
Reindeer, camel, giraffe	Narwhal, porpoise, sloth
Uvula and nodule: Development very good	Development very poor
Tail Movements	
Very Active and Powerful	**Activity Limited**
Narwhal, porpoise, seal	Beaver, rat, guinea-pig, rabbit
Lobus paraflocculus anterior: Development extraordinary	Development very poor

* Riley, H. A.: The Mammalian Cerebellum, Arch. Neurol. & Psychiat. **20**: 895 (Nov.) 1928.

well established, considering that similar lobes in these cerebella give exactly similar reactions. Though the homology between the lobes of the cerebella of the monkey and the human being may be in the main generally accepted, there are great differences of opinion about one lobe, the tonsil. Bolk considers it the homolog of the paraflocculus; Ingvar favors the view that it represents the paramedian lobe, while Tilney and Riley believe it to be the hemispheral expansion of the uvula. My own opinion, already mentioned in detail, is that the tonsil is the homolog of the ventral lobule of the paramedian lobe in the cat and of the tonsil in the monkey.

Bearing these considerations in mind, a classification of the cerebellar lobes has been presented which is claimed to be equally applicable to the cat and the monkey as well as to man.[8]

8. Mussen's classification (footnote 1, second reference, p. 13).

This classification is based on the reactions of the individual lobes to stimulation as observed in the cat and the monkey. The reactions in the vermis have also been confirmed in the rabbit. According to these reactions there is an anterior lobe the function of which is concerned with the maintenance of forward balance through its influence over the activities of the posterior neck muscles and the associated coordination of this posterior neck reflex on the body posture. In a similar manner the posterior lobe is concerned with the preservation of backward balance. When stimulated it contracts the anterior neck muscles and brings into play the necessary coordination throughout the body to overcome any tendency to fall backward. Between the anterior lobe which regulates forward balance and the posterior lobe which governs backward balance, lie a group of lobes the reactions of which are entirely different. The function of this group is concerned with the conjugate deviation of the head and eyes to one side or the other, and with the lateral movements of the head. It is through the influence of these lateral reflexes that lateral balance is maintained.

These three different groups of activities have therefore determined the classification of the lobes of the cerebellum into an anterior, a middle and a posterior division; the limits of these lobes are the primary fissure and the prepyramidal sulcus.

In suggesting that each of these cerebellar lobes has a definite localized reaction, and in proposing a new classification of the lobes based on these activities, it is realized that new ideas are being advanced that are contrary to the views of most leading authorities. But it must be remembered that this method of investigation has never before been tried in the same precise manner; that the experiments of Horsley and Clarke,[9] which are largely responsible for the view that the cerebellar cortex was inexcitable, were not entirely negative, for they also reported movements in the head, eyes and extremities, though not localized. In many instances the reactions to stimulation are entirely supported by operative results and developmental conditions.

After several years of experimentation on the cerebellum, the reason why so many investigations have proved fruitless is fairly clear. The usual method of free exposure for either stimulation or destruction is usually accompanied by severe hemorrhage which lowers its activity and greatly weakens the animal; as precautions against hemorrhage by the temporary constriction of the vessels are not satisfactory, for they reduce the excitability of the cortex, this manner of operating cannot be recommended. Another obvious cause for the absence of localizing symptoms in experimental lesions is the fact that in almost every instance the destruction of tissue has been far too extensive, involving lobes of

9. Horsley and Clarke: On the Intrinsic Fibres of the Cerebellum, Its Nuclei and Efferent Tracts, Brain **28**:13, 1905.

different functions and producing results that were naturally confusing. In addition, there is an extraordinary lack of interest among most investigators as to how a normal animal behaves in certain tests and why, for without a clear understanding of these reactions it is impossible to appreciate or to explain the disturbed conditions.

As the localized reactions of the cerebellar cortex are dependent on the direct application of the current to the Purkinje cells of the particular folium under investigation, and as the best results from a localized lesion are found to follow a small subcortical operation, the steriotaxic instrument must be used. In addition, it is essential to understand thoroughly the grouping of the folia; charts of the surface lobes and sections drawn to scale must be prepared. With this equipment and a clear working knowledge of the instrument, results will be obtained confirming those already reported. With the new interest in cerebellar investigation that will be aroused by the possibility of observing the results of lesions confined to individual lobes, there is little doubt but that during the next few years the knowledge gained by the careful examination of the symptoms produced by such experiments will be of great assistance in the diagnosis of cerebellar disease.

THE ENVIRONMENTAL BACKGROUND OF JUVENILE DELINQUENCY *

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A garment will not be cleaner than the water in which it is washed. Individual disorders are reflections of social disorders. The important problem for the individual is his relation to the totality of his environment. How much is he in harmony with it? How much confidence has he in it? How does it disturb him? What is his goal, and in what way is he striving for it?

The child normally begins life with an actual inferiority. He is weak; he is inadequate to meet life without help. His normal process of growth is a striving to overcome the experience of inferiority, to rise from this inadequate position to a point of superiority. If he finds encouragement, help, training and love, he makes real progress. Slowly the feeling of inferiority is diminished. But man's is a long childhood, the longest childhood of any animal—from sixteen to eighteen years. Throughout this he must learn to harmonize his egotistic feelings with community feelings. It is a difficult adjustment. But if he has the great good luck to be born into a helpful environment his whole experience will constitute a training to active and useful membership in the family group.

Usually the child is not born into such an ideally educated environment. Usually the surroundings are far from perfect, and under their influences the child does not develop community feeling harmoniously, but tends rather in self-defense to intensify his egotistic attitude, to look on the world too subjectively, too much with the feeling "what is there in this for me?" This personal attitude is the very beginning of neurosis.[1] Parental training in the earliest years too often enhances it; the child loses his objectivity, and instead of meeting a situation with the normal objective question, "What is to be done here?" the child begins not only to say "What is there in this for me?" but "What will mother say?" and "What will they think of me if I do so and so?"

To give a brief example: One can praise a child for building a house of blocks in two ways. On entering the room one can exclaim "Fine! what a wonderful boy you are!" (personal, egotistic, subjective

* Submitted for publication, June 3, 1930.

* A lecture given at the Harvard Summer School of Education, Aug. 14, 1929.

1. Künkel, Fritz: Einführung in die Charakterkunde, Leipzig, S. Hirzel, 1929. Wexberg, Ervin: Individual Psychology, New York, Cosmopolitan Book Corporation, 1929.

valuation). Or, "You have done that well!" in which remark the emphasis is on the action, the object instead of the doer.[2] Naturally the goal of a child is to overcome his weakness, his smallness, his inadequacy in the big world and to become strong and superior to the immediate surroundings. He wishes to count, to amount to something. At first all his energies are bent in this direction; all his fundamental emotions and mechanisms—motor, sensory, metabolic—work in the direction of this goal. It is the great educational process; if directed early, helped and allowed to take a normal course, a normal objective attitude toward the demands of the community develops naturally and early. But if confidence is lost, all this raw material goes in the wrong direction.

Organic inferiority may play a great rôle.[3] The child may be born with a defect of his eyes, heart, gastro-intestinal tract or any part of his body. Not of necessity an obvious defect but an inferiority that causes him to feel: "I have not the same chance as other children." Here is the point where confidence may be lost. Fear of failure may creep in, and its corollary the overestimation of the importance of conspicuous success, the feeling that what other people think of you is the important thing. An exaggerated but remarkable example of this is seen in the life of Hermann Unthan.[4] He was born without arms. He developed marvelously; learned to do everything himself, to write with his toes and even to play the violin. How easily could all this have been made impossible by a wrong attitude in early youth! Most cripples do not go ahead with such courage. An investigation of this man's early training shows that he had an exceptionally wise father, one who understood the fundamental needs of the situation. He made three rules for his armless son: 1. Do not pity him. 2. Do not help him. 3. Do not give him stockings!

The economic situation[5] into which the child is born also plays a great part in his development. Poverty, hunger, over-appreciation of money and exaggerated materialism all may be important factors. If the father and mother are continually apprehensive about the future, about rent and about where the next meal is to come from, an atmosphere of confidence is impossible. If the children are crowded into one room, proper rest is difficult to obtain. The mother and father are fatigued and continually irritated, and that most subtle and devastating of

2. Zilahi, Agnes: Zur Erziehung des Säuglings, Internat. Ztschr. f. Individualpsychol. **7**:287 (July-Aug.) 1929.

3. Adler, Alfred: Studien über Minderwertigkeit von Organen, Munich, J. F. Bergmann, 1927.

4. Unthan, Hermann: Pediscript, Stuttgart, Mohr, 1925.

5. Rühle, Otto: Die Seele des proletarischen Kindes, Dresden, Andern Ufer, 1925.

situations arises—emotional tension between father and mother—which may destroy the child's confidence at its very roots. Of course, this is only an example. Similar and even worse situations may arise in the mansions of the rich, for the causes of the parental disharmony are not so obvious. The children of divorced parents make an especially interesting study. Home stress, parental bickerings and incompatibility of father and mother are almost constant observations in the histories of neurotic and delinquent persons.

The factor, however, that seems most universally to affect the child is his position in the family constellation, i. e., his relationship to the several members. How often you hear it said: "Here are three children brought up in an identical environment, yet how differently they have developed. It must be their different inheritance." Obviously, of the three children in this "identical environment" one was an oldest child, one was a youngest child [6] and one was neither the oldest nor the youngest. Also one may have been a girl with two boys, or vice versa. The oldest child may be spoiled [7] or be made too responsible, or be expected to be too perfect;[8] any of these factors may lead to discouragement. In his first years he was the center, but when the next child came he was dethroned. The youngest, too, is often spoiled, and for one reason or another any one of the children in a family may be the favorite. Obviously the varieties in these relationships are legion, and no two children can have identical environments. The situations that may cause loss of confidence and insecurity are many.[9]

Sex difference is another great factor. The male sex is today overappreciated; in most parts of the world there is a male culture; it is a man's world. Not only the men but the women overemphasize this importance of man. Girls are weaker physically in certain ways; the girl child may feel this and be oppressed by it, by being "only a girl." Boys are often more desired; too much is expected of them; overweening ambition and discouragement result.

In their first three or four years of life, the attitudes of those around the child constitute his education. But how poorly is the average parent prepared for this task! On the one extreme, spoiling leads to egotism; the child gets everything he desires as a matter of course. He is trained

6. Seelmann, Kurt: Das Jungste und Alteste Kind, schwer erziehbare Kinder, no. 17, Dresden, Andern Ufer.

7. Schirrmeister, M.: Das verwöhnte Kind, schwer erziehbare Kinder, no. 6, Dresden, Andern Ufer.

8. Seif, Leonhard: Das Musterkind, schwer erziehbare Kinder, no. 12, Dresden, Andern Ufer.

9. Adler, Alfred: Understanding Human Nature, New York, Greenberg, Publisher, Inc., 1927. Wexberg, Ervin: Your Nervous Child, New York, Albert & Charles Boni, 1927.

to want too much, to expect too much. He is never trained to deal with life and to develop his abilities. At an older period, when he has to stand more on his own feet, he does not know how to do so; he revolts in one way or another against meeting the world as it is, this world that at first was all his, given to him "on a silver spoon."

The opposite extreme is the selfish, loveless parents, imposing their wills on the child as by "divine right" and acting in cruel and tyrannical ways. Of course there are moments of affection, but no steady, dependable attitude. Illegitimate children often have the most difficult time. The mother is unhappy and usually herself the product of a most unfortunate childhood. Either she does not want the child at all, or she may dote on it, making it the substitute for all her attempts at affection. The child may be sent away to foster parents, later returning to the mother expecting too much, only to be disappointed. In conditions of poverty, as mentioned, the situation for all is difficult. The parents may want the food the children take; they want sex pleasure, but do not want children or at least so many children. Such children soon know that they are not wanted and that they never were really wanted, and they find that they are less than nothing in the family. Their first education is to trust no one and to shift for themselves—a hard school that may lead to an exaggerated ambition to count for something somewhere, finding outlet too often in antisocial channels but never in cooperation and happiness.

Personal authority exercised by the parent educates the child to obedience and subordination. But the child is already subordinated by the very fact of his small size, and his normal feeling of inferiority is easily increased to a harmful point, especially if corporal punishment is used. Parental authority may not be bad if carried out with friendly benevolence so that the child feels the justice and reasonableness of it, but in most cases the parent bolsters up his position with a feeling of mental superiority over the child. Of course, he is physically superior, and this makes him think he is more superior mentally than he really is. He does not respect the child enough, or realize early enough that the child is already a person. Longing to overcome his own inferiorities and remembering the authority exercised over him in his own youth, the parent really feels that he has some God-given authority, and that he should be "obeyed without question." He can even feel it his duty to "demand obedience," and thus avoid the trouble of thinking about the child's problem from the child's point of view. Such exaggerated attitudes are quickly felt and resented by the child; an oppressive rule by mere authority invariably raises a counter-pressure of some sort on the child's part, and the consequence is a vicious circle. Examples of this are so common that the literature and language are full of them,

e. g., the proverbial "minister's son" [10] and the "remittance man." This repressive education only intensifies the child's inferiority feeling. Confidence may be lost during the school years because of too strict treatment or too much competition; this comes as nothing less than a catastrophe to young children. Oppressive treatment at the age of about 2, the time of the "Ichfindung," when the child begins to feel his individuality, is especially harmful. The result is that life is experienced as a war, and thereafter parents and children behave like enemies facing each other. Such an attitude may lead to an egotistic striving for superiority and to precocity, but it is all too likely that the child will desert the long road to real education, and will take either the bypath of neurosis or that of delinquency. Immediate satisfaction is craved by the discouraged child. He cannot wait for success; he wants the sweets right away. This naturally leads to a superficial attitude, to sham and to acting for effect. Early sex gratification and masturbation are common reactions. Delinquents are the great pleasure seekers; they refuse patient work. They find short-cuts. Slyness is developed as a technic to count, to achieve prestige without laboriously earning it. They get an understanding of the weaknesses of their environment, and play on them skilfully. Boastfulness is another common trait. They have nothing to show, for they have not the patience to wait for results. Bolstered up by such facile and tempting slogans as "the world takes you at your own valuation," they try to "tell the world." They will not really recognize their own faults. They have not the courage frankly to admit mistakes, because they are really deeply discouraged and have no true self-assurance.

The neurotic person [11] reacts in a different way. He also has had his inferiority feeling intensified to a pathologic extent, but he may work steadily and apparently very well, up to a certain point. As the burden becomes heavier, however, and the road seems longer, he uses symptoms to get rid of decisions and responsibility, and to make himself a center of interest: "I would like to do my school work, but I have a headache." Self pity creeps in: these persons think how wonderfully they might do if they "only were strong," if they "only did not feel so tired all the time" or if they "did not fall asleep when they tried to work," and a hundred other automatic subterfuges that relieve them of responsibility for their acts or their inactivity.

Both the delinquent and the neurotic person act egotistically. Both have lost the courage to look on their situation in a reasonable, objective

10. Butler, Samuel: The Way of All Flesh, New York, E. P. Dutton & Company, 1916.

11. Adler, Alfred: Ueber den nervösen Charakters, Munich, J. F. Bergmann, 1928; Practice and Theory of Individual Psychology, London, Kegan Paul, 1927. Wexberg (footnote 9, second reference).

way. They cannot see the social necessities of any situation. All is colored by their early reactions. Their "style of life" has been set early in the wrong mold. The tricks of adaptation of the neurotic person are quite different from those of the delinquent, but the fundamental background is the same. Where the neurotic person evades responsibility through the misuse of symptoms, the delinquent attains the same goal by stubbornness, slyness and intrigue. He may make a pretense of courage, but he has no patience. He is often irascible and irritable, and is unable to understand how any one can be stupid enough to trust mankind.

Another common source of discouragement for the child is the talk about inheritance and "gifts."[12] Early in school he may hear that he has "no gift" for languages or mathematics, for drawing or music;[13] it gives him an "alibi" for reducing his work, and it gives the teacher an excuse for accepting poor work. Both are willing to believe the statement which usually is based on altogether inadequate data. Prejudice and conservatism play a great rôle in this attitude of mind. When a boy begins to do unexpected things in order to attract attention to himself, the relatives quickly put the blame on an uncle, a great uncle or some black sheep, and always at least one can be found to account for the "bad streak in the child"; saying that it is "in the blood" and shaking one's head are easier than realizing one's mistakes as parent or teacher. Eventually such attitudes and remarks reach the child, and discourage him all the more. The theory of hereditary wickedness relieves both the parent and the child from real responsibility. If the child's behavior is inherited, why should he try? He might as well "make a good job of it," and be a spectacularly bad boy!

One of the commonest examples of this kind of "inheritance" is found when an illegitimate child is brought up by the mother. When the boy begins to be difficult to handle she tells the neighbors, and eventually the boy, that he is wicked, "just like his father." This emotional scolding is mixed with demonstrations of affection. The boy is confused, does not know what to expect next, and is virtually pushed into a position where he has to act more and more like his father.

In another stratum of society one may find similar situations. For instance, a boy of 18 was apprehended for seducing a girl. His father, whose own youth was sexually loose but whose life now is exemplary, was socially prominent. He was affectionate toward his children, but ruled them by teasing and sarcasm. The mother educated the boy to egotism very early by excessive fondling, cuddling and spoiling. Three years after the birth of the patient, a second son arrived. This tem-

12. Adler, Alfred: Begabung und Unbegabtheit, Vienna, Moritz Perlis.

13. Jacoby, Heinrich: Jenseits von "Musikalisch und Unmusikalisch," Stuttgart, Ferdinand Enke, 1925.

porary removal of his prestige caused him to have tantrums, which brought him back into the center of interest. He began to lie and steal and after puberty to flirt with girls, bending them to his wishes, and finally seducing them. One girl he conquered so completely that, after seducing her, he made her watch outside the door of her younger sister while he, inside, seduced the other too! When this boy was examined and his history was elucidated, he told what heights and depths of happiness and despair he had known in his youth, how jealous he had been, and how he had done everything to gain or hold prestige. Failure had caused despair, and prestige in this predicament was gained only by "feeling big" in his wickedness. He felt continually depreciated in favor of his brother, and he never could be sure of his father's reaction. His mother's spoiling made him wish to play the man. The result was a kind of sadism, as if he said "I have suffered so much from depreciation, I'll show the rest of you what depreciation is!" The parents reported that he had "had everything," that no unhappiness had clouded his childhood. It often happens in such cases, however, that the parent says, "But if I were to tell you of my brutal childhood you wouldn't believe me." Thus it seems to be more a matter of "traditional" up-bringing than "inheritance." Family points of view and tradition have a strong and subtle influence on behavior, and unless this behavior is analyzed it may appear to be inherited.

In evaluating the relative importance of inheritance and environment in these cases one must be cautious. There are few facts to go on. But in so far as we are practitioners with a duty to help, our line of procedure is clear. We must behave "as if" the delinquent child had inherited just as good a chance as any other. We shall then not overlook a chance to help a child that needs and can profit by help, and we shall help many. The feebleminded group is not under consideration; such children present a different problem.

Neurosis is not inherited, but acquired; so, too, is delinquency. No child is born with an obligation to either. But there is a great temptation to develop one of these styles of life and then consider it as inherited. Such styles of life start early. In its first three or four years, the child may accept a certain attitude, a certain point of view, and thereafter always look on the world in that way. Such a preparation in the first four years may cause a person to repeat certain reactions throughout seventy or eighty years of life. It is certainly worth while to make a great effort to have the early years train the child to objectivity, confidence and courage, not to discouragement and egotism. As Pestalozzi said: "Circumstances make the man, but man makes the circumstances!"

Without confidence no relationship is possible between men. A feeling of reciprocity and responsiveness is essential before anything

good can be accomplished. Without it the child is brought up to feel that he is in a hostile country; he is seduced to take on a hostile attitude toward his environment; the result will be hatred, cruelty, lying or stealing. He feels that he must play a rôle; he wants to count somehow. If he cannot get praise like the others, if he cannot be the best, he will at least not be insignificant; he will try to shine as the worst of his group. The gang is a community formed by those who have similar reactions, similar antagonisms, and thus join to form a small society of their own within, but opposed to, the larger society.

To understand this end-product, however, it is necessary to try to understand each individual who makes up the gang. The study of many cases brings out certain reaction types which allow one to generalize without doing violence to the data. If one wishes to know how crime starts, one should try to find out when and why the child began to be discouraged, to lack faith, be cynical, irritable, irascible or impatient. Failures in school play a great rôle. The later overt acts, like stealing and lying, are complex developments built on loss of confidence in self and environment. Analysis of such cases shows that frequently there is good evidence to indicate that the attitude of the delinquent at the age of 12 or 15 is a repetition of the attitude aroused by the father-and-mother situation at the age of 2 or 3.

For example: A girl, aged 9, was caught in the act of pushing a baby into the river. She appeared to have tried wilfully to drown the child. It was known that two other children, previously in her charge, had met death by drowning, and after this the implications were clear that she had drowned these other two children. On going into her early history, it was learned that she had been spoiled up to the age of 6, when a younger sister was born. The patient was extremely jealous of this intruder in the household, but she was unable to do her own sister any harm because of the watchfulness of the parents. Therefore, she had been "taking it out on" other younger children, her efforts at last culminating in the drowning episodes.

Another case of a boy, aged 14, brought in for stealing, shows the danger of uncontrolled expressions of emotion by the mother. There had been an older brother, the idol of the mother, and he had died while the patient was quite young, but the mother, beside herself with grief, had said, "the best are always taken" and later, to the younger boy, "you never can be like your brother, he should have lived" and other remarks in that vein. He was discouraged because he could make no impression on her, and he tried to gain prestige by inventing fantastic lies and stealing, thus "getting even with" his mother. Later, when we gained his confidence and made him understand the situation, he was cured. The great trouble was that the egotistic mother was expecting too much of him for her own glory.

One of the most dramatic criminal cases in recent years in Germany was that of Fritz Harman, the butcher who killed more than a score of boys before he was apprehended. In court he behaved in a most aggressive manner, answering questions cynically and apparently without fear. At last the strain became too great; he broke down, and wildly cried out: "With my last breath I curse my father." In going into his childhood history it was learned that he had been most unhappy, was continually repressed and had been humiliated over and over again. Discouraged and cowed he had taken on a fierce brutality, gaining revenge and satisfaction by injuring weak boys.

Other cases might be cited of children, 10 or 11 years of age, who were made suspicious and cynical at an early age, and sneered at the psychologist who tried to give them confidence. These children do not believe in love and trustworthiness. It is my belief that if parents are helpful, trustworthy, objective and affectionate the child will never be delinquent.

The child reflects the faults of the educators. The parents and the school teachers stand at the head of the list; clergymen, physicians and social service workers may also be factors. Pestalozzi said: "If you try to win a nervous or delinquent child for social life, you must expect that he will resist your attempt with all his power." Why? Individual psychologic study indicates that it is because he has lost his confidence in faithfulness and love both in himself and in others. The first step to a new fertile cooperation is to arouse the lost confidence by becoming trustworthy to the child, by showing him friendly benevolence and by taking him as fully equal and equally worthy.

Preaching and moralizing are poor tactics; they only increase the inferiority feeling. The worst thing the educator can do is to deny the child his future, his chance to make good. The educator should be a bridge between the child and social living; he should encourage him, and in a patient, friendly way help him to understand his failures as "understandable but not justified." His great task is to teach the child to work, to help him to learn how to deal with stuff and with human relationships. This develops his usefulness as a member of society. But parents are many and varied and are likely to take situations too personally; the teacher can more easily be objective and he has the child for many years.

The obvious way to progress lies in the cooperation of child, parents, teacher, physician, day-nurseries, etc. The immediate problem of delinquency is to educate the educators. The further problem is the improvement of all social relationships, the educating of society from egocentrism to social solidarity. If the water is cleaner, the garment will become cleaner too.

PSYCHOTIC AND EMOTIONAL PHENOMENA ASSOCIATED WITH AMYOTROPHIC LATERAL SCLEROSIS *

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Amyotrophic lateral sclerosis is a disease characterized by: (1) muscular atrophy with fibrillary twitchings, (2) spasticity with evidence of lesions of the upper motor neurons and (3) symptoms of disorder in the brain stem, especially its bulbar portion. Although Charcot [1] (1870) was first to differentiate ordinary muscular atrophy and amyotrophic lateral sclerosis, he said little about psychic disturbances not essential to a diagnosis of the disease but sometimes associated with it.

Westphal [2] (1885) and Zacher [3] (1886), in isolated cases, noted amyotrophic lateral sclerosis associated with dementia paralytica. Oppenheim and Siemerling [4] (1886) were the first to consider and separate various types of purely bulbar palsy. They thought that the explosive emotional reactions in such cases were due to lesions of the upper motor neurons that end in the nuclei. Marie [5] (1892), thinking psychic disturbances fairly common in amyotrophic lateral sclerosis, was among the first to call attention to the easily provoked spasmodic laughing and weeping of certain patients with the disease. Oppenheim (1894) was of the opinion that any psychosis associated with the disease was more or less coincidental. Raymond and Cestan [6] (1905) reported eighteen cases of amyotrophic lateral sclerosis and believed that half of the patients were mentally feeble. They mentioned depressive periods, hypermotility and laughing and weeping on slight stimulation. Cullerre [2] (1907) reported a case in which there was depression. Fragnito [2] (1907) reported three cases: One patient was a man, sad, disoriented,

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* From the Section on Neurology, the Mayo Clinic.

1. Charcot: Sur un cas de paralysie glosso-laryngée, Arch. de physiol. norm. et path. **3**:247, 1870.

2. Quoted by van Bogaert: Encéphale **20**:27 (Jan.) 1925.

3. Zacher: Ein Fall von progressiver Paralyse compliziert mit amyotrophischer Lateralsclerose, Neurol. Centralbl. **5**:551, 1886.

4. Oppenheim, H., and Siemerling, E.: Mitteilungen über pseudobulbär Paralyse und acute bulbär Paralyse, Berl. klin. Wchnschr. **23**:791, 1886.

5. Marie, Pierre: Leçons sur les maladies de la moelle, Paris, Masson & Cie, 1892, p. 470.

6. Raymond, F., and Cestan, R.: Dixhuit cas de sclérose latérale amyotrophique avec autopsie, Rev. neurol. **13**: 504 (April) 1905.

with signs of a bulbar lesion, who attempted suicide. The second patient, a man with symptoms of a bulbar lesion, became markedly disoriented toward the end of the course of the disease. The third patient, a man, was depressed at times and possibly affected with hallucinosis; he did not have signs of a bulbar lesion, but finally became disoriented. Pilcz [7] (1908) reported the case of a patient with persecutory ideas and hallucinations. Gentile [2] (1909), Gerbert and Naville [8] (1921) and Büscher [9] (1922) reported cases showing intellectual impairment. Van Bogaert [10] (1925) reviewed the literature on psychic disturbances associated with amyotrophic lateral sclerosis and gave his experience with thirty-one patients, eighteen of whom had no appreciable symptoms of such a nature. The tendency to episodes of depression and euphoria were especially noted. Later in the course of the disease, speechlessness and impoverishment of the usual intellectual processes (sometimes called dementia) were apparent. Disorientation did not seem uncommon. Van Bogaert thought that psychosis with amyotrophic lateral sclerosis might be due to cerebral lesions. However, he did not believe that a diagnosis of amyotrophic lateral sclerosis could be made on the basis of the psychic disturbances which were, nevertheless, worthy of much interest.

I have been especially interested in the relationship of the explosive mimicry of emotional reactions to impaired function or destruction of elements of the central nervous system. These occur in amyotrophic lateral sclerosis as well as in other diseases of the central nervous system. Accordingly, one hundred and one records of patients with amyotrophic lateral sclerosis seen at the Mayo Clinic between Jan. 1, 1925, and Jan. 1, 1930, were reviewed. Sixty-nine of the patients were men and thirty-two were women. The youngest patient examined was aged 24 years and the oldest was 74. The average age of the patients was slightly less than 50. The patients were observed, among other reasons, with the idea of correlating the explosive emotional reactions with signs of lesions of the brain stem. The signs of disorders in the brain stem were classified into lower motor neuron (nuclear) and upper motor neuron types; the former were represented clinically by fibrillary muscular twitchings and atrophy; the latter, by sucking and hard palate reflexes, with stiffness and slowness of musculature not explained by weakness due to atrophy or to disease of the extrapyramidal system.

7. Pilcz: Ueber einen Fall von amyotrophischen lateral Sklerose, in Lewandowsky: Handbuch der Neurologie, Berlin, Julius Springer, 1922, vol. 2, p. 311.

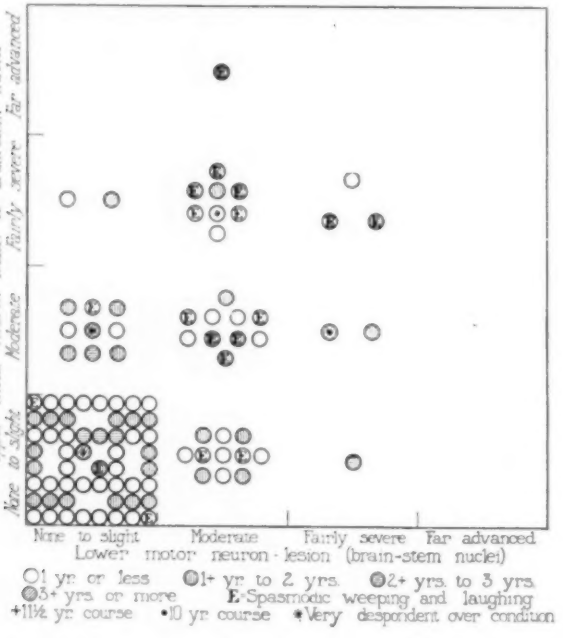
8. Gerbert, I., and Naville, F.: Contribution a l'étude histologique, Encéphale **1**:113 (March) 1921.

9. Büscher, J.: Zur Symptomatologie der sogenannten amyotrophischen Lateralsklerose, Arch. f. Psychiat. **66**:61, 1922.

10. Van Bogaert, Ludo: Les troubles mentaux dans la sclérose latérale amyotrophique, Encéphale **20**:27 (Jan.) 1925.

Each patient was observed for only a few days. Among the one hundred and one patients there were persons in all stages of the disease. The degrees of involvement of the brain stem were further classified as slight, moderate, fairly severe and far advanced. The results of this study are recorded in the accompanying figure.

Nineteen patients manifested spasmodic explosive laughing or crying; all except one patient of these nineteen had signs of lesions of the brain stem. However, several patients with well advanced signs of lesions of the brain stem did not manifest such reactions. Two patients with no such emotional reactions were despondent over the seriousness



Analysis of 101 cases of amyotrophic lateral sclerosis as regards length of course, emotional reactions and brain stem signs.

and the progress of the disease. One patient had been depressed in previous years but was not depressed at the time of the examination, nor did she exhibit labile emotional responses. Three patients declared that they always had been unusually emotional, but had not experienced uncontrollable laughter and weeping. In the nineteen patients with labile emotional reactions, explosive weeping was more common than laughing. One of these felt especially euphoric much of the time. One patient declared that he had seizures (almost convulsions) of laughing and crying; one said that he could laugh and cry at the same time; two said that they could stop laughing or weeping only with the greatest

difficulty once they had started. Several patients declared that although they wept or laughed easily and violently, their emotions were not those which usually go with such reactions. One patient, besides weeping spasmodically, had violent and uncontrollable outbursts of rage. From these data it might seem that the integrity of the upper motor neuron to the nuclei in the brain stem was more closely related to the initiation of emotional mimicry than the nuclei in the brain stem themselves.

Wilson,[11] in an article on pathologic laughing and weeping caused by intracranial lesions of various types, cited examples: (1) laughing or weeping violently with the least stimulus, one which ordinarily would be inadequate to elicit such responses; (2) little if any voluntary control of facial muscles and free and violent use of them in spasmodic weeping or laughing; (3) voluntary control of the facial muscles, but emotional control absent or diminished; (4) lesion of the brain stem involving the upper motor neuron and absence of spasmodic laughing and crying; (5) emotions which do not coincide with the outward motor expressions usually associated with emotion, and (6) emotions which are profound but without corresponding motor expression. Wilson critically reviewed previous theories regarding pathologic laughing and weeping, but summarized them by saying that the tracts controlling these voluntary or involuntary movements are not known but are probably separate.

This raises questions concerning the neuro-anatomic basis of emotions and their control which are far from settled. The subject deserves much study. Most textbooks on neuro-anatomy and neurophysiology concede that those upper motor neurons that end in the nuclei of the brain stem have their origin in the Betz cells of the motor cortex. Herrick[12] cited evidence that neurons from widely distributed areas of the cerebral cortex make synaptic connections with the nuclei in the brain stem. It seems clear, in some cases, that the emotions themselves are not changed, but that the motor reactions resembling those seen in well defined emotional reactions behave as an ankle clonus or an overactive, easily elicited reflex.

Further interest was added to the whole problem by the opportunity to study three patients with psychosis associated with amyotrophic lateral sclerosis.

REPORT OF THREE CASES

Case 1.—A woman, aged 51, was brought to the Mayo Clinic in May, 1926, because of "loss of mind and inability to speak," of three or four years' duration. Nothing was elicited in the family history which seemed relevant. The patient

11. Wilson, S. A. K.: Some Problems in Neurology, J. Neurol. & Psychopath. **4**:299 (Feb.) 1924.

12. Herrick, C. J.: The Brains of Rats and Men, Chicago, University of Chicago Press, 1926.

had always been happy, but never very strong; she had always been somewhat restless, complained much of her stomach, and had dysmenorrhea. She had enjoyed social activities such as her health would permit. She had married at the age of 29, and a year later had given birth to a dead child, following which she had had puerperal fever and had been in poorer health than usual for a year. She did not become pregnant again. In 1922, a pelvic tumor was removed because of abdominal cramps and menstrual disturbances. One night, about ten days after the operation, she became delirious and extremely restless. Soon after this she appeared to have a "wild-eyed and staring appearance" and changed rather markedly to a suspicious woman, suspecting that her husband was with other women. She even had hallucinations of "women with her husband, negroes, and piles of bones." When asked what she was doing she would say "waiting" and when asked what for, she would say, "John" (her husband) or "the women." She would readily forget things in her immediate environment, even what she might be doing. She gradually got worse, and lost some weight. In the summer of 1925, she began to have difficulty in talking, although she could repeat what was requested of her. At about the same time she also began to experience difficulty in swallowing. Her emotions became labile, and she wept or laughed easily and seemed depressed at times. In September, 1925, she was in a sanitarium, but grew worse gradually. She picked her arms so that sores developed. A few weeks before she was brought to the clinic she could hardly swallow, often regurgitated what she ate, and in place of speech could only make crying noises. She expectorated freely and wrung her hands.

The patient weighed 94 pounds (42.6 Kg.) (previous average weight, 135 pounds [61.2 Kg.]). The Wassermann reaction of the blood was negative. In the course of examination, she laughed and wept frequently. She was disoriented for time and place. Her tongue was weak and atrophied, and displayed numerous fibrillary twitchings. The soft palate was somewhat weak. Speech was impossible; fibrillary twitchings were seen around the mouth and in the biceps and triceps muscles. Atrophic changes in the hands were marked. Signs of lesions of the pyramidal tract were elicited at the mouth and in the arms but not in the legs. The spinal fluid was normal, but it had to be withdrawn with a syringe. A diagnosis of amyotrophic lateral sclerosis with psychosis was made.

In the hospital the patient wore a hat and glasses in bed, and often tried to leave the room. If she was undressed, she would dress at every opportunity, putting her clothing on over her night clothes. She was untidy and restless. She seemed entirely confused about time, place and person. She remained in the hospital a short time, returned to her home, gradually grew worse, and died on Nov. 18, 1926. Necropsy was not obtained.

Case 2.—A farmer, aged 51, was brought to the Mayo Clinic in August, 1928, by a brother, because of mental trouble which had begun eleven months before. There seemed to be nothing significant in the family history. The patient had always been well. Seventeen months before, he had been in an automobile accident, in which he had got wet and cold, but he did not seem to suffer ill effects from it. Four months after the accident he began to complain of numbness of the hands, with atrophy of the muscles of the arms and hands. At this time he noted a nasal twang to his speech and experienced slight difficulty in swallowing. Soon thereafter he began to act strangely. He was irritable and quarrelsome. He laughed or wept with great ease. His neighbors noticed that while he was working in the field he would stand beside a farm implement staring at it and doing nothing for several hours at a time. His memory failed so much that he forgot where he had put tools, implements, etc.

The patient had lost much weight. The Wassermann reaction of the blood was negative. Leukocytes numbered 11,400 in each cubic millimeter of blood. Atrophy and weakness of the arms, hands and feet were marked. He could not elevate the arms to the level of the shoulders. The tongue, soft palate and pharynx were very weak. Many fibrillary twitchings were noted on the tongue and over the entire body. Hoffmann's sign was apparently present; also, a sucking reflex. There were no signs in the feet of lesions of the pyramidal tract. He reacted to pin pricks as if sensation was normal to pain. He could be induced to say only a word or two, and to do this he had great difficulty. He would not write. He wept and laughed often, at the slightest provocation. It appeared that he was disoriented as to time and place; he was restless, but could not express what he wished. Although the chief features in the case were essentially those of chronic anterior poliomyelitis, a few signs indicative of lesions of the pyramidal tract seemed to be present. Because the psychosis resembled delirium, a diagnosis of delirium associated with amyotrophic lateral sclerosis was made.

The patient returned to his home. His physician reported that he became almost maniacal at times, and could not sleep well. The blood pressure rose to 280 systolic and 160 diastolic. He died suddenly "as if shot" on Oct. 6, 1928. Necropsy was not obtained.

Case 3.—A woman, aged 59, came to the Mayo Clinic in August, 1926, because of weakness in the legs of nine months' duration. Her mother had died of a "stroke" at the age of 50. The patient probably had had acute appendicitis at the age of 25. The menopause had come at the age of 50. About nine months before she came to the clinic she had noticed weakness and stiffness in the right leg, associated with some aching pain in the lumbosacral region, which extended up the spinal column. The weakness extended to the other leg and to the left arm. Four months previously, she had had some teeth extracted and had experienced annoying tremulousness and twitching under the skin throughout the body. She lost about 20 pounds (9 Kg.) in weight thereafter and became irritable, fearing that she would become paralyzed, a condition she had always dreaded. Periapical infection of three teeth was present. The Wassermann reaction of the blood was negative. Roentgenograms of the spinal column were negative. Fibrillary twitchings were seen over the whole body, but not over the face, tongue and neck. Little atrophy was apparent. Hard palate and sucking reflexes were present. The Hoffmann sign was markedly present bilaterally, as well as Babinski, Oppenheim, Rossolimo, Gordon, Chaddock and Mendel-Bechterew signs in the feet. Ankle clonus was present bilaterally. The sensory examination gave negative results. The gait was spastic. The extremities were moderately weak. Examination of the spinal fluid gave negative results. The patient was often angry at a sister who came with her, and she wept spasmodically while angry. She could not be tolerant of her disability and fretted continually about it. She was oriented. A diagnosis of psychoneurotic reactions associated with amyotrophic lateral sclerosis was made.

Within the next six months, the patient's physician reported that she grew worse and became spastic, and that signs of bulbar lesions became pronounced. She had marked insomnia, was irritable, used vile, obscene and profane language, shrieked day and night, struck and tried to bite those who came near her and spat at friends and relatives and into her food. Her attending physician and the relatives declared that she was the hardest patient to care for they had ever seen. It was thought that she was oriented for place and person. It became necessary to place her in a state hospital; there her neurologic disabilities grew so profound as to preclude a diagnosis of psychosis. She died on Aug. 15, 1929. Necropsy was not obtained.

COMMENT

The three patients presented signs of lesions of the brain stem, either of the nuclei or of the upper motor neurons. The first two patients showed early the essential features of a severe toxic psychosis; there was disorientation for time and place and sometimes for person. The third patient was irritable, and the chief symptoms were psychoneurotic reactions as precursors of a psychosis with reactions of anger and rage. All displayed explosive laughing or weeping.

Although a psychosis occurred in only three of one hundred and one patients, it is believed that it is more common during the course of the disease, especially near the end. Possibly also, the condition occurs in those cases in which signs of lesions of the brain stem are prominent and in which there are other intracranial lesions.

The literature reveals a variety of psychotic reactions associated with amyotrophic lateral sclerosis. It would seem that sufficient emphasis has not been placed on disorientation for varying periods; such manifestations are characteristic of a toxic psychosis, which is so protean in its manifestations. The episodic variations, including even the more or less meaningless explosive laughing and weeping, are not unknown in toxic psychoses. Patients with advanced involvement of the brain stem are often deprived of the ability to express themselves, and thus the content of speech, which is so essential in evaluating human reactions, is greatly reduced or entirely lost. From observations on the frequency of a toxic psychosis associated with encephalitis, there is reason to believe that in amyotrophic lateral sclerosis, with extensive chronic destruction of the central nervous system, there may be associated chronic delirious reactions which are well known to vary widely in the same patient within a short time. Individual susceptibility to such reactions would vary greatly, so that early in the disease they would be manifested by certain patients, whereas by others they would not be shown even late in the ravages of the disease. That the disease may progress from toxic delirium to irreparable dementia due to intracranial lesions, seems apparent from its nature. It is further presumed that the psychosis and spasmodic emotional reactions probably bear a significant relation to the previous personality of the patients, and that these have been inadequately studied.

ELECTRICAL SKIN RESISTANCE DURING HYPNOSIS *

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The great increase of the electrical resistance of the skin during normal sleep (as shown by Richter [1]) suggested the possibility of analogous changes during hypnosis. In some respects, the analogy between sleep and hypnosis is obvious. The subject is usually relaxed, his eyes gradually close, he shows little spontaneous overt activity, and he does not react to most of the environmental stimuli to which he would react in the waking state. Further, the physician frequently uses the phrase "falling asleep" during the period of induction.

A survey of the literature does not reveal any studies of the sort reported in the present paper. There are isolated reports of records of the psychogalvanic reflex in hypnotized subjects, such as those of Moravcsik,[2] Georgi,[3] Gregor,[4] Prideaux,[5] Peiper,[6] and Prince and Peterson.[7] All of these, however, are studies of the psychogalvanic reflex, that is, of the Féré and Tarchanoff phenomena (the small, rather brief variations in the electrical state of the skin with or without the passage of an external current). This study, on the other hand, is one of the effect of hypnosis on the more basic electrical skin resistance level on which the psychogalvanic reflex is superimposed.

TECHNIC

The apparatus used in the present investigation was exactly the same as that used by Richter, and the technic has been described elsewhere (Richter [8]). The

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* From the Henry Phipps Psychiatric Clinic, Johns Hopkins Hospital.

1. Richter, C. P.: The Significance of Changes in the Electrical Resistance of the Body During Sleep, Proc. Nat. Acad. Sc. **12**:214 (March) 1926.

2. Moravcsik, M. E.: Experimente über das psychogalvanische Reflexphänomen, J. f. Psychol. u. Neurol. **18**:186, 1912.

3. Georgi, F.: Beiträge zur Kenntnis des psychogalvanischen Phänomens, Arch. f. Psychiat. **62**:571, 1921.

4. Gregor, A.: Beiträge zur Kenntnis des psychogalvanischen Phänomens, Ztschr. f. d. ges. Neurol. u. Psychiat. **8**:393, 1912.

5. Prideaux, E.: The Psychogalvanic Reflex: A Review, Brain **43**:50, 1920.

6. Peiper, A.: Untersuchungen über den galvanischen Hautreflex (psychogalvanischen Reflex) in Kindesalter, Jahrb. f. d. Kinderh. **107**:140, 1925.

7. Prince, M., and Peterson, F.: Experiments in Psychogalvanic Reactions from Co-Conscious (Subconscious) Ideas in a Case of Multiple Personality, J. Abnorm. Psychol. **3**:114, 1908 and 1909.

8. Richter, C. P.: A Study of the Electrical Skin Resistance and the Psychogalvanic Reflex in a Case of Unilateral Sweating, Brain **50**:216, 1927.

nonpolarizable electrodes consisted of zinc disks and a paste made of kaolin and a solution of saturated zinc sulphate. One electrode was attached to the back and palm of each hand so that the resistance of the backs and palms might be measured separately. An imperceptible galvanic current was passed through the body, and the resistance was measured with the string galvanometer.

Before each experiment, the string of the galvanometer was so standardized (without the subject in the circuit) that the introduction of 1 millivolt into the circuit corresponded to a 10 mm. deflection of the galvanometer string. With the subject in circuit, a higher voltage was needed to deflect the shadow 10 mm. From this voltage (V) and the known resistance (X) of the galvanometer string, the resistance of each pair of skin areas can be derived by the formula $R = X(V-1)$. Four determinations of the skin resistance were made; back of one hand to back of the other ("back to back resistance"), palm of one hand to palm of the other ("palm to palm resistance"), and back to palm of each hand. Determinations were made before, during and after hypnosis.

The average resistance before and after hypnosis, i. e., in the waking state, was compared with the average during hypnosis. Six subjects were studied, and 360 determinations made on skin resistance before, during and after 31 seances. Hypnosis was induced with the patient lying on a couch with his hands in a comfortable position on the electrode stands. The technic of inducing the hypnosis was that of suggesting relaxation and sleep in a low monotonous tone of voice while the patient focused his eyes on a key or coin held about 10 inches from his face. The induction of hypnosis was facilitated in the first few periods when the physician stroked the patient's forehead synchronously with monotonous verbal suggestions. In no case was the patient told to close his eyes, and his instructions were to keep them open until they "closed of themselves." Of all of the indicators of the presence of the hypnotic state, the gradual closing of the patient's eyelids (without direct order) seems to be the most reliable. This indicator was present in all six patients, and was most striking in the patient G. W. S. After several successful hypnoses he was told to keep his eyes open as long as he could, and the opening and closing of his eyelids during the induction period was apparently identical with that shown by a person who is trying to keep himself from falling into a normal sleep.

RESULTS

The average skin resistance shown by each of the six subjects follows:

Subject W. B.

Average back to back resistance:	
Before and after hypnosis	155,000 ohms
During hypnosis	162,000 ohms
Average palm to palm resistance:	
Before and after hypnosis	14,000 ohms
During hypnosis	9,200 ohms

In this patient only very light hypnosis was obtained, with moderate relaxation and gradual closure of the eyes. There was no catalepsy, paralysis or amnesia.

Subject F. B.

Average back to back resistance:	
Before and after hypnosis	60,500 ohms
During hypnosis	82,000 ohms
Average palm to palm resistance:	
Before and after hypnosis	35,500 ohms
During hypnosis	48,000 ohms

In this patient a rather light hypnosis was obtained. Relaxation was fairly complete. Paralysis of the eyelids was easily obtained but there was no catalepsy or amnesia.

Subject A. C.

Average back to back resistance:	
Before and after hypnosis	155,000 ohms
During hypnosis	162,000 ohms
Average palm to palm resistance:	
Before and after hypnosis	14,000 ohms
During hypnosis	9,200 ohms

In this patient only very light hypnosis was obtained, with moderate relaxation and gradual closure of the eyes. There was no catalepsy, paralysis or amnesia.

Subject A. K.

Average back to back resistance:	
Before and after hypnosis	45,500 ohms
During hypnosis	38,500 ohms
Average palm to palm resistance:	
Before and after hypnosis	14,000 ohms
During hypnosis	15,500 ohms

In this patient the hypnosis was fairly deep, with good relaxation and paralysis of the eyelids. There was no amnesia or catalepsy.

Subject G. W. S.

Average back to back resistance:	
Before and after hypnosis	87,500 ohms
During hypnosis	96,500 ohms
Average palm to palm resistance:	
Before and after hypnosis	55,700 ohms
During hypnosis	71,100 ohms

The hypnosis in this case was very deep. The relaxation was striking and later it was possible to obtain catalepsy, paralysis, hallucinations and partial amnesia.

Subject L. S.

Average back to back resistance:	
Before and after hypnosis	1,050,000 ohms
During hypnosis	1,170,000 ohms
Average palm to palm resistance:	
Before and after hypnosis	46,500 ohms
During hypnosis	42,500 ohms

The hypnosis in this case was very deep. Catalepsy, paralysis, anesthesia to pain and touch, hallucinations, and complete amnesia were obtained.

COMMENT

The data given show definitely that there is no essential difference between the electrical skin resistance during the waking state and that

during hypnosis. During each hypnosis an increase or decrease in resistance may appear, but these changes are relatively slight compared with the changes during sleep, etc., as shown in the accompanying table. Consequently, it is not possible to use the skin resistance as a criterion of the presence or the depth of hypnosis.

Some of the hypnoses lasted more than an hour, and in them the electrical skin resistance showed only minor fluctuations during the course of the hypnosis. The gradual slight decrease in skin resistance which occurs when most persons are quiet for some time was usually present. The fractionated method of hypnosis (hypnotizing and awakening the patient repeatedly during one period) produced little change in the skin resistance in spite of the patient's statement that he seemed to be more deeply asleep each time.

The subjects used in the present investigation were patients who belonged to the hysteric, encephalitic and depressive groups; in all of them there was a definite therapeutic indication for the use of hypnosis. The skin resistance of some of these subjects during the waking state did not fall within the range of normal variation as given by Richter.[9] Hence it seems probable, from this series of cases, that the induction of hypnosis does not materially alter the electrical skin resistance, either when that resistance is within normal limits or when that resistance is beyond the normal limits.

The accompanying table offers a basis of comparison of the results of the present investigation with those made of other conditions in the studies in the Phipps Clinic (Richter,[10] Syz and Kinder,[11] Richter [12]).

The table shows the similarity of the hypnotic state with the "catnaps" of normal life and the mild attacks of narcolepsy. The term "catnap" is used to designate the brief period of sleep (e. g., after dinner) from which the person can be easily aroused and from which he usually awakens spontaneously after a few minutes.

The difference between the resistance in normal sleep and that in hypnosis is chiefly that palmar resistance is increased in normal sleep, and is not increased in hypnosis. In normal sleep, the palmar skin resistance is increased not only when the patient appears relaxed, but also when he appears tense, perhaps during an exciting dream (Richter, unpublished). So long as he is not responsive to external stimuli (e. g., commands), however, the palmar resistance remains high. In contra-

9. Richter, C. P.: The Electrical Skin Resistance, Arch. Neurol. & Psychiat. **19**:488 (March) 1928.

10. Richter, C. P.: Pathologic Sleep and Similar Conditions, Arch. Neurol. & Psychiat. **21**:363 (Feb.) 1929; footnote 9.

11. Syz, H. C., and Kinder, E. F.: Electrical Skin Resistance in Normal and in Psychotic Subjects, Arch. Neurol. & Psychiat. **19**:1026 (June) 1928.

12. Richter: Unpublished data.

distinction to normal sleep, a successful hypnosis has as one of its outstanding phenomena the responsiveness to commands, and in hypnosis the palmar resistance is not increased. Hence one may conclude that the present studies in hypnosis offer added evidence that the palmar skin resistance is an index of the presence of absence of alertness and responsiveness to stimuli, and not of the degree of relaxation.

Skin Resistance in Various States

	Back to Back Resistance		Palm to Palm Resistance	
	Average	Range of Variation	Average	Range of Variation
Waking state (normals) 9 cases	298,300	98,800-721,300	77,100	21,000-126,000
Sleep (normals) 20 cases	302,000 (little change from waking state of each subject)	12,000-1,100,000	662,000 (at time of deepest sleep)	21,000-1,500,000 (increasing with the depth of sleep)
Hypnosis 6 cases	Almost the same as that during the waking state of each subject	.....	Almost the same as that during the waking state of each subject	
"Catnaps" (normals) 5 cases	Almost the same as that during the waking state of each subject	.....	Almost the same as that during the waking state of each subject	
Narcoleptic patients, during mild sleep attacks, 5 cases	Almost the same as that during the waking state of each subject	.....	Almost the same as that during the waking state of each subject	
Narcoleptic patients while awake 5 cases	633,400	30,000-1,520,000	180,800	97,000-418,450
Depressive stupor 1 case	519,000	.....	65,250	
Catatonic stupor 12 cases	1,153,200	226,000-2,500,000	44,500	19,000-115,000
Tense schizophrenic patients, 2 cases	59,410	40,000-78,000	42,200	36,000-48,000
Hyperthyroidism 8 cases	15,800	10,000-26,000	17,000	10,000-26,000
Depression 4 cases	.....	Within normal limits	.....	Within normal limits
Manic patients 4 cases	.....	Within normal limits	.....	Within normal limits

It would be of interest in this connection to study the skin resistance of persons who maintain an unusual degree of alertness and responsiveness during sleep, for example, the mother who awakens at the faint cry of the child, and the person who is able to decide, on going to sleep, the time of his awakening.

The foregoing table shows, also, the similarity and difference in skin resistance between the hypnotic state and catatonic stupor. In both, passivity feelings and attitudes are frequently present. In both, catalepsy may appear. The similarity is reflected in the fact that in both states the palmar skin resistance is relatively low, indicating a responsiveness to stimuli. In hypnosis the responsiveness is to the talk and commands of the physician; in catatonic stupor the responsiveness may

be to the stimuli from the physician, e. g., in catalepsy and automatic obedience, or may be to stimuli arising in the patient himself. The difference between the hypnotic state and catatonic stupor is reflected in the fact that in hypnosis, the dorsal skin resistance is relatively low, while in catatonic stupor the dorsal resistance is very high.

SUMMARY

1. A comparison of the electrical skin resistance during the waking state with that during hypnosis is presented, based on the study of six subjects.

2. The induction of hypnosis does not materially alter the electrical skin resistance, either when that resistance is within normal limits or when it is beyond the normal limits.

3. Changes in skin resistance cannot be used as criteria of the presence or of the depth of hypnosis.

4. With regard to skin resistance, hypnosis resembles the mild narcoleptic attacks and the "catnaps" of normal persons, and differs from normal sleep, catatonic stupor and other states.

5. The palmar electrical skin resistance is an index of the presence or absence of alertness and responsiveness rather than of gross muscular tension and relaxation.

THE MIGRAINE-EPILEPSY SYNDROME

A STATISTICAL STUDY OF HEREDITY *

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So much has been written on the apparent clinical relationship existing between idiopathic epilepsy and migraine that one hesitates to contribute anything more to the literature lest one overburden the medical reader. In offering this statistical study, I am fully aware that the same ground has been covered comprehensively by other observers, but I feel that some points of interest may be brought out that have not appeared in other contributions, owing to the fact that the statistics utilized have been derived entirely from records of private patients, and not from those of public or charitable institutions.

For many years I have been especially interested in the hereditary and clinical relationships apparently existing between the two diseases or syndromes. As a result, much care has been taken in obtaining ample and searching histories.

For the purpose of this article, I have utilized the clinical histories of 104 persons suffering from typical migraine, 171 sufferers from idiopathic epilepsy, and 100 normal persons, who serve as a control.

In the subsequent nomenclature it will be noted that the term ancestral histories is used for the purpose of distinguishing between the incidence of symptoms in the preceding generations and those manifested in siblings. In order that the reader may form a clear conception of the criteria on which my diagnoses of migraine have been based, the headaches were of the habitual, irregularly recurring type, associated with dizziness, nausea or vomiting and prostration, with intervals of good health between the attacks. The attacks had a clinical similarity to each other and were not ascribable to any discoverable systemic disease. In addition, a searching cross-examination attempted to uncover any collateral evidence, such as transient ophthalmoplegic phenomena, aura, cyclic vomiting in childhood and the incidence of similar headaches in the ancestors or siblings. In determining on idiopathic epilepsy as a diagnosis, I have confined my classification to recurring attacks of generalized convulsions, obviously not the result of organic diseases of the nervous system, essential arterial hypertension, nephritis or injury of the head.

Migraine, popularly known as sick headache, is a common constitutional defect, disease or syndrome. Neuropsychiatrists and internists especially appreciate its prevalence, because they are more apt to recog-

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nize its protean manifestations and atypical forms. A prolonged and critical study of migraine inevitably leads the observer to conclude that it is not only common, but is in some way related to epilepsy, and that heredity has much to do with its transmission through successive generations. The frequency with which the clinician encounters ancestral histories of migraine in persons themselves suffering from migraine or epilepsy is truly astounding.

With these observations in mind, I decided to review my clinical records for the purpose of determining whether or not the empiric assumptions mentioned would be borne out by them.

For the purpose of systematizing this paper, the following questions have been formulated in the hope that the subsequently reviewed data and discussion will afford satisfactory answers: 1. Is one justified in assuming that migraine is hereditarily transmitted as migraine? 2. Is one justified in assuming that ancestors with migraine are prone to beget epileptic offspring? 3. Is one justified in assuming that migraine and epilepsy are clinically related? 4. Do epileptic persons show a preponderance of epilepsy in their ancestral histories?

In substantiation of the contention that migraine is hereditarily transmissible, it is of interest to note that of 104 patients with migraine whose clinical histories have been utilized, 71.1 per cent gave ancestral histories of migraine, and 9 per cent gave histories of migraine on both the maternal and paternal sides, whereas of 100 normal persons, only 17 per cent revealed ancestral histories of migraine. This preponderance of migraine in the forebears of sufferers from migraine as compared with those of normal persons is too great to be ignored and offers a satisfactory answer to the first question, especially since practically the same results have been revealed by others who have compiled statistics.

In answer to question 2: Of 171 patients suffering from epilepsy, 60.8 per cent gave ancestral histories of migraine as compared with 17 per cent of migraine in the ancestral histories of normal persons.

It is of interest to note that the ancestral histories of 171 persons suffering from idiopathic epilepsy reveal the presence of epilepsy in only 14.03 per cent of all cases, thus indicating that migraine probably has a much greater influence in hereditary predisposition to epilepsy than has epilepsy itself; also that of the 104 persons suffering from migraine, only 5.7 per cent gave ancestral histories of epilepsy. It appears from these statistics that migraine is possibly the morbid ancestor of both migraine and epilepsy. This statistical evidence corresponds to the empiric observations of most clinicians.

Question 3 cannot be answered so easily, and the arguments used must be more circumstantial. I have been forced to the conclusion that migraine and epilepsy are morbid first cousins if not twin sisters. My reasons are as follows: (*a*) Migraine is found in the ancestral histories

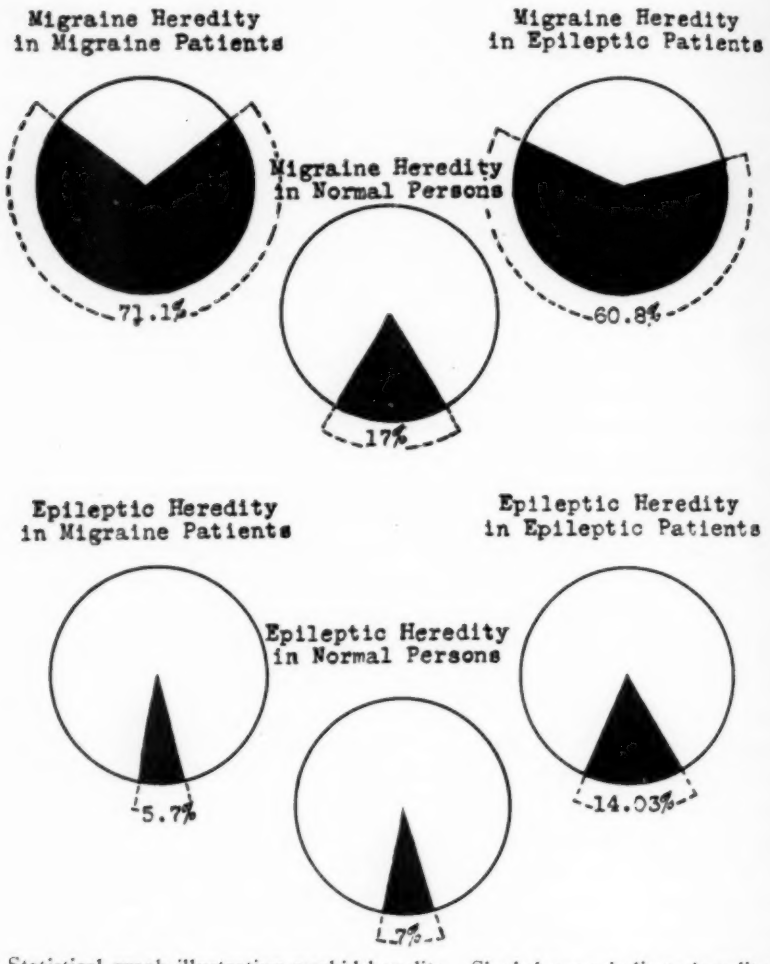
of 71.1 per cent of all patients with migraine. It is also found in those of 60.8 per cent of all epileptic patients. (*b*) The etiologic theories which fit one fit the other equally well. (*c*) Of 171 patients with epilepsy recorded by me, 15.2 per cent had suffered also from migraine, and of 104 patients with migraine, 8.6 per cent had suffered also from epilepsy. These figures are too meager of themselves to justify any conclusions, but it has been my experience and that of others to observe migraine and epileptic attacks alternating in the same patients and to recognize migraine in early life replaced by epilepsy in later life. (*d*) The aura or preconvulsive phenomena of epileptic seizures are in many respects similar to those preceding or attending attacks of migraine: ringing in the ears, color scotoma, blurring of vision, dizziness, and transient hemiparesthesias are frequently associated with the attacks of either disease.

Reference has previously been made to the transient oculomotor and hemiparetic phenomena in migraine. It has been my privilege to observe over a number of years several patients who have suffered from epilepsy, and who subsequent to their seizures exhibited transient hemiparesis, yet never developed any dependable evidence of brain neoplasms or progressive organic diseases of the brain.

(*e*) In migraine of the ophthalmoplegic variety, the headache is preceded by color scotomas, blurring of vision, diplopia or hemianopia. These ophthalmoplegic attacks of migraine are usually abrupt in onset, reaching their acme quickly. In this respect the eye symptoms are similar to, and suggestive of, the aura of epilepsy. It has been my experience that ophthalmoplegic migraine is more amenable to the inhibiting influences of phenobarbital and bromides than any of the other forms, and in this respect suggests a similarity to epilepsy. (*f*) Both migraine and epileptic attacks are susceptible to the same exciting or precipitating influences, namely, the menstrual periods in women, excitement, worry, indiscretions in diet, brief and radical changes in environment, such as a trip to the county fair, a train ride or dancing until the small hours of the morning; in other words, any radical departure from life's routine seems to pull the trigger and explode the convulsive mechanisms in the stem and cortex of the brain. (*g*) Both patients with migraine and epilepsy are apt to belong to allergic families. (*h*) The transient irritable and psychotic mental states incident to migraine are similar to those of epilepsy. I have in mind as I write this paper a sufferer from migraine who almost invariably becomes definitely psychotic during attacks.

I have no doubt that there are many other points of similarity that I have failed to enumerate, but those outlined are the ones that have come most forcefully to my attention.

In a review of the statistics gleaned from my case histories, I have been interested to note a certain item which is both surprising and provocative of speculation. Although I found 60.8 per cent of epileptic patients giving ancestral histories of migraine, I found only 14.03 per



Statistical graph illustrating morbid heredity. Shaded areas indicate hereditary tendency. Percentages are illustrated by the division of the circle into 100 segments.

cent giving ancestral histories of epilepsy and 5.7 per cent of patients with migraine having epilepsy in their ancestral histories. I must admit that this discovery is contrary to my previous beliefs. I had always taken it for granted that the hereditary relationship between epileptic parents and epileptic offspring was more pronounced; also that epileptic

parents would beget more offspring of the migrainous type. This discovery, taken together with the fact that migraine seems to be the morbid and statistical parent of both migraine and epilepsy, has led me to scrutinize my statistics in order to find out whether some error has crept in. I have, therefore, asked myself the following questions: 1. Have I been at fault in eliciting the case histories? 2. Has there been a tendency on the part of my patients and their accompanying relatives to suppress ancestral histories of epilepsy? 3. Can it be possible that migraine in one or more consecutive generations may subsequently be followed by epilepsy with ultimate reversion to the normal? Nature's tendency to revert to the normal should here be borne in mind. 4. Does the incidence of epilepsy in one generation discourage marriage in that generation and thus by preventing propagation account for this seeming discrepancy?

A judicial consideration of question 1 leads me to answer that an element of error in eliciting the histories is untenable, since I made a more careful attempt to bring out instances of epilepsy than those of migraine. In answering question 2, it must be conceded that patients and their accompanying relatives have unquestionably, in some instances, denied the presence of epilepsy in their families. I doubt, however, whether this is sufficient to account for the comparatively few cases in which epilepsy in the forebears preceded epilepsy in the patients questioned. Question 3 on the surface suggests an entirely new line of statistical research. In an effort to determine whether or not migraine in one generation or more is subsequently followed by epilepsy, with ultimate reversion to the normal, one would be obliged to obtain a large number of family histories running through six or seven generations and be forced to make a more careful study of familial and mendelian influences than has yet been made. This question is not of any great practical value, but is an illustration of the fact that research along one line opens up many others, all of which stimulate the fancy and lead one to broader thinking. In answering question 4, pertaining to the possibility that epilepsy serves as a preventive against marriage and reproduction, I am inclined to believe that as my statistics were derived from patients who have consulted me in private practice and have come chiefly from enlightened homes in the rural districts, where people have considerable knowledge about each other before marriage, and where eugenic problems are frequently discussed, it is highly probable that marriage with epileptic persons has taken place less frequently.

In summarizing the answers to the foregoing questions, it seems logical to conclude that errors in taking histories have been negligible; that reticence on the part of patients and accompanying relatives to reveal ancestral histories of epilepsy unquestionably accounts for some instances that should have been recorded; that the cycle theory is entirely

too speculative and at present incapable of proof to be worthy of serious consideration, and that the restraining influences of eugenic knowledge have something to do with the surprisingly small percentage of instances revealing hereditary transmission; but that all of these circumstances taken together are insufficient to account for the fact that while migraine preponderates in the ancestral histories of those with both migraine and epilepsy, epilepsy itself seems to have little influence as a hereditary, predisposing factor in either.

Charles W. Burr [1] investigated the conditions in the relatives of 1,449 epileptic patients, and while not less than 621 cases of serious nervous and mental diseases were found among them, he found that direct transmission of epilepsy was not common, as the fathers of only 14 and the mothers of only 17 had the disease, or an ancestral history of epilepsy in 2.1 per cent. This percentage is astoundingly low as compared with my statistics, and is, I think, open to question. A practical deduction that may be drawn from my data and from those referred to is, in accord with the conclusions of others, that the outlook is not so dark for the offspring of epileptic persons as has previously been thought.

Up to this point my statistics have been rather illuminating as to the relationship between migraine and epilepsy, both from the point of view of heredity and from the standpoint of association of the two syndromes in the same individual. Modern observers have come to look on epilepsy and migraine as expressions of the same underlying constitutional defect. Some observers go so far as to state that the seizures of idiopathic epilepsy are normal for the epileptic type of individual, meaning by this that certain persons have explosive central nervous mechanisms or metabolic idiosyncrasies which are normal to them. While this may be true, it only tends to prove that the idiopathic epileptic syndrome is a constitutional affair rather than that an epileptic person is normal. The term idiopathic as applied to epilepsy is indicative only of the fact that one does not know its etiology. As time goes on one is finding more and more instances of organic disease of the brain in the etiology of epilepsy, thus indicating that it may be nothing more or less than a symptom rather than a disease. Anything that predisposes the cerebral cortex or brain stem to a convulsive explosion may cause symptomatic epilepsy. Since one knows more about the frequency of meningeal hemorrhages and hemorrhages of the brain in the new-born, one can with greater facility trace many cases that would otherwise have been termed idiopathic to a structural origin. However, after all due consideration is given to the possibilities of overlooking organic lesions of the brain, it must be admitted that there is a type of epilepsy which,

1. Burr, C. W.: Heredity in Epilepsy, Arch. Neurol. & Psychiat. **7**:721 (June) 1922.

without specific demonstrable etiology or pathology, is associated with migraine and is subject to its hereditary influences. Some observer has stated that epilepsy is the motor manifestation while migraine is the sensory manifestation of the same underlying constitutional defect or disease. At any rate, those who are continually coming in contact with this clinical problem feel justified in speaking not alone of epilepsy or of migraine but of the migraine-epilepsy syndrome.

CONCLUSIONS

From the foregoing statistics it would seem that the following conclusions are justified:

1. A constitutional tendency to the development of migraine is transmissible from parent to offspring.

2. A migrainous ancestral trend predisposes the offspring to epilepsy.

3. Ancestral epilepsy is a less important factor in predisposition to epilepsy in the offspring than has previously been believed.

4. There is a preponderance of evidence indicating some definite clinical relationship between migraine and epilepsy.

ARCHAIC REGRESSIVE PHENOMENA AS A DEFENSE MECHANISM IN SCHIZOPHRENIA*

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The history of modern research in schizophrenia may be divided roughly into two stages: (1) the description and interpretation of the phenomena or symptoms of the disease, a service in which Kraepelin laid the foundation and Bleuler the superstructure; (2) the interpretation of the disease as a whole, a phase of the subject which has increasingly engaged the attention of recent investigators. The tendency of recent years has been to interpret schizophrenia from a broadly biologic, or what Adolf Meyer has called a "genetic-dynamic," point of view. The disease is looked on as an essentially dynamic reaction representing the adjustment of a psychologically and morphologically distinctive type of person to the environment. The main steps in the evolution of this point of view were the following:

1. As far back as the first decade of this century, Adolf Meyer and August Hoch began to dispute the view then held by Kraepelin that the disease might befall any one. They found that as a rule the disease occurred in persons possessing a certain type of personality, those who "do not have a tendency to be open, and to get into contact with the environment, who are reticent, seclusive, often sensitive and stubborn. . . . They show little interest in what goes on. . . . they do not unburden their minds, are shy, and have a tendency to live in a world of fancies." Hoch [1] termed this personality the "shut-in" type (Jelliffe has pointed out that Hecker many years before had spoken of these patients as "verschlossen"). Meyer and Hoch in this way focussed attention on the constitutional aspect of the problem of schizophrenia.

2. The work of those who studied psychologic reactions in relation to morphologic types came to fruition in the studies of Kretschmer,[2] who demonstrated a correlation between the type of psychosis (whether manic-depressive or schizophrenic) and the morphologic type, the majority of schizophrenic reactions occurring in "asthenic," "athletic," and "dysplastic" persons. This greatly strengthened the implications of the work of Hoch and Meyer.

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* From the Community Health Center.

1. Hoch, A.: Constitutional Factors in the Dementia Praecox Group, Rev. Neurol. & Psychiat. **8**:463, 1910.

2. Kretschmer, E.: Körperbau und Charakter, Berlin, Julius Springer, 1922.

3. In the meantime Bleuler,[3] differentiating the symptoms of schizophrenia into the primary and the secondary, argued that the primary symptoms (such as a specific type of disordered association) point strongly to an organic defect of the brain (as yet not conclusively demonstrated by histopathologic methods). The secondary symptoms, he thought, are the result of the adjustive efforts of a person handicapped by the presence of the primary symptoms.

SCHIZOPHRENIA A "REGRESSION"

Finally, it has been shown that the manifestations of schizophrenia, far from being bizarre and incomprehensible, are not without parallel in other fields of human psychology. Specifically, schizophrenic mentation parallels in many respects the mentation of primitive peoples. In other words, the schizophrenic person reacts with an archaic pattern of behavior—a type of reaction that has been termed regression.

The evidence that schizophrenic symptoms parallel to a certain extent the manifestations of primitive mentation has been collected in an admirable study by Storch.[4] This author showed that the features characterizing both schizophrenic and primitive thinking are: (1) the profuse employment of images and symbols in preference to more abstract conceptions; (2) insufficient differentiation of ideas, leading to fusions, etc.; (3) an indefinitely circumscribed consciousness of self —"fusion of the ego with the objective world," and (4) "overestimation of the scope of one's thoughts and wishes," manifesting itself in the belief in magic wish-fulfilments and transformations.

Thus it is apparent that many similarities exist between the acts and thoughts of schizophrenic persons and those of primitive peoples. As Campbell[5] has said, one finds in schizophrenia "fragments of modes of thought and behavior intelligible in the setting of the child or of the primitive man."

It is seen, therefore, that schizophrenia is today regarded as the reaction of a person with specific morphologic and psychologic characteristics and inadequacies. The schizophrenic person is essentially an immature person who cannot cope adequately with the problems of everyday life, and who presents symptoms of two types: (1) a specific

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3. Bleuler, E.: Dementia Praecox oder Gruppe der Schizophrenien, Leipsic, Deuticke, 1911.

4. Storch, A.: The Primitive Archaic Forms of Inner Experiences and Thought in Schizophrenia, trans. by Clara Willard, Washington, D. C., Nervous & Mental Disease Publishing Company, 1924.

5. Campbell, C. M.: Schizophrenia (Dementia Praecox), Association for Research in Nervous and Mental Disease, New York, Paul B. Hoeber, Inc., 1928.

primary disorder of thinking and of affectivity; (2) a variety of secondary phenomena, some of which are regressive in nature.

This paper is concerned with the mechanism by which regression in schizophrenia manifests itself. One must bear in mind that the demonstration of a similarity between the beliefs of primitive and of schizophrenic persons does not necessarily force one to conclude that the modes of thinking whereby these beliefs were attained were identical in the two cases. Indeed it is inconceivable that an African savage and a schizophrenic person in a metropolitan community, both believing in the evil eye, would have arrived at this belief through identical channels of observation and interpretation. Nevertheless, it seems justifiable for practical purposes to regard the similarity of beliefs as indicative of an approximate parallel between the thinking processes of the two groups in question.

The Mechanism of Regression in Schizophrenia.—The similarity between schizophrenic and primitive mentation being granted, the question arises: How do the archaic phenomena in schizophrenia come to make their appearance? The indications are that most authors would answer this question as follows: The schizophrenic person is biologically immature, imperfect morphologically and probably suffering from a specific type of cerebral defect. He is therefore inadequate to cope with reality, and if the discrepancy progresses and becomes sufficiently great, he will automatically revert to modes of reaction belonging to a phylogenetically lower level, comparable to the immature level of his own personality. The principle involved in this interpretation is that a person patterns his behavior on that level of biologic differentiation for which he is adequately equipped.

An analogy is seen in those cases of gross organic brain disease in which one observes evidences of regression, such as the reappearance of the primitive reflexes normally found in infancy. Betlheim,[6] for example, described a patient with left hemiplegia who showed the primitive grasping reflex. I have seen a patient with the tabetic type of dementia paralytica, an Italian, aged 44, who had immigrated to America at the age of 21 and who had become fairly proficient in English. When I saw him, about six months after the onset of the symptoms of dementia paralytica, he found it no longer possible to express himself adequately in English, although in Italian, according to a competent interpreter, he still conversed fluently. One sees here a regression similar to, if not as extreme as, that seen in Betlheim's case. The point illustrated by both cases is that a patient handicapped by gross disease of the brain tends to revert to an earlier level of behavior.

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6. Betlheim, S.: Zur Frage des zwangsmässigen Greifens bei organischen Hirnerkrankungen, Monatschr. f. Psychiat. u. Neurol. **57**:141, 1924.

Buckley [7] pointed out that the primitive swallowing, sucking and grasping reflexes occur sometimes in advanced psychotic states. In explanation he said, "When inhibitory influences are removed as the result of functional disintegration, primitive reflexes control the type of response to such an extent as to make them stand out conspicuously."

In like fashion many authors regard the regressive phenomena in schizophrenia as due to "functional disintegration," a disintegration which unfits the person for the more highly differentiated levels of behavior.

Thus, Storch, after a lengthy exposition of primitive phenomena in schizophrenia, said:

> Throughout our exposition we have studied the disturbance in schizophrenics mainly from a phenomenonological point of view, merely describing the altered mental experiences; and we have only hinted at the biological processes conditioning these manifestations which so closely resemble the archaic primitive world of emotion and thought. In conclusion we must go briefly into the question of the dynamic changes which are at the foundation of the experiences here described. We will limit ourselves to a few indications which are not regarded as being a complete theory of schizophrenia but which will permit the arrangement of the psychogenic data in a complete clinical and biological picture. *We assume that there has been a weakening of the rational superstructures* caused by the schizophrenic pathological process, an enfeeblement of the "higher cerebral functions" (Gross), or the higher intentional spheres (Berze, Kronfeld), with the result that the synthesis of the psychic functions of the personality into a complete unity is destroyed. Wernicke has already spoken of the cessation "of the union of the higher functions into an entity, i. e., into an ego," of a disintegration of the individuality.
>
> The loss of constancy and definiteness of the structure of the object, the disappearance of the boundaries of the ego, the abolition of the consciousness of self, are the phenomenonological expressions of this fundamental dynamic disturbance. The outbreak of the magic primitive feelings and trends of experience is likewise caused by a relaxing of the rational superstructure. All the resemblances and parallels between the schizophrenic and the primitive psychic conditions may be explained dynamically from the point of view."

At other points in the discussion Storch spoke of the "crumbling of the rational superstructure." In support of his view, he cited the following statement by Kronfeld: "A relaxing of the psychic apparatus in the highest strata of consciousness takes place (in schizophrenia). Through the hiatuses are thrust up the representations and projections of archaic preformations, which are driven upward out of the primitive instinctive life."

Von Domarus,[8] who classified thinking from the point of view of its logic into (1) logical-paralogical, (2) paralogical-archaic and (3)

7. Buckley, A. C.: Observations Concerning Primitive Reflexes as Revealed in Reactions in Abnormal Mental States, Brain **50**:573, 1927.

8. von Domarus, E.: Prälogisches Denken in der Schizophrenie, Ztschr. f. d. ges. Neurol. u. Psychiat. **87**:84, 1923.

pre-archaic or demonic (magic), forming a continuous gradation from the highest to the lowest type, made the suggestion that the appearance of magic thinking in schizophrenia was due possibly to "failure of the inhibiting effect of the disposition to logical thinking." This view coincides essentially with that of Storch.

Thus the regressive manifestations of schizophrenia are thought to make their appearance through the "weakening" or "crumbling" of the "rational superstructure" in very much the same way that patients with organic disease of the brain begin again to show the reflex behavior of infancy. The extent to which this analogy is taken for granted is well illustrated by a phase used recently by White,[9] who ascribed regression in schizophrenia to "functional decerebration."

The view advanced by Storch, White and others seems worthy of credence. In this paper I do not wish to dispute it, but to present a case in which it seems reasonable to assume an entirely different mechanism at work: a case in which archaic magic practices appeared seemingly for the direct purpose of protecting the patient in situations of psychic stress.

REPORT OF A CASE

History.—A boy, aged 16, first came under my observation in July, 1929, with a history of symptoms (to be described) dating back to the summer of 1923. He was tall and physically well developed, but immature in his manner and somewhat below par in intelligence (intelligence quotient about 80).

The patient was the third of five children. The father and mother, both orthodox Jews, were born, reared and married in Russia, later coming to America, where the patient was born. The father was a quiet, submissive man, economically a failure, at the time when the patient was seen, occupying the post of sexton in a poor downtown synagogue. The mother, comparatively young and energetic, was unhappy in her marriage. She had married, after the briefest acquaintance with her husband, out of deference to her own parents who had arranged the match. She had never loved her husband; she had for a time contemplated divorce, but had finally resigned herself to a life of unrealized hopes.

The patient was strongly attached to and dependent on his mother, partly through his own immaturity and partly through the following unusual circumstances. When he was 9 months of age, his mother took him and the two older children back to the home of her own parents in Russia. This was made necessary by the inability of her husband to earn a sufficient wage. He intended shortly thereafter to join his wife and children in Russia, where prospects of a livelihood seemed better. The World War, however, intervened, and for many years travel was impossible. In the meantime, through changing political and economic conditions, the mother's parents lost whatever they had, and in November, 1922, the mother and the three children returned to America. To all intents and purposes, the patient then saw his father for the first time. During the eight troubled years in Russia the mother had overprotected and pampered the patient, and the latter, as her then youngest child, had grown accustomed to

9. White, W. A.: Schizophrenia (Dementia Praecox), Association for Research in Nervous and Mental Disease, New York, Paul B. Hoeber, Inc., 1928.

the major share of her attention and love. For example, throughout the entire period he had slept with her. He therefore felt no joy on returning to America, where he was compelled to share his mother with a hitherto virtually nonexistent father as well as with the two little children who came subsequently. Less than a year after the return to America, the patient's symptoms began.

There were other complicating situations: 1. The father's attitude was indifferent and hostile, and he would say to his wife, "The two youngest children are mine; the others are yours." 2. The patient, virtually a foreigner, immature and mediocre intellectually, found it difficult to adapt himself to the American environment. Other boys made fun of him. When he came under observation he still had a pronounced foreign accent.

The symptoms, beginning in 1923, marked the onset of a progressive maladjustment, which soon made him the outstanding concern of the family. He was treated, now with sympathy, now with exasperation and disbelief in the reality of his illness. For therapeutic purposes he was removed from his home and placed in two different private foster homes from March, 1928, to May, 1929, but no fundamental improvement was accomplished.

In a series of interviews with the patient, an account of the evolution of the symptoms was obtained. The data germane to this discussion are here presented.

Data Given by the Patient.—At the first interview, on July 11, 1929, the patient spoke of his "nervousness." "I used to get certain ideas and they used to make me nervous." By this he meant that different "bad thoughts" would occur to him, for example, the thought that when he grew up he would become a "crook." These thoughts were accompanied by a fear that they would come true. To allay this fear it was necessary for him to return to the place and assume the posture in which he had found himself at the moment the thought had occurred and then "say to himself" that the dreaded event would not materialize. For example, once, while sitting at the table with his hands resting on the table in a certain position, the thought occurred that he would be run over by a street car or automobile. Some minutes later, suddenly recalling this thought, he became alarmed and felt it necessary to return to the table, sit and lay his hands in exactly the previous position and say to himself, "I will *not* be run over." He felt that unless he did this the dreaded disaster would almost certainly materialize, whereas if he performed the ritual the chances were reduced to a minimum. This symptom began in May or June, 1927, and cleared up in the autumn of 1928. While subsequently the patient looked on the symptom as "foolish," during the period of its existence it had for him the validity of a natural law.

I shall here be concerned mainly with the evolution and meaning of this symptom, which, for the sake of convenience, I may call the "evil-forestalling ritual."

The patient dated the onset of his psychic maladjustment in the summer of 1923, when the following incident occurred. While he was eating a sour tomato, his mother called him. In a hurry to run to his mother, he hastily swallowed a piece of the tomato, which lodged in his throat and momentarily choked him. At that moment he suddenly recalled having read of people who were choked to death in this fashion, and he became panicky. There was general commotion during which someone administered medicine to the patient, after which his composure was restored. During the following three years, the patient had recurring attacks of anxiety, sometimes on eating solid food and sometimes unassociated with eating. During these attacks his heart beat rapidly, and he often feared he had heart disease.

One or two years after the tomato incident, a further symptom made its appearance. One day as the patient sat down to a meal, he found that he had to adjust his chair and his position at the table for a full minute before he could comfortably begin to eat. As the patient expressed it, "I used to have a hard time getting comfortable—when I was beginning to eat—I would just move around with the chair till I was in a comfortable position." This "table phenomenon" lasted till May or June, 1927.

About a half year after the onset of the table phenomenon, another symptom very much like it was noted. It was the patient's habit, on going to bed, to lay his clothes on the top of a bureau. Presently he noticed that he had to lay the clothes in a special position on the bureau before he could fall asleep. If he failed to obey this compulsion, "it would make me feel uncomfortable. A certain feeling would make me feel like I had to do it." This "bureau phenomenon" cleared up simultaneously with the table phenomenon in 1927.

As in the case of the evil-forestalling ritual, so with the table and bureau phenomena the patient was not impressed with the "foolishness" of the symptoms until after they had subsided.

In May or June, 1927, the table and bureau phenomena disappeared, and simultaneously the evil-forestalling ritual occurred for the first time.

In subsequent interviews the patient threw further light on the essential nature of these symptoms. I asked him to try to recall whether any particular circumstances favored the appearance of the table phenomenon. He replied, "It always used to happen when I was real hungry and there was something good to eat and I was real anxious to eat it."

This statement revealed an association between the tomato incident and the table phenomenon. In the former case, anxiety followed an attempt to swallow hurriedly a piece of unchewed tomato. In the latter case, the table compulsion made its appearance whenever the patient was hungry and consequently desirous of eating in a hurry. In both cases the desire to eat hurriedly was prominent. At this point in our discussion it seemed justifiable to assume that the original tomato incident was associated with some conflict: that is, the situation in which the incident occurred stirred up a hidden conflict leading to the exhibition of anxiety; an association was then established between the apparent cause of this anxiety (eating hurriedly and choking) and the real cause (the assumed conflict), so that in the course of time the ordinarily innocent situation of being hungry and wanting to eat hurriedly came to be invested with the power of reviving the conflict in question.

In speaking further of the table phenomenon, the patient remarked, "It was to me like a person, in order to have a good thing, would first have to sacrifice something." He meant that it was as if in order to satisfy his ravenous appetite he first had to make a certain sacrifice or pay a price. We may, however, read between the lines of the patient's remark. The table phenomenon, which compelled him to wait about a minute before he could attack his meal, occurred precisely on those occasions when he was most hungry and eager to eat. It was therefore a form of self-punishment. The conflict, which had by this time become associated with the desire to eat fast, was one in which some forbidden impulse struggled for recognition—an impulse which could be tolerated only if the patient paid a certain price in the form of self-denial.

The patient regarded the bureau phenomenon as having the same sacrificial significance as the table phenomenon, so that one may assume that eventually also the situation of going to bed became capable of stirring up the original conflict.

The patient next made the statement that the evil-forestalling ritual occurred for the first time one evening while he was adjusting his clothes on the bureau preparatory to going to bed. On this particular occasion, while in the act of placing the clothes on the bureau, some "bad thought" occurred to him. (He was unable to recall what this thought was, except that it was to the effect that some "bad thing" was going to happen.) A few moments later, while walking from the bureau to the bed, he recalled having had the "bad thought," and suddenly the idea came to his mind that the "bad thing" was actually going to happen. A momentary panic ensued, and just as suddenly the patient "realized" that he could forestall this event by going back to the bureau, adopting his previous position, laying his hands on the clothes in the exact position that they had occupied when the thought had occurred, and assuring himself that the evil event was not going to happen.

One may assume that the evil event which the patient so dreaded was one which unconsciously he wished would really transpire. It was probably connected with the original conflict, which had by this time become associated with the situation of going to bed.

The patient was then asked to try to recall all the "bad thoughts" which had at various times made it necessary for him to perform the ritual. After some hesitation he replied, "One of the bad thoughts was that I might commit a crime." Another was "that I might get killed." He could recall no others of any significance.

He was then asked to mention all the crimes that he knew. His first reply was "murder." When asked whether any of the "bad thoughts" were to the effect that he might commit murder, he replied, reluctantly, "Yes." After some encouragement he stated that at times he had fancied that he might kill "my older brothers—and maybe some other boys."

In an attempt to discover the motives that possibly underlay the murder fancies, he was questioned as follows:

Q.—"Why do some people kill other people?"

A.—"There are different reasons."

Q.—"What are they?"

A.—"Some do it to get their money."

Q.—"What other reasons are there?"

A.—"Sometimes they get mad at somebody."

Q.—"Over what might it be?"

A.—"It would have to be a very serious thing to make them so mad that they would kill somebody."

Q.—"What might make a person as mad as all that?"

A.—"Sometimes if one person treats the other person in a very severe way, he will get mad at him."

Subsequently, in speaking of his attitude toward his parents, the patient stated most emphatically that he preferred his mother, since "she treats me better." The father, on the other hand, "used to hit me every time, but not now . . . but still he hollers at me. Most of the time he would get mad at me. He would act like he didn't like me. Sometimes I would just ask him a question and he would get mad and holler at me."

It is noteworthy that after he had mentioned "treating another person in a very severe way" as an inciting cause of murder, the patient described his father's attitude toward him in terms fully justifying the epithet "severe." Though the patient had failed to include him among the objects of his murder fancies, it

seemed not improbable that such fancies had on occasion been directed toward his father.

At this point it became possible hypothetically to reconstruct the case as follows: In the initial episode, when the mother called the patient while he was eating a tomato, some forbidden desire or fancy was stirred up, and the resultant conflict led to an anxiety attack which the patient falsely interpreted as the result of having tried too hastily to swallow a piece of the vegetable. At various times thereafter the forbidden fancy threatened to erupt into consciousness, each time giving rise to anxiety. In the course of time an association was established, as already indicated, with the neutral situation of sitting down hungry at the table, and the resultant table phenomenon arose as a "sacrifice" or punishment to atone for the forbidden desire. Later, an association was established with the situation of going to bed, and the bureau phenomenon arose on a similar basis. Still later, the forbidden desire flared up with unusual intensity one evening while the patient was preparing for bed and gave rise to the "bad thought" that some dreaded (but unconsciously desired) event was going to happen. The patient could not recall the content of this thought, but he did remember the nature of the "bad thoughts" that came to him on subsequent occasions. Prominent among these was the fancy that he might kill various persons, including his two older brothers and, with a high degree of probability, his father. The evil-forestalling ritual arose as a means of suppressing these "bad thoughts" or disguised wishes.

In view of the relationship existing between the patient and his mother, it seemed not unlikely that the forbidden fancy stirred up in the original episode concerned itself with a persistent infantile "mother attachment," which in turn gave rise to jealousy of the father and to the murder wishes assumed to have been directed against him.

Subsequent disclosures gave strong confirmation to the assumption of the existence of a murder-wish against the father. At an interview in April, 1930, the patient said that the attitude of his father had made him lose all courage. Recalling a recent occasion when his father had struck and abused him for not getting up when ordered to do so, he said, "After he saw these bad spells I have (referring to anxiety attacks which had reappeared in February, 1930), and he could have the nerve to hit me—it made me lose courage. It made me feel bad, I had a bad feeling toward my father. Certain bad thoughts about my father flashed through my brain."

Q.—"What were these thoughts?"

A.—"Certain thoughts like if you hate a person. I just didn't care for him. I felt him like an enemy toward me (undoubtedly partly a projection). I felt like he wasn't one of my relatives (disowning his father). You shouldn't get such a feeling toward your own father. It says in the Ten Commandments you should honor your father and mother—and the way I felt, I felt like I was committing a sin the way I felt toward my father. I felt like even if I would commit a sin, I wouldn't care—even if I would be killed by God."

Q.—"What were the thoughts you had at that time about your father?"

A.—"You know what thoughts you would get if somebody would treat you this way."

Q.—"What thoughts would you get if somebody treated you this way?"

A.—"If it's your father, or anybody?"

Q.—"Anybody."

A.—"When you get real angry at a person, you forget it's your father."

Q.—"At any rate, what thoughts would you get if any one, not your father, treated you this way?"

A.—"You would try to do him harm, either by speech or by action. . . . You would think that he's a wicked man, cruel. You could kill him sometimes, that is, if you don't control yourself."

Q.—"That is, if he's not your father."

A.—"Well, I read once where a boy killed his father. . . . Of course he wasn't of the Jewish religion—you don't find such things among the Jewish people (an attempt to convince himself of the remoteness of such a possibility in his own case)."

The reality which the murder fancies had for the patient and the threat which they offered to his psychic integrity are evident from an incident that occurred in 1928, while he was living in a private foster-home. The foster-mother, the patient and the milkman were discussing the great frequency of murders and crimes of violence as recorded in the newspapers. The foster-mother remarked that life is not safe any more, to which the patient replied that murders do after all serve a purpose, for without them the world would become overpopulated. (The patient had never heard of Malthus, and his argument was the spontaneous result of his own psychic processes.) Soon after this conversation the patient began to feel uncomfortable about it. "I started to think what I had said and things got into my head. I thought that the milkman would believe what I said was true and he would go out and kill people. Also, the milkman goes to see everybody in the neighborhood, and I thought he would tell everybody and it would get around, and the whole world would believe it, and it would start war and bloodshed." On questioning it became clear that this fear, which continued to disturb the patient for several months, represented not merely an obsession but an actual delusion. "I thought that peace and war depended on what I had said." So disturbed was he that a few months later, after he had left the foster-home, he wrote to his foster-mother entreating her not to think he had seriously meant what his remark had seemed to imply. He begged her to communicate this to the milkman. Even then he worried that the letter had failed to reach her or that she might fail to tell the milkman. Such behavior is explainable only if one assumes that the patient's "innocent" remark in defense of murder expressed his innermost feelings—feelings which he was "trying" to repress and disown.

For diagnostic purposes I may digress here to state that the general picture of the case pointed beyond a mere neurotic development. The patient, always unusually preoccupied, became rather definitely dilapidated toward the end of 1929. He became more and more careless of his appearance, to the point where he appeared in public with large rents in his trousers, through which his genitals were visible. His behavior became quite erratic. At home he would lie in bed till some time in the afternoon, and would either demand his meals in bed or would come into the kitchen half-clothed. When the mother attempted to enforce discipline by refusing him food unless he came to the table at stated hours properly dressed, he created a disturbance, at times throwing things around, breaking the window-panes, and tearing the bed sheets into strips. At times he was disturbing during the night, sometimes keeping the family awake the entire night. He sometimes stood in the center of the room in a fixed position for as long as an hour. At an interview in March, 1930, he seemed dazed, and his speech was not as coherent as usual. This picture, together with the grandiose delusion in 1928 as a result of which he believed that his remark might precipitate

a world-wide war, made it seem probable that the patient had an early case of schizophrenia.

Briefly, then, the patient is an immature young man, probably an early schizophrenic type, overprotected by his mother and dependent on her, accustomed in early life (through the absence of the father) to the major share of her attention and at 9 forced to face the reentry of the father into his life. Antagonism to the father developed, and eventually the point was reached where the patient became aware of "bad thoughts," among which the most prominent was the thought (or disguised wish) that he would murder his father or other members of the family. Energetic repressive measures were applied to these wishes, and the patient developed a strong sensitiveness on the topic of murder, so strong that an ostensibly innocent, unconsciously conditioned remark in defense of murder led to an acute fear that this remark would precipitate widespread murder and bloodshed. The evil-forestalling ritual arose as an emergency defensive measure for the better repression of these murder fancies and other "bad thoughts."

Comment.—The archaic nature of the evil-forestalling ritual is apparent. There is a strong similarity between it and the thinking of primitive peoples. A "thought" occurred to the patient; he unconsciously wished that this thought would come true, but consciously he dreaded it, and he believed that he could prevent it by going back to the position and posture in which he had found himself at the time the thought had occurred, and then saying to himself, "It will not happen." Now it is characteristic of primitive thinking to overvalue associations that are in truth only superficial. Frazer, in "The Golden Bough," gives numerous illustrations.[10] Among certain savage races, for instance, it is thought that one's discarded hair, teeth, etc., must be kept from evil persons, for otherwise harm could be done to the former possessor by doing certain things to his onetime appendages. It is supposed that objects which once formed a part of a person continue to exist in a state of sympathetic union with that person, whereas in fact the association is a superficial and negligible one. Similarly, my patient attached more than superficial significance to the association of bodily posture with an event represented by a thought existing simultaneously with the posture. To him the posture was an integral part of the event in question, and to forestall the event he first had to resume the posture.

Furthermore, the patient overestimated the rôle of thought as a controller of destiny. Thinking that a certain event was going to happen promptly gave rise to the belief that it would happen. Also, to forestall this expected happening it sufficed (after assuming the appropriate posture) to think, "It will not happen." Here again one sees a similarity to primitive thinking, which is characterized, as is well known, by a belief in the "omnipotence of thought." According to Frazer,

10. Frazer, J. G.: The Golden Bough, A Study in Magic and Religion, New York, The Macmillan Company, 1925.

"(primitive) men mistook the order of their ideas for the order of nature, and hence imagined that the control which they have, or seemed to have, over their thoughts, permitted them to exercise a corresponding control over things."

Since my patient believed that the deed was sure to follow the thought, he attempted to prevent the deed by "undoing" the thought. This he accomplished by repeating the thought in its negative form. This, too, is similar to certain manifestations of magic. For instance, superstitious persons of today who have stepped through a window and fear that they have thereby stunted their growth will undo the "harm" by stepping back through the same window; or, such a person, having stepped over a child, will step back over the same child to prevent the stunting effect which the original act is thought to have on its growth.

The evil-forestalling ritual may for these reasons be regarded as a magic ritual, designed in accord with primitive archaic modes of thought.

Furthermore, in keeping with the general purpose of primitive magic practice, my patient's ritual was a defense mechanism designed to ward off evil. He was culturally sufficiently advanced and psychically sufficiently well integrated not to tolerate his unconscious murder wishes, and the eruption of these wishes into consciousness rendered him panicky. In this situation of danger—as real as any physical danger—the evil-forestalling ritual functioned to repress the forbidden wishes and so maintain his psychic integrity.

It is apparent, therefore, that in the case here reported it would not be justifiable to regard the magic symptom as merely appearing automatically through the "crumbling of the rational superstructure." One cannot of course say that this mechanism does not exist in the background, but in any event another mechanism is plainly evident: The evil-forestalling ritual occurred at specific times and in specific situations, frequently (if not always) as a means of protecting the patient against his own disturbing and havoc-producing thoughts.

The difference between the two mechanisms lends itself to an analogy. An army in the field flees in utter rout when hopelessly outnumbered and unable to make a stand against the enemy. On the other hand, when the odds are not so great it may retire for "strategic purposes," in which case it retreats, not to flee destruction, but to strengthen its position and to unify its forces. The patient who regresses to the stage of magic symptom-formation for defensive purposes is like the army in strategic retreat; the patient in whom archaic phenomena crop up for no apparent purpose, but merely because the "rational superstructure" has broken down, is like the army that is utterly routed.

THE DEFENSIVE FUNCTION OF CERTAIN SCHIZOPHRENIC SYMPTOMS

That schizophrenic symptoms may exist for defensive purposes is by no means a new idea. Adolf Meyer,[11] in his Toronto address in 1906, pointed out that they may originate as "a remedy of difficult situations." In 1910,[12] he described a patient in a catatonic stupor, "in which the patient is a mere bundle of tense inactive self-defense." In this article he took issue with the view that catatonic stupor is explainable organically rather than psychologically. He maintained that, far from being unexplainable psychologically, catatonic stupor is closely related to what is seen in certain hypnotic states and in mystic fancies. In this connection he said, "The very frequency with which especially catatonic reactions appear outside of the actual (organic) deteriorations . . . would corroborate their interpretation as a specific functional reaction type possibly founded on a phylogenetically very old reaction partly of protection and partly of mystic surrender." Likewise, in 1917, Dr. Meyer [13] said, "It is not by any means excluded that the capacity to go into a catatonic reaction may be looked on as a positive asset, i. e., not as a product of the 'disease,' but as a defense mechanism indicative of the constitutional makeup." Similarly, Bleuler [14] expressed the belief that schizophrenic negativism is partly a self-defense mechanism.

Apart from schizophrenia, the magic of primitive people is thought to serve, directly or indirectly, the purpose of self-defense. To quote Storch: "The deepest impulse to form concepts of magic thought probably lies in the instincts of self-preservation and self-defense. . . . Originally the magic rights and usages of primitives arose everywhere from the efforts in the direction of self-protection against evil influences and to gain power over the surrounding world."

Since the function of self-defense is thus seen to be served both by certain symptoms of schizophrenia and by the magic of primitive races, it may well have been anticipated that magic and other archaic phenomena in schizophrenia might, at least in some cases, serve a protective purpose. That this is indeed true is shown by the case here recorded.

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11. Meyer, A.: Fundamental Conceptions of Dementia Praecox, Brit. M. J. **2**:757, 1906.

12. Meyer, A.: The Dynamic Interpretation of Dementia Praecox, Am. J. Psychol. **21**:385, 1910.

13. Meyer, A.: The Approach to the Investigation of Dementia Praecox, Chicago M. Rec. **39**:441 (Oct.) 1917.

14. Bleuler, E.: The Theory of Schizophrenic Negativism, trans. by William A. White, New York, Journal of Nervous & Mental Disease Publishing Company, 1912; also in J. Nerv. & Ment. Dis. **39**:50, 133, 195, 274, 1912.

DEFENSIVE REGRESSION AMONG NEUROTIC AND "NORMAL" PEOPLE

Archaic regressions of a protective nature may occur not alone in schizophrenia but also in less serious disturbances, such as the neuroses, and indeed even in clinically well people. Freud [15] has given many examples of neurotic compulsions and obsessions that correspond approximately to the magic acts of primitives. Referring to the neurotic acts, he says: "There is no doubt that these acts are in the nature of penances, expiations, defense reactions, and purifications."

Although both my patient with his evil-forestalling ritual and Freud's patients with compulsion neuroses with their compulsive rituals revert to primitive magic modes of thought for self-protection, one important difference between them is apparent. The person with compulsion neurosis has, culturally speaking, progressed comparatively far from his primitive forbears, and therefore the archaic symptom is to him foreign and remote. Indeed he characteristically complains that although he must obey his compulsions, he cannot understand them; they are "absurd," "silly," etc. The schizophrenic person, on the other hand, is less highly differentiated. Biologically he belongs on a lower level, in some respects roughly comparable with that of primitive mankind, and his archaic symptoms are no more absurd to him than are the magic practices of savages to them. It was not until after the disappearance of the evil-forestalling ritual that my patient looked on it as "foolish."

A few instances of the occurrence of magic in normal life may now be given. It happens frequently that an experienced motorist, sitting next to an inexperienced driver, reacts, in the face of a threatened collision when the driver is slow in applying the brakes, by pressing his own right foot on the floor, as though he himself were stepping on the foot-brake. Although this is partly a conditioned reflex, one observer has told me that in him it is accompanied by the thought, "I wish the driver would hurry up and step on the brake." This suggests that the act is, in part, an attempt to influence the driver by imitative magic. I have seen a mother, holding in her lap and feeding a refractory child with a spoon, open her mouth at the time she brought the spoon near the child's mouth. There was no possibility of the child seeing and so imitating the mother, and the mother's act therefore seemed explainable only as an attempt to control the child by imitative magic. A famous teacher of singing, attending a recital given by his pupils, was seen going through some of the facial and trunk movements appropriate to the phrase about to issue from the lips of the singer. He, too, eager for the success of his pupils and desiring to ward off their failure, resorted to magic in order to assist them. Here we may

15. Freud, S.: Totem and Taboo, trans. by A. A. Brill, New York, Moffat, Yard & Company, 1918.

include the obvious efforts of spectators at a football game to help their team by making thrusting movements with their own bodies.

The "normal" person, like the one with compulsion neurosis and unlike the schizophrenic person, is too highly differentiated to "believe" in the magic of which he may at times avail himself. When the magic act is called to his attention, he will as a rule smile in recognition of its primitiveness. Of course, I do not include those clinically well but immature persons who have implicit faith in superstitions of one sort or another.

In the instances of magic from normal life already cited, it is clear that the magic performance serves to forestall major or minor unpleasantness. In this respect the mechanism is similar to that of my patient's evil-forestalling ritual.

In view of the occurrence of defensive magic in normal, neurotic, and some schizophrenic persons, one may say that human beings generally tend to react to situations of stress by reverting to archaic patterns of behavior. Primitive patterns of activity, both physical and psychic, serve to protect the individual in emergencies.

PROGNOSTIC SIGNIFICANCE OF DEFENSIVE REGRESSION IN SCHIZOPHRENIA

The clearly purposive function of my patient's magic in contrast with the automatically appearing archaic phenomena of other schizophrenic persons raises the question whether any prognostic significance may be seen. It would seem plausible to argue that regression which serves a protective function would tend to indicate a better prognosis than otherwise, since it suggests that the patient retains to a corresponding extent the capacity and the "willingness" to adjust, albeit on an inferior and primitive level. Actually, however, it is not known at the present time whether this inference is correct.

SUMMARY

Recent investigations have shown that the schizophrenic reaction may be looked on as, in certain respects, a "regression" to a phylogenetically archaic type of behavior. The behavior and thinking of schizophrenic persons are to a certain extent similar to the manifestations of the psychic life of primitive races. Regarding the mechanism whereby archaic phenomena become manifest in schizophrenia, the view generally held is that in this disease there is a "crumbling of the rational superstructures" of the mind (Storch), following which there is an automatic regression to archaic modes of thought (much as some patients with extensive destruction of the brain regress to the stage where they show again the swallowing, sucking and grasping

reflexes of infancy). A case is cited in which, in addition to (if not instead of) this mechanism, another mechanism is evident. The case is that of a young man who developed a magic ritual by which he protected himself against the fulfilment of "bad thoughts," behind which lay certain thinly disguised wishes, including a murder-wish directed against his father. The archaic symptom in this case protected the patient by helping him to "repress" the forbidden wishes, and therefore served an adaptive purpose. Analogies are found among neurotic and normal persons who resort to magic modes of thought when confronted with impending danger or unpleasantness.

RESPONSES ELICITED BY STIMULATION OF THE MESENCEPHALIC TEGMENTUM IN THE CAT*

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Experiments have shown that in the cat, the rostral portion of the mesencephalic tegmentum and its continuation into the hypothalamus are involved in the act of walking. In the absence of the cerebral cortex and thalamus, a number of reflex patterns are present which would necessitate descending pathways other than the corticospinal tracts, i. e., tracts of an extrapyramidal nature. There are a number of such pathways, any one of which may be essential for such descending conduction.[1]

There have been several observations which show that stimulation of the mesencephalic tegmentum in the region of the red nucleus in the monkey and the cat produces ipsolateral flexion and contralateral extension in the fore limbs and varying responses in the hind limbs. This may represent one of the components of walking and other reflex activities of the mesencephalic tegmentum, and it was with the purpose of a further analysis of this reaction in the cat that the present investigation was undertaken.

The mesencephalic tegmentum has been explored with electrical stimulation by Thiele[2] (1905, cat and monkey), by Graham Brown[3] (1913 and 1915, monkey and anthropoid ape), by Weed[4] (1914,

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1. Hinsey, J. C.; Ranson, S. W., and McNattin, R. F.: The Rôle of the Hypothalamus and Mesencephalon in Locomotion, Arch. Neurol. & Psychiat. **23**: 1 (Jan.) 1930.

2. Thiele, F. H.: On the Efferent Relationship of the Optic Thalamus and Deiters' Nucleus to the Spinal Cord, with Special Reference to the Cerebellar Influx Theory of Dr. Hughlings Jackson and the Genesis of the Decerebrate Rigidity of Ord and Sherrington, J. Physiol. **32**:358, 1905.

3. Brown, T. Graham: On the Postural and Non-Postural Activities of the Mid-Brain, Proc. Roy. Soc. **87B**:145, 1913; Note on the Physiology of the Basal Ganglia and Mid-Brain of the Anthropoid Ape, Especially in Reference to the Act of Laughter, J. Physiol. **49**:195, 1915; On the Occurrence of a Plastic Flexor Tone in the Monkey, ibid. **49**:180, 1915; On the Effect of Artificial Stimulation of the Red Nucleus in the Anthropoid Ape, ibid. **49**:185, 1915.

4. Weed, L. H.: Observations upon Decerebrate Rigidity, J. Physiol. **48**:205, 1914.

cat) and by Környey [5] (1927, cat). They all observed that on stimulation of the mesencephalic tegmentum there is ipsolateral flexion and contralateral extension in the fore limbs. The hind limbs are said usually to show ipsolateral extension and contralateral flexion. The neck and trunk are turned so as to be concave to the side of stimulation, and the hind limbs may swing out and toward the side of stimulation. On stimulation of the cerebral peduncles in the region of the corticospinal tracts, contralateral flexion in both the fore and hind limbs is the result. Brown expressed the belief that the activity of the tegmental mechanism is postural, owing to the presence of both flexor and extensor after-discharges, while the corticospinal activity is nonpostural and seems to abolish the postural midbrain activity, as is seen when a contralateral corticospinal flexion is produced during ipsolateral flexor after-discharge following tegmental stimulation.

There is a difference of opinion in regard to the focal point for the tegmental response. Thiele believed that it lay in the medial nucleus of the thalamus and the red nucleus, and that the conducting pathway was the rubrospinal tract or one that passed down with it. In the monkey, Brown found two focal points, one in the region of the medial longitudinal fasciculus and another in the red nucleus. In the ape, he attributed it to red nucleus stimulation. Weed found it in the cephalic portion of the red nucleus and Környey in the substantia nigra. The response occurred following degeneration of one or both pyramidal tracts (Thiele), after section of the decussation of Forel (Brown and Környey), removal of the cerebellum (Brown and Környey), of the superior colliculi (Brown), division of one superior cerebellar peduncle (Brown), bilateral section of the medial longitudinal fasciculi (Környey) and bilateral section of the eighth nerves (Környey). It was eliminated by hemisection caudal to the red nucleus (Brown and Környey) and by a lesion involving the substantia nigra as well as additional tegmentum dorsal to it (Környey). It was not elicited by stimulation of the tectum (Brown, Weed and Környey) or by stimulation of the inferior olivary nucleus (Környey). Környey believed that it did not depend on tonic neck reflexes.

The evidence as a whole indicated that the focal point was in the region of the red nucleus and that the conduction must have been ipsolateral down into the pons at least, thus removing the crossed rubrospinal tract from consideration. The one investigator who did not regard the region of the red nucleus as a focal point was Környey, whose work indicated that this point was the substantia nigra. This

5. Környey, S.: Experimentalstudien am Nervensystem von E. A. Spiegel. X Mitt.: Tonusänderungen, insbesondere der Rumpfmuskulatur bei Reizung des Mittelhirnquerschnittes, Arb. a. d. neurol. Inst. a. d. Wien. Univ. **30**:120, 1927.

evidence is based on the absence of the reaction following destruction of the basis pedunculi and substantia nigra on each side. It is not convincing, because the lesion involved one red nucleus and was close to the other one. It is impossible by examination of the extent of an anatomic lesion to know how far the physiologic lesion extended in an acute preparation, and it is possible that in this experiment, a considerable portion of the tegmentum was involved.

METHOD

The cats used in these experiments were anesthetized, a tracheal cannula was inserted, and both carotids were tied in the neck. The cats were then decerebrated at a level extending from the rostral border of the superior colliculus to the region of the exit of the third nerve, usually just rostral to it. Following this procedure, the animal was placed in a hammock with the fore and hind limbs projecting through holes in the canvas. The head was fixed by placing a rigid transverse bar through the mouth and then tying the head in place to the frame so that there was little movement. The cranial cavity was covered with a pad of cotton, moistened with warm saline solution, when the brain stem was not being stimulated. Pads of cotton moistened in warm saline solution were sometimes used to keep the brain stem from cooling.

Both unipolar and bipolar stimulation were used, and the results were identical when applied in the same experiment. In the unipolar stimulation, the indifferent electrode was applied to the abdominal wall. The stimulating electrode was made of silver wire coated with silver chloride. A Harvard coil was used with one dry cell delivering between 20 and 30 amperes, and the coil separation varied between 9 and 13 cm. During stimulation every precaution was used to keep the surface of the brain stem dry, and to prevent the spread of the stimulus as much as possible.

We recorded a number of kymograph tracings of contractions of the biceps brachii and the lateral portion of the triceps brachii. In this procedure, the head was fixed in a position that would correspond nearly to the position of minimal labyrinthine tonus. The scapula and the proximal and distal ends of the humerus in the left fore limb were immobilized with the animal in the ventral position. The biceps and the lateral head of the triceps were isolated, with their blood and nerve supply intact and freed from the surrounding muscles and connected to muscle levers. The contractions recorded were isotonic with the muscles contracting against the resistance of long rubber bands. As the pattern is a definite one, it was deemed unnecessary to record tracings for all of the experiments.

The extent of the experimental lesions made was controlled anatomically by removing the brain stems, fixing in formaldehyde and staining with Weil's[6] (1928) method. While this did not give exact information as to the extent of the physiologic lesions, the anatomic lesions were definitely delimited.

RESULTS

In a normal animal in the hammock with the head fixed by a rigid transverse bar in the 180 degree position of Magnus, stimulation of the mesencephalic tegmentum, either by unipolar or by bipolar stimu-

6. Weil, A.: A Rapid Method for Staining Myelin Sheaths, Arch. Neurol. & Psychiat. **20**:392 (Aug.) 1928.

lation, caused a turning of the neck and trunk so as to form a concavity on the side of stimulation. The ipsolateral fore limb was flexed and the contralateral fore limb extended. The fore limbs sometimes swung out to the side opposite the stimulation. The hind limbs as a rule followed the rotation of the body and swung out to the side of stimulation. Sometimes there was bilateral flexion of the hind limbs at the hip joint, but it was difficult to see any homolateral extension and contralateral flexion in the hind limbs as has been described. In cat 108, on stimulation of the left tegmental area, there was ipsolateral flexion and contralateral extension in the fore limbs and contralateral flexion in the right hind limb. Ipsolateral hind limb extension in addition to that already present due to decerebrate rigidity was not evident. The responses of extension and flexion were by no means as evident in the hind as in the fore limbs. When observed in the intact animal, the ipsolateral flexor contraction in the fore limb was slow in reaching its maximum and did not outlast the stimulus for any appreciable length of time as the extensor contraction in the contralateral limb was seen to do. When the basis pedunculi was stimulated, there was quick contralateral flexion in both fore and hind limbs without any evident participation of the ipsolateral limbs in the reaction.

When kymograph tracings were made of the dissected left fore limb, stimulation of the left tegmental area was seen to produce ipsolateral biceps contraction which was either slow or rapid in its rise, but generally relaxed fairly rapidly in the cat, and was not prolonged in an after-discharge as Graham Brown described for the monkey. The ipsolateral triceps relaxed if there was tonus present (fig. 1*A*). When the right tegmental area was stimulated, there was a contralateral triceps contraction which was usually slow to reach its maximum and which showed a prolonged after-discharge. If the left tegmentum was stimulated during this extensor after-discharge, the after-discharge was inhibited and there was an ipsolateral flexion on the left side (fig. 1*D*). As no prolonged flexor after-discharge was observed in normal animals in our experiments, it was impossible to test this out in the reverse manner (fig. 1*E*) as Graham Brown did. On stimulation of the right basis pedunculi, contralateral flexion in both fore and hind limbs was generally observed. Accompanying this contraction of the biceps in the left fore limb, the triceps in the same limb was seen to relax (fig. 1*C*), and at the end of the contraction of the biceps there was an extensor rebound. As a rule, on stimulation of the left basis pedunculi, no participation was seen in the ipsolateral muscles.

In this type of experiment it is exceedingly difficult to localize the focal point with any degree of accuracy. An attempt to do this was made by stimulating over the area, localizing the most irritable point and then inserting a hair in it immediately afterward. This method

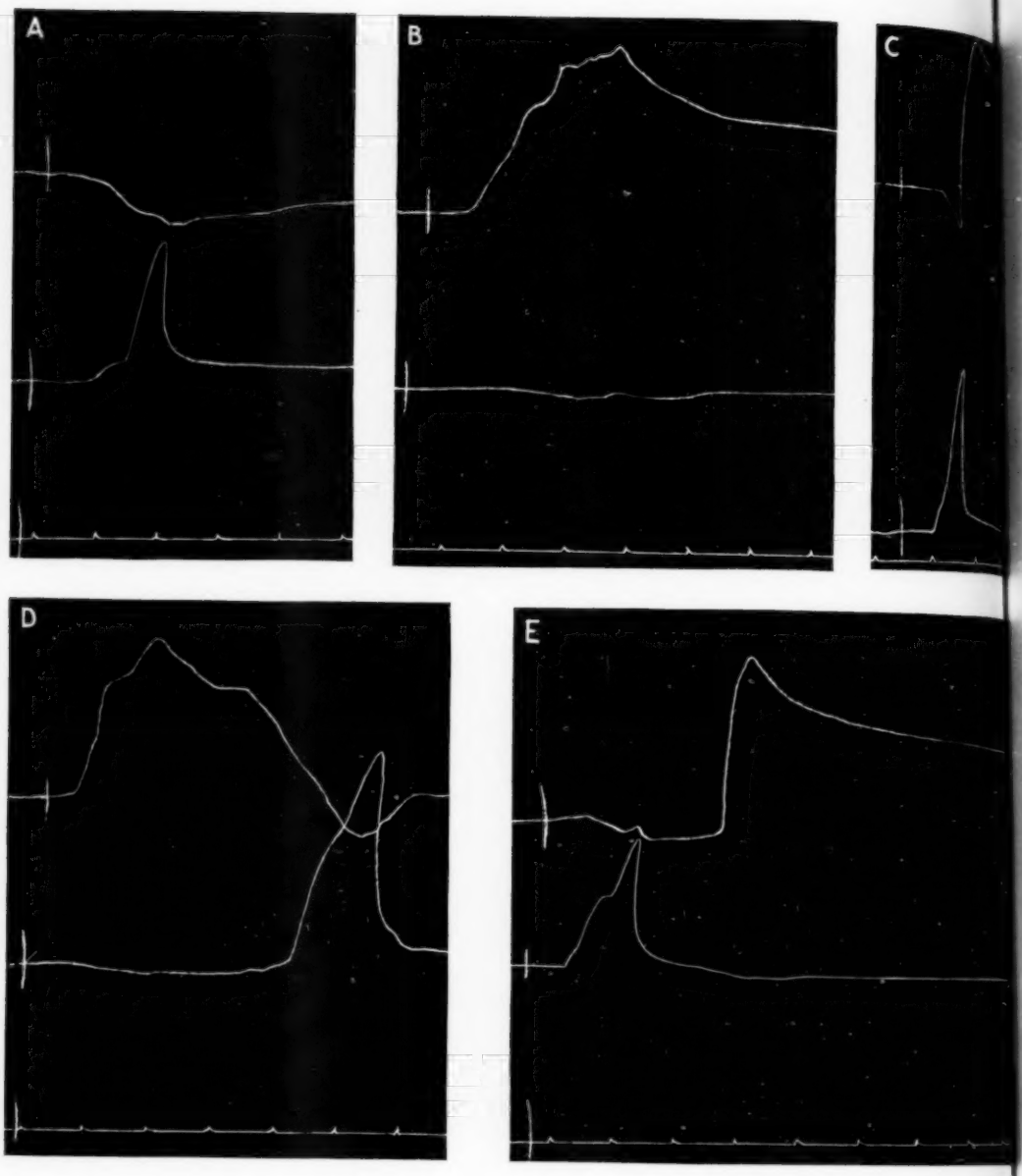

Fig. 1.—Responses in the lateral head of the left triceps brachii (upper tracing) and in the left biceps b
(lower tracing). The stimulus duration is not shown because under the conditions of the experiment it
only be approximately correct. The time is given in seconds. *A* shows a stimulation of the left tegmen
the region of the red nucleus with ipsolateral flexion and relaxation of the extensor; *B*, the stimulation of the
tegmentum in the region of the red nucleus, showing contralateral extension; *C*, the stimulation of the right
pedunculi showing contralateral flexion, and relaxation of the extensor followed by extensor rebound; *D*
stimulation of the right tegmentum in the region of the red nucleus with contralateral extension and some
cation of flexor relaxation. During the extensor after-discharge, the left tegmentum in the region of the
nucleus was stimulated, causing ipsolateral flexion and inhibition of the extensor after-discharge; *E*, the st
lation of the left tegmentum in the region of the red nucleus with ipsolateral flexion which relaxes quick
cessation of stimulation. Then the right tegmentum was stimulated and the contralateral extension wi
prolonged after-discharge is seen.

has its limitations, but in four of six experiments the hair was found to be definitely in the red nucleus (cats 108, 109, 66 and 107). In cat 110 it was about 1 mm. dorsolateral to the red nucleus, and in cat 105 in the region of the tegmental fasciculus. The surface of the brain stem was explored, and it was found that the tectum was silent and the tegmental response could not be obtained from any other area. Figure 2*A* shows the hairs in two red nuclei and in the basis pedunculi, where contralateral flexion in the fore and hind limbs was obtained. It is impossible to say that the focal point for the tegmental response resides only in the red nucleus, but it certainly is to be found either in it or in the surrounding reticular formation. At times, a somewhat stronger stimulus was required to elicit the peduncular response than the tegmental one. In the experiment on May 9, 1929, a coil separation of 13 cm. gave the tegmental response, and at a coil separation of 9 cm. the basis pedunculi became responsive. However, this variation was not constant and depended a great deal on the trauma caused by the section and by disturbances in the blood supply.

It might be that the pattern assumed by the limbs is secondary to the turning of the neck on stimulation of the tegmentum and is due to tonic neck reflexes. Although the fore and hind limbs do not exhibit tonus changes in a manner that one would expect from tonic neck reflexes, it seemed advisable to test out this possibility. The fixation of the neck and trunk, while it prevents movements, may not eliminate differences in tension in the muscles and ligaments on the two sides of the body, and these differences in tension might serve as stimuli for the tonic neck reflexes. According to Magnus[7] (1924), the first, second and third cervical dorsal roots subserve the afferent conduction for the tonic neck reflexes in the cat, with the exception of the vertebra prominens reflex. These roots were sectioned bilaterally in a number of animals.[8] By this procedure most, if not all, of the afferent pathway of these reflexes to the spinal cord was removed. Since the tegmental response is still present undiminished in these animals, it cannot be attributed to tonic neck reflexes. We have found the tegmental response well developed in six animals (cats 61, 62, 63, 66, 67 and 101) in which the first three cervical dorsal roots had been sectioned bilaterally several months before the experiment. Two of these deserve special mention. In cat 66, the tegmental areas on each side on stimulation gave ipsolateral flexion and contralateral extension in the fore limbs. The basis pedunculi each gave contralateral flexion in the fore and hind limbs. When the left tegmentum was stimulated, the left fore limb flexed and remained so for long periods of time.

7. Magnus, R.: Körperstellung, Berlin, Julius Springer, 1924.

8. These operations were performed by Dr. Robert F. McNattin.

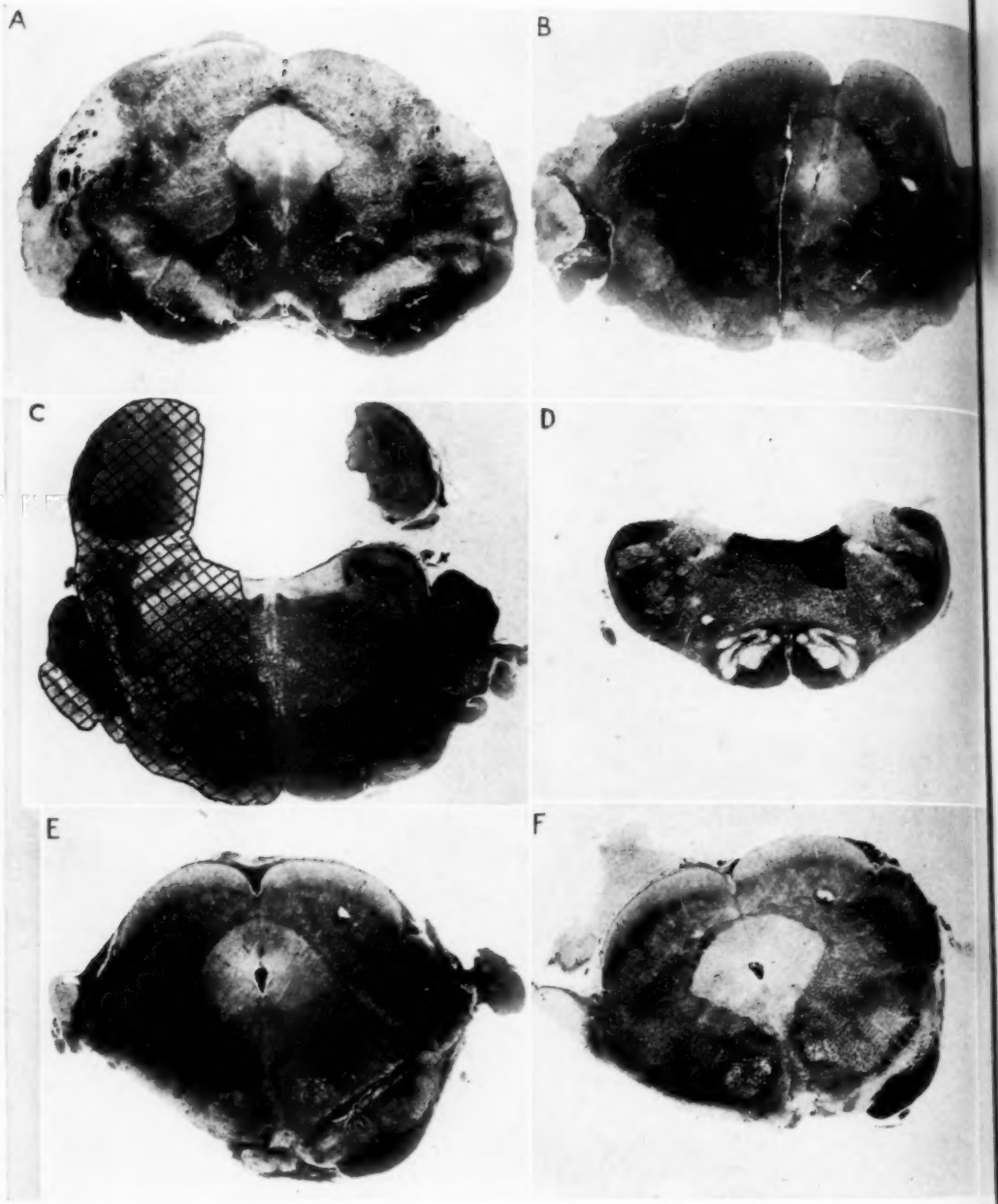

Fig. 2.—*A* shows a section through the rostral portion of the mesencephalon in cat 107, with arrows po to the hairs in the red nuclei and the basis pedunculi where responses were elicited; *B* gives a section th the mesencephalon of cat 66, showing the position of a sagittal section which extended back into the pons, arrow points to hair in the right red nucleus; *C*, is a section showing the extent of hemisection in cat 10 the extent of the lesion in medial longitudinal fasciculus in cat 116; *E* is a section through the mesenc in cat 63. On the right side the lesion is shown separating the nigra and basis pedunculi from the rest stem. On the left side, the removal of the basis pedunculi and substantia nigra from the rest of the s shown; *F* shows a section through the mesencephalon of cat 112, showing the removal of left basis pe and substantia nigra.

If during a period of flexion in the left fore limb the right tegmental area was stimulated, the left fore limb extended and remained so; the ipsolateral flexion of the right fore limb, which was thus elicited, while of a tonic nature was not maintained for long periods of time. Cat 101 was operated on Jan. 9, 1929, and the first, second and third cervical dorsal roots were sectioned bilaterally and the right fifth, sixth, seventh and eighth cervical and first thoracic dorsal roots were sectioned. The experiment was performed on June 10, 1929. Stimulation of the right tegmental area produced flexion of the right fore limb, and the left was markedly extended. The flexion of the right fore limb was maintained for some time, and if during this period the left tegmental area was stimulated, the right fore limb was put down in extension and the left fore limb was flexed and was so maintained for some time following cessation of stimulation. Then on stimulation of the right tegmental area, the right fore limb was again flexed and the left fore limb was put down in extension. From this animal it is evident that in the absence of tonic neck reflexes and of the afferent innervation to the limb of the right side flexor after-discharge did occur in both fore limbs.

In two animals (cats 109 and 66) a sagittal section was made through the mesencephalon near the midline, and the anatomic control showed that the decussation of Forel was completely sectioned in each case. In both of these cats the tegmental responses remained following the section. In cat 66, the tegmental and peduncular responses were both present on each side of the brain stem. The sagittal section was then made (fig. *2B*). The responses, both ipsolateral and contralateral, on tegmental and peduncular stimulation remained unchanged. The section is to one side of the median raphé, but the decussation of Forel was found to be completely sectioned as the lesion passed back into the pons. The tegmental response cannot depend on crossed rubrospinal conduction, as was shown by Brown and Környey.

In cat 106 (fig. *2C*) nearly complete left hemisection of the brain stem was made caudal to the red nucleus, after it was shown that the tegmental and peduncular responses present were on both sides of the brain stem. Following the section, the tegmental response was typical on the right but was absent on the left side of the brain stem. The peduncular response was present on the right, but the left basis pedunculi was silent. This experiment shows from the negative standpoint that the conduction on the left side was ipsolateral, at least caudal to the red nucleus and to the decussation of Forel; from the positive standpoint that the conduction of the right side did not involve the crossed rubrospinal tract, as it was sectioned on the left side after it had crossed.

Thiele pointed out that in cases in which the mesencephalic tracts were stimulated, the medial longitudinal fasciculus was also stimulated.

Owing to the close proximity of this tract to the red nucleus, it is nearly impossible to stimulate this region without bringing it into activity. In three animals (cats 115, 116 and 117) in which the medial longitudinal fasciculus was sectioned in the floor of the fourth ventricle, the tegmental responses were present following the lesion. Figure 2*D* shows the extent of the lesion in this experiment in cat 116. The tegmental and peduncular responses were typical before the section. After the section of the medial longitudinal fasciculi, the tegmental responses were still characteristically present with turning of the neck and trunk. The peduncular responses still remained. This confirms Környey's observation.

The tegmental and peduncular responses were present on both sides of the brain stem in cat 117. The medial longitudinal fasciculus was then sectioned, and typical responses were still elicitable. The tegmental response with ipsolateral flexion and contralateral extension in the fore limbs was very tonic, and the turning of the neck and trunk was evident. Then the cerebellum was removed, following which the right and left tegmental responses were still present. This again confirms the observations of Graham Brown and of Környey.

The experiment on cat 63 was very enlightening as far as a possible connection of the substantia nigra with the tegmental response was concerned. Stimulation of the tegmentum in the region of the red nucleus gave ipsolateral flexion and contralateral extension in a typical manner. Peduncular stimulation elicited contralateral flexion in the fore and hind limbs. A section was made parallel to the ventral surface of the brain stem on the right side so as to separate the substantia nigra from its connections with the rest of the stem (fig. 2*E*). Stimulation in the region of the red nucleus dorsomedially to the section produced the typical tegmental response of ipsolateral flexion and contralateral extension in the fore limbs. The peduncular response of contralateral flexion in the fore and hind limbs was caused by stimulation of the right basis pedunculi. Stimulation ventral to the section never gave ipsolateral flexion, so that the response from the more dorsal tegmental region could not be attributed to spread or to substantia nigra stimulation. The left side of the stem gave responses similar to those obtained before the section on the right side. A similar section was made on the left side. The ipsolateral flexion and contralateral extension were still obtained from the left red nucleus area but were not elicited ventral to the section. The left peduncular response was still obtained. Then the brain stem ventral to the section was removed on the left side. The left tegmentum then gave variable responses, but twice the typical tegmental response was observed. On microscopic examination, sections showed that the left substantia nigra was completely removed by the section. On the right side the nigra was

completely separated from the rest of the brain stem, with the exception of a very small medial strand of connection which is seen in figure *2E*. If the nigra was responsible for the tegmental response seen here, it is difficult to understand why this response was still obtained in the region of the red nucleus after the nigra was separated from the rest of the stem. Of course, it might be said that the nigra was silent owing to the fact that all of its efferent connections were sectioned; but the significant fact is that the response occurred after this had been done.

In cat 112, the section extended from the rostral border of the superior colliculus to just rostral to the exit of the third nerve. The tegmental response was obtained on the left side but not on the right side of the brain stem. The peduncular responses were elicited from both sides. The left basis pedunculi and the substantia nigra were removed (fig. *2F*) and the tegmental response was still present on the left side and absent on the right, as it was before the section was made. On microscopic examination, it was found that the substantia nigra was completely removed on the left side.

In all, twelve different experiments were made in an attempt to show substantia nigra association with the tegmental response. It is difficult to remove all of the substantia nigra back to the pons, but in several experiments when just a small tag of the medial portion of the nigra was present at the rostral border of the pons the response was obtained. When one realizes that the point of stimulation is at the rostral border of the mesencephalon, it is difficult to see how these small bits of nigra can be of any significance. The two experiments described remove any possibility that the substantia nigra may be the focal point of stimulation in the tegmental response. Negative results in an experiment of this kind are of little value, because it is impossible to ascertain how far above such a lesion trauma and anemia extend. When it is shown that the tegmental response still occurs after the substantia nigra is removed there is positive evidence that other pathways are capable of conducting impulses for it.

COMMENT

It is evident from a review of the literature and from the experiments detailed that there is a definite pattern of response that may be elicited by stimulation of the mesencephalic tegmentum. This response differs from that obtained on stimulation of the cerebral peduncles in the region of the basis pedunculi. From our observations it appears that the focal point exists somewhere in the region of the red nucleus or the reticular formation surrounding it. It cannot be the medial longitudinal fasciculus, because it has been possible to section this pathway on both sides and still obtain the response. It is not due to a

bringing into action of tonic neck reflexes, because it has appeared undiminished in animals in which the first three cervical dorsal roots on each side were sectioned. The substantia nigra is not essential. As the decussation of Forel can be sectioned without removing it, the crossed rubrospinal tract can be eliminated from consideration. The same thing can be said for the cerebellum.

It seems that the pathway is ipsolateral, at least back into the pons, owing to the fact that, together with the other evidence which has been cited, a hemisection caudal to the red nucleus and the decussation of Forel removes the response. It may be possible that it is an ipsolateral pathway from the red nucleus down into the reticular formation, and that from there the reticulospinal tracts may be utilized. Környey's observation that stimulation of the inferior olive did not produce the response points against the olivospinal tract as a possibility.

It has been shown that the nucleus ruber or the surrounding tegmentum is concerned in the inhibition of the crossed extensor after-discharge in deafferented muscle (Ranson and Hinsey, 1929).[9] The focal point for the tegmental response has been found in this same region. It would appear that in this region of the mesencephalic tegmentum there is not only an inhibitory but also a motor mechanism. If they both reside in the red nucleus proper, the former may be subserved by the crossed rubrospinal tract, the latter by an ipsolateral pathway made up of the uncrossed rubroreticular and the reticulospinal fibers, which may cross over at some lower level (Papez, 1926).[10] It cannot be denied, however, that the inhibitory and motor functions may be integral parts of the same mechanism.

Brown emphasized the fact that the tegmental response was of a postural nature. Whether or not an after-discharge will occur in the flexors or extensors probably depends on the neural balance in the brain stem and spinal cord (Brown, 1911).[11] In experiments on the normal cat, an extensor after-discharge was found, but the flexors relaxed fairly quickly. We have seen a prolonged flexor contraction which outlasted the stimulus for some time in two animals operated on. In one, the first three cervical dorsal roots were sectioned bilaterally, and in the other, the first three cervical roots were sectioned on both sides and the right fifth, sixth, seventh and eighth cervical and first thoracic

9. Ranson, S. W., and Hinsey, J. C.: The Crossed Extensor Reflex in Deafferented Muscle After Transection of the Brain Stem at Varying Levels, J. Comp. Neurol. **48**:393, 1929.

10. Papez, J. W.: Reticulo-Spinal Tracts in the Cat: Marchi Method, J. Comp. Neurol. **41**:365, 1926.

11. Brown, T. Graham: Studies in the Physiology of the Nervous System: VIII. Neural Balance and Reflex Reversal, with a Note on Progression in the Decerebrate Guinea-Pig, Quart. J. Exper. Physiol. **4**:273, 1911.

dorsal roots were sectioned. The experiment described by Graham Brown [8] (1915) on an anthropoid ape is interesting in this regard, for it showed at the beginning predominantly flexor reactions with prolonged flexor contractions ipsolaterally and poorly maintained extensor contractions contralaterally. Later in the experiment, just the reverse was found, in that the ipsolateral flexor response was poorly maintained and relaxed with cessation of stimulation, while the contralateral extensor contraction was tonic and was maintained very well. Whatever may have been the cause, there was a shift from the flexor side to the extensor side in the neural balance. As the decerebrate cat showed predominantly extensor involvement, it might be expected that there would be poorly maintained flexor responses and well maintained extensor responses.

CONCLUSIONS

The tegmental response elicited by stimulation of the mesencephalic tegmentum in the region of the red nucleus in the cat is characterized by ipsolateral flexion and contralateral extension in the fore limbs and varying responses in the hind limbs. In the cat on which no operation was performed, the ipsolateral flexion relaxed quickly on cessation of the stimulation while the contralateral extension was followed by a prolonged tonic after-discharge. Stimulation of the basis pedunculi in the region of the corticospinal tracts caused quick contralateral flexion in the fore and hind limbs. In these experiments, the tegmental response was found to occur following section of the decussation of Forel, bilateral section of the dorsal roots of the first three cervical nerves, removal of the cerebellum and the substantia nigra and bilateral section of the medial longitudinal fasciculi. It was not found to occur on stimulation of the tectum or on the ipsolateral side following hemisection caudal to the red nucleus and the decussation of Forel. These observations, together with the other evidence, suggest that the pathway is ipsolateral down into the reticular formation, from which it may be mediated over the reticulospinal tracts.

PROPRIOCEPTIVE BODY REACTIONS IN TOPICAL BRAIN DIAGNOSIS

WITH SPECIAL REFERENCE TO CEREBELLAR LESIONS *

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Application of the physiology of posture by means of a study of postural reflex responses has been made to evaluate their aid in topical brain diagnosis. Weisz formulated several specific tests from knowledge based on Magnus' researches, and reported a number of cases in which he demonstrated that the abnormal responses shown were diagnostic of the site of the lesions. These tests have been reapplied, first in a series of normal persons and then in patients with known lesions in various parts of the brain, whose responses have been studied. With the information gained, the tests were then applied for diagnostic purposes in patients suspected of having cerebellar lesions. The relative value of these tests was compared with that of the usual tests applied in routine neurologic examinations to estimate their worth as a part of neurologic examination, to decide their assistance in localization of lesions of the brain and to determine the specificity of the individual abnormal responses in lesions involving similar areas or parts of the brain in different patients, as well as the degree of variation between responses shown by normal persons and those shown by patients with lesions of the brain.

THE PHYSIOLOGY OF POSTURE

The physiology of posture [1] is extremely complex and precludes local, segmental and general postural activities. Many constituents [2] enter into a harmonious result: (*a*) the coefficients of elasticity and plasticity of muscles in tensile reaction to stretch,[3] (*b*) myotatic reaction,[4] the afferent

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1. Magnus, R.: Some Results of Studies in the Physiology of Posture (Cameron Prize Lectures), Lancet **2**:531 and 585, 1926.

2. Sherrington, C. S.: Integrative Action of the Nervous System, New Haven, Conn., Yale University Press, 1906.

3. Liddell and Sherrington: Further Observations on Myotatic Reflexes, Proc. Roy. Soc. Med. **97**:267, 1925.

4. Liddell and Sherrington: Reflexes in Response to Stretch, Proc. Roy. Soc. Med. **96**:212, 1924.

nerve fibers of extensor muscles possessing two functions, one producing reflex inhibition of its own muscle and other allied extensor muscles and reflex contraction of the flexor muscles antagonistic to the muscles that it inhibits, the other producing reflex contraction of its own muscle; (*c*) the varying functions of muscles or of muscle groups under differing circumstances;[2] (*d*) the varying state of muscle tone at different times;[5] (*e*) synergistic reinforcements of tonic contractions;[6] (*f*) the antagonists' synergic action in joint fixation as indicated; (*g*) the nature and source of the proprioceptive stimulation; (*h*) the integrity of the nervous mechanism involved; (*i*) varying positions of the head that change the distribution of tone,[7] and (*j*) cooperation, and coordination of muscular activity in appropriate combination, accommodating and regulating the body and its parts to its environment according to the attitude at the time of the stimulation.

REACTIONS OF THE BODY IN THE PHYSIOLOGY OF POSTURE

Reactions of the body preclude normal posture, which may be defined as the appropriate combination and coordination of muscular activity resulting in a harmonious attitude or reaction of the body, or any part thereof, in its relation to space and to its environment.

Magnus[8] demonstrated four prerequisites for normal posture, which he designated as an active process accomplished by the cooperation of many reactions. These constituents are: (1) reflex action, the muscles involved requiring a certain degree of tone; (2) normal distribution of tone in their antagonists as well as the muscles involved; (3) attitude, the position of different parts needing to harmonize, and (4) the righting function.

Spinal centers can cause and regulate complicated combinations of movements, but they are unable to give the tone or strength necessary even for simple standing, which requires the aid of the midbrain. By numerous experimental sections at specified levels in the brain stem, Magnus showed that the centers for these constituents lie close in the subcortical brain stem, and possess the functions of compounding the

5. McCouch, G. P.: Method of Recording Tension of Muscle in Situ, with Some Preliminary Results Concerning Tensile Relations of Antagonistic Muscles in Reflex Action, Am. J. Physiol. **72**:217, 1925.

6. Sherrington, C. S.: Flexion, Reflex, Standing and Stepping, J. Physiol. **40**:28, 1910.

7. Magnus, R., and de Kleijn, A.: Die Abhängigkeit des Tonus der Extremitätenmuskeln von der Kopfstellung, Arch. f. d. ges. Physiol. **145**:455, 1912; Zur Technik der Labyrinthextirpation und Labyrinthausschaltung bei Katzen, ibid. **145**:549, 1912.

8. Magnus, R.: Animal Posture, Proc. Roy Soc. Med. **98**:339, 1925; Korperstellung, Berlin, Julius Springer, 1924, vol. 13.

activity of the whole body musculature into posture by integrative action of the nervous system. The nervous impulses that can influence posture arise from: (1) the labyrinth; (2) proprioceptive sense organs in the muscles, joints and tendons; (3) exteroceptive nerve endings in the body surface, and (4) teleceptors—the eye, ear and nose.

His experiments illustrated that the decerebrate animal stands and maintains postures with high tone and in abnormal positions. In the section including the red nucleus,[9] normal tone carried by the rubrospinal tract replaced decerebrate rigidity. The thalamus animal had just sufficient tension of the extensors to balance the body and maintain normal positions; the righting function being present though there was no forebrain connection, precluding voluntary correction. Extirpation of the otoliths in the suspended thalamus animal gave proof that they were the seat of labyrinthine righting reflexes. Magnus also demonstrated that there are doubly secured righting reflexes, as normal station and posture was again secured through the proprioceptive neck and body righting reflexes by bringing the thalamus animal, from which the otoliths had been removed, in contact with the ground.

In higher animals the optical righting reflex, the only one with its center in the cortex cerebri instead of in the brain stem, is also present, assisting in steadying the reaction. De Kleijn's experiments [7] demonstrated that change of position of the head gives the body a number of attitudes, the body, trunk and limbs normally following the direction in which the jaw points, as a result of righting reflexes. With the higher development of the forebrain and a greater complication of movement, the postural reflexes are suppressed and less easily detected.

The influence of other parts of the brain on posture has not been definitely demonstrated. Striatal and pallidal involvement is shown in the parkinsonian syndrome and in Wilson's disease, but other parts of the brain are also involved.

The connections of postural reaction with the cerebellum have not been found, owing to the complexity of the problem, as this organ has numerous connections with every central motor unit and yet can even be extirpated without disturbing postural reaction responses. Herrick [10] gave the function of the cerebellum as the supervision and coordination of movement, stabilizing, prolonging and readjusting local intrinsic activity, posture or tone of the lower neuromotor unit with improvement in strength and efficiency—a higher administrative center. Synergia,

9. Magnus, R., and Rademaker, G. G. J.: Die Bedeutung des roten Kernes für die Korperstellung (Vorl. Mitt), Schweiz. Arch. f. Neurol. u. Psychiat. **13:** 408, 1923.

10. Herrick, C. J.: An Introduction to Neurology, ed. 3, Philadelphia, W. B. Saunders Company, 1922.

according to Mills and Weisenburg,[11] is the fundamental cerebellar function, which includes not only its activity during motor functioning, but also its operation in all motor performances. Pathologic involvement of the cerebellum, as would be expected from its function, does, however, decidedly influence the postural reflexes, for they are all dependent on proper synergy for normal responses.

APPLICATION OF POSTURAL ACTIVITIES BY FORMULATED TESTS

Weisz [12] reported a series of cases in which the knowledge based on Magnus' researches was utilized to assist in topical brain diagnosis. He formulated several special tests with the following resultant observations:

1. Basic Test: The patient extends the arms parallel, horizontally, closes the eyes and turns the head to one side and then to the other as far as possible, the observer noting any change in the position of the arms. Normally, the arm on the side toward which the head is turned shows a gradual elevation.

2. Spontaneous Rising Reaction: The same position of the arms is assumed, the eyes being closed, and slow elevation of the arms (more in the right than in the left as a rule) is noted. This elevation was noted to be increased in cerebellar lesions.

3. Divergence Reaction: With the same arm position the examiner notes the amount of divergence of the arms—a slight degree occurring normally.

4. Convergence Reaction: The arms never converge normally, but the hands approach each other when striopallidonigral disease is present.

5. Pronation Phenomenon: With the eyes closed, the arms extended horizontally and parallel, and the palms turned upward, the thumb side of the hand normally turns up. This response was found to be increased in patients with pathologic conditions of the cerebellum or pyramidal tract.

6. "Lagebeharrung": The arms are extended again as in the basic test, the eyes are closed, and each arm is successively elevated and depressed by the patient for 60 degrees from the horizontal plane of its fellow for thirty seconds and then brought to the original level. From elevation the arm is normally brought to within a few centimeters above and from below to several centimeters beneath the level. Weisz reported that this action was negative only in striopallidonigral disease.

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11. Mills, C. K., and Weisenburg, T. H.: Cerebellar Symptoms and Cerebellar Localization, J. A. M. A. **63**:1813 (Nov. 2) 1914.

12. Weisz, Stephan: Proprioceptive Body Reactions in Topical Brain Diagnosis, Ztschr. f. d. ges. Neurol. u. Psychiat. **118**:167 (Dec.) 1928.

7. Imitation Phenomenon: With the patient recumbent in the supine position, the eyes are closed and passive flexion of one leg is made, the foot being supported. The other leg is to be brought by the patient to the same position of flexion. Overflexion was noted as a positive symptom of cerebellar disease on the same side.

8. Paradox Deviation Reaction: The original position of extension of the arms with the eyes closed having been assumed, the head is turned actively or passively in one direction and then in the other, the arms deviating to the opposite side from which the head is turned and occasionally being associated with spontaneous rotation.

Figure 1

Figure 2

Fig. 1.—Spontaneous rising reaction; elevation of the right arm.

Fig. 2.—Pronation phenomenon in postural reflex response; left cerebellar tumor.

9. Spontaneous Rotation: Spontaneous rotation of the body around its longitudinal axis was observed in patients with cerebellar and parieto-occipital lesions.

10. Body-Tipping Reaction: The patient, sitting with eyes closed, grasps the examiner's hands and pulls. The pull in one arm diminished with increasing rapidity, the trunk at the same time reeling more and more toward the side of the diminishing pull. This reaction was found in cerebellar and frontal lesions and absent in involvement of the pyramidal tract.

11. Hyperflexion: The flexed leg was further flexed, by patellar stimulation as in eliciting the knee jerk, in cerebellar lesions.

Weisz [13] definitely averred that these reactions are of great value in localizing cerebral disease as to side and site, reporting all cerebellar cases as showing an increased pronation sign and a positive imitation phenomenon on the side of the lesion. The imitation and tipping phenomena were given as signs of homolateral cerebellar lesions and involvement of the pyramidal tract. He found that the divergence reaction increased, usually on the side of cerebellar injury, and that the course of certain reactions is influenced by the different sites of the

Figure 3

Figure 4

Fig. 3.—"Lagebeharrung"; hypometria on the right from elevation.

Fig. 4.—Paradox deviation; reaction to the left.

lesion, namely, the protracted, slow, discontinuous convergence reaction shown in pontile lesions and with it the sinking of the arm on the side toward which the base of the skull is turned in rotation of the head, away from the lesion in cases involving the pontile angle.

These tests have been reapplied to determine and illustrate their practical application in the localization of lesions of the brain, particularly to estimate their assistance in the diagnosis of cerebellar lesions.

These reactions were first investigated in normal persons to arrive at an average mean reaction in order to interpret properly pathologic

13. Weisz (footnote 12; abstr., Arch. Neurol. & Psychiat. **23**:557 [March] 1930).

modifications in the reactions of patients suspected of having lesions of the brain, and also to illustrate the varying responses in so-called normal persons, as has been similarly demonstrated under Weisenburg's direction by La Mar [14] and Waggoner and Ferguson [15] and others.

POSTURAL REFLEX RESPONSES IN NORMAL PERSONS

The tests were applied to fifty-seven persons who had no complaints or obvious signs of disorder. The least perceptible variation in the responses, noted by close observation, was recorded.

1. The basic test showed no perceptible elevation or depression of either extended arm on turning the head in either direction in twenty-

Figure 5

Figure 6

Fig. 5.—Paradox deviation reaction. The arms deviate toward opposite side from that toward which the head is turned, associated with some rotation of the body. The elevation of the opposite arm is also shown with droop of the arm on the side to which the head is turned. The case is one of a left cerebellar tumor.

Fig. 6.—This illustrates the body-tipping reaction in cases of cerebellar tumor.

one (37 per cent) of the subjects. Three (5.2 per cent) showed slight elevation of the left arm on turning the head to the left, with no change in the horizontal position of the right arm on turning the head to the

14. La Mar, N. C.: Tests for Sensibility: An Investigation Among Normal Subjects, Arch. Neurol. & Psychiat. **23**:2 (Feb.) 1930.

15. Waggoner, R. W., and Ferguson, W. G.: Development of the Plantar Reflex in Children, Arch. Neurol. & Psychiat. **23**:4 (April) 1930.

right; three (5.2 per cent) slightly elevated the right arm when the head was turned to the right, without change in position by the left arm on the left turn of the head; two (3.5 per cent) elevated both arms slightly in the left turn of the head, and three (5.2 per cent) showed slight upward movements of both arms when the head turned to the right. Depression of the arm opposite the direction in which the head was turned was demonstrated by two persons (3.5 per cent). Slight elevation of the arm on the side to which the jaw pointed was exhibited by twenty-three (40 per cent) in either direction of the head turn. The amount of elevation or depression did not exceed 2 cm. and was usually about one half of the thickness of the finger.

Fig. 7.—The body-tipping reaction with a postural reflex response in a patient with cerebellar agenesis.

2. The spontaneous rising reaction showed no perceptible elevation or depression of the extended arms in twenty (35 per cent) of the fifty-seven in whom the test was utilized.

Both arms showed a slow, gradual elevation in twenty-eight (49 per cent), more on the right in eighteen (28 per cent), and more on the left in ten (17 per cent). The right arm alone was slightly elevated by five persons (87 per cent).

Elevation of the left arm without a change in the position of the right appeared in four (7 per cent); depression of either arm was not observed.

3. In fourteen no divergence was noted, but the remainder, forty-three (75 per cent), showed a slight spreading of the extended arms.

4. None of the normal persons examined demonstrated any convergence of the extended arms.

5. Pronation was observed in both hands, approximately equally in nineteen (33 per cent), more in the left hand than the right in nine (16 per cent), and more in the right hand than in the left in twelve (21 per cent), with no change perceptible in seventeen (30 per cent).

6. "Lagebeharrung" applied to normal persons disclosed the following: The left arm was brought from elevation insufficiently by thirty-six (63 per cent), too far in five (8.7 per cent) and level by sixteen (28 per cent). In elevation from depression the left arm passed the level in four (7 per cent), was brought level by six (10 per cent) and was brought to slightly below level in forty-seven (82 per cent). The right arm was brought down from elevation slightly insufficiently in thirty-three (58 per cent), too far in four (7 per cent) and approximately level in twenty (34 per cent). Elevation from depression was brought to the level in eighteen (32 per cent), too far in three (5.3 per cent), and insufficiently in thirty-six (63 per cent). The deviations from the level did not usually exceed 3 cm.

7. Application of the imitation phenomenon showed approximately equal flexion by the left leg in imitation of the flexed posture of the right in forty-one (72 per cent), insufficient flexion in eleven (19 per cent) and slight hyperflexion in five (8.7 per cent). The right leg was equally flexed with its supported fellow in forty-seven (82 per cent), insufficiently flexed in seven (12 per cent) and slightly hyperflexed in three (5.3 per cent). Hyperflexion was not evidenced by both legs in any one person, but hypoflexion on both sides was shown by three.

8. There was no paradox deviation.

9. Spontaneous rotation was not observed.

10. Body-tipping reactions were not shown.

11. Hyperflexion of the flexed leg on eliciting the knee jerk was not observed in any person, either normal or suffering from a neurologic disorder.

In these examinations the most usual normal responses were:

1. The basic test showed elevation of the extended arm on the side toward which the head was turned (shown in 40 per cent with no perceptible rise in 37 per cent).

2. In the spontaneous rising reaction both arms gradually rose (in 49 per cent) the right (in 32 per cent) more than the left (in 17 per cent).

3. Slight divergence was observed in 75 per cent.

4. Convergence was not present in normal persons.

5. In the pronation phenomenon the thumb side of the hand turned slightly upward (in 70 per cent).

6. "Lagebeharrung" was observed when the arm was brought from elevation to several centimeters above level (60 per cent) and from below slightly below level (70 per cent).

7. The imitation phenomenon showed approximately equal flexion by the imitating leg (about 75 per cent).

8. There was no paradox deviation.

9. Spontaneous body rotation was not observed.

10. No body-tipping reaction was shown.

From these results it is seen that normal subjects usually show slight deviations in the basic test, the spontaneous rising reaction, divergence of the arms, the pronation phenomenon, the "Lagebeharrung" and the imitation phenomenon, but any response more than a slight variation in the reaction could be considered indicative of some pathologic lesion, as any variation noted in this series of patients by close observation was recorded. Convergence of the arms, paradox deviation of the arms in the opposite direction from which the jaw pointed in turning the head, spontaneous body rotation or a positive body-tipping reaction was not shown by any of the normal persons examined. When any one of these reactions is found, it definitely indicates interference with the proprioceptive reflex arc.

REACTIONS IN STRIOPALLIDONIGRAL DISEASE

The tests were applied in eighteen patients with chronic epidemic encephalitis for the investigation of the postural reactions in striopallidonigral disease. Six of the patients, in the earlier stages of the disease, showed sufficiently definite symptoms to confirm the diagnosis, but were capable of working in occupations not requiring precision and dexterity of movement; six patients had moderately advanced symptoms, and the other six were in a more advanced stage of the disease but without contractures or sufficient rigidity, tremors or lack of cooperation to vitiate the interpretation of the resultant reactions to the tests.

In response to the basic test none of the patients showed any elevation of either extended arm. Instead, four showed some drooping of the arm on the side showing the most involvement in either turn of the head, two of them also allowed some relaxation of the elbow in the involved arm, which was likewise demonstrated by six others with the comparative change in level. The same respective patients showed relaxation of the elbow and drooping of the involved arm when the

head was not turned, illustrating the absence of the influence of change in the position of the head on the position of the arms.

All patients examined demonstrated the convergence reaction definitely, from just perceptible convergence in the early cases to touching of the hands in advanced cases, and approximately in degrees corresponding to the advancement of the disease, being shown by the action of but one arm in the six patients in the early stage. The pronation phenomenon was slightly more than normal in three advanced cases and in one patient (M. F.), who also had cerebrospinal syphilis, with no involvement demonstrable in the upper limbs, indicating probably some pyramidal as well as extrapyramidal pathologic condition.

The pronation movements shown in these patients were different, however, in execution from those observed in patients with cerebellar dysfunction in whom the hand gradually and progressively turned definitely, as in a slow, purposeful movement, while in these patients the movement was jerky, awkward, irregular and varying as though electrically stimulated at irregular intervals, similar to the cogwheel resistance felt in passively extending the arm of patients with the parkinsonian syndrome.

Contrary to my interpretation of Weisz's observations, in applying the "Lagebeharrung" in patients with striopallidonigral disease, only three in this series of eighteen patients with chronic encephalitis showed a reaction that would be considered approximately normal; while nine (50 per cent) overestimated the distance to reach the original level with both arms from elevation and depression, and the remaining six did not reach within an appreciable distance of the level from elevation or depression on the more involved side and passed the level in both directions with the apparently uninvolved arm. Other postural test reactions were within the limits of normal and could not be consistently interpreted to show cerebral localization of the involvement.

Application of the postural reflexes to this series of patients with striopallidonigral disease demonstrated a consistently definite convergence reaction which is always absent in normal persons and which is not demonstrated when there is involvement of other parts of the central nervous system. Other postural tests were not sufficiently specific to be diagnostic of localization of a pathologic condition in the extrapyramidal system, but neither were they sufficiently consistent to allow the interpretation of localization elsewhere in the brain.

REACTION RESPONSES IN PYRAMIDAL, FRONTAL, PARIETAL AND OCCIPITAL LESIONS

Lesions in parts of the brain other than the cerebellum and the basal ganglia gave abnormal postural reaction responses only commensurate with the degree of involvement by extension or pressure on the pyramidal, cerebrospinal, vestibular or spinocerebellar tracts.

In examining the patients who had jacksonian attacks involving one upper extremity and several with cerebrospinal syphilis and postero-lateral sclerosis in whom no demonstrable paresis was present, but who gave evidence of involvement of the pyramidal tract by slightly abnormal reflexes or a positive Hoffman sign, no consistently abnormal postural reaction responses were elicited except the increased pronation phenomenon, which usually showed a movement more marked and faster with the increasing height of the lesion in the central nervous system.

Patients with tumors in the frontal lobe demonstrated increased pronation signs varying with the involvement of the pyramidal tract. When extensive infiltration had occurred, diverse abnormal responses appeared, but accuracy of localization was no longer required, as it was of no practical value.

Parieto-occipital tumors caused abnormal pronation responses and a positive "Lagebeharrung" when the cerebellum or spinocerebellar tracts were involved.

REACTION RESPONSES IN PROVED CEREBELLAR LESIONS

For the investigation of the responses in cerebellar lesions, the postural tests were applied in a patient with cerebellar agenesis, in one with progressive cerebellar degeneration, in Friedreich's ataxia of the cerebellar type and in seven patients who had had cerebellar tumors localized and exposed at operation in the Neurosurgical Clinic of the University Hospital, for one of which there was a necropsy report.

REPORT OF CASES

CASE 1.—In a white man, J. B., aged 26, showing the syndrome of cerebellar agenesis, the postural reaction responses definitely illustrated their application. With a turn of the head in either direction the extended arms drooped and deviated definitely in the opposite direction from that in which the head was turned, accompanied by slight spontaneous rotation of the body. With the head held straight and the arms extended, the left arm drooped while the right was elevated. In the same position with the palms turned up the pronation phenomenon was increased in both hands, more in the left. In the "Lagebeharrung" both from elevation and depression the level was passed by both arms. The imitation phenomenon was definitely positive on both sides, overflexion on the left being more marked. The body-tipping reaction to either side, varying in different trials, was always demonstrated.

CASE 2.—A. B., a man, aged 44, with disturbance in speech, marked general ataxia and incoordination, who had been unable to walk for the preceding two years on account of pronounced ataxia and dyssynergia from progressive cerebellar degeneration, showed the following responses:

With arms extended and eyes closed, the arms drooped decidedly with either turn of the head and deviated much with rotation of the body, in the same direction as the head was turned, but body-tipping was not present. When the arms were held extended without the head being turned, the right arm was

elevated from 6 to 8 inches (15 to 20 cm.) and the left drooped about 3 inches (7 cm.). Some convergence was also present, and in the pronation test the left hand was turned nearly 60 degrees from the horizontal plane. In the "Lagebeharrung," repeatedly the left arm did not reach the original level by from 3 to 5 inches (7 to 12 cm.) and the right passed the level by 2 or 3 inches (5 or 7 cm.). The imitation phenomenon showed much over flexion on the left and some on the right leg.

This patient's responses indicated more involvement on the left side than on the right, with marked lack of synergic control as demonstrated by the excessive turning of the arms and body with the head, the increased pronation reaction, the elevation of the arm and the drooping and the faulty measuring shown by the "Lagebeharrung" and the imitation reactions. The convergence reaction suggested some striopallidal involvement not otherwise shown.

Case 3.—A woman, M. G., aged 66, with Friedreich's ataxia of the cerebellar type, who had been hospitalized for thirty-four years, demonstrated involvement of the cerebellar system in her responses to the postural tests by a positive pronation reaction, more marked on the left, a decidedly positive "Lagebeharrung," the arms far passing the original level on both sides from either elevation or depression, and the positive paradox reaction, the arms deviating definitely to the opposite side from that toward which the head was turned.

Case 4.—Mrs. P. H., aged 38, at an operation on June 21, 1927, had presented a right cerebellar hemisphere larger than the left and marked deviation of the midline to the left. With but three series of roentgen treatments she had continued her household duties until about Jan. 15, 1930, when cerebellar herniation, which had been intermittent for about one month, persisted and marked cerebellar dysfunction appeared which was definitely demonstrated neurologically. A suboccipital craniotomy on Feb. 21, 1930, disclosed a bulging of the cerebellar hemispheres, the vermis and tonsils, from an infiltrating, undefined tumor. On section the brain revealed a tumor in the fourth ventricle, involving the entire vermis, both dentate nuclei and a small area of the lateral lobes, causing a definite obstructive internal hydrocephalus. Postural reflex abnormalities at the time of admission on Feb. 13, 1930 were marked: (1) In the basic test the arm drooped on the side toward which the head was turned; (2) in the spontaneous rising reaction the right arm tended to rise and the left to lower; (3) the left arm diverged; (5) pronation was slightly abnormal; (6) the "Lagebeharrung" displayed hypermetria on both sides, from both the elevated and the depressed positions; (7) the imitation phenomenon was evidenced by overflexion on both sides, and (8) paradox deviation was demonstrated in either direction of head turn; (9) slight body rotation but (10) no body-tipping was evidenced.

Case 5.—A midline cerebellar gliomatous cyst was evacuated in M. V., a girl, aged 16, on Oct. 4, 1927, but it was impossible to remove the wall of the cyst. She was well until October, 1929, when the original symptoms recurred—headache, projectile vomiting, progressive diminution in acuity of vision and staggering gait. At reoperation, on Dec. 13, 1929, the tumor was seen to have grown upward in the median line, more on the left, but its exact dimensions were not determinable. A small cyst was evacuated, but further procedure was impractical. Pronounced cerebellar symptoms and postural reflexes were demonstrated on March 28, 1930, as follows: (1) drooping of the left arm on turning of the head in either direction; (2) this reaction also evidenced without change in the position of the head; (3) much divergence of the arms, the left arm moving farther outward than the right with abduction of the left hand at the wrist; (5) increased pronation sign,

marked on the left; (6) hypermetria with the right arm, in elevating from depression, and hypometria in depression of the right arm from elevation, and in both elevation and depression with the left arm; (7) overflexion of the left leg in the imitation reaction; (8) deviation of the arms to the opposite side from that toward which the head was turned, with (9) associated spontaneous rotation of the body and (10) a marked tipping reaction to the left, so extreme that she would have fallen from the chair if she had not been caught.

CASE 6.—A girl, C. R., aged 14, at an operation on Feb. 8, 1929, presented a left cerebellar tumor which could be but partially removed. On return for a fifth series of roentgen therapy on March 10, 1930, she had shown marked improvement and had gained in weight. The only neurologic sign disclosed was nystagmus, increased in full rotations of the eyeballs, and she had noticed that her eyes "jerked" and the letters "shimmied" when she read. Postural reflexes investigated at this time disclosed: (1) a tendency for the left arm to droop when the arms were extended with or (2) without turning the head; (3) divergence, (4) convergence or (5) pronation did not exceed normal limits; (6) a positive "Lagebeharrung" appeared, however, in overestimation with the left arm and hypometria with the right in either elevation or depression toward the original level; (7) in leg flexion imitation both legs were insufficiently flexed, and (8) the arms were slightly but definitely turned in the same direction as the head; (9) no spontaneous rotation or body-tipping reaction was evidenced.

CASE 7.—E. B., aged 29, had an inoperable glioma of the left cerebellar hemisphere exposed by a suboccipital craniotomy on Oct. 4, 1929. On return for roentgen treatment on March 12, 1930, he walked with a somewhat broad base with the trunk and head held stiffly, and he demonstrated mild hypotonia and horizontal nystagmus on full lateral rotation of the eyeballs. The postural reflex responses were more definite than the mild neurologic signs that were present. With the arms extended, whether or not the head was turned, the left arm tended to droop. The divergence and convergence reactions and the pronation phenomenon could not be considered abnormal but the "Lagebeharrung" showed hypermetria with the left arm and hypometria with the left leg in approaching the original level from both elevation and depression, slight hypermetria with the left leg and some hypometria on the right in the imitation phenomenon, deviation of the right arm to the left when the head was turned to the right, while when the head was turned to the left both arms deviated to the left, the left arm more so than the right.

CASE 8.—An inoperable tumor in the third ventricle was exposed in A. F., aged 19, on Oct. 11, 1929. On account of two convulsions in the preceding two weeks he was readmitted to the neurosurgical service of Dr. Charles H. Frazier at the University Hospital on April 2, 1930. He presented less than 1 diopter of choking in each eye, and no other neurologic signs were elicited. The responses in the postural reactions, however, were distinctly abnormal: (1) The basic test, and (2) spontaneous rising reaction disclosed slight drooping of the left arm and abnormal elevation of the right; (4) the left arm converged, and (5) the left hand was pronated more than normally in the pronation phenomenon reaction; (6) "Lagebeharrung" demonstrated hypermetria with the right arm and definite hypometria with the left; (7) the imitation phenomenon showed overflexion with the left leg; (8) paradox deviation appeared in the left arm.

CASE 9.—W. J. S., a boy, aged 15, was admitted to Dr. Spiller's service on Jan. 10, 1930, with a history of rapidly progressive symptoms and signs of cerebellar disturbance. A suboccipital craniotomy by Dr. Frazier on Jan. 17, 1930,

disclosed the left cerebellar hemisphere to be larger than the right and what appeared to be a tumor without definition at a depth of about 3 cm. Extirpation was impracticable.

Neurologic examination on March 27, 1930, disclosed only disturbances in station and gait and some choking of the disks, but the postural reaction responses were as follows: (1) The left arm was elevated with either turn of the head on parallel extension with the eyes closed; (2) without turning the head both arms were slightly elevated, the left the more, and (3) some spread of the arms was shown which was more noticeable on the left; (5) the pronation phenomenon was more evidenced on the left, and (6) in applying the "Lagebeharrung," slight underestimation was evidenced more by the left arm; (7) hyperflexion of both legs was more marked on the left in the imitation test; (8) the paradox deviation reaction was demonstrated by the arms deviating to the right when the head was turned to the left, but no change in arm position was evidenced in turning the head to the right; (9) spontaneous rotation of the body, and (10) the tipping reaction were not shown.

Case 10.—J. F., aged 15½, presenting symptoms and signs of cerebeller involvement by tumor, was subjected to a suboccipital craniotomy on Feb. 11, 1930. The left cerebellar hemisphere was found to be larger and softer than the right, and the tonsils were more widely separated than normal. Their separation revealed a rather tough, granular tumor at about the entrance to the fourth ventricle, evidently extending as far as the cerebellopontile angle, not entirely blocking the ventricles but impossible of removal.

At his return for roentgen treatment on March 21, 1930, examination of the postural reflexes gave the following abnormal reactions, though he had no complaints and demonstrated no obvious neurologic signs: (1) a slight droop of the extended left arm with the head turned in either direction, and (2) about a 2½ inch (6 cm.) drooping of the left arm with the head held straight; (3) no divergence, or (4) convergence was shown; (5) the left hand was pronated more than normally when the arms were extended with the palms up; (6) the left arm was not brought within the normal limits in the "Lagebeharrung" in elevation from depression or in bringing it down from elevation; (7) the imitation phenomenon reaction showed overflexion on both sides, more marked in the left leg; (8) the paradox deviation phenomenon was positive in turning the head either way, the arms deviating in the opposite direction.

Comment.—In these seven patients with cerebellar involvement by tumors definitely localized by exposure at operation, postural reflex responses, repeatedly compared and rechecked, were abnormal in all in a relatively similar and uniform manner.

1. The basic reaction was characterized by a drooping of the left arm on either turn of the head in six patients having all or most of the tumor involvement in the left cerebellar hemisphere. In one patient with deep involvement of the left cerebellar hemisphere, there was slight elevation of both arms on turning the head either way and in a patient with widespread cerebellar tumor infiltration there was a droop of the arm on the side toward which the head was turned.

2. The spontaneous rising reaction responses were evidenced by drooping of the left arm in four patients, elevation of the left arm

in one, and slight elevation of the right arm and definite lowering of the left in two.

3. No consistent abnormal divergence was shown by four of these patients; in two the left arms diverged from the median line more than the right, and in one with marked cerebellar involvement the divergence was marked, more so on the left.

4. Convergence of the left arm was exhibited in the patient with a tumor in the third ventricle.

5. The pronation phenomenon would be considered abnormal in all but one of this series. In two, slight pronation was shown on both sides; in three others it was more definitely increased on the left side, and in one slightly more obvious in the left hand. Pronation of both hands was marked in one patient with advanced involvement, more so on the left.

6. "Lagebeharrung" was definitely abnormal in all the responses in all of the patients. In both elevation and depression to the original level, five patients overestimated with the left arm and two showed hypometria. On the right side underestimation was evidenced in four patients in bringing the arm from either elevation or depression and hypermetria in three in both movements.

7. The imitation phenomenon showed hyperflexion of the left leg more marked than the hyperflexion on the right in six patients, and one patient showed some overextension of both legs in imitating passive movement of the opposite leg.

8. The paradox deviation reaction gave the following results: With the head turned to the left, five patients deviated both arms to the right, one other deviated only the left arm, and the other patient turned both arms with the head. With the head turned to the right, three deviated the arms to the left, two showed insufficient movement to be designated abnormal, and two deviated with but one arm to the left.

9. Spontaneous rotation was demonstrated by one patient with advanced cerebellar involvement.

10. The same patient showed a marked body-tipping reaction.

In the examination of this series of patients with proved cerebellar tumors and aplastic or degenerative cerebellar conditions, positive imitation phenomena and increased pronation signs on the side of the lesion, as well as a positive "Lagebeharrung," more marked on the same side as the involvement, were shown in all of them. Also there was usually a sinking of the arm on the side of the lesion but a change in level was always evidenced in the spontaneous rising reaction. Paradox deviation was demonstrated in most instances, sometimes by but one arm, and it was associated with spontaneous rotation of the body in

two of this group. Tipping of the body was definitely demonstrated in one patient with a cerebellar tumor and in one showing the cerebellar agenesis syndrome.

APPLICATION OF POSTURAL REACTION RESPONSES IN THE DIAGNOSIS OF SUSPECTED CEREBELLAR LESIONS

Considering the abnormalities of the postural reflex responses evidenced in the three patients with degenerative and hypoplastic lesions of the cerebellum, examined and observed over long periods of time by a number of competent neurologists, and in the seven with tumors directly observed at operation as involving the cerebellum, the tests were applied for diagnostic purposes in the following patients suspected of having cerebellar lesions.

Case 11.—R. L., aged 15½, was sent to the University Hospital by Dr. Frazier on Feb. 10, 1930. He complained of pain in the back of the head which had begun mildly in July, 1929, lasting but a short time before breakfast for a few weeks. The severity increased late in the fall, becoming marked during the Christmas holidays, and at that time it was accompanied by nonprojectile vomiting, preceded by nausea. Neurologic examination on admission disclosed 4 diopters of choked disk in each eye, slight dysdiadokokinesia of the left hand, slight dysmetria of the left fingers and hand, and slightly diminished bilateral biceps and triceps and left patellar reflexes. The roentgenologic evidences were interpreted as representing a posterior fossa lesion close enough to the ventricular system to cause some obstruction. Beginning widening of the sutures and slight atrophy of the dorsum sellae and anterior clinoids were shown. Postural reactions showed a slight droop of the extended left arm, both with and without turning the head. With the palms up and the arms extended, more pronation than normal was exhibited by the left hand. The "Lagebeharrung" reaction brought out slight hypometria in the movements of the left arm, and slight overflexion of the left leg was shown at times in the imitation test, still fewer times by the right leg. Paradox deviation was shown in a slight degree in a few trials. The responses were sufficiently consistently abnormal to justify the impression that the patient had involvement of the cerebellum, more marked on the left side.

A suboccipital craniotomy on Feb. 17, 1930, following the ventriculogram which showed no air in the fourth ventricle or aqueduct, disclosed the tonsils crowded into the cervical canal with marked deviation of the midline to the right. The left cerebellar hemisphere was paler and softer than the right. Inspection of the midline by separation of the tonsils revealed no tumor. Localization was made in the left posterior fossa but it was not uncovered.

Case 12.—S. H., aged 10, had demonstrated progressive visual impairment for over a year with unsteady station, staggering, and a tendency to fall backward, when he was transferred from Dr. Weisenburg's service at the Graduate Hospital. At this time he presented 4 diopters of choking in each optic nerve head, vision decreased to sight of movements only, dyssynergia of the pelvis particularly with practically none in the upper limbs, and symptoms of marked internal hydrocephalus with no consistent signs of unilaterality. Observation of the postural reflex responses were noted to be as follows: (1) The droop of both extended arms was more marked when the head was turned to the left; (2) in the spontaneous

rising reaction test the left arm was elevated somewhat and the right arm drooped; (3) some divergence was shown, and (5) pronation was increased about equally by each hand; (6) "Lagebeharrung" showed sagging of either arm when the other was elevated, and neither arm was brought quite to the level from depression or elevation, a more marked abnormality being shown by the right arm; (7) both legs were overflexed in the imitation test, the right more than the left; (8) the arms deviated to the opposite direction from that toward which the head was turned. With the patient supine, on passive turning of the head, the opposite arm was abducted, the hand supinated and the opposite leg adducted with some flexion of the foot. This movement was more marked in the right limbs when the head was passively turned fully to the left. The responses indicated a right cerebellar lesion, from the droop of the extended arms, more marked when the head was turned to the left, drooping that was more marked in the right arm in the spontaneous rising reaction, positive "Lagebeharrung" more abnormal on the right, more overflexion of the right leg in the imitation phenomenon responses and the paradox deviation reaction particularly in the leg movements with the patient supine. The dyssynergia of the pelvic movements, more marked evidences of abnormal postural response in the lower limbs than in the upper, and the tendency to retropulsion and falling backward in his gait suggested involvement of the vermis and the anterior portion of the inferior lobes.

Examination of the cerebellum at necropsy disclosed a large discrete tumor, about the size of a plum, flattened into an ellipsoid involving the inferior two thirds of the vermis and of the medial portions of the right semilunar and biventral lobules.

Case 13.—J. R., aged 36, was admitted on Jan. 28, 1930, to the neurosurgical service of the University Hospital. On March 8, 1930, a cold had developed, followed by pain and discharge from the left ear. The pain increased in severity in the left mastoid and occipital regions. He had vomited five or six times since March 20, without nausea, and he was dizzy when sitting up in bed. There had been slight difficulty in swallowing liquids. This patient showed positive postural reflex responses in a definite lowering of the extended right arm in the spontaneous rising reaction, deviation outward of the right arm, slow pronation of the right hand to about 60 degrees from the horizontal, a positive "Lagebeharrung" in the right arm, hypometria being evidenced in lack of return to normal from both elevation and depression by 3 inches (7.6 cm) and overflexion of the right leg in the imitation test—all definitely indicating right cerebellar involvement.

On March 29, trephine and drainage of a right cerebellar abscess was done by Dr. F. C. Grant.[16] Along the posterior surface of the temporal bone behind the mastoid, at a depth of 3 cm., a tense resistance was met. On puncture, 7 cc. of thick, greenish pus was evacuated. The patient died on April 5, of respiratory failure. Pathologic examination showed that the right cerebellar hemisphere contained three distinct abscess cavities from 2 to 3 cm. in diameter with no apparent communication. The largest and most external of these had been evacuated and drained, the other two contained partially organized green pus. One cavity posteriorly in the superior lobe showed a little walling or limitation, while the others had a well developed, thick wall.

Case 14.—F. F., aged 9, was admitted to Dr. Frazier's neurosurgical service on March 28, 1930, suspected of having cerebellar abscess. Severe pain and tender-

16. Grant, F. C.: Cerebellar Symptoms Produced by Supratentorial Tumors, Arch. Neurol. & Psychiat. **20**:292 (Aug.) 1928; Nervous & Mental Diseases, Practical Medical Series, Chicago, 1928, p. 152.

ness in the left mastoid area had developed on Dec. 28, 1929, but two mastoid operations failed to relieve the symptoms. On Feb. 20, 1930, he presented retraction of the head, rigidity of the neck, bilateral Kernig signs and a marked opisthotonos with flexion of the legs and thighs, all of which had persisted and increased in intensity until the legs were flexed against the thighs and the thighs nearly to the abdomen, and on admission the opisthotonos formed nearly a half circle.

Postural reactions applied gave negative responses. Extending the arms without turning the head showed no abnormal reactions other than easy fatigability which allowed them to droop readily and to converge somewhat, with the relaxation at the elbows. The pronation phenomenon and "Lagebeharrung" were negative. No paradox deviation, spontaneous rotation or body-tipping reactions were presented. The imitation phenomenon could not be carried out on account of the position maintained by the legs.

In the absence of any positive postural reflex responses, the presence of a cerebellar abscess was unlikely, since all patients with cerebellar lesions showed definite and comparatively uniform abnormal responses. The mastoid was reopened with drainage of considerable retained pus and the febrile reaction subsided. The institution of position corrective measures relieved the abnormal posture which he had assumed, probably as the result of a meningitis serosa.

EVALUATION OF POSTURAL REACTIONS AS AIDS IN THE DIAGNOSIS OF LESIONS IN THE BRAIN

Application of postural reflexes based on the physiology of posture offers much complexity and difficulty in interpretation. Experimental research made on animals, in which there is less development of the forebrain and fewer interconnections between the various centers influencing motivation, and in which there is less complication of movements, and simpler, more obvious, consistent reflex reactions, is frequently inapplicable or unproductive of practical results when attempts are made to apply its results to the human being. The studies by Weisenburg [17] and Mussen [18] bring to attention the marked differences existing in the motor reactions in the human being and lower animals, particularly when the cerebellum is involved. Furthermore, the results and interpretations of the researches by the Utrecht school have not been fully checked and are not universally accepted, the results of Luciani and Sherrington varying in many instances on important, fundamentally basic principles.

Consequently, formulated tests for postural reflexes in man based on the physiologic reactions shown experimentally in animals do not have the universal localizing value one might assume on superficial consideration. When the pyramidal tract is involved, some limitation or paralysis will be elicited by various tests if only demonstrable in

17. Weisenburg, Theodore H.: Cerebellar Localization and Its Symptomatology, The Cerebellum, Brain **50**:357 (Oct.) 1927.

18. Mussen, A. T.: Experimental Investigations of the Cerebellum, Brain **50**:313 (Oct.) 1927.

easy fatigability, as shown in the inability to maintain the postures required by these tests. The slight variations in the responses due to pathologic conditions at various levels of the pyramidal tract are too inconsistent and difficult of interpretation for general usage. The consistent convergence reaction shown by patients with striopallidonigral disease is definite, but numerous other diagnostic signs are demonstrated in this syndrome.

The greatest value of the tests is demonstrated when they are applied in cases in which pathologic conditions of the cerebellum exist, for they are all tests of synergy. The imitation phenomenon and "Lagebeharrung" are more definitely tests for dysmetria.

Degree of tonus is elicited by the responses to all tests, being influenced by changing positions of the head which indicates the height of the lesion in the brain stem, the limbs and body not following the head movements when the head and neck righting reflex pathway is involved. Spontaneous rotation and tipping of the body result from dyssynergia of the trunk.

The practical significance resulting from the application of postural tests is in eliciting dyssynergia, the one fundamental symptom with its various signs of dysfunction, and to which numerous names have been applied, manifested in cerebellar lesions as pointed out by Weisenburg.[17] With the cerebellum supervising and coordinating all movement, having connection with all central motor units and functioning in every motor activity, its influence will always be manifested in so complex a motor reaction as posture. This fact was clearly demonstrated in applying the postural tests in known and proved cerebellar lesions.

All patients with cerebellar lesions showed a positive imitation phenomenon and increased pronation signs on the side of the lesion as well as a positive "Lagebeharrung" more marked on the same side as the involvement. Usually there was a sinking of the arm on the side of the lesion, but a change in level was always evidenced in the spontaneous rising reaction. Paradox deviation was demonstrated in most instances, sometimes by but one arm, and it was associated with spontaneous rotation of the body in two of this series. Tipping of the body was definitely demonstrated in one patient with a cerebellar tumor and in one showing the cerebellar agenesis syndrome.

The variation in all of these responses from those exhibited by normal persons was definite. Normal variations were slight and no more obvious than normal responses to any other tests requiring some degree of accuracy of movement or position. No normal persons demonstrated the convergence reaction, paradox deviation, spontaneous rotation or the body-tipping reaction. In the basic test the arm on the side toward the direction in which the jaw pointed showed a slight elevation of from 2 to 3 cm. if any change in position of the arms

occurred, while in patients with cerebellar lesions there was always a definite change of level of the arms. In the spontaneous rising reaction the normal response was a slight movement upward, more often with the right arm, never more than the distance equal to the thickness of the hand if any discernible movement was observed. In the patient with a cerebellar lesion there was usually sinking of the arm on the side of the lesion and always a definite change from the original level of the arm.

Divergence of the arms was slight in normal persons when it did occur, but when cerebellar disease was present definite spreading was usually obvious.

The pronation phenomenon was definitely increased on the side of the lesion in all patients with cerebellar lesions, to a 60 degree angle in some, while in normal persons the turning of the hand was slower and slight if present. The "Lagebeharrung" in normal persons was manifested by not more than a few centimeters' difference from gaining the original level, while patients with cerebellar lesions all showed a distinct failure in approaching the level, by several inches in some cases, that was more marked in the discrepancy on the side involved in unilateral lesions. The imitation phenomenon was definitely demonstrated by hypotonic hyperflexion in all cerebellar cases, more marked on the side of the lesion, while normal persons approximated the duplication of the flexion of the other leg closely, and in most cases accurately.

The definitely abnormal responses in postural reflexes as shown in brain lesions, particularly when the cerebellum is involved, commend themselves to use in routine neurologic examinations and should always be applied when pathologic processes of the cerebellum are suspected, in conjunction with the usual tests for dyssynergia. They are convenient, add little fatigue, require slight concentration on the part of the patient, do not require mental alertness and may be applied to children and uncooperative patients better than many of the usual tests. The abnormal responses are definite and consistent and are frequently more obvious and diagnostic of the pathologic involvement as to side and site than the ordinary neurologic tests, which may give negative results when abnormal postural reflex responses are obvious and consistently elicited, as demonstrated in several of the cases reported.

In lesions outside of the cerebellum the interpretation is more difficult and more liable to be misleading than the more frequently used and better understood signs of cerebral involvement unless some study is given to their application.

Further study of the abnormal reflex responses with close observation of the finer variations, particularly as to the movements of the hands and fingers, should offer still more diagnostic criteria in localization.

CONCLUSIONS

The application of the physiology of posture by means of formulated tests demonstrated that lesions of the brain involving the proprioceptive reflex pathways result in abnormalities of responses sufficiently consistent and uniform to assist materially in localization of the pathologic conditions as to side and site and are indicative of the extent of the involvement. The examination of the postural reflexes offers additional aid in localization, particularly when the cerebellum is involved, when the symptoms are often misleading and difficult to interpret.

ENCEPHALOMYELITIS COMPLICATING MEASLES

REPORT OF A CASE WITH NECROPSY *

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NEW HAVEN, CONN.

The majority of the reports on central nervous system complications of measles have appeared since 1925. The impetus created by the reports by Mosse,[1] Bergenfeldt,[2] and especially Wohlwill,[3] of a definite anatomic picture associated with clinical cerebral complications during the course of, or immediately following, measles is probably responsible for this. And yet it is the opinion of men of such wide experience as Spielmeyer that the encephalitis of measles as well as of the anatomically related postvaccinal encephalitis has been seen in recent years, whereas it was practically unknown previously. Case reports of the condition appeared sporadically in the past, in a day when anatomic studies of the nervous system were limited technically, which prevented the recognition of the true nature of the disease from an anatomic point of view and possibly discouraged clinical case reports. For instance, the reports of Bergeron in 1868, of Bayle [4] in 1886 and of Barlow [5] in that same year included little more than a description of the clinical course and the gross observations, consisting of congestion and softening of the spinal cords. It is true, however, that even with the advent of newer methods of study at the beginning of the present century few case reports with anatomic studies have been added.

Clinically, the observation of encephalitis in association with measles is of rare occurrence, even if it has been on the increase in recent years. Boenheim,[6] in a monograph written in 1925, stated that in a series of almost 6,000 cases of measles, nervous complications occurred in 23, of which 6, or 0.1 per cent, were of the nature of encephalitis. Ker,

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1. Mosse, K.: Jahrb. f. Kinderh. **112**:272, 1926.
2. Bergenfeldt, E.: Acta med. Scandinav. **61**:281, 1924.
3. Wohlwill, F.: Ztschr. f. d. ges. Neurol. u. Psychiat. **112**:20, 1928.
4. Bayle, L.: Des paralysies consécutives à l'enfant mobilleuse, Thèse de Paris, 1886.
5. Barlow, T.: Brit. M. J. **2**:923, 1886.
6. Boenheim, C.: Ergebn. d. inn. Med. u. Kinderh. **28**:598, 1925; Berl. klin. Wchnschr. **33**:1552, 1927.

in his book on infectious diseases, stated that in almost 12,000 cases of measles he did not see a single case of an encephalitic syndrome and only 1 case of transverse myelitis. In 1928, Ford [7] published a complete summary of the clinical and of the clinico-anatomic case reports that had appeared in the literature up to that time. In all, he collected 113 cases, to which he added twelve of his own; 4 of them came from this clinic. Of this whole series, approximately 19 were reported with post-mortem observations. Since Ford's paper, Greenfield [8] has published the clinical histories of 4 patients with encephalomyelitis in the course of measles, with necropsy observations of 1, and Walthard [9] has added a case which came to autopsy about one month after the onset of nervous symptoms in the course of measles.

REPORT OF CASE

Clinical History.—W. P., a boy, aged 4, was brought to the hospital on July 21, 1929. The following history was obtained from the child's mother. The family history was unimportant, except that a brother, one year older, was convalescing from an attack of measles. The birth of the patient was normal in all respects and terminated an uneventful pregnancy. The patient was breast-fed for four months, and was then given a diet of boiled, whole cow's milk with added lactose. There were no feeding difficulties, and the gain in weight followed a normal curve. The physical and the mental development were essentially normal in all respects. The boy had mumps at 2 years of age, from which he recovered without complications. There were no other illnesses, except occasional infections of the upper respiratory tract. The general health was excellent.

The present illness dated back to July 14, 1929, seven days before admission to the hospital, when a hacking cough developed, food was refused and irritability was noticed. The cough became more marked, and on July 15, the child was put to bed, as he had developed some fever. On July 16, a rash appeared, which quickly spread over the entire body. It was diagnosed by the family physician as a typical measles exanthem. On the two days following, the child seemed to improve; the temperature, which previously had ranged between 102 and 103, fell to 100 F. On July 19, two days before admission, the temperature suddenly rose to 104 F. Nausea was experienced, but there was no vomiting. On July 20, pain and tenderness developed along the back of the neck, and vomiting occurred three times. By evening, the neck was definitely stiff and exceedingly painful on passive anterior flexion. That night it was noted that the boy was becoming abnormally drowsy; control of the bowels was lost, and the bladder, according to the attending physician, was distended, reaching almost to the umbilicus. The following morning, July 21, the child was brought to the New Haven Hospital.

Examination.—On admission to the hospital, the patient's temperature was 39 C. (102.2 F.); the pulse rate was 120 and respirations, 24. The child was drowsy and apathetic; he was well nourished and well developed. There was moderate retraction of the neck. Breathing was not irregular either as to depth

7. Ford, F. R.: Bull. Johns Hopkins Hosp. **43**:140, 1928.

8. Greenfield, J. G.: Brain **52**:171, 1929.

9. Walthard, K. M.: Ztschr. f. d. ges. Neurol. u. Psychiat. **124**:176, 1930.

or rhythm. There was no cyanosis or jaundice. The skin showed a fading morbilliform eruption without petechiae or purpura. The superficial glands were not enlarged. The pupils were very small, regular and reacted but slightly to light. Ophthalmoscopic examination revealed suggestive fulness of the retinal veins. The nose and ears were normal. The throat was only slightly injected, and some mucopus was seen in the posterior pharynx. The neck was rather stiff and evidently painful on anterior flexion. There was definite tenderness over the cervical vertebrae. The lungs and heart were normal. The liver and spleen were not felt, while the bladder extended well above the umbilicus. The deep reflexes were present and equally active on both sides. The cremasteric reflex was sluggish, while the abdominal reflexes were absent. Kernig's sign was negative, and the plantar response was flexor in type. There was no evident involvement of the cranial nerves nor any evidence of paralysis. Sensation was not tested.

A lumbar puncture was done, and a clear, colorless fluid was obtained under normal pressure and contained 90 cells per cubic millimeter; 90 per cent of the cells were mononuclears. The Pandy and Ross-Jones tests for globulin were both strongly positive. No organisms were seen on direct smear, and cultures subsequently proved to be sterile.

Course.—On the day following admission it was evident that the drowsiness had increased. A divergent strabismus also had developed. During the course of the next three days, the patient became progressively more lethargic. The tendon reflexes, which previously had been fairly active, became less easily obtainable, and finally could not be elicited. The plantar response became extensor in type soon after the patient's entrance to the hospital. The limbs were flaccid and showed little active movement, although paralysis did not develop. Distention of the bladder persisted, and there was a slight but constant overflow of urine. A urologic consultant described the condition as being dependent on a lesion of the central nervous system. On July 25, four days after the patient's admission, definite dysphagia developed, which made feeding by gavage necessary. The temperature, which was elevated throughout the period in the hospital, reached 41.8 C. (105.8 F.). On the afternoon of July 25, the respirations became exceedingly rapid and shallow, while the pulse, which previously had maintained a fairly good quality, became very rapid and thready. The patient died late that day.

The laboratory observations were as follows: On July 21 the blood count showed: red cells, 4,260,000; hemoglobin, 70 per cent (Sahli); white cells, 16,000, with 76 per cent polymorphonuclears; 14 per cent lymphocytes and 10 per cent large mononuclears. On admission a specimen of urine showed large numbers of white blood cells, some red cells, casts and a faint trace of albumin. All subsequent examinations gave essentially negative results. On July 21, examination of the cerebrospinal fluid showed 90 cells, 90 per cent mononuclears, and globulin tests strongly positive; on July 23, 135 cells, 92 per cent mononuclears, and globulin tests strongly positive; chemical examination revealed 86 mg. of sugar per hundred cubic centimeters; the cultures were sterile. Blood culture on admission was negative. Nose and throat cultures showed *Staphylococcus aureus.* A Kahn test of the blood was negative.

Necropsy Observations.—Gross Examination: The postmortem examination was restricted to the brain. No abnormalities were noted in the vessels of the circle of Willis nor in the dural sinuses. The leptomeninges were delicate and clear. The pial vessels were slightly congested. The cerebral convolutions were somewhat flattened, and the whole brain appeared edematous. On frontal section, the cortical gray matter was seen to be of normal width and sharply

demarcated from the white matter. There was slight congestion of the blood vessels of the cerebral cortex. The perivascular spaces in the internal and external capsules were dilated to such a degree as to make them visible macroscopically. No hemorrhages or softened zones were found in the brain. The ventricles were not dilated, and the ventricular ependyma was smooth.

Microscopic Examination: In the delicate meshwork of the pia-arachnoid, large mononuclear cells with abundant cytoplasm and round or horseshoe-shaped nuclei were distributed diffusely but sparsely. A small proportion of these cells were filled with translucent, pale green phagocytosed pigment granules. There was no evidence of hemorrhage in the subarachnoid space, nor were the pial vessels particularly congested. None of these vessels were thrombosed.

The Nissl preparations yielded the clearest and most striking pictures of the anatomic changes encountered throughout the brain. In both cerebral hemispheres the lesions were confined entirely to the white matter of the centrum semi-ovale and to the projections of white matter which formed the cores of the cerebral convolutions. Furthermore, they were confined to the vicinity of, and in nearly every instance surrounded, thin-walled veins and the larger venules of the white matter. When a thick-walled vessel, an artery, lay adjacent to a thin-walled vein, the reaction spared the former and was confined solely to the latter. The lesions consisted of large accumulations of glia cells, which were most numerous around the vessels, but which spread out in smaller numbers for variable and often considerable distances into the adjacent tissue. The ground substance in these zones was fragmentarily or not at all stained in the Nissl preparations and appeared to be made up of a loose meshwork in which lay the glia cells. These, as regarded their morphologic appearances and their apparent functional characteristics, were chiefly of two kinds: (1) the large transformed microglia with dark, round nuclei each containing a nucleolus and abundant deep-staining cytoplasm of indefinite, wavy outlines with numerous short, swollen processes; (2) the large, round, phagocytic, fat-granule cell. It was possible in every zone to find typical microglia and those showing active proliferation. There were found, here and there, glia cells of enormous size, with pale, spherical ground-glass cytoplasm, the nuclei of which were in mitosis. These cells often measured four to five times the diameter of the large, fat-granule cells.

The cellular reaction just described followed the veins throughout their courses in the white matter, even extending along their smaller branches. In no instance, however, could evidence of this reaction be found in the cortical gray matter. Rarely the sixth layer of cortical gray matter was involved to the extent that it was infiltrated by small numbers of the microglial wandering cells described by Spielmeyer as polyblasts, but the fusiform ganglion cells of this layer showed no degeneration. What is most striking in this entire picture is the sharp limitation of the pathologic changes to the white matter, which was involved in the frontal, temporal, parietal and occipital lobes to an equal degree. None of the cortical vessels, nor even those of the cerebral white matter, were strikingly congested, and there were no petechial hemorrhages. There was no evidence of intimal proliferation in any of the vessels. It was impossible to find perivascular collections of lymphocytes or plasma cells, even in small numbers. The Virchow-Robin spaces were difficult to identify, both because they were undistended and because the perivascular glial reaction was most marked immediately adjacent to the adventitia of the vessels.

In the subcortical white matter of the island of Reil were seen the same perivascular glial reactions (fig. 1), and here was brought out particularly clearly the sheath-like involvement of the vessels and their numerous branches. The

involvement was continuous; these vessels along their whole courses in the white matter were sheathed in glia cells. Perivascular lesions were found in the capsula extrema, but the claustrum was completely spared. Again, the external capsule had numerous blood vessels characteristically involved. The putamen was uninvolved, but the internal capsule showed a rather marked perivascular reaction. The caudate nucleus was entirely spared, and where it bordered on the lateral ventricle there was no sign of a subependymal gliosis. This fact appeared to be of considerable significance, as the corpus callosum, which also bordered on the ventricle, was the seat of a marked glial reaction. Nor was the reaction here always clearly perivascular in location. More often the glia cells, the majority

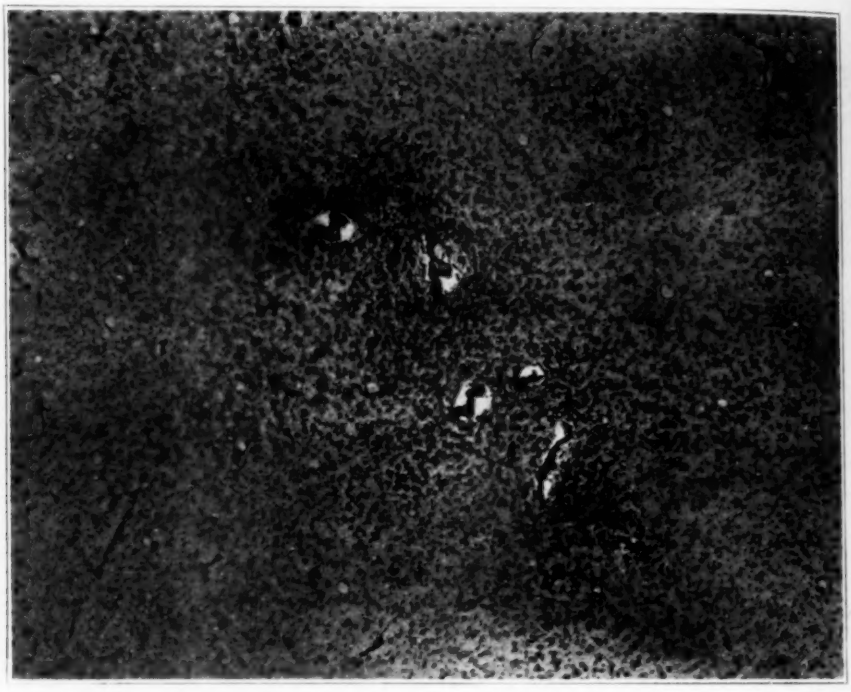

Fig. 1.—Marked glial proliferation around the blood vessels in the white matter of the Island of Reil. Nissl stain; × 65.

of which were the polyblasts of Spielmeyer (they had large round bodies with clear ground-glass cytoplasm and small round chromatin-rich nuclei), were arranged in long parallel columns. Here and there a glia cell in mitosis gave evidence of a proliferative reaction. The ependyma was intact over the caudate nucleus and over most of the corpus callosum, but over the latter structure it was also desquamated in part.

A word should be said about the dilated perivascular lymph spaces in both the internal and the external capsules. These spaces were wide and completely devoid of cells. No glial processes were seen to bridge these spaces to insert foot-plates on the adventitia of the vessels, and numerous Cajal gold chloride-sublimate preparations were utilized in a search for them. Whether this condition was an antemortem phenomenon or whether it was possibly produced

artificially in the preparation of the sections, is difficult to determine. In support of the former conclusion is the fact that only the vessels in the locations enumerated showed this condition; in support of the latter conclusion are the lack of perivascular hemorrhages or cellular infiltrations and the fact that glial processes were not seen bridging these spaces.

As already mentioned, the cortical gray matter was practically free from the disease process. What was the condition in the central gray matter? In the putamen and caudate nuclei all the veins were found entirely free from perivascular cellular collections; nor did the ganglion cells show any deviations from the normal picture. These considerations held true for the thalamus, except that

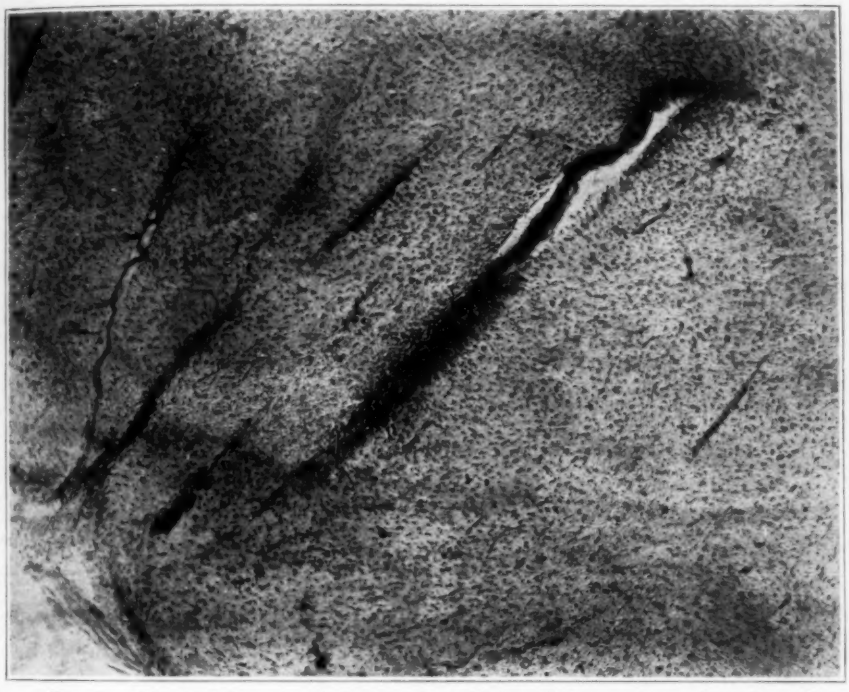

Fig. 2.—Glia sheaths around the venules which radiate out from the substantia nigra through the pyramids toward the pia. Nissl stain; × 55.

rarely there was a disintegrating ganglion cell surrounded by a clump of glia cells (neuronophagia). In the midbrain the periventricular gray matter, the red nuclei and the substantia nigra were spared. The vessels which ran a semicircular course in the white matter dorsal to the red nuclei, the vessels in the dorsal and the ventral decussations and those which radiated out from the substantia nigra through the cerebral peduncles to the pia (fig. 2) were involved by the same process. In but one small focus in the substantia nigra had the contiguous lesion in the white matter encroached on this structure. And yet the nerve cells stained normally in every detail. There was a definite subpial glial proliferation in each cerebral peduncle, forming a narrow, closely packed band of cells. Some of the latter cells were in mitosis and resembled in all morphologic details the reacting glia cells in other parts of the white matter.

In the pons, the ventral white matter of the pyramidal tracts was diffusely involved in this proliferation. There was a tendency for the glia cells to arrange themselves in horizontal parallel layers in the direction of the myelin sheaths, a single cell in width. Often the relationship of this glial reaction to blood vessels was not distinct, but at other times there was no doubt as to such a relationship. The majority of these glia cells were the "Fettkörnchenzellen" or the compound granular cells. Rather frequently the pontile nuclei were infiltrated with them (fig. 3), and the ganglion cells showed "acute swelling" with cell bodies rounded, the Nissl substance stained poorly or not at all, and the nuclei were large, round and vesicular. This stage of "acute swelling" had rarely progressed

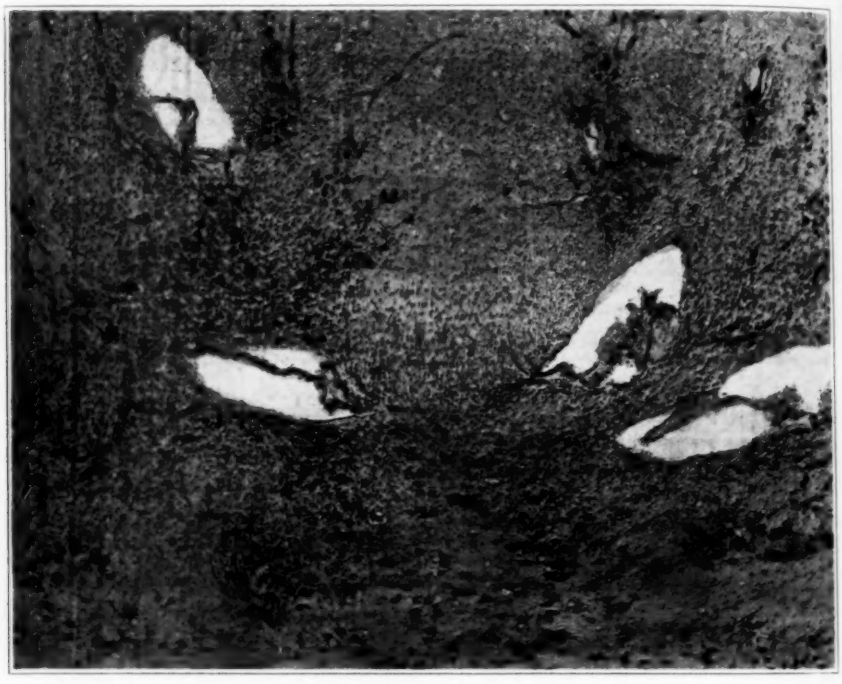

Fig. 3.—Perivascular glial proliferation in the white matter of the pons with encroachment on the pontile nuclei. Nissl stain; × 65.

further, with beginning disintegration of the cells. The picture was in no respect like that of neuronophagia, nor was it like the focal glial proliferations one sees in septicemia. It was rather a diffuse lesion that encroached on the gray matter from the white matter, and the glia cells involved had an entirely different morphology from those seen in either neuronophagia or in cerebral involvement from septicemia.

Perivascular glial reactions were present in the cerebellum, entirely confined to the central medullary body, and here they were of slight extent and relatively few. None of the laminae of white matter that projected into the lobules of the cerebellum harbored any of these perivascular lesions. The Purkinje cells were normal in appearance, and no lesions were found in the granular layer.

At the level of the middle of the inferior olive of the medulla, the reacting glia cells were arranged in a radial manner and in parallel columns along the venules that lay in the white matter beneath the pia. Many of these cells again had large, round, clear cell bodies with small round nuclei and suggested "polyblasts." In addition, there were the usual compound granular cells. None of the vessels deep within the medulla showed these perivascular cellular collections. At a level through the caudal angle of the fourth ventricle, the perivascular radial arrangement of the reaction was still present, but the white matter in the center of the inferior olive also contained the perivascular changes. Where the pyramids decussated, marked glial proliferations could be seen along the sides of both the anterior and the posterior median fissures. Dorsal to the central canal there was a marked proliferation of the rod-shaped Hortega glia cells. The rubrospinal, spinothalamic and dorsal and ventral pyramidal tracts were similarly, and equally extensively, involved.

Of unusual interest and import were the neuroglial changes in all of the cranial nerves. The majority of the glial cells here had very scant cytoplasm but large, round, pale nuclei, which were stippled and contained eccentric nucleoli. These represented the so-called progressive glial transformations. The cells were arranged in single file and in parallel columns in the direction of the long axes of the nerves. A small portion of the glia was represented by the ever present fat-containing, phagocytic type of cell. Both types were often found along the margins of the nerves immediately beneath their pial enclosures, and occasionally they were also seen within the pia-arachnoid. It would seem likely, therefore, that at least in part this was the source of the presence of mononuclear cells in the cerebrospinal fluid.

Comment.—To summarize the microscopic character of the lesions as brought out in the Nissl preparations: There was a degenerative and proliferative process affecting the perivascular tissues of the white matter of the entire brain, and occasionally this process reached over into the gray matter. In each instance, the degenerative part of the process greatly predominated over the proliferative part and both were manifested by a glial reaction in which proliferating microglia, fat-granule cells and the "polyblasts" of Spielmeyer each played a part. This process was seen in the white matter beneath the ependymal lining of the ventricles, in the cranial nerves and wherever white matter lay beneath the pia, as in the cerebral peduncle and in the medulla. In all these places, however, the process was perivascular in position, as it was in the centrum semiovale. No changes were noted in the choroid plexuses. Nowhere were there evidences of hemorrhage or of leukocytic reaction.

In the description given, frequent mention was made of fat-containing glia cells. Sudan III stains and the Herxheimer scharlach R. stain were employed in the study of the degenerative process which these cells signify. For variable and irregular distances around the blood vessels in the white matter the homogeneous terra cotta appearance, which normal myelin has when stained by these methods, was destroyed. A definite ground substance was lacking, and in its place

were numerous large mononuclear cells engorged with fat droplets which stained bright red (fig. 4). Large quantities of fat droplets were loosely scattered in the surrounding tissue and were as yet unphagocytosed. Around the greater portion of vessels encased by these fat-granule cells, no definite perivascular lymph spaces were noticeable, the phagocytic cells being present in such large numbers and spreading out so diffusely into the surrounding tissue as to obscure them. There was, however, an occasional venule with a wide peri-

Fig. 4.—Large fat-granule cells engorged with fat droplets in the perivascular tissues. Herxheimer fat stain; × 375.

vascular space in which were crowded fat-containing cells. The endothelium of the blood vessels contained no fat, not even of a finely granular nature.

Fragments of myelin were found intracellulary and extracellularly in narrow zones of demyelinization which surrounded the blood vessels (fig. 5), around which changes were noted with other staining methods. Spielmeyer stains (myelin sheath stains on frozen sections) showed fragmentation and ballooning of individual sheaths, always confined to the perivascular zones. The débris which lay loosely in these zones was poorly stained and brown; that which was phagocytosed within cells

was black. This demyelinization could be traced along the whole lengths of blood vessels and their branches; nowhere was a vessel seen to dip into or out of a demyelinated focus, as is the case in multiple sclerosis. The cellular reaction appeared to cover a wider perivascular margin than did the demyelinization, and so cells on the periphery of the reaction lay among normally preserved myelin sheaths.

It is somewhat surprising that in a destructive process that involved the myelin fairly extensively, the axis cylinders should be preserved.

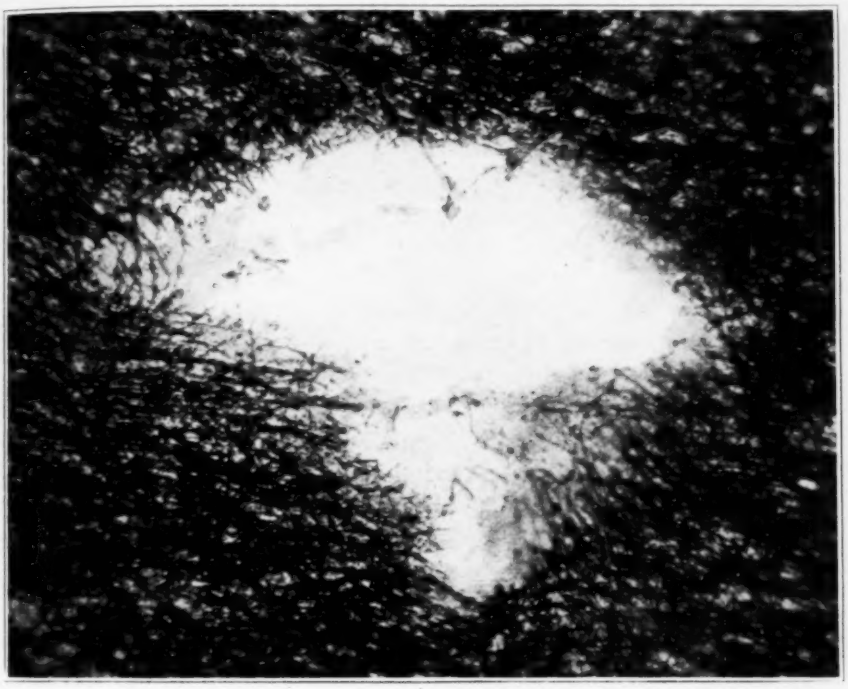

Fig. 5.—Zone of demyelinization around a venule in the corpus semiovale. Spielmeyer stain; × 350.

Such was the case, however, even in the perivascular zones where the myelin disintegration was most severe. It was less a matter of surprise to find all the intraganglionic neurofibrillae intact, as the Nissl stains also showed practically no involvement of the neuron elements.

Of what nature were the glia cells that played so large a rôle in the perivascular reaction? Cajal gold chloride-sublimate stains showed no increase in the number of astrocytes or of their processes, nor were definite pathologic forms observed. Only in rare instances were such cells found containing two nuclei. Their processes were seen extending through the perivascular cellular collections to attach their foot-plates

in a normal manner on the adventitia of the vessels. The Globus and the Kanzler-Kufs modifications of the Hortega silver carbonate stains for microglia (the material for these stains was fixed in formaldehyde) showed large numbers of these cells in the perivascular zones. Particularly was this true in the preparations by the Kanzler-Kufs method. The majority of the cells impregnated showed marked deviations from the morphology of normal microglia—the processes were short and stubby and the cell bodies were rounded and large. A surprisingly great number of these cells had nuclei in mitosis. Large numbers of the cells that had been called "polyblasts" and fat-granule cells were left unimpregnated by all the silver methods, but this was a common experience even with material primarily fixed in formaldehyde-ammonium bromide according to the original Hortega method, and did not speak against the origin of these cells from microglia.

To determine whether or not there was any connective tissue reparative process in progress, van Gieson preparations were made. These showed a lack of reaction on the part of the mesoderm both in the perivascular zones of the cerebral parenchyma and in the leptomeninges. What there was of a proliferative reaction, therefore, was confined to the microglia and was part of the widespread perivascular degenerative process rather than of a truly reparative one.

To summarize briefly the anatomic observations in this case: There was a slight mononuclear cellular reaction in the leptomeninges which, in part at least, was composed of transformed microglial wandering cells that had found their way into the subarachnoid space from the perivascular spaces of the white matter and from the cranial nerves. The most important lesion was a degeneration of the perivascular myelin sheaths of the white matter throughout the brain. This demyelinization was accompanied by a marked proliferation of microglia and the transformation of the latter into polyblasts and into phagocytic fat-granule cells. This combined degenerative and proliferative process encroached on the gray matter, cortical and central, in only the rarest instances. No attempt at repair on the part of either the astrocytes or the mesoderm was seen. The axis cylinders were entirely uninvolved in the degenerative process. There was no evidence of hemorrhages of any size or of leukocytic reactions anywhere in the brain.

COMMENT

Exclusive of the cases of mild and transitory central nervous system involvement in the course of measles, the clinical picture of postmeasles encephalitis is fairly uniform from case to case. The onset is characterized by great suddenness and a decided elevation of temperature. The time of onset may be simultaneous with, and in rare instances

may precede, the exanthem. Neurologic symptoms, however, may become manifest at any time during a period of fifteen days following the appearance of the measles rash, but in the majority of cases the fifth day marks the onset. A sudden convulsion, usually generalized, or severe headache and persistent vomiting may be the initial symptoms. Often the sudden development of drowsiness with gradually increasing lethargy and finally coma usher in the picture of postmeasles encephalitis, or signs of meningeal irritation may be present. Rarely, the abrupt appearance of choreiform movements (as in a case described by Redlich [10]) or definite behavior abnormalities (as in Winnicott's [11] case) are the first signs of this complication. Muscular ridigity and twitching are commonly seen at this stage.

The temperature, which at first ranges around 40 C. (104 F.), may rise to extraordinary heights in cases that end fatally. In the nonfatal cases it begins to swing downward on the third or fourth day.

The neurologic symptoms during the course of the disease may point to multiple focal cerebral lesions, and in patients who survive, residual mental defects or personality changes may persist. Hemiplegias of a cerebral type are not infrequently noted and often persist even when recovery is otherwise complete. Paraplegias of spinal cord origin are mentioned thirty-three times in the recorded cases; in six cases death followed respiratory paralysis, and in somewhat less than 30 per cent of the patients that recovered, various types of motor weaknesses persisted. A surprisingly large number of the patients develop complete urinary retention during the acute stage of the disease. In smaller numbers cerebellar syndromes are outstanding, and in others nervous complications such as delirium or hallucinations are in the foreground. Epileptic attacks in addition to the mental changes and motor weakness already mentioned are known to date back to postmeasles encephalitis. Approximately 10 per cent of all patients who have this complication die, and about 65 per cent of those who survive show residual symptoms.

The spinal fluid presents no uniform picture. In most cases the pressure is definitely increased, and may reach as high as 400 mm. of water. The cells may or may not be increased in number, and are of the mononuclear type. In a few instances, however, polymorphonuclear leukocytes have also been reported. Increase in globulin is rather a constant observation. Some affirm and some deny an increase in sugar. Film formation is rarely seen. Bacteriologically, the fluid has always given negative results.

10. Redlich, F.: Ztschr. f. Kinderh. **43**:178, 1927.
11. Winnicott, D. W.: Proc. Roy. Soc. Med. **22**:1247, 1929.

To date, all the anatomic reports of the encephalitic complications of measles are of cases that have come to autopsy in the acute stages of the disease. In only one case, that of Walthard,[9] was there a history of illness as long as four weeks. What the anatomic picture is in those who survive longest remains problematic for the present. In the acute stages, however, the lesions present a rather uniform picture. The most constant observations are the perivascular zones of demyelinization in the white matter of the brain and cord, which contains numerous phagocytic glia cells filled with fat granules. The axis cylinders in these zones are nearly always intact, but in the subacute case of Walthard they were already mostly destroyed. Somewhat less constantly are found perivascular infiltrations of lymphocytes and plasma cells. Observations that are mentioned in some of the reports are the petechial hemorrhages and the cerebral congestion, and although no definite data are available clinically, it would appear that these depend on terminal convulsions. In the eight cases reported by Musser and Hauser,[12] perivascular hemorrhages were the most striking observations. The anatomic changes in postmeasles encephalitis, as outlined, correspond closely to those of postvaccination encephalitis as described by Baumann and Bok [13] and by Turnbull and McIntosh.[14]

In the early papers on the subject under discussion, the question was raised as to whether or not this condition was a bizarre manifestation of epidemic encephalitis. None of the patients who have survived the encephalitic complications following measles have presented the parkinsonian syndrome. From an anatomic point of view also the two conditions are different. In epidemic encephalitis it is the gray matter, chiefly the central gray area in the vicinity of the substantia nigra, that suffers, whereas in postmeasles encephalitis the lesions are sharply limited to the white matter. In the literature, references are made repeatedly to the similarities and differences between this condition and multiple sclerosis and anterior poliomyelitis. It is a difficult matter to argue about conditions the etiologies of which are not known, but there is no question that anatomically there are certain differences between these conditions. For example, in multiple sclerosis the perivascular demyelinization is focal in distribution—vessels are seen to dip in and out of demyelinated areas—whereas in postmeasles encephalitis, the demyelinization follows the whole course of a vessel. These and other anatomic differences are discussed by Wohlwill and by Greenfield.

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12. Musser, J. H., and Hauser, G. H.: Encephalitis as a Complication of Measles, J. A. M. A. **90**:1267 (April 21) 1928.

13. Baumann, L., and Bok, S. T.: Ztschr. f. d. ges. Neurol. u. Psychiat. **111**:495, 1927.

14. Turnbull, H. M., and McIntosh, J.: Brit. J. Exper. Path. **7**:181, 1926. Wilson, R. E., and Ford, F. R.: Bull. Johns Hopkins Hosp. **40**:337, 1927.

SUMMARY

The history is presented of a white boy, aged 4, who on the fifth day of an attack of measles had a sudden elevation of temperature to 104 F. associated with nausea and stiffness of the neck, and later with vomiting. The child became drowsy and lost control of the bowels; the bladder became distended, and there was dribbling. Tenderness was present over the cervical vertebrae. Drowsiness increased, and a divergent strabismus developed. The tendon reflexes finally disappeared; the Babinski sign became positive, dysphagia developed, and the respirations became shallow and rapid. Six days after the onset of the encephalitic complication, he died. The cerebrospinal fluid obtained was under normal pressure and contained between 90 and 135 cells per cubic millimeter; 90 per cent of them were mononuclears. The globulin tests were strongly positive. The fluid was sterile.

Anatomically, the lesion was characterized by a perivascular degeneration of the myelin of the white matter, with a marked glial proliferation around these vessels, and in the white matter beneath the ventricular ependyma and beneath the pia. There was active phagocytosis of fat in these regions but no axis cylinder destruction. The gray matter was rarely involved, and then only when it was closely adjacent to lesions in the white matter. Whatever the etiologic agent underlying the process was, it seemed to be dependent on a venous distribution; this was also true in zones adjacent to the ventricles and the subarachnoid space. That the spinal fluid played no part in its distribution seemed evident from the fact that the choroid plexuses and the gray matter bathed by spinal fluid, such as the periventricular and the cortical gray, were wholly uninvolved.

Clinical Notes

TUMOR OF THE SPINAL CORD ASSOCIATED WITH BILATERAL ACOUSTIC TUMORS

Report of a Case *

W. J. Gardner, Cleveland

The patient, a report of whose case follows, is a member of a family in which bilateral deafness has been transmitted as a true mendelian dominant character. The condition has been traced through five generations of the family, which includes 217 members.[1] Thirty-eight members have been affected. Of these thirty-eight, fifteen subsequently became blind, the blindness being preceded by headache and vomiting in each case in which information was available. Of the deaf and blind persons, four were examined prior to death, and were found to have choking of the optic disks with secondary atrophy. Of the deaf persons, seven were personally examined. Five of these had entire absence of vestibular responses in the Bárány test. In the other two, a sluggish response was obtained from the left horizontal canal, but the remaining semicircular canals were nonfunctioning. In addition, four subjects were found who had little or no impairment of hearing, but whose vestibular responses were absent in the Bárány test. These Bárány observations, together with the neurologic signs which these persons presented, made the diagnosis of bilateral acoustic tumors practically indisputable. The two affected members of this family who came to necropsy had bilateral acoustic neurofibromas. There was practically no associated evidence of von Recklinghausen's disease in this family, and at the time of the investigation, there was nothing to indicate the presence of tumors elsewhere than on the acoustic nerves.

Following publication of the first report on this family, however, one of the affected members, the subject of the following case history, developed symptoms of a tumor of the spinal cord. The tumor, which proved likewise to be a neurofibroma, was correctly localized and successfully removed. Therefore, it seems probable that other affected members of this family may also have tumors on other portions of the central nervous system.

REPORT OF CASE

Clinical History.—VA9 (fig. 1), a man, was admitted to the neurological service of the Cleveland Clinic Hospital on Jan. 22, 1930, having been referred by Dr. T. K. Wood, of Muncy, Pa. The chief complaint was weakness of both legs and of the left hand. The patient had been a little unsteady on his feet, especially after dark, for a period of four or five years. For about two years there had been occasional indefinite cramps in the left hand. For over a year there

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* From the neurosurgical service of the Cleveland Clinic.

1. Gardner, W. J., and Frazier, C. H.: Bilateral Acoustic Neurofibromas: A Clinical Study of Field Survey of a Family of Five Generations with Bilateral Deafness in Thirty-Eight Members, Arch. Neurol. & Psychiat. **23**:266 (Feb.) 1930.

had been bilateral tinnitus, marked on the left side. For nine months the patient had noticed some difficulty in retaining feces, and constipation requiring catharsis had been present. For four months there had been progressive weakness and atrophy of the muscles of the left hand and also progressive weakness of both legs. Pain had not been a symptom.

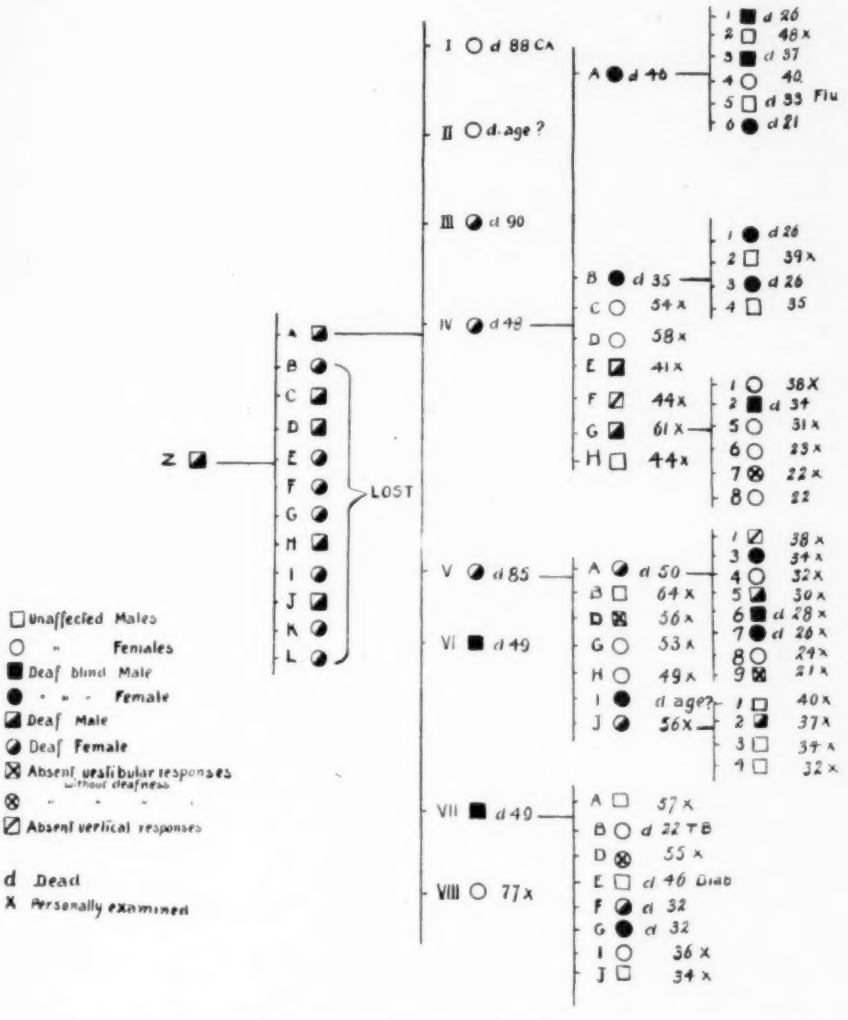

Fig. 1.—Chart of the patient's family tree. This chart includes only the children of affected parents who attained the age of 20 years, at which average time the condition became manifest. For the sake of simplicity, the charts representing the complete family tree have been omitted. These may be seen by consulting the original article (Arch. Neurol. & Psychiat. **23**:266 [Feb.] 1930).

The patient who is the subject of this report is indicated as VA9.

Physical Examination.—The patient was a large, healthy-looking man. His gait was ataxic and lurching, and he tired readily on walking. There were no other points of interest in the physical examination.

Neurologic Examination.—The positive signs were: The retinal veins were slightly engorged, but the optic disks were not choked. A fine horizontal nystagmus appeared on lateral rotation of the eyes. There was a slight impairment of hearing for high tones in the left ear. The lower extremities were weak and spastic. The grasp of the right hand was slightly weak, and the left was extremely weak and flaccid. The dynamometer readings were: right 80, left 5. There was distinct atrophy of the interossei and hypothenar muscles of the left hand and a lesser degree of atrophy in the flexors and extensors in the forearm.

The right biceps and triceps reflexes were normal; the left were slightly exaggerated. The right patellar reflex was normal, but the left was decidedly hyper-

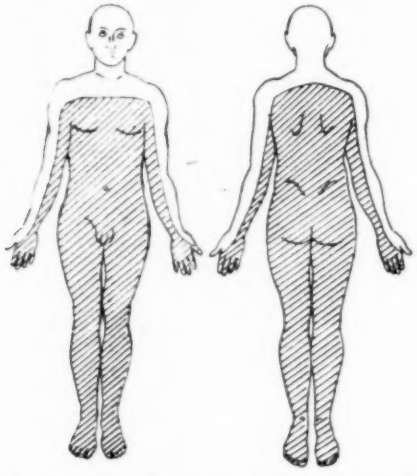

Fig. 2.—Preoperative level impaired for tactile, pain and thermal perception.

active. On testing the achilles reflexes, a bilateral ankle clonus was elicited. The Babinski response was positive on both sides. The corneal reflexes were normal. The abdominal and cremasteric reflexes were absent. The Romberg sign was strongly positive. There was no dysmetria in the finger-to-nose or heel-to-knee tests. There was decided impairment of tactile, pain and thermal perception up to and including the eighth cervical segment (fig. 2). It was not possible to demonstrate a pilomotor or vasomotor level. Horner's syndrome was not present.

Diagnosis.—On the basis of the atrophy of the muscles of the left hand, the sensory level and the freedom from pain, the diagnosis was neurofibroma of the left eighth cervical anterior root.

Vestibular Studies.—Tests by Dr. W. V. Mullin disclosed that the right labyrinth was entirely nonfunctioning, while a very sluggish response was obtainable from only the horizontal canal on the left side.[2] The hearing was normal

2. Similar results had been obtained by Dr. James A. Babbitt and Dr. Lewis Fisher of Philadelphia a year previously.

with the right ear, but there was a mild nerve deafness on the left. These observations, together with the family history, indicated the presence of bilateral acoustic tumors.

Spinal Fluid Examination.—At the spinal puncture, the initial pressure was found to be 280 mm. of water (fig. 3). The pressure rose to 295 when the patient coughed, and returned promptly to 280. Straining increased the pressure to 365, and it fell to 275 on release. Jugular compression for ten seconds caused a rise only to 280. On straining once more, the pressure rose to 445, and fell promptly to 250. Jugular compression was again applied for ten seconds, with no response. The withdrawal of 3 cc. of fluid reduced the pressure to 210 mm. of water. The jugular-compression tests indicated a complete block from above downward, but the response to straining indicated that the block was not complete from below upward, as the pressure after straining was found to be below the initial pressure.[3] A specimen of the fluid was faintly yellow. It con-

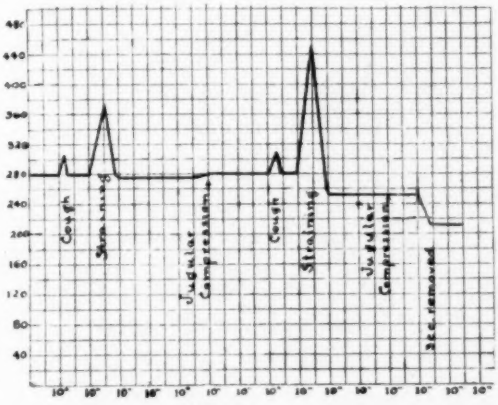

Fig. 3.—Graph of the spinal fluid pressure responses, indicating practically a complete block on jugular compression and a partial block on straining.

tained 5 cells per cubic millimeter and the globulin was four plus. The Wassermann and colloidal gold reactions were negative.

In an effort to exclude the presence of other spinal tumors below the level of the main lesion, an injection of iodized oil was performed in the lumbar region. Roentgenograms taken with the patient in the head-down position showed that the oil stopped at a point opposite the middle of the body of the first dorsal vertebra, where it outlined the lower border of an oval tumor (fig. 4). No evidence of obstruction of the oil elsewhere was manifest. Operation was decided on, therefore.

Operation.—A laminectomy was performed, the laminae of the third cervical to the first dorsal vertebrae, inclusive, being removed. On opening the dura, the arachnoid membrane was found to be nonpulsating except at the extreme upper end of the exposure. In the upper two thirds of the exposure, the cord was displaced backward and flattened as though by a tumor on its anterior aspect.

3. The latter point is of interest and can be demonstrated in many cases of partial block. It has not received mention in the literature.

The eighth cervical and first thoracic posterior roots were sectioned on the left side, after which the cord was gently rotated and pulled to the right. This disclosed a yellowish-pink, smooth, firm tumor anterior to the cord. The tumor was firmly adherent where the left eighth cervical root made its exit from the dural sac (fig. 5). The tumor was freed at this point with a scalpel and removed from the canal. The left eighth cervical anterior root was found to be thickened and

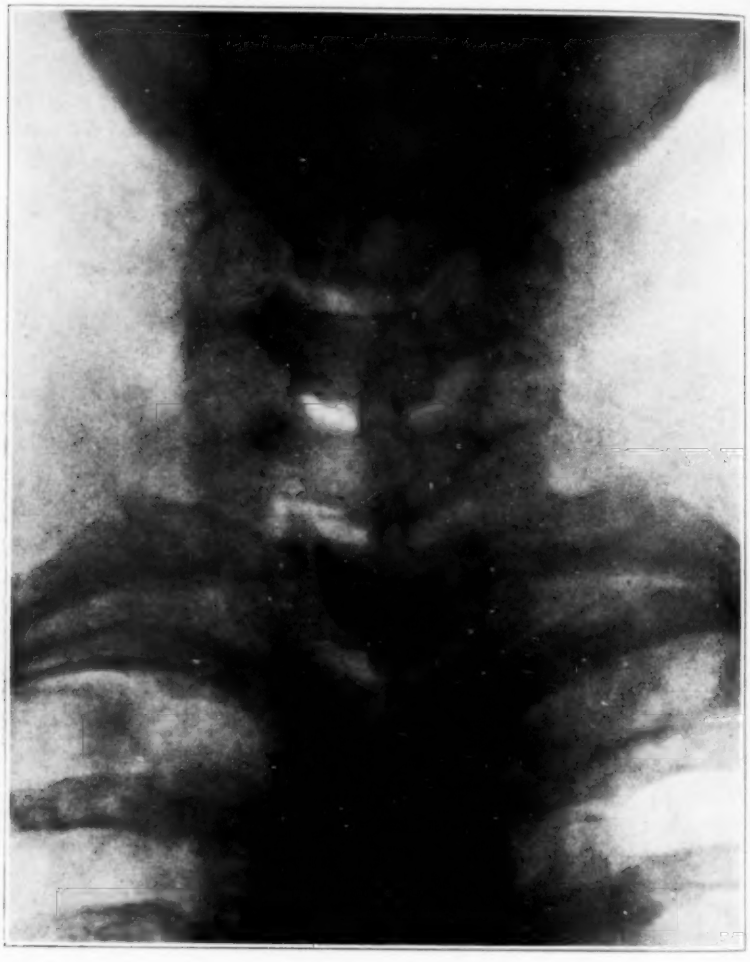

Fig. 4.—Roentgenogram made after the introduction of 2 cc. of campiodol into the lumbar sac. The lower border of an oval tumor is outlined.

elongated up to the point at which it made its entrance into the tumor. About 2 cm. of the proximal portion of this root was removed with the tumor. The point of attachment of the tumor to the distal portion of the root was then thoroughly curetted and painted with Zenker's solution. The cord was replaced in its normal position in the canal and the wound was closed. Aside from a minor wound complication, the patient's convalescence was uneventful.

Course.—One month after the operation, a neurologic examination showed the following: The gait was slightly ataxic and the Romberg test was mildly positive. Nystagmus was present as before the operation. The biceps, triceps and achilles reflexes were normal. The left patellar reflex was moderately exag-

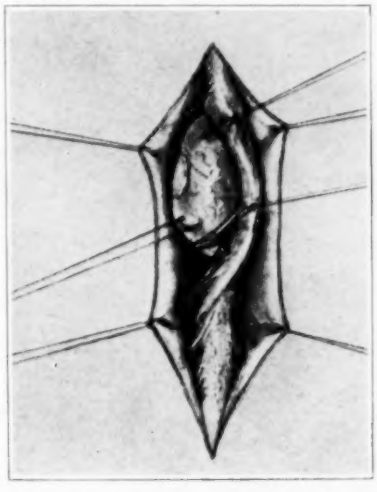

Fig. 5.—The tumor in situ after it had been freed from its distal attachment to the left eighth anterior cervical root.

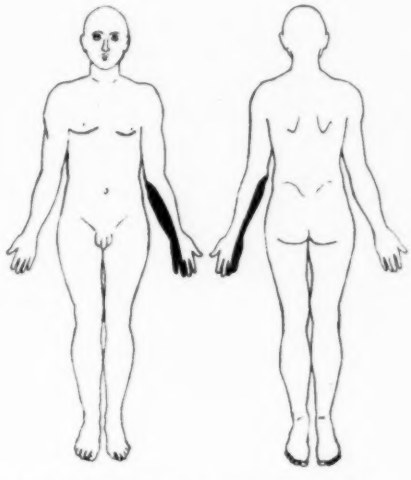

Fig. 6.—Postoperative anesthesia resulting from operative section of the eighth cervical and first thoracic posterior roots.

gerated; the right was normal. The Babinski response was negative, and there was no ankle clonus. There was a slight improvement in the strength of the left hand, but the atrophy was unchanged. There was complete anesthesia on the ulnar side of the left forearm and hand (fig. 6).

Fig. 7.—Photograph of the tumor after its removal, showing the point of entrance of the nerve. Its point of exit is marked by the abraded area in the capsule.

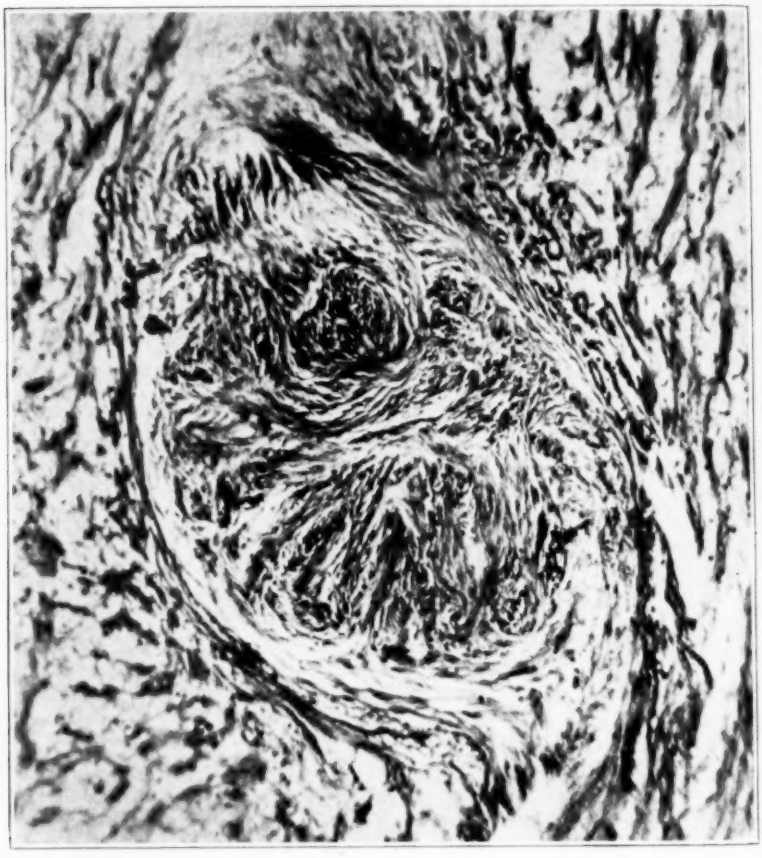

Fig. 8.—Photomicrograph showing the typical structure of a neurofibroma. Hematoxylin and eosin stain; × 125.

Pathologic Report.—Grossly, the specimen consisted of an oblong, flattened, encapsulated tumor, removed from the anterior root of the left eighth cervical nerve (fig. 7). The proximal portion of the anterior root was present, measuring 1.5 cm. in length and 0.5 cm. in diameter. It was grayish in color, moderately soft, and appeared edematous. Distally, the anterior root expanded into a tumor, which was flattened and roughly oval in shape, measuring 3.2 by 2.2 by 1.3 cm., and weighing 8 Gm. Directly opposite the anterior root was an abraded area marking

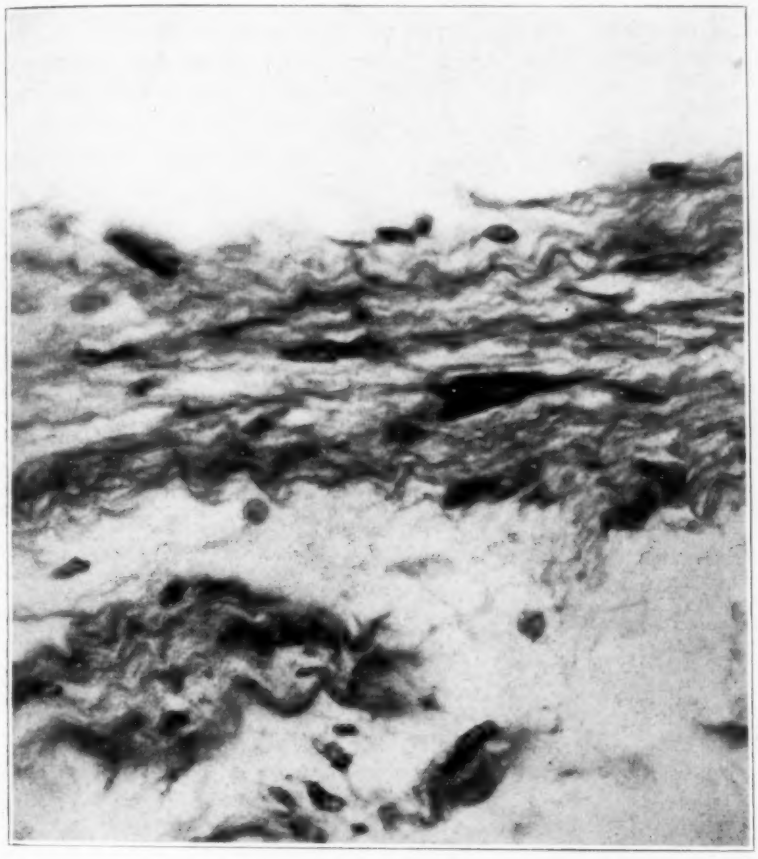

Fig. 9.—Same field as in figure 8; × 600.

the point where its fibers continued distally to join the dorsal root. The remainder of the tumor was covered by a thin membrane containing numerous fine blood vessels. The specimen was preserved in Zenker's solution before sectioning (fig. 8).

Microscopically, a section through the nerve showed a mass of tumor tissue made up of bundles of spindle cells running in various directions, with a tendency to form whorls. The nuclei varied considerably, generally being elongated, but in many instances they were short, oval, and sometimes large, irregular or stellate forms. There was a large amount of blue-staining intercellular substances, principally fibrillar. Along one surface of the section there were fairly large areas

of loosely arranged, pink-staining tissue, suggestive of nerve fibers with degenerative changes. The tumor mass itself had a well defined capsule along one surface. On the opposite surface, the capsule was not so distinct. No collagen fibers were shown with the van Gieson stain.

A longitudinal section of the tumor, fixed with Zenker's solution, included at one end a portion of nerve trunk which had a structure similar to that seen in the section through the nerve. The remainder of the section consisted of an outer lamellated zone of long, wavy fibers, loosely arranged and with few nuclei present. In the central portion of the section were compact masses of spindle cells arranged in scattered whorls and separated by a loose, fibrillar tissue.

Gross section of the tumor mass showed an essentially similar distribution of fibers in the peripheral portion, with occasional whorls, and near the center large areas of individual whorls.

The pathologic diagnosis was neurofibroma.

SPECIAL ARTICLE

THE MECHANISM OF THE ABDOMINAL AND CREMASTERIC REFLEXES

COLLECTIVE REVIEW *

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BALTIMORE

This review deals particularly with the anatomy and physiology of the abdominal and cremasteric reflexes. It is difficult to understand why, after injuries to the pyramidal tract, the tendon reflexes become hyperactive while the abdominal and cremasteric reflexes are lost. Attempts have been made to explain the physiology of these reflexes in many ways.

TYPES OF REFLEXES DEMONSTRABLE IN MAN

The reflexes normally elicited in man may be divided into three groups: tendon reflexes, cutaneous reflexes in a normal person and cutaneous reflexes demonstrable only after injury of the nervous system.

The mechanism of the tendon reflexes and their abnormalities in disease are fairly well understood owing to the fundamental physiologic investigations of Sherrington and his followers and the interpretations of modern clinical neurologists. The afferent pathway for the reflex consists of the proprioceptive fibers from the muscle itself. The sudden stretch of the muscle produced by tapping the tendon provides the adequate stimulus to the sensory nerve endings, the neuromuscular spindles and sensory tendon endings. It is clear that the stretch reflex is normally inhibited by impulses from the cerebral cortex, and the reflexes become accentuated when this normal control is removed by severing the corticospinal pathway.

Several years ago, it was demonstrated by Babinski (1904) that an abnormal reflex could be obtained after certain types of injuries to the central nervous system by stimulation of the outer plantar surface of the foot. Under these conditions the great toe extends and the other toes fan. When the reflex is very active, flexion of the ankle, knee and hip also occur. Other neurologists later demonstrated similar reflexes in the legs after injury of the pyramidal pathways. Recently, it has been shown that these are all manifestations of the same flexor reflex

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in the legs; Babinski called it the defense reflex. When well developed, it may be obtained from nocuous cutaneous or deep stimulation of the leg as high as the inguinal region, although it has its sensory locus on the outer plantar surface of the foot. The motor response consists of flexion of the leg at all joints and may include also contraction of the abdominal muscles.

The cutaneous reflexes most commonly elicited in normal man are the abdominal and cremasteric reflexes. There are others that are also observed in healthy persons. For example, cutaneous stimulation of the plantar surface of the foot produces flexion of the toes. Other types of cutaneous reflexes are obtained easily in laboratory animals. Thus Sherrington made exhaustive studies of the scratch reflex. In animals, cutaneous stimulation over areas covered by the panniculus carnosus elicits reflex contraction of this muscle.

NORMAL ABDOMINAL AND CREMASTERIC REFLEXES

Abdominal reflexes may be obtained on cutaneous stimulation over the recti abdominis or the oblique-transversalis muscles. The cremasteric is closely related to the abdominal reflex, since the cremaster muscle is, in reality, a portion of the internal oblique. Abdominal reflexes are mediated through the segments from the seventh to twelfth thoracic and the cremasteric reflexes involve the first and second lumbar. The cutaneous zones overlap in the case of all these segments so that there are areas from which abdominal and cremasteric reflexes may be elicited simultaneously.

Attempts have been made to name the abdominal reflexes involving different spinal segments. They have been classed as the epigastric, intermediate and hypogastric; as the epigastric, parumbilical and hypogastric, or as the supra-umbilical and infra-umbilical. In general, the reflexes obtained from above the umbilicus involve the seventh and eighth thoracic segments, those below the umbilicus from the tenth to the twelfth. It is important, however, not only to test the abdominal reflexes above and below the umbilicus but to examine the response of each segment of innervation.

The value of the abdominal reflex in clinical medicine was first pointed out by Rosenbach in 1876, and has since been emphasized by numerous neurologists, Strümpell, Babinski, van Gehuchten and others, particularly in hemiplegia, paraplegia, multiple sclerosis and tabes. Oppenheim said that it is inconstant in health in many persons and therefore not of much practical importance. Müller and Seidelmann explored the reflex in 3,000 persons free from nervous and abdominal diseases. With only one exception, in which only a single and not a complete examination was made, the reflex was present in all.

ABNORMALITIES IN THE REFLEXES ASSOCIATED WITH DISEASE OF THE CENTRAL NERVOUS SYSTEM

It has already been observed that the mechanism of tendon and cutaneous reflexes is not the same, since one group may be lost while the other is exaggerated. The loss of abdominal and cremasteric reflexes after injury of the corticospinal pathway suggested to several neurologists that these reflexes were not segmental but dependent on a reflex arc involving the cerebral cortex. Jendrassik believed that the tendon reflexes were spinal reflexes, while the cutaneous were cortical reflexes. Pandi thought that both types were cortical.

Van Gehuchten, on the other hand, suggested that neither the cutaneous nor the tendon reflexes were primarily dependent on the spinal segmental mechanism. He believed that in a complete transverse section of the cord both types of reflexes were permanently abolished. He found also that in certain rare cases the cutaneous reflexes were exaggerated and the tendon reflexes lost. One example in his own practice was that of a tumor destroying a large portion of the mesencephalon but leaving the pyramidal tracts uninjured. He pointed out that for a normal reflex two things are required, the anatomic and physiologic integrity of the reflex arc and a certain degree of tone in the muscles. He postulated that the rubrospinal pathway augmented the deep reflexes and the corticospinal pathway the cutaneous reflexes.

Schwarz found that at the beginning of a jacksonian epileptic attack both cutaneous and deep reflexes were increased. Immediately following the seizure the deep reflexes were still very active, but the cutaneous were abolished. He thought that the two types of reflexes were in connection with two different cortical centers, one excitatory and the other inhibitory.

Monrad-Krohn (1918) believed that the abdominal reflex is dependent on a long cerebral reflex arc which reaches up to the psychomotor and psychosensory areas of the brain. He also thought that there is an inhibiting or controlling system represented by the rubrospinal arc. In paralysis agitans and chorea, the abdominal reflexes are exaggerated on the side affected or chiefly affected.

In support of the latter hypothesis, Grossman (1922) has shown that in the parkinsonian syndrome following encephalitis the abdominal reflexes were disturbed in thirty-three of forty cases. In twenty they were greatly exaggerated, in eleven moderately increased and in two more active on one side than on the other.

Monrad-Krohn pointed out further that in partial paralysis of the abdominal wall, unaccompanied by any sensory loss, the paralyzed areas required a greater stimulus to elicit an abdominal reflex and gave a maximal motor response at a level different from that of the eliciting

stimulus. The normal abdominal reflex is homosegmental, but from the partially paralyzed abdominal wall the reflex is heterosegmental. In tabes with slight hypesthesia the abdominal reflex is brisker than normal; only with a pronounced hypesthesia or anesthesia is it diminished or lost. Van Gehuchten (1900) mentioned a case in which the cremasteric reflex was lost on the right but present on the left. Stimulation on the right side in this case elicited a cremasteric reflex on the left.

Harris (1927) studied the abdominal reflex after the cutaneous nerve branches to the abdominal wall were severed. He found that areas of skin which are analgesic to ordinary pin prick may be very sensitive to a scratch, due perhaps to summation of stimuli. This phenomenon of excessive sensitiveness to scratch over an area where tactile sensation and pin prick are diminished may be seen in the stage of protopathic recovery of an injured nerve. Probably it is owing to this summation of stimuli that the abdominal reflex is often brisk, although the skin may be analgesic to pin prick.

There are seen to be differences of opinion concerning the anatomic and physiologic mechanism of the abdominal reflexes. Many authors assume a reflex pathway through the cerebral cortex. It is difficult to believe, in view of recent physiologic studies, that this reflex is not dependent primarily on spinal reflex arcs. It is important to inquire, therefore, as to whether the reflexes are ever present after total transection of the spinal cord with all cerebral influences removed.

ABDOMINAL AND CREMASTERIC REFLEXES IN MAN AFTER COMPLETE TRANSVERSE SECTION OF THE SPINAL CORD

Before the work of Riddoch and Head (1917) and Riddoch (1917), it was doubtful whether the completely isolated spinal cord of man ever carried out any reflex activity. Their study of war wounds gave them a unique opportunity to study this problem. They found that movements of the flexor type were the only motor reactions observed after complete transverse section of the spinal cord. The flexor muscles regained their tone before the extensors and always had more tone. Both groups were always hypotonic. They showed that after lesions of the higher thoracic segments the abdominal and cremasteric reflexes returned early after injury. In one case they returned by the seventh day.

Riddoch (1917) divided the musculature of the abdominal wall into two groups. The recti are flexors and belong to the kinetic or phasic group of muscles. He believed that the oblique and transversalis muscles are chiefly postural and belong to the static muscle group.

Riddoch described three types of abdominal response after total section of the cord. The first was obtained from the rectus abdominis. A

scratch or pin prick over the muscle resulted in a motor response limited to this muscle. The response was not delayed and consisted of a tightening of the muscle so that the abdominal wall flattened quickly and relaxed almost as quickly. The oblique muscles did not take part in the response so that the umbilicus was not pulled to the side. Although the muscle contracted more strongly near the point of stimulation, it could be proved by palpation that the whole muscle responded actively.

If the sole of the foot was stimulated in these patients, the impulse spread up the cord and produced a contraction of the rectus abdominis of the stimulated side. The flexor muscles of the abdominal wall, therefore, acted as adjuvants in protective movements. Bilateral rectus contraction was obtained by pricking or scratching the abdominal wall in the midline. Nocuous stimulation of the perineum evoked contraction of the recti abdominis associated with bilateral flexion of the lower extremities. The recti took part in the coitus reflex of spinal man.

Riddoch next described the reflexes elicited from the oblique-transversalis muscles after transection of the human spinal cord. Nocuous stimulation of the skin surface produced a localized, undulatory contraction of the external oblique. It was vermicular in appearance, and the contraction followed the course of the external oblique fibers. This could be seen by dragging the pin outward, when the contraction ran from the edge of the rectus sheath outward and upward toward the costal margin. The rectus did not take part in the motor response unless the stimulus was intense or reflex activity great. A crossed response was not obtained, and there was no associated movement of the legs.

Riddoch continued by describing a flexor response involving all the muscles of the abdomen. A mass reflex of all the ventral abdominal musculature was obtained fairly early in most cases of lesion of the cord. A firm scratch or deep pin prick evoked an apparently simultaneous contraction of the external oblique and rectus muscles so that the whole stimulated half of the abdominal wall flattened sharply and the patient was pulled to that side. Frequently the whole of the abdominal wall responded, the onset of the contraction of the opposite side being somewhat delayed. At the same time both lower extremities flexed. This extensive flexor response was obtained by pricking sharply the skin of the perineum even with a stimulus of comparatively slight noxa during the period of heightened reflex activity of the isolated cord segments.

It is clear from the careful and well recorded experiments of Riddoch that abdominal reflexes may be obtained in man after all influences from the central nervous system have been cut off. They are, therefore, primarily reflexes presided over by the spinal segments. The reflexes elicited from spinal man were more active than those obtained from the normal person. The cremasteric reflexes were also present and very

active. It is next important to inquire as to whether there is any deep inherent difference between the abdominal reflexes in the normal and in a patient with the spinal cord completely transected. Certain evidence on this point may now be presented.

Monrad-Krohn and others have pointed out that deep stimulation may produce reflexes of the abdominal musculature that are increased after injury of the pyramidal pathway. These are analogous to the tendon reflexes and are true stretch reflexes. Thus, tapping the costal margin a little mesial to the mammillary line produces a contraction of the abdominal muscles, particularly the external oblique. Strong percussion in the region of the nipple causes reflex contraction of the rectus. Similarly stimulation with a reflex hammer over the pubis elicits not only a contraction of the rectus but also a cremasteric reflex. These must be carefully differentiated from abdominal reflexes elicited on cutaneous stimulation.

Monrad-Krohn cited two cases in which abdominal reflexes were obtained, altogether different, he believed, from those elicited in normal persons. One was a case of multiple sclerosis, probably with a plaque in the upper dorsal portion of the cord, the other cerebrospinal syphilis with double pyramidal lesions above the cervical region. He thought that the reflexes obtained were similar to those observed by Riddoch after transverse severance of the cord. They differed from normal abdominal reflexes, according to Monrad-Krohn, in the following characteristics: There was a long latent period following stimulation—one or two seconds. The contraction was markedly bilateral; contraction on the contralateral often was stronger than on the ipsilateral side. The contraction was often accompanied by slight flexion of the hip and knee joint. The stimulus required was much stronger than that required to elicit normal abdominal reflexes. The tickling sensation normally accompanying the abdominal reflex was absent. Heat and cold as well as nocuous stimuli elicited the reflex. The reflex was more easily exhausted than the normal reflex.

Monrad-Krohn, therefore, supported the thesis that not every reflex contraction of the abdominal wall was identical with a normal abdominal reflex. While the existence of the normal abdominal reflex is dependent on the integrity of the corresponding pyramidal fibers, the abnormal abdominal reflexes are independent of the pyramidal tract. The abnormal reflexes are reflexes of spinal automatism and the distinction is important in connection with segmental focal diagnosis. It is often difficult to tell normal from pathologic abdominal reflexes. The sensory areas from which the two types of reflexes may be elicited overlap.

It is interesting that Monrad-Krohn explains the tickle that accompanies the abdominal reflex as a result of the motor response, a sensation produced by reflex muscular contraction.

This summarizes the differences in the abdominal reflex under pathologic conditions from those of the normal reflex. All these variations seem quantitative rather than qualitative. There is little need of explanation to show that in these pathologic changes one has the manifestations of a spinal reflex freed from normal cerebral control. The bilateral contraction, the participation of the flexor musculature of the legs in the reflex, the lack of specificity of the stimulus, all these are explained on the basis of loss of cerebral control. Riddoch and Head (1917) pointed out that in spinal man a mass reflex was obtained, in that the reflex arcs had lost their local sign.

Riddoch and Head described the development of reflex activity after transverse section of the cord in man as follows: At first it is possible to produce a local segmental reflex only. This gradually gives place to a vigorous general contraction of one half of the abdomen in which the rectus takes part, and to this may be added all the phenomena in the lower extremities which otherwise follow scratching the sole of the foot.

It may be considered, therefore, that the contraction of the abdominal muscles simultaneously with the flexor muscles of the legs is a primitive protective reflex guarding the safety of the vulnerable abdominal wall. Babinski (1904 and 1922) called this mass reflex muscular contraction, elicited from the spinal segments, the defense reflex. It may be concluded, therefore, that in man the abdominal reflexes may be elicited from the isolated spinal cord and these reflexes differ only slightly from those obtained in normal persons.

THE PHYLOGENETIC DEVELOPMENT OF THE ABDOMINAL REFLEXES

Astwazaturow (1925), who believed that abdominal reflexes were dependent on a cerebral reflex arc, tried to explain this fact from the point of view of phylogeny. The fact of the disappearance of the abdominal reflexes in pyramidal lesions suggested that the abdominal reflexes are phylogenetically new acquisitions. Abdominal reflexes cannot be obtained in domestic animals. They are absent in infants and become constant at about the eighth month. This is the age when the child learns to assume the sitting position. One cannot help postulating, according to Astwazaturow, that the abdominal reflexes have a relation to the erect posture. If the child does not acquire the function of sitting and standing, the abdominal reflexes do not develop.

The author of this hypothesis quoted Keith to show that, in the evolution of man's posture, the muscles of the abdominal wall, especially

the transversalis muscles, assume great importance when the body assumes a standing or sitting posture. The reflex mechanism throws the muscles of the body wall into postural tone.

Astwazaturow further maintained that the skin of the abdomen is the only region in man from which cutaneous reflexes may be elicited. This region has no bony support. He considered the abdominal reflexes as merely a manifestation of the peculiar tone of the body wall muscles. When this tone is greatly decreased the abdominal reflexes may disappear without any disturbance in the function of sustaining the viscera in the erect posture. Finally, the abdominal reflexes are neoreflexes elaborated in acquiring the erect posture.

Since it has been shown already that the abdominal reflexes are dependent primarily on a spinal reflex arc, this explanation of Astwazaturow's is only of academic interest. It does, however, bring up many important subjects for discussion.

First, the question arises concerning change in postural tone in the abdominal wall on assuming an erect posture. It must be at once evident that the abdominal musculature serves as important a function in supporting the viscera in the quadriped as in the erect position. Moreover, Keith pointed out that it is chiefly the transversalis muscle that would assume the added burden in man. All the muscles of the abdomen take part in the abdominal reflex. In truth, all the muscles of the abdominal wall are flexor muscles and the suggestion will be made later in this paper that their peculiar control by the cerebral cortex is due to the fact that they are flexor, phasic muscles.

Regarding the absence of the abdominal reflex in animals, it has been my experience that it is difficult to obtain an abdominal reflex in many of the laboratory mammals. In the case of the guinea-pig, however, the following interesting reflex was obtained. On stimulation of the skin of the abdomen, a contraction of the ipsilateral musculature was obtained. At the same time the hind leg of the same side was flexed at the hip and knee. Obviously this is a reflex of defense similar to that found in spinal man. It seems likely that animals in a quadriped position have little need for a defense reflex protecting the abdomen and for this reason the reflex becomes strongly developed in forms that have assumed the erect posture.

RELATION OF THE CREMASTERIC TO THE ABDOMINAL REFLEXES

It has already been suggested that there is much evidence that the cremasterics are abdominal reflexes at the lowest metameric level. Monrad-Krohn and Kornfeldt (1925) pointed out that the contracting element in the cremasteric reflex was the most caudal portion of the

obliquus internus which forms a portion of the body wall. From certain portions of the sensory zone one can obtain both abdominal and cremasteric reflexes with the same stimulus. They both are homolateral and the type of adequate stimulus is the same for each. They found, however, that in many cases in which the abdominal reflexes were brisk, the cremasteric reflexes were feeble. One group was often abolished while the other was intact. From the clinical point of view, therefore, the cremasteric cannot be considered a lower abdominal reflex. Monrad-Krohn and Kornfeldt thought that the cremasteric reflex was probably dependent on a shorter and less exposed reflex arc.

Aronovitch (1926) explained that one would expect identical changes in the abdominal and cremasteric reflexes in disease. In hemiplegia, however, he found the cremasteric reflex less often involved than the abdominal. The cremasteric reflexes are seldom lost in multiple sclerosis. In multiple sclerosis, the upper abdominal reflexes are often lost before the lower.

The cremasteric reflex is seldom elicited in laboratory animals, although it may be obtained in the stallion.

The cremasteric reflex is absent in 2 per cent of men. Of forty new-born boys, three had no cremasteric reflex. It can be elicited earlier in life than the abdominal reflexes.

In summary, it is observed that the cremasteric and abdominal reflexes are not necessarily diminished or abolished by the same injuries to the nervous system. One group may be lost and the other remain. The cremasteric reflex becomes active earlier in life than the abdominal reflexes.

LOSS OF ABDOMINAL REFLEXES WITH ACUTE ABDOMINAL INFECTIONS

It has been known for a considerable time that the abdominal reflexes may be lost in acute abdominal or pelvic infections; unilateral loss is not exceptional. Rolleston (1906) found that in forty-five cases of typhoid fever the abdominal reflexes were lost in thirty-one, impaired in forty-two and unaffected in only three. The reflexes below the umbilicus were the first to be lost and the last to return. The abdominal reflexes are not diminished in cases of hyperpyrexia.

Rolleston pointed out that the abdominal reflexes cannot be reinforced, since the muscles must be relaxed and attempts at reinforcement contract the abdominal walls. A single negative result is of very little value. Attempts to elicit the reflex should be repeated several times.

Rolleston found that the abdominal reflexes are more active in women until repeated pregnancies occur. In early infancy the reflex is poorly developed and may be masked by crying. The fact that there is

no obesity or laxness of the abdominal walls may account for the briskness of the reflex in childhood.

CEREBRAL CONTROL OF THE ABDOMINAL REFLEXES

The evidence seems conclusive that the abdominal reflex is primarily initiated by a reflex arc through the spinal segments. After all cerebral control is removed, the abdominal reflexes become very active, and tend to be bilateral and associated with flexor movements of the legs. The abdominal reflex is part of a widespread defense reflex that protects the vulnerable abdominal wall from injury.

The spinal reflex arcs are normally under the control of pathways from the brain; the result of this control is either augmentation or inhibition of the spinal reflex. From knowledge of clinical cases it is possible to learn the effect of certain of these cerebral influences on the reflex arc initiating the abdominal reflexes.

After injury of the corticospinal fibers the abdominal reflexes are decreased or abolished. It is therefore clear that influences from the motor cerebral cortex normally augment the abdominal reflex. The motor cerebral cortex, on the other hand, normally inhibits the tendon reflexes so that they become hyperactive after the pyramidal pathways are injured. It is indeed difficult to understand these two types of response. The muscles from which tendon reflexes are obtained are the muscles of the extremities normally exhibiting postural tone. In order that the normal phasic movements initiated in the motor cortex may be carried out, the postural tone of the antagonistic muscles must be inhibited. Therefore, a mechanism for this inhibition has been developed in the cerebral cortex.

The abdominal muscles, on the other hand, are flexor, phasic muscles which do not exhibit the tonus of the antigravity musculature. Moreover, they have no antagonistic muscle groups. The need for an inhibitory center in the motor cerebral cortex has never developed.

The problem then remains as to why the motor cerebral cortex should augment the reflex. It can only be suggested that this reflex of defense has become more important with the assumption of the erect posture; since it has acquired a recent phylogenetic significance, it receives augmentation from the motor cerebral cortex.

In cases of paralysis agitans and the postencephalitic parkinsonian syndrome, the abdominal reflexes become hyperactive. Moreover, van Gehuchten cited a case in which a tumor involved the rubrospinal pathway. In this case the abdominal reflexes were hyperactive and the tendon reflexes were lost. This suggested normal inhibition of the abdominal reflexes through the corpus striatum and rubrospinal pathway.

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News and Comment

INTERNATIONAL NEUROLOGICAL CONGRESS

The preparations for the International Neurological Congress to be held in Berne, Aug. 30 to Sept. 4, 1931, have continued to progress during the past few months. The special topics to be presented before the Congress are: (1) Diagnostic and Therapeutic Procedures (Surgical and Otherwise) in Brain Tumors; (2) Muscle Tonus, Anatomy, Physiology and Pathology; (3) Acute Nonsuppurative Infections of the Nervous System, and (4) The Rôle of Trauma in the Production of Nervous Symptoms. The attention of the chairman of each morning program has been focused on the selection of contributors from all parts of the world who will be able to throw the most light on these subjects. These programs have already passed the tentative stage and, in all probability, during the next six or eight weeks will become sufficiently definite to warrant publication.

The local Swiss Committee has been preparing plans for suitable entertainment. Tentative plans have been made for receptions, evening entertainments in the vicinity of Berne and for a day's trip to Interlaken, the Lakes of Thun and Brienz and the vicinity of the Jungfrau. Definite announcements will be forthcoming in the near future.

The sessions of the Congress will be held in the Municipal Casino which will afford ample accommodations for the delegates, members of their families and guests. The large gallery will be reserved for members of the family and guests who may be enrolled at the time of the Congress as Affiliated Members at a moderate fee. Only members of the Congress will be admitted to the floor of the Casino. Neurologists and psychiatrists in the United States, members of psychiatric societies and those whose chief interest is in these two fields are eligible to membership in the Congress. Application forms for membership may be obtained from the secretary-general of the Congress, Dr. Henry Alsop Riley, 117 East Seventy-Second Street, New York.

The firm of Thomas Cook and Son has been appointed as the official travel agency and has prepared an attractive itinerary, one trip being to the north and east and the other to the south and west; both include Paris and end at Berne two days before the opening of the Congress. The cost of these trips of six weeks, in which all necessary expenses, transportation, hotel accommodations, etc., are included, is moderate. Detailed information in regard to these trips can be obtained from Thomas Cook and Son. On account of the fact that the tentative reservations for accommodations on the French Line steamship "de Grasse" and for the hotels on the proposed tour cannot be held beyond a date early in 1931 unless definitely reserved, it is necessary for those planning to take either one of the tours to make at least tentative arrangements with Thomas Cook and Son at once. Persons wishing to have special itineraries can arrange for them with Thomas Cook and Son. From present indications the number of American neurologists and psychiatrists with their families will require almost one half of the total accommodations available in Berne, so that if arrangements are not made through Thomas Cook and Son at an early date, many members of the Congress will have to be satisfied with inferior arrangements or reservations outside of Berne. Thomas Cook and Son have complete control of the available accommodations in Berne, and it will be almost impossible for persons to obtain proper accommodations unless they secure them from Thomas Cook and Son.

Plans are being formulated by the local Swiss Committee for the demonstration of commercial exhibits of all kinds, such as pharmaceutical supplies, medical publications, roentgen apparatus, physiotherapeutic equipment and surgical instru-

ments. Applications for space for such exhibits should be addressed to the local chairman, Dr. Charles Dubois, 20 Falkenhöheweg, Berne, Switzerland.

Neurologists and psychiatrists who plan to attend the Congress and wish to present papers before it are urged to send the titles and abstracts to the secretary-general not later than December 1. It will be impossible to consider titles and abstracts submitted after that date.

According to preliminary calculations a large participation of neurologists and psychiatrists from all parts of the world is already assured and the Congress should be a milestone in the history of neurology and psychiatry.

Abstracts from Current Literature

THE DISSEMINATION OF THE ENCEPHALITIC REACTION IN BORNA'S DISEASE OF HORSES AND ITS RELATION TO EPIDEMIC ENCEPHALITIS, HEINE-MEDIN'S DISEASE, AND LYSSA IN MAN. O. SEIFRIED and H. SPATZ, Ztschr. f. d. ges. Neurol. u. Psychiat. **124**:317 (March) 1930.

Borna's disease, a form of encephalitis, occurs in horses. In addition to the inflammatory changes in the brain, there is found in the ganglion cells the so-called Joest inclusion bodies. Joest, who first described these, found certain similarities to the Negri bodies in lyssa, and therefore grouped a number of encephalitides of animals under the heading of "ganglion cell inclusion diseases." These included Borna's disease, lyssa, distemper, chicken plague and porpoise paralysis. In 1920, Tobler gathered together a group of polio-encephalitides to which, in addition to Borna's disease, lyssa, distemper and chicken plague, he added epidemic encephalitis, poliomyelitis and the trypanosome diseases. Authors have believed that a relationship exists between Borna's disease and other encephalitides. Joest believed that the disease was due to an ultravirus, and Zwick, Seifried and Witte were able to show that brain emulsions of horses sick with Borna's disease when injected into rabbits, apes and other animals produced the disease. Etiologically, a group of diseases was in this way evolved which comprised the following: (1) Borna's disease, (2) lyssa, (3) distemper, (4) porpoise paralysis, (5) chicken plague and (6) poliomyelitis. Efforts to transfer epidemic encephalitis to other animals have failed.

Comparative studies of epidemic encephalitis with Borna's disease have not been made. Hassin made such studies of poliomyelitis and encephalitis and found that the only difference in the inflammatory and degenerative changes of the two diseases consisted in the fact that in epidemic encephalitis they tended to diminish spinalward and in poliomyelitis cerebralward. The intensity and distribution of the changes may be so similar in the two diseases that they cannot be distinguished. Marinesco and his school speak of a mesencephalic form of poliomyelitis. In 1925, Schükri and Spatz found in two cases of lyssa that the nature and distribution of the changes were such as to be absolutely indistinguishable from epidemic encephalitis. This has recently been confirmed by Loewenberg-Krinitzky, and Slotwer found marked changes in the substantia nigra in lyssa, and so also did Marinesco. Schükri and Spatz, in their comparative study of lyssa and epidemic encephalitis, laid particular stress on the dissemination of the process. Some studies of this nature have been made in Borna's disease. Joest mentions the following as being especially affected: (1) olfactory gyri, (2) nucleus caudatus and hippocampus, (3) parietal and temporal lobes, (4) medulla oblongata and (5) spinal cord and occipital lobes, as well as the cerebellum.

The material investigated consisted of: (1) sixteen brains of horses dead of Borna's disease, (2) sixteen brains in cases of acute epidemic encephalitis, (3) a case of poliomyelitis with cerebral changes and (4) two cases of lyssa in man.

Before studying the dissemination of the disease process it is well to know some of the characteristics of Borna's encephalitis. This consists of a marked vascular infiltration consisting of lymphocytes chiefly, but with some plasma cells and so-called macrophages. Often the infiltration is limited to the perivascular spaces and forms a typical mantle. The meninges are either not at all or only mildly infiltrated in local areas. The neuroglial changes are important. They represent less an expression of the inflammatory reaction than an immediate effect of the inflammation-exciting agent. The neuroglial reaction is as constant as the vascular changes. It consists of a diffuse glial proliferation on the one hand and of small glial foci on the other. The former reaction is found often in the entire substantia nigra. The microglia of Hortega are much more concerned in the process than the astrocytes.

The points in common of Borna's disease, epidemic encephalitis, poliomyelitis and lyssa are: (1) A lack of meningeal reaction. The process is an encephalitis and not a meningo-encephalitis. (2) A predominant involvement of the gray matter. (3) A nonpurulent type of infection, the reaction being of lymphocytes, plasma cells and large mononuclears. (4) A glial proliferation of a diffuse and local nature. (5) A lack of hemorrhages and softenings.

Differences between the foregoing encephalitides are ones of degree: a local meningitis is more common in poliomyelitis than in the other diseases; leukocytes also play a greater rôle in the inflammatory reaction in poliomyelitis than in the other encephalitides. They may occur in epidemic encephalitis and in lyssa, but they are lacking entirely in Borna's disease.

Dissemination of the Inflammatory Reaction.—Borna's disease, lyssa, poliomyelitis and epidemic encephalitis have a predilection for the nervous system. Changes are not found elsewhere in the body. This peculiarity they have in common with herpes encephalitis, vaccine and variola encephalitis. In describing the dissemination of the process, Seifried and Spatz speak of four zones, which are not anatomic, but are zones in relation to the inner and outer surfaces of the brain. They are: (1) Zone 1, the inner surface, in the neighborhood of the ventricular spaces. The entire ventricular gray matter, the dorsally situated cranial nerves and the caudate nucleus fall into this zone. (2) Zone 2, the external surface, includes the so-called basal portions of the midbrain and hind brain. (3) Zone 3 includes the dorsal portion of the external surface—the cerebellar cortex, the quadrigeminal plate, the dorsolateral thalamus and the cerebral convexity. (4) Zone 4 lies between the inner and outer surfaces deep in the brain.

Midbrain: The midbrain of the horse is essentially the same as that of man, except that the pes pedunculi are relatively much smaller, the substantia nigra is relatively much larger, and the nucleus ruber is small. In Borna's disease the periaqueductal gray matter (zone 1) is much involved. So also are the nuclei of the third and fourth nerves and the cells of the mesencephalic root of the trigeminal nerve. This aqueductal gray matter was not markedly affected in a single case. Often the process stops abruptly, but more often it spreads out into the nuclei of the muscles of the eyes and the trigeminus. The posterior longitudinal bundle is but little involved, and in the majority of cases it remains intact. In addition, the substantia nigra (zone 2) is very much affected, and here the inflammatory reaction reaches a degree which is not equaled either in the midbrain or in the rest of the brain. The zona compacta is more affected than the zona reticulata. By contrast, the pes pedunculi is but little involved in the process. Inflammatory and glial reactions are found, but to a mild degree. Similarly, mild reactions are encountered in the interpeduncular ganglion and raphe. In the quadrigeminal plate region (zone 3), inflammatory changes, while present, are definitely less pronounced than in the two preceding zones. The most marked changes in this region involve the periphery of the quadrigeminal bodies. In zone 4—substantia reticulata and nucleus ruber—the changes are mild. Indeed, the mildest changes are found here. The substances of the superior cerebellar peduncle and the nucleus ruber are practically unaffected.

If the spread of the process in Borna's disease is compared with that of the other encephalitides the following is noted: Epidemic Encephalitis: The tendency of this type of encephalitis to involve the gray matter around the aqueduct was first noticed by Economo, who also noted the predilection for the oculomotor nuclei. He also called attention to the involvement of the substantia nigra, but this was more clearly brought out by later studies of the sequelae of encephalitis. Seifried and Spatz believe that a more constant involvement of this region was not noted by early observers because it was not carefully studied. More recent studies by Creutzfeldt and later by Spatz in acute cases of epidemic encephalitis show a marked involvement of the substantia nigra, and often even a marked loss of cells in the acute stages. The quadrigeminal region is affected slightly in epidemic encephalitis. The nucleus ruber is often untouched by the process. Poliomyelitis: Harbitz and Schul have called attention to a marked involvement

of the midbrain. Tobler has described involvement of the substantia nigra, the aqueductal gray substance and the quadrigeminal plate. Hassin has described extensive involvement of the midbrain. Marinesco and others described changes in the aqueductal gray substance, and especially in the substantia nigra, in fifteen of twenty-eight cases. In the majority of cases, changes were noted in the quadrigeminal region and in the nuclei of the oculomotor nerves. Lyssa: Schükri and Spatz have described marked involvement of the midbrain, and have noted that the inflammatory reaction reaches its maximum in the substantia nigra. It is only slightly less around the aqueduct and in the oculomotor nuclei, while the nucleus ruber remains intact. These observations have been confirmed by Loewenberg.

In summary, it may be said that as far as the midbrain is concerned, the dissemination of the inflammatory process is strikingly similar in Borna's disease and in epidemic encephalitis. The material of poliomyelitis and lyssa is small, but striking similarities exist here also. The particular significance of the substantia nigra as well as the aqueductal gray for these encephalitides is important.

Interbrain: In this region, marked changes are found in the hypothalamus (zone 1). The analog of the nucleus paraventricularis is particularly severely involved. The changes decrease in intensity as one leaves the region of the ventricle. The corpus Luysii is involved only in the medial portion and often remains untouched by the process. In the thalamus the extent of the infiltration depends on the intensity of the process. In severe cases the entire medial nucleus is involved, while in less severe cases only that portion adjacent to the ventricle is infiltrated. A portion of the interbrain which is severely affected is the infundibulum and tuber cinereum (zone 2). The changes in these areas compare favorably with the marked changes in the substantia nigra. In sixteen cases the process in the region of the interbrain was most marked here. The corpora mammilaria are involved, but not severely. The nucleus supra-opticus is almost always much affected. Of the globus pallidus, the peripheral portions are most involved, while the more centrally placed portions are more or less free. The pulvinar is markedly infiltrated.

A comparison of the spread of the process in Borna's disease with that in epidemic encephalitis, poliomyelitis and lyssa shows that in the latter three cases the distribution of the encephalitis is practically the same. In general, the changes are most marked in the portions of the hypothalamus bordering on the ventricles — in the centers in the floor of the third ventricle, in the infundibulum and in the tuber cinereum. In Borna's encephalitis, the medial part of the thalamus is markedly affected, while the lateral portions go unscathed. In lyssa the areas of choice are in the tuber and infundibulum, while in polymyelitis and epidemic encephalitis, besides the hypothalamus and basal centers, the ventromedial part of the thalamus is involved.

Forebrain: The caudate nucleus (zone 1) is markedly infiltrated, but not to the same degree as the substantia nigra and the tuber cinereum. The head is most involved and the tail relatively little implicated. The cornu ammonis, that part of the cortex bordering on the ventricle, is also much involved. The olfactory cortex (zone 2) is very much infiltrated. Joest laid great stress on this, but Seifried and Spatz find that the changes are not more marked here than in the substantia nigra, tuber and aqueductal gray, and find also that it is not confined to the olfactory cortex. The amygdaloid nucleus is also infiltrated. The process is marked in the insula and opercular cortex, and diminishes in intensity as one goes over the lateral convexity of the cerebrum. The changes in the putamen are mild.

In epidemic encephalitis the changes in the forebrain are found in the caudate nucleus, near the ependyma, in the most anterior portion of the anterior horn of the lateral ventricle, and in those portions of the brain bordering on the basal cisterns — the anterior perforated substance, the lobus pyriformis and the uncus. In poliomyelitis extensive involvement of the cortex is rare. Cases have been

reported with changes near the anterior perforated substance. The process may spread along the sylvian fissures. In lyssa the changes in the forebrain are rare. In the cases reported by Schükri and Spatz no changes were found in the cortex.

Seifried and Spatz conclude that although the changes in the endbrain are less extensive in epidemic encephalitis, poliomyelitis and lyssa, nevertheless, the mode of spread of the process is essentially the same in these diseases as in Borna's encephalitis.

Medulla and Spinal Cord: The severest changes are found in the ventricle region, and in the ventral part of the ventricular territory — in the nuclei of the trigeminal, abducens, vestibular, cochlear, glossopharyngeal and vagus nerves. The more deeply placed hypoglossal nucleus shows less marked changes. The dorsal regions of the ventricular gray are less affected than the ventral, though in some cases the Deiters nuclei and the cerebellar nuclei are much involved. The cerebellar cortex is not involved in the inflammation. The pontile nuclei are only mildly invaded. The substantia reticulata is fairly markedly involved. In the spinal cord the process is diffuse.

Seifried and Spatz conclude that the infection in the various encephalitides discussed here is borne by the spinal fluid. They conclude this, in general, on the basis of the fact that the inflammatory process is more marked in those regions of the brain in close contact with the spinal fluid, while more central portions are more or less untouched. Two objections to this theory present themselves: If the process is borne by way of the spinal fluid there should be a meningeal reaction, which is absent in these cases. These diseases are not meningo-encephalitides, but encephalitides. Then there is the objection that in the pons and medulla the process is more marked in the central than in the peripheral portions. As to the meningeal reaction, it is possible to have a fluid-borne encephalitis without having an involvement of the meninges, just as in herpes it is possible to have an infection borne along the nerves without having pathologic changes in the latter. As to the changes in the pons and medulla, Seifried and Spatz explain the changes on the basis of "Pathoklise."

ALPERS, Philadelphia.

THE ETIOLOGY OF DISSEMINATED SCLEROSIS. KATHLEEN CHEVASSUT, Lancet **1**:552 (March 15) 1930.

Ever since the description of disseminated sclerosis by Charcot in 1866, many workers have concerned themselves with an attempt to establish the etiology of this disease. Gye, Kuhn, Siemerlung, Marinesco and others have worked in this field, the latter investigators adhering to the spirochetal theory of the origin of the disease. In 1921, Birley and Dudgeon reported uniformly negative results with material from thirty-five cases. In 1923, Noguchi published the results of a large number of experiments and concluded that the demonstration of spirochetes in disseminated sclerosis and its transmission to animals remained unproved.

Chevassut first became interested in the problem while working on the essential nature of the colloidal gold reaction. She observed that in 77 per cent of cases of disseminated sclerosis the colloidal gold test was positive. This led her to investigate the entire subject of the etiology of disseminated sclerosis anew. In studying this problem three important questions arise: (1) What is the nature of the essential disease process itself; is it developmental, inflammatory or toxic? (2) What is the primary element to be attacked by the causative agent? (3) Is this disease of endogenous or exogenous origin?

As far as is known, disseminated sclerosis is limited to the central nervous system. Its fully developed lesions show changes in the myelin sheaths, neuroglia and blood vessels. Charcot believed that the primary process was in the glia. Dejerine and Marie expressed the belief that it was in the blood vessels, leading to changes in the nutrition of the surrounding tissues and subsequent degeneration of nerve fibers, with extension of the inflammatory process and secondary glial proliferation. Borst held it to be a primary arteritis which he thought was due to a virus. Dawson, in an extensive study, pointed out the differences between

infective and toxic myelitis, and on the basis of his histologic material concluded that disseminated sclerosis is a toxic disease, and that the primary agent acts on the myelin and almost simultaneously on the glia around the blood vessels. Symmonds believed that the perivascular infiltration which may occur in the acute phases of the disease resembles that found in diseases of the central nervous system due to micro-organisms. Summarizing the pathologic evidences, the author believes that this much has been established; (1) the lesion passes through an inflammatory stage; (2) there is an agent, probably in the nature of a toxin, which has an especial affinity for myelin.

Clinical studies throw little light on the problem of the etiology of disseminated sclerosis. The clinical course requires that the causative agent be one whose influence extends over years, the remissions being due either to intermittent evolution or activation of the morbid agent or to a periodically deficient elimination. As the result of clinical studies, many possible etiologic agents have been advanced, e. g., infectious diseases, climate, trauma, syphilis, heredity and even psychic trauma. Endogenous toxins, such as indol and skatol, and exogenous poisons, such as the heavy metals, have been offered.

The author studied the spinal fluid in 189 cases of disseminated sclerosis and 219 control cases, the latter representing practically all the degenerative, neoplastic and inflammatory lesions of the central nervous system. Forty per cent of the cases of disseminated sclerosis gave a positive globulin reaction and 77 per cent a positive gold curve. Precipitation was found to occur almost invariably in the fourth tube (dilution 1:80). The usual curve was 0003222000. Complete precipitation and precipitation in the last tubes ("Rechtsverschiebung") were only rarely seen. The technic used by the author for the colloidal gold reaction is given in detail.

The precipitation of colloidal gold by spinal fluid is usually held to be due to the products of nerve degeneration and hence to represent a result and not the cause of the disease. This fact ignores the specificity of the test in various diseases. The true nature of the colloidal gold reaction, however, is unknown. It was first applied to spinal fluid in 1912 by Lange, who thought that the reaction was due to the presence of various proteins. Felton, in 1917, believed that the reaction depends on the ratio of globulin to albumin. Cruickshank reached the same conclusion in 1920. Mellanby and Davies concluded that the precipitation was due to euglobulin and that pseudoglobulin has a protective function. The author holds that these theories ignore the following facts: the exact ratio between globulin and albumin is unknown, as is the nature of the substance precipitated by half saturation with ammonium sulphate; cases of cerebral neoplasm with a high globulin content in the spinal fluid show negative colloidal gold curves, whereas cases of disseminated sclerosis give a positive gold curve when no globulin whatsoever can be precipitated. On the basis of dialysis and electrolysis experiments, using 380 fluids from various types of cases all of which gave positive gold curves, the author concluded that the globulin so collected is inactive in producing precipitation of colloidal gold. The author did, however, find that in fluids which gave a positive Wassermann reaction the precipitate obtained by half saturation with ammonium sulphate could give a positive gold curve. This was found not to be the case in other fluids which gave a positive globulin reaction. She concluded from these experiments that, although in some fluids, particularly in those giving a positive Wassermann reaction, the gold precipitating substance might possibly be attached physically to the globulin, it has no connection with the globulin beyond this. In most cases of disseminated sclerosis the substance precipitated by ammonium sulphate could be removed completely without altering the gold curve. There is no evidence that the precipitating substance is a globulin or other protein.

The author expresses the belief that the form of the gold curve must be related to the causative factor. If this is so, she should be able to obtain a similar gold curve from the blood serum. In order to compare the gold curve obtained from spinal fluid with that from serum it is necessary to dilute the amount of protein in the latter until it becomes equal to that of the cerebrospinal fluid.

The time elapsing between the withdrawal of the blood and the performance of the test must also be taken into account, since serum itself will precipitate colloidal gold, the type of curve obtained depending on the interval of time. When these factors were compensated for it was found that both the cerebrospinal fluid and the serum obtained in cases of disseminated sclerosis gave similar gold curves, and that in each instance these curves could be obtained after the removal of globulin. In both cases the initial and maximal precipitation occurred in the same tubes. These experiments were controlled with parallel ones on normal serum. It was therefore concluded that the factor responsible for the gold curve is present in the blood as well as in the cerebrospinal fluid.

The author next directed attention to an attempt to discover if any results of a toxic action of the causative agent could be found elsewhere in the body. Investigation of the liver function was carried out in eighty-six cases, in sixty-four of which the glycuronic acid test was completely negative after the administration of acetylsalicylic acid. Furthermore, in all of these patients there was indicanuria. Sixty per cent of these patients gave abnormal curves in a dextrose tolerance test. On the basis of these tests the author concludes that in a high percentage of cases of disseminated sclerosis there is a deficiency in the antitoxic and metabolic function of the liver.

Despite the fact that all previous attempts to isolate the causative organism in disseminated sclerosis have failed, the author made bacteriologic investigations of the cerebrospinal fluid. All attempts were negative until a trial was made with the addition of the fluid to Hartley's broth to which normal human serum had been added. Cultures made with this medium remained clear and were negative from an ordinary bacteriologic point of view, but it was noted that a change of reaction occurred in the medium itself. The p_H changed from 7.5-7.6 to 7.8-8.0. This change of reaction was specific in that it occurred only in the tubes containing the cerebrospinal fluid from cases of disseminated sclerosis and was absent in control tubes which had been inoculated with fluid from cases other than disseminated sclerosis. The possibility that this change might be due to an enzyme or to fermentation seemed improbable in view of the fact that it occurred only when the specific medium was used. Aerobic and anaerobic cultures and subcultures of this material were completely negative, and it became clear to the author that if anything in the nature of a living virus were present, it could not be detected by the usual bacteriologic methods.

The investigation was then carried on with the technical assistance of Mr. J. E. Barnard, who devised the special optical apparatus used in the experimentation. This apparatus is described in detail in the paper.

The method of cultivation devised by Welch for growing organisms on cover slips was used, the advantage being that observations are made on thin layers of nutrient medium, and it is therefore possible to see in any stage of growth whether organisms or colonies are developed. Chemical staining was avoided due to the danger of artefacts and to the author's desire to study living material. Microscopic observations on slip cultures, examined with a 2 mm. objective and dark-field illumination, showed after from twenty-four to thirty-six hours of incubation at 37 C. small colonies or groups of spherical bodies some of which appeared to have refractile granules attached to them. There may be one or more on each sphere. At a slightly later stage many similar spheres with and without granules could be seen. The appearance is said to be absolutely characteristic. After from forty-eight to seventy-two hours, the colonies were seen to have increased in size. After from seven to ten days, large degenerating colonies could be seen. Subcultures could be effected in fresh tubes of Hartley's broth and serum. Such bodies have been described as the causative agent in bovine pleuropneumonia. The author admits that on occasions bodies appear in uninoculated tubes that have the same appearance as both the organisms responsible for bovine pleuropneumonia and those here described. It is her belief that these are filtrable contaminants and that they can be microscopically distinguished from the cultures described. The conditions affecting the growth of the cultures are: aerobic cultivation is essential; the virus

is more sensitive to high than to low temperature and does not survive heating to a temperature of 55 C. for a few minutes nor one of 50 C. for more than thirty minutes; cultures can withstand a temperature of 0 C.; they are killed by 0.5 per cent carbolic acid and inhibited by 5 per cent glycerol; the p_H of the medium must not be greater than 7.6 nor less than 7.5. The fluid should be received under strict asepsis directly into the culture mediums. The use of human serum is essential for reliable results.

In 170 of the 188 cases studied a living virus was cultured from the cerebrospinal fluid. These cases included patients undergoing remissions as well as those stationary and clinically advancing. Cultures of the fluid from 269 control cases proved to be completely negative as did cultures of the blood serum of patients suffering from disseminated sclerosis. Many samples of uncultured cerebrospinal fluid have been examined according to this microscopic technic but in no case were spheres or granules observed.

Further evidence of the presence of a living virus in the spinal fluid of patients with disseminated sclerosis was obtained from experiments in which sugars were added to cultures in various stages of their development. While there are particular difficulties in this method, even in the preliminary communication it could be stated that fermentation is probably induced, although the products of the fermentation remain to be detected. In no case could the original dextrose, fructose or mannitol be recovered from the cultures in which the production of acidity had occurred. It is noteworthy too that, although a p_H of 7.6 is essential for the initiation of a culture, after a certain stage growth may be maintained even though the p_H has fallen to 7.0. Filtration experiments using the method of Elford have as yet not been concluded, but it has been found that with a certain grade of membrane the filtrate contained only granules, and that this filtrate inoculated into the serum broth gave the characteristic appearance of spheres and granules, leading to the inference that spheres can be produced from the granules in culture.

The relationship of this virus to a possible toxic factor is indicated by the fact that a definite correlation exists between the colloidal gold reaction and the presence of a positive culture. In all cases of disseminated sclerosis in which the colloidal gold was positive, the virus could be cultured from the fluid taken at that time. Further, if on a subsequent occasion a sample of fluid from the same patient yielded negative cultures, the gold curve had also become negative. This factor responsible for the precipitation of colloidal gold cannot be directly due to the presence of the virus since the fluid will precipitate colloidal gold many hours after its withdrawal, at which time culture of the fluid would be negative. Furthermore, the gold test may be negative in fluid from which positive cultures can be obtained. The precise relationship is being studied. The author believes that she has offered proof of the existence of a body less than 0.2 microns in diameter which is actually living, which can be cultured in artificial medium, which apparently goes through a definite life cyle and which exhibits specific cultural characteristics.

GINSBURG, New York.

A CRITICAL CONSIDERATION OF OBESITY. EDITORIAL, J. A. M. A. **95**:36 (July 5) 1930.

Obesity has been described as a state in which the amount of fat stored in the body is excessive. The depletion of this fat reserve therefore is the end sought in all attempts at the reduction of obesity. Theoretically, at least, this should be accompanied by a reduction in the energy intake to such an extent that the body will be required by the exigencies of the inevitable metabolism to consume some of its energy reserves to meet the current needs. The process may be accelerated by increasing the demands for energy. This means, first of all, by augmenting the amount of work done. Muscular exercise always increases the conversion of energy and is the foremost factor in determining the food requirement on the one hand or the tissue catabolism on the other.

These are the seemingly simple principles on which the augmentation, maintenance or depletion of the body energy reserves may be assumed to depend in

adult life when growth or the production of new tissue is not under consideration. Gain or loss of fat becomes a matter of physiologic bookkeeping, representing the balance between supply and demand in the organism. If this were the whole story, the problem of altering body weight should be comparatively simple. It usually is. Now and then, however, despite a marked reduction in the energy intake, decrease in body weight apparently is not attained. Indeed, persons have been known actually to gain in weight on an admittedly inadequate energy intake. Such experiences have led to the classification of obesity into exogenous and endogenous types, the latter being ascribed to "constitutional disease that unrelentingly causes a progressive deposition of adipose tissue, independent of activity or dietary habit." As might be expected, the omnipotent endocrine glands are assumed to develop the anomaly in which restriction of food intake fails to lead to weight reduction.

In considering some of the assumptions of so-called endogenous obesity, Newburgh and Johnston (Endogenous Obesity — A Misconception, *J. Am. Dietet. A* **5**:275 [March] 1930) of the University of Michigan Medical School have insisted that obesity is always caused by an overabundant inflow of energy. The excess is deposited as adipose tissue. They remind us of features that are all too often overlooked in the study of human size: that body weight is the resultant of two factors — gain or loss of tissue and a gain or loss of water. The loss of one and a gain in the other may neutralize each other; or a large retention of water may cause a gain in weight, even though body tissue has been consumed, and may lead an observer who fails to take water exchange into account to draw erroneous conclusions.

The studies at Michigan in which the water balance as well as the energy debit and credit are taken into account leave no doubt that the response of various types of obese people does not differ from that of normal people. All of them oxidize body tissues in accord with the prediction from the caloric deficit. Retention of water may proceed for several days or loss of water may be suddenly precipitated. The body weight from day to day under conditions of reduction in energy intake may show no parallelism to the expected figures. In the long run, however, the body weight almost always approaches the predictable figure. In reply to the query as to how long a person may maintain his weight in the face of a diet deficient in calories, Newburgh and Johnston cite their own observations that the failure to lose weight is only a matter of days. Thus far the longest period observed by them has been sixteen days; usually it is shorter.

Much of the mystery in the attempts at reduction of obesity is thus dispelled. The principle of the conservation of energy remains intact when the facts of the behavior of the obese are presented in quantitative fashion. The disproportions leading to obesity may be classified, according to the Michigan clinicians, into two categories. The first group includes various human weaknesses, such as overindulgence and ignorance. The second group is composed of conditions that cause a decrease in the requirement for energy, such as lessened activity or lowering of the basal metabolic rate for any reason. If the long established food habits do not respond to this lessened demand, obesity is inevitable. The fundamental feature of obesity remains a positive energy balance. On that basis it can be intelligently treated.

THE EFFICIENCY OF HUMAN MUSCLES. EDITORIAL, J. A. M. A. **95**:799 (Sept. 13) 1930.

A distinguished American physiologist has recently reported the results of painstaking investigations that demonstrate clearly how little energy is consumed, in terms of requisite food fuel, during the progress of an hour's intensive intellectual effort. The added calory need for such an effort does not exceed the contribution supplied by a single oyster cracker or half a peanut. In striking contrast with this is the demand for fuel created by the muscular work of man. The production of 600 calories an hour is probably in the neighborhood of the highest

possible maximum of human physical capacity for sustained effect (Lusk, Graham: The Elements of the Science of Nutrition, Philadelphia, W. B. Saunders Company, 1928). This is true regardless of the type of work done. It has been exemplified by a champion bicycle rider, a long-distance runner, an expert mountain climber and a capable swimmer. It is furthermore important to remember that by a reduction of body weight one may economize in the amount of energy necessary for the basal metabolism; one may economize in the quantity of food fuel necessary to move the lesser body weight; but if a given amount of work is to be done, it can be accomplished only at the expense of a definite quantity of energy, irrespective of the body weight (Lusk).

The body is often compared to a steam engine in respect to the manifestations of energy and work. Both produce waste heat. As the situation has recently been summarized (Halliburton, W. D., and McDowall, R. J. S.: Handbook of Physiology, Philadelphia, P. Blakiston's Son & Company, 1929), an ordinary locomotive wastes about 96 per cent of its available energy as heat, only 4 per cent being represented as work. In the best triple expansion steam engine, the work done rises to 12.5 per cent of the total energy. In man, from 20 to 28 per cent of the energy liberated during muscular contraction appears as work. Thus, muscle is more economical than the best steam engines; but the muscle has the great advantage over any engine that the heat which it produces is not wasted but is used for keeping up the body temperature, the fall of which below a certain point would lead to death, not only of the muscles, but of the body generally.

It is sometimes disappointing to the student of man to find that the human mechanism is not capable of even better performance from a mechanical and energetic standpoint. There have been records of human muscular efficiency reaching 33 per cent of the energy involved; but these figures are unique. Sprinting represents an extreme effort that cannot be continued long. Fenn (Fenn, W. O.: Frictional and Kinetic Factors in the Work of Sprint Running, Am. J. Physiol. **92**:583 [April] 1930), at the University of Rochester, N. Y., recently ascertained that the rate of energy expenditure while running at a maximum speed is about 13 horse power for an average man. From measurements on isolated muscles as well as from calculations on sprinters, it may be concluded that about 40 per cent of this energy was expended during the sprint in the "initial" or anaerobic phase of muscle contraction, the remainder representing the inefficiency of recovery.

According to the Rochester physiologist, an average sprinter is incurring an oxygen debt at the rate of 13 horse power while he is turning out mechanical work at the rate of 2.95 horse power, or with an efficiency of 22.7 per cent. This includes work against gravity (0.1 horse power), changes in velocity (0.5 horse power), acceleration of the limbs (0.68 horse power), and deceleration of the limbs (0.67 horse power). It excludes contractions of facial and body muscles, sidewise movements of the body, and work against viscosity or internal friction. The mere mention of the incidental yet inevitable problem of the heat generated as a by-product of such vigorous muscular activities will start a train of thought from which perspiration, respiration and coincident discomforts cannot easily be dismissed.

THE INFLUENCE OF INTENSE AUDITORY STIMULATION ON ARTERIAL PRESSURE IN NORMAL PERSONS AND IN THE DEAF (LABYRINTHINE). R. NYSSEN and J. HELSMOORTEL, JR., Rev. d'oto-neuro-opht. **7**: 725 (Dec.) 1929.

Interest was aroused by the experiments of Binet and Vaschide, Strauss, Bing, Josué and Paillard, and Zabel on the influence of strong sensory stimuli in raising blood pressure. The object of the present experiments was to determine whether the action of strong but subpainful auditory sensations would establish an objective test of cochlear excitability, similar to the cochleopupillary, the cochleopalpebral and the psychogalvanic reflexes. The authors employed an electric bell and the électrophonoïde of Zünd-Burquet as the source of the sound. The blood pressure was measured by the auscultatory method with the latter and by the instrument of Pachon with the former apparatus. Ten normal persons,

eleven labyrinthine deaf mutes and one woman with hysterical deafness were examined. Each normal person was subjected to high and low tones of the électrophonoïde, each of three different intensities, the length of the séances being three minutes. To the lowest tone of minimum intensity, seven of ten persons reacted by an increase of arterial tension, nine reacted to the tone of medium intensity and ten reacted to the tone of maximum intensity. To the high tone of minimum intensity, five reacted by increase of arterial tension, seven reacted to the tone of medium intensity and nine reacted to the tone of maximum intensity. Five normal persons were tested with an electric bell and no change in blood pressure was noted.

Eleven deaf girls, ranging in age from 8 to 23, were tested. All were completely deaf in both ears. Each was exposed twice to the maximum intensity of the high tone of the électrophonoïde. Of the eleven subjects, two reacted twice, four reacted once and five showed no reaction.

One woman, aged 45, with complete hysterical deafness in the left ear, was tested. Each ear was excited three times, the low tone of maximum intensity of the électrophonoïde being used. More reaction was obtained from stimulation of the hearing ear than from stimulation of the deaf ear.

As regards the influence on the systolic pressure, the ease of production of the reaction in normal persons seems to depend on the intensity of the auditory excitation. The effect on the diastolic pressure is less regular. In the deaf, the variations in arterial pressure found in the tests were not markedly different from those found in normal persons. Therefore, the conclusion is reached that the principal afferent pathway of the reflex is extracochlear.

In the case of hysterical deafness, tests of the deaf ear gave variable reactions, but less marked than tests of the hearing ear. Again, the conclusion is that the excitation is by extracochlear pathways.

The conclusions are: 1. Very intense auditory excitations in general raise the arterial pressure. This is more marked on the systolic pressure. 2. These excitations seem to act as such and do not require the concomitant action of pain or of emotion. 3. These excitations influence blood pressure above all by the mechanical impression on extracochlear receptor organs. 4. These excitations, practiced as described, cannot constitute a test of cochlear excitability.

DENNIS, Colorado Springs, Colo.

A CASE OF THE LATE FORM OF AMAUROTIC IDIOCY WITH ATYPICAL COURSE AND WITH TERMINAL SEVERE DISTURBANCES OF FAT METABOLISM IN THE ENTIRE ORGANISM. H. KUFS, Ztschr. f. d. ges. Neurol. u. Psychiat. **122**:395, 1929.

Kufs points out that there are cases of amaurotic idiocy that for decades show only symptoms of a stationary mental deficiency and are identified with amaurotic idiocy only through the familial history. The symptom-complex of a severe, organic, destructive disease of the brain may develop late in life. Kufs reports a case in which the latter first developed at the age of 36. Necropsy revealed the typical cell changes of amaurotic idiocy spread throughout the brain, but possibly more marked in both frontal lobes. The basal ganglia and cerebellum were markedly involved. The ganglion cells were balloon-shaped, with eccentric nuclei, loss of endocellular fibrils and little disturbance of architecture. Fat stains showed the cells filled with fat. The glia showed regressive and progressive changes. On the other hand, the myelo-architecture of the cortex was but little disturbed. The cerebellum was even more involved than the cerebrum. The entire cerebellar cortex was much smaller than normal, the molecular layer decreased in size and the granular layer thinned out. The net about the Purkinje cells had disappeared, but the myelo-architecture was intact. The Purkinje cells were filled with fat.

Other organs in the body were found loaded with lipoid pigments. The cortex of the kidney was filled with fat, especially the tubuli contorti. The capsule and

capillary endothelium of the glomeruli were also partially filled with fat. The suprarenals were filled with fat. The connective tissue cells and follicle epithelium of the thyroid, as well as the mesenteric lymph glands and the liver were loaded with lipoids. In the latter, the Kupffer cells in particular were filled with fat. The spleen, on the other hand, showed only a mild fatty infiltration. The heart and pancreas were quite severely involved.

Pick's theory that in splenohepatomegaly there is a primary metabolic disturbance that leads to a saturation of the blood and tissue juices with lipoids, so that the natural depots of neutral fat disappear with the progression of the disease, is fully substantiated by the case of Kufs. Furthermore, the conception of Bielschowsky and Pick that infantile amaurotic idiocy is a part of a disease of the entire organism, designated as a heredofamilial disturbance of the lipoid metabolism, holds true in Kuf's case of late amaurotic idiocy. In the infantile form, however, the lipoid cell splenohepatomegaly begins in the first month of life and leads to death in the second year. In Kuf's case of late amaurotic idiocy, the disturbance in fat metabolism developed at the end of the thirty-ninth year and persisted for two years as a severe marasmus. The fat in the cells in the late form differs from that in the infantile form in that the characteristic large lipoidophages are lacking except in the lymph glands. This rich development of lipoidophages may be characteristic of the infantile as distinct from the late form of amaurotic idiocy.

ALPERS, Philadelphia.

CYTOARCHITECTONIC ATLAS OF THE CEREBRAL CORTEX IN THE MOUSE. MAXIMILIAN ROSE, J. f. Psychol. u. Neurol. **40**:1 (Nov.) 1929.

Rose was able to detect fifty-five architectonic areas in the small brain of this animal; he believes that many more mixed and transitional areas and superpositions could be found, but he selected for study only those areas that could be made out in every layer of the cortex and whose margins ran in straight lines and not in zigzag fashion. These fifty-five areas are undoubtedly the anatomic basis for the complicated psychic existence of this mammal. The possibilities for association between the fifty-five centers can be readily appreciated when one employs the well known formula n. (n-1) /2; this yields 1,485 combinations. The relatively great number of masses of fibers in the forebrain of the mouse would also seem to be good evidence that there actually exists such a large number of associations. It is noteworthy that there exist a number of architectonic centers in the mouse which are still uniform in structure, whereas in higher mammals and in man these same centers have undergone an extensive differentiation into subareas. On the other hand, it is also noteworthy that there are found in the mouse some architectonic centers which are well formed and extensively differentiated, but which have undergone marked regression in the primates, especially in man. The sifinificance of these facts for comparative psychology, Rose believes, is obvious.

Regarding the macroscopic appearance of the brain in the mouse, one is struck by the fact that, aside from the fissura hippocampi, the brain has practically no convolutions at all, and is a lissencephalic brain. The sulcus rhinalis, which appears regularly in all mammals, is found on macroscopic examination in the mouse only in the frontal and in some areas in the caudal portion of the cerebral hemisphere. There are no other sulci in the brain of the mouse except one very slight indentation around the tuberculum olfactorium, principally between the latter and the regio diagonalis. There is no sulcus corporis callosi.

Histogenetically, the cerebral cortex of the mouse is divided as follows:

I. Cortex semiparietinus sive striatalis (semicortex). This cortex consists of the following regions: regio praepyriformis, tuberculum olfactorium, regio periamygdalaris, regio diagonalis, septum pellucidum.

II. Cortex totoparietinus sive pallialis (totocortex): (a) Schizoprotoptychos (schizocortex); (α) parumstratificatus (regio praesubicularis, regio perirhinalis); (β) multistratificatus (regio entorhinalis). (b) Holoprotoptychos (holocortex); (α) bistratificatus (cornu ammonis, subiculum, taenia tecta, fascia dentata, regio

retrobulbaris); (β) quinquestratificatus (regio infraradiata, regio subgenualis, regio retrosplenialis granularis, regio retrosplenialis agranularis); (γ) septemstratificatus (regio frontalis, regio parietalis, regio temporalis, regio occipitalis).

III. Cortex palliostriatalis sive bigenitus (bicortex): (α) quatuorstratificatus (area praepyriformis I); (β) septem-(octo)-stratificatus (regio insularis agranularis); (γ) novemstratificatus (regio insularis granularis and propeagranularis).

KESCHNER, New York.

A CONTRIBUTION TO COMPARATIVE PSYCHIATRY. N. SKLIAR and K. STARIKOWA, Arch. f. Psychiat. **88**:554 (Oct.) 1929.

The authors report observations on 1,988 cases of persons with mental diseases admitted to the hospital in the Astrachan region in Russia. This region, situated between Europe and Asia, has a population in which one finds a most unusual mixture of racial as well as cultural characteristics. The types reported in these cases were as follows: Kalmicks, belonging to the Mongolian race, Kirgis, who are of a Turkish-Mongolian origin, Tartars, Persians, Russians, Armenians and Jews. This material offered an opportunity of comparing the incidence of mental disease in such widely differing groups and also the types of mental diseases that are apt to develop in these people. The results were: The Kalmick and Kirgis people show a much lower percentage of mental diseases than the others. Next to them in order of increasing percentages come the Tartars, Persians, Armenians, Russians and Jews. In the opinion of the authors, this order of incidence does not depend on any racial characteristics, but on the degree of culture. The higher the state of culture, the greater the incidence of mental diseases. The Kalmicks show a greater number of mentally diseased women than men, whereas in all the other groups the opposite is true. This is due to the trying conditions under which the Kalmick women live. Of the different disease forms, the Kalmick and Kirgis people show a predominance of manic-depressive psychoses, 66 per cent of all the patients of these nationalities. This is compared with 37 per cent in the Persians, 29.3 per cent in the Tartars, 22 per cent in the Jews, 20.4 per cent in the Armenians and 15.6 per cent in the Russians. The authors are of the opinion that the occurrence of manic-depressive psychoses is indirectly proportional to the height of culture. Dementia praecox, on the other hand, shows a direct relationship to the cultural state. Only 1.9 per cent amongst the Kirgis people had dementia praecox, whereas 19.3 per cent of the Armenians had this disease.

Dementia paralytica does not occur among the Kalmicks and Kirgis, whereas it becomes increasingly more frequent as one ascends in the scale of the state of civilization. This is also true to a certain extent of alcoholic psychoses, with the exception that the Jews show a remarkably low percentage of these psychoses. Hysterical and degenerative psychoses are similarly related to the state of culture.

The authors did not find any indication that there is a special type of psychosis among primitive people but they think that the psychoses that do occur in these people may show some atypical features.

MALAMUD, Iowa City.

THE HISTOLOGY AND ANATOMY OF THE HYPOPHYSIS. HANS SCHEELE, J. f. Psychol. u. Neurol. **40**:70 (Dec.) 1929.

In this study special attention was paid to the pars nervosa of the hypophyses of 268 adults examined. The weight of the gland was proportionate to the size of the person in both sexes, but the weight of the female hypophyses exceeded considerably that of the male, when both persons were of the same weight. In the later decades of life, the weight of the gland was less in both sexes than in the earlier decades. The specific gravity was highest in both sexes in the third decade of life; in contrast to the female hypophyses, the specific gravity of the male hypophyses was strikingly diminished between the ages of 71 and 90.

The neurohypophyses in fifty-four cases from sane and insane persons showed no evidences of glial tissue of the type usually observed in the central nervous

system, although the possibility of the occurrence of a few glia fibers interspersed in the connective tissue of the stalk of the hypophysis could not be definitely determined. On the other hand, the Bielschowsky stain showed regularly the presence of a fairly dense network of nerve fibers in the neurohypophysis. Although the numerous round and elongated oval cellular granules of the neurohypophysis seemed to be closely related to the nerve fiber network, nevertheless the author believes that these granules may have been derived from the endoneurium and from the neurilemma. From a morphologic point of view it would seem proper to regard the neurohypophysis as a peripheral nerve organ. No chromaffin cells were found in this part of the gland. Collagenous connective tissue from the middle lobe and to a slight extent from the capsule of the gland could be seen to invade the neurohypophysis in the form of strands. Only the sections near the capsule showed elastic connective tissue. In colloid cysts of the middle lobe there were found frequent deposits of cells that had apparently undergone destruction; these cells contained considerable fat and red blood cells.

The neurohypophyses of children differed from those of adults by the greater delicacy of the entire tissue and smaller content of glandular cells, pigment, connective tissue and colloid material. The middle lobe was narrower and more regular in structure in children than in adults.

Finally, histologic examination gave undoubted evidence that the hypophyses with a high specific gravity were of denser structure than those with a lower specific gravity.

KESCHNER, New York.

ON THE EXCITATION PROCESSES OF FITS AND OTHER CONVULSIVE AND EMOTIONAL STATES. W. BURRIDGE, J. Ment. Sc. **75**:395 (July) 1929.

As in the case of two other articles by this author in this issue of this journal, the article here abstracted is presented so concisely as to render the task difficult. Yet the subject matter is of interest. The reasoning is based on experimental studies of heart muscle. When a heart that is being perfused with Ringer's solution is given a large dose of certain substances, such as sodium chloride, in sufficient strength, there follows a rapid fall in the contractions and then, with continuation of the perfusion with sodium chloride, a more gradual rise to the previous level of contraction. If now, when the contractions are at the former level, the sodium chloride is omitted from the perfusing Ringer's fluid, there follows a series of changes in contraction which are exactly the reverse of those just described. The contractions rapidly rise to a new level and then more gradually fall to the starting point. The original fall and the subsequent rise that occurs on returning to plain Ringer's solution are of equal magnitude. If these changes are of sufficient degree, the rise may exceed the normal maximum response of the heart, which the author asserts is a fixed and measurable quantity. Being unable to continue normal contractions beyond this point, the excessive stimulation of the heart gives rise to a tonic contraction which persists until the excitation process falls within the limits of normal response, when the heart resumes its ordinary beating.

Using these observations as the basis of his argument, Burridge suggests that, in an exactly similar manner, a nerve cell may under appropriate conditions be stimulated beyond its capacity for normal response, with the consequence that a fit may follow. This leads to consideration of the question as to which element of an excitation process—colloidal aggregation or electrolytes—holds prior possession of the field of response. Conceding this to the colloidal aggregation, which he has already alined with subconscious activity, he speculates on the process of repression (Freud) and neurotic and emotional states. He adds that one can recognize three kinds of unconsciousness: (1) that due to excitation processes of too small intensity; (2) that due to excitation processes of unfavorable composition (as opposed to size), and (3) that due to excitation processes of too great intensity.

SINGER, Chicago.

A Study of the Cerebrospinal Fluid in Genuine Epilepsy. A. E. Kulkow, Arch. f. Psychiat. **88**:114, 1929.

The author discusses the problem of changes in the cerebrospinal fluid in cases of epilepsy as reported in the literature and compares them with the results of a study of his own on forty patients. He takes up the following points for investigation: Pressure relationships in the subarachnoid space before and after the attack; influence of lumbar puncture on the state of the patient; the hydrogen ion concentration, albumin and globulin contents, formed elements, colloid reactions and Wassermann reactions in the cerebrospinal fluid; the state of the blood-cerebrospinal barrier; quantitative cholesterol, choline, sugar chloride, urea, proteolytic ferments, pituitary substance, inorganic phosphorus, lactic acid and calcium determinations. He also considers the question of the toxic properties of the cerebrospinal fluid in genuine epilepsy by experimental injection into animals.

He comes to the following conclusions: (1) Although there are no definitely consistent changes in the cerebrospinal fluid of epileptic patients, the observations reported in the literature, as well as those discovered by the author's studies, would make it appear that there are practically always some deviations from the normal. (2) Among these deviations may be mentioned: There may be an increase of the pressure in the subarachnoid space, not only during the attack but also in the free intervals. This pressure may also be found in the cisterna magna. There may be an increase in the protein content as well as a lymphocytosis. At times an absence of pituitary substance in the cerebrospinal fluid may occur. There may be a positive reaction for choline, an increased sugar content (up to about 90 mg.), an increase of lactic acid, of the p_H and at times an increase of the proteolytic ferments and of the chlorides. Frequently, one finds colloidal curves (colloidal gold and mastic) of the syphilitic type. (3) In a large number of the cases, the cerebrospinal fluid proved to be toxic to animals. (4) The blood-cerebrospinal fluid barrier, even if disturbed at times, is not always so. (5) The removal of cerebrospinal fluid has no definite influence on the disease and sometimes may invoke attacks. (6) The removal of cerebrospinal fluid in large quantities and replacement of these by injections of air may sometimes cause a decrease in frequency of attacks.

Malamud, Iowa City.

Changes in the Cerebrospinal Fluid After Encephalography. S. A. Tschugunoff, Ztschr. f. d. ges. Neurol. u. Psychiat. **122**:452, 1929.

Tschugunoff says that encephalography is not without its dangers. In 106 cases of ventriculography and encephalography, fever was present in 76 per cent. The rise in temperature occurs toward the evening of the day on which the operation is performed; less often it occurs after from twenty-four to thirty-six hours. The temperature in encephalography rises to from 37.5 to 38 C. (99.5 F. to 100.4 F.), reaches its maximum on the second day and then falls. In one third of the cases the fever lasts for twenty-four hours, in one-third it lasts for forty-eight hours, and in a few cases it persists for three days. The fever is accompanied by meningeal symptoms, such as rigidity of the occipital muscles, more or less pronounced Kernig's sign, hyperesthesia of the skin, etc. The headaches persist and are often accompanied by vomiting.

The fluid changes are of interest. Herrmann was the first to call attention to them. In a series of cases of encephalography he demonstrated an increase in albumin content, the appearance of globulin and an increase in cells. These observations were later confirmed.

Tschugunoff investigated the spinal fluid in thirty-two cases of encephalography. In all there was a change in the spinal fluid. The cell count was increased in 100 per cent of the cases and consisted of polymorphonuclears. Often the count was as high as 115. Albumin and globulin were present in 60 per cent of cases. The pressure was increased in 82 per cent. These changes were found at the end of the injection of air, reached their maximum on the two following days,

quickly fell off and eventually disappeared entirely. The fluid changes ran parallel with the temperature and meningeal changes. There is therefore a proliferative and exudative change in the meninges following the introduction of air. The fluid is increased for thirty-six hours after the introduction of air.

The introduction of air into the subarachnoid space is accompanied by an acute serous meningitis. The meningitis is not dangerous, but it leads to a definite change in the patient for the worse.

ALPERS, Philadelphia.

SOME NOTES ON THE ATTITUDE OF CHILDREN TO DRESS. EVE MACAULAY, Brit. J. M. Psychol. **9**:150 (Aug. 7) 1929.

This report embodies the result of an enquiry undertaken in connection with Flugel's study on the "Psychology of Dress." Three simple subjects for short essays were presented to 122 girls and 183 boys between the ages of 6 and 15 years, with the object of trying to elicit answers from which the general attitude of the children to clothing could be discerned. The questions were: 1. What sort of clothes do you like best to wear at a party? Say why you like them. 2. What sort of clothes do you like best to wear for every day? Say why you like them. 3. Are there any clothes that you dislike, and would do without if you could? Say why you dislike them.

From a study of these essays the author concludes as follows: (1) Children, up to about the age of 9, look on clothing simply as being decorative and would probably, if free to choose, wear anything so long as the color is sufficiently brilliant. Clothing has little if any significance for the self, and is not considered when the claims of the body for physical enjoyment are to the fore. From the tenth to the twelfth year the desire for decoration increases, and some very slight attention is given to the actual design and cut as well as to color. The edicts of convention also oppress the child during this period, and there is some conflict between the desire of the body for unrestricted enjoyment and the necessity of caring for and considering the clothes. During adolescence begins the sublimation of interest from the body on to the clothes, probably accompanied, on the part of the girls, with a certain amount of consciousness of sex. (2) The motive of modesty is strongly considered in connection with clothes so far as the females in the lower sections of society are concerned. Those at the bottom of the social scale have been unwilling to accept the now widely held opinion that a lightly veiled body is not necessarily and deliberately immodest. (3) Children are particularly intolerant of tight or rough garments, and quickly find their clothing too hot. Probably the unconscious impulse, up to the ninth or tenth year, is in favor of nakedness.

PEARSON, Philadelphia.

A CASE OF CHIASMATIC SYNDROME WITH ATYPICAL SCOTOMAS. M. A. COLRAT, Rev. d'oto-neuro-opht. **7**:673 (Nov.) 1929.

The importance of this report lies in its contribution to an early diagnosis in cases of hypophyseal tumors. The patient, aged 37, had never been ill before 1919 when slight epileptic attacks began. A lumbar puncture and a Wassermann test gave negative results. In March, 1928, he noticed sudden diminution of vision in the left eye. An examination in April revealed an absolute central scotoma in the left eye, dilated veins in the eyeground and a slight papillary edema; vision was 1/50. The right eye was normal with 9/10 vision. Neurologic and rhinologic examinations gave negative results. Six months later, the left papilla was discolored, and the caliber of the vessels was diminished. The visual field was reduced to a small area in the inferior internal zone. In the right eye nothing different was noted except a slight discoloration of the external segment of the papilla. The spinal fluid was normal. The Wassermann reaction of the spinal fluid and of the blood was slightly positive. Injections of bismuth and cyanide of mercury were given. However, vision in the right eye began to fail and one month later was 4/10; the papillary discoloration was more marked and an

absolute external paracentral scotoma was noted. A roentgenogram showed widening of the sella and absence of the anterior clinoid processes. A central scotoma for green in the right eye was now found. Intensive roentgenotherapy was instituted.

Early perimetric signs of the chiasmatic syndrome appear to be most often temporal scotomas. An onset of the type of retrobulbar neuritis is rarer. The case reported exhibits the two types: on the left, a central scotoma; on the right, a paracentral lacuna and a central scotoma for green. Recently, Christiansen has referred to the possibility of central scotoma in suprasellar tumors.

The cases of Weill and Nordman, as well as this one, show that the hypophyseal origin of such signs must be taken into account if no infections or toxic etiologic factor can be found.

DENNIS, Colorado Springs.

OBSERVATIONS ON THE ETIOLOGIC RELATIONSHIP OF ACHYLIA GASTRICA TO PERNICIOUS ANEMIA: I. THE EFFECT OF THE ADMINISTRATION TO PATIENTS WITH PERNICIOUS ANEMIA OF THE CONTENTS OF THE NORMAL STOMACH RECOVERED AFTER THE INGESTION OF BEEF MUSCLE. WILLIAM B. CASTLE, Am. J. M. Sc. **178**:748 (Dec.) 1929.

The fact that the reduction or absence of hydrochloric acid in patients with pernicious anemia is so profound, leads to the question of its direct relationship to the disease. In a variety of conditions, e. g., gastrectomy, in which a disturbance of the secretory activity of the stomach is an achylia, undoubted pernicious anemia has developed. In patients who have benefited by the administration of liver extract there is a total lack of any amelioration of the secretory incapacity of the stomach. Because of the quantitative nature of the response of the anemia to liver therapy, it is somewhat plausible to think of pernicious anemia as a dietary deficiency disease. With a defect in the gastric digestion due to the absence of functional gastric juice, a dietary deficiency might be produced. To test this hypothesis, it was decided first to carry out the digestion of protein in the stomach of a normal man and to introduce subsequently the products of that activity into the stomach of the patient.

The gastric contents of a normal man, recovered in from three-fourths to one hour after a meal of 300 Gm. of rare beef muscle, were given daily to each of ten patients with classic addisonian disease. Comparing the response of these patients with the changes in the blood associated with the feeding of liver and liver extracts, marked clinical improvement began within a week. Three patients with pernicious anemia were given from 200 to 300 Gm. of beef muscle directly without any demonstrable effect on the reticulocytes or red blood cells. The author concludes that, in contrast to the conditions within the stomach of patients with pernicious anemia, there is found within the normal stomach during the digestion of beef muscle some substance capable of promptly and markedly relieving the anemia of these patients.

MICHAELS, Detroit.

CEREBRAL MUSCULAR ATROPHY. J. KISS, Arch. f. Psychiat. **88**:411, 1929.

The author reports the case of a man, aged 48, who for twenty-two years preceding admission had had epileptiform convulsions. Six years before that he contracted syphilis and received three courses of antisyphilitic treatment. About one month before admission a left facial tic developed. On the second day after admission he became stuporous, and a gradually progressing paralysis of the left arm developed. This condition was accompanied by vomiting, slow pulse and increased intracranial pressure. He became progressively more stuporous and died about ten weeks after admission. During the ten weeks there was a rapidly progressing atrophy of the muscles of the left upper extremity. On postmortem examination, tuberculosis of the lungs and of the intestines was found and a large angioma in the region of the left anterior central convolution occupying the middle third of it and spreading forward into the frontal lobe. There was much destruc-

tion and a recent hemorrhage into the tumor. In the spinal cord recent degeneration in the right anterior and left lateral pyramidal tracts of the cervical region (limited to it) was noted. There were also scattered lesions of the cells in the anterior horns, which were more marked in the lumbar region. These lesions were limited to the small ganglion cells, whereas the large ones were generally intact. The author concludes that the monoplegia was due to the bleeding into the tumor, whereas the muscular atrophy of the left upper extremity was caused by the disturbances of the peripheral neurons. He is of the opinion that the degeneration of the pyramidal tract cannot be considered as causative of this atrophy in such cases. The disturbances of the peripheral neurons are, according to him, due to the lack of proper central stimuli that serve to keep the biochemical equilibrium of the cells. Sometimes these disturbances may be so marked that actual structural changes may occur in the motor cells of the anterior horn. These, however, do not necessarily have to be present. The occurrence of bilateral degeneration of the pyramidal tract in a case of unilateral central lesion would justify an assumption of a close anatomic connection between the two.

MALAMUD, Iowa City.

THE EFFECT OF CARBON MONOXIDE ON THE NERVOUS SYSTEM. Z. SWETNIK, Monatschr. f. Psychiat. u. Neurol. **74**:71 (Nov.) 1929.

In this article the pathologic observations in a case of carbon monoxide poisoning are described. Clinically, there were signs of general rigidity, and death occurred nine days after accidental exposure to the gas. In the cerebellum, the Purkinje cells were severely degenerated and somewhat thinned out. Many of the cells of the dentate nucleus also showed marked degenerative changes. In the red nucleus, caudate nucleus and putamen the cells were affected to a lesser extent. There were bilateral pallidal softenings in the stage of connective tissue and gliogenous organization. The blood vessels were very hyperemic in all regions except the dentate nucleus. Occasional small extravasations of blood were found in the pallidum, putamen and red nucleus. No definite changes were observed in the nerve cells of the cortex. As the lesions of the nerve tissues did not exhibit any apparent relationship to the vascular changes, the author rejects the theory that attempts to explain all the changes on the basis of primary vascular involvement. After summarizing the literature on carbon monoxide poisoning, he concludes that the pathologic changes in the central nervous system are of two types, focal and diffuse. He explains the coexistence of two kinds of lesions by resorting to the hypothesis that different parts of the nervous system are more sensitive than others by reason of their differing chemical structure. The fact that a focal lesion may occur in one case but fail to appear in the same region in other cases is thought to be due to such circumstances as the concentration of the gas, the duration of exposure and the individual characteristics of the organism. The author believes that in his case, at any rate, the changes in the nerve tissue were probably caused by the direct action of the carbon monoxide. He is, however, unable to exclude the possibility that the lesions may be produced by the effects of asphyxia or by a combination of these two factors. Hyperemia and stasis are regarded as probable accessory factors.

ROTHSCHILD, Foxborough, Mass.

VASCULAR CHANGES IN TUMORS OF THE BRAIN. JOSEPH C. YASKIN, Arb. a. d. neurol. Inst. a. d. Wien. Univ. **31**:29, 1929.

Yaskin studied four cases of glioma of the brain. They showed a striking dilatation of all blood vessels which were overfilled with blood, and most of them consisted only of one or two coats, the media being completely absent. In a vessel the wall of which appeared somewhat wider, this width was also found to be at the expense of the adventitia only. Furthermore, these vessels were found markedly necrotic, leading to homogenization and disappearance of the nuclei. When this was the case the vessel was not necessarily dilated. In some of the cases the

homogenization was not only in the adventitia but also in the intima, leading to complete occlusion. It must also be emphasized that although vessels with such changes were most common in the degenerated parts of the tumor, here and there diseased vessels were also found in recent parts of the neoplasm. Thus it would seem that it is precisely this degeneration of the vessels which produces tumor necrosis. On the other hand, it must also be borne in mind that it is possible that both the changes in the vessels and the necrosis of the tumor may be due to the same noxa. Another factor to be considered is that tumor masses may invade the adventitia, first perhaps the vascular sheath and later the wall of the vessel itself, which they may penetrate. It was noteworthy that the vessels nearest to the tumor were relatively very slightly involved; here one was dealing chiefly with stasis and minimal injury to the wall of the vessel. Another interesting observation was the involvement of the large blood vessels of the brain, vessels situated remotely from the site of the tumor. These vessels showed almost invariably a moderate or marked thickening of the intima which may in some instances be associated with definite changes in the elastica and thus make it appear that there is a dilatation of the media. One may, therefore, conclude that in most cases of brain tumor there occurs an arteriopathy of the large cerebral vessels, which serves only to demonstrate how far-reaching the effect of increased intracranial pressure may be on the walls of the blood vessels.

KESCHNER, New York.

BILATERAL COLOBOMA OF THE OPTIC NERVE. P. PHINIZY CALHOUN, Arch. Ophth. **3**:71 (Jan.) 1930.

The coloboma recorded was associated with holes in the disks and with a cyst of the optic nerve sheath. The patient, aged 10 months, showed, in addition to the fundus picture of optic nerve colobomas, a displacement of the right globe downward and outward. The differential diagnosis of the etiology of the proptosis lay between cyst of the nerve sheath, a meningocele and an intra-orbital tumor. At operation, the latter two were ruled out, the cyst and the globe were resected and enucleated, and the patient made an uneventful recovery. There is every evidence of useful vision in the unoperated left eye. The child has been under observation since operation for three years. A microscopic report on the globe contained nothing unusual save for the optic nerve. The scleral part of the optic nerve was present only in the upper part. The retina at the depressed disk showed an absence of nerve fibers and swollen, irregular areas in the nuclear layers. The hole, seen ophthalmoscopically on the nerve disk, was partially filled with pigment, retinal elements and débris. No definite trace of lamina was observed. The bulbar portion of the nerve was small and undeveloped, with only a few nerve fibers. The vaginal meningeal sheath below was welded into the connective tissue strands of the nerve; above it was normal. There were many varicosities of the central vein between the pial sheath and the vein. They became more numerous as the globe was approached.

The microscopic report of the cyst stated that it was composed of dura reinforced above by a thin optic nerve. Elements of arachnoid were found in its lining. Cross-section of the wall showed strands of nerve fibers and several large vessels. At operation it had been demonstrated that there was no connection between this cyst and the intracranial cavity.

A discussion of the embryologic basis making possible the development of this anatomic defect is included in the article.

SPAETH, Philadelphia.

SOFTENING OF THE PONS. CEREBELLAR AND VESTIBULAR DISTURBANCES. H. VERGER, P. DELMAS-MARSALET and P. BROUSTET, Rev. d'oto-neuro-opht. **7**:436 (June) 1929.

A woman, aged 55, two weeks before admission to the hospital suddenly had cramps in the limbs of the left side, vertigo, vomiting, double vision and difficulty of speech. Examination revealed a peripheral right facial paralysis, paralysis of

the right external rectus with homonymous diplopia, and paralysis of associated movement of the eyes to the left. The eyegrounds were normal. There were no motor, sensory or trophic troubles in the right limbs, and the reflexes were lively. In the left limbs there were athetoid movements, astereognosis, ataxia, asymetria and adiadokokinesis. The Babinski sign was positive on both sides. On standing, the patient fell to the left, and on walking, deviated to the left. There was dysmetria in the left upper and lower limbs. Cold irrigation of the left ear caused no nystagmus, but warm irrigation caused a definite reaction. This is explained as being due to the paralysis of the left turning associated movement of the eyes. The arterial tension was twenty-five twelfths. During the next three months, the facial paralysis and the athetoid movements disappeared.

A diagnosis of vascular syndrome of the pons was made.

This case resembled those reported by Raymond and Cestan, but with two additional symptoms: peripheral facial paralysis and the cerebellar syndrome. It is difficult to explain the coexistence of a right pontile lesion with signs of a lesion of the left cerebellum. To imagine two lesions is not justified. The authors think it logical to attribute the cerebellar troubles to a lesion of the right middle peduncle, causing a crossed cerebellar syndrome. Probably there was pontile softening from chronic arteritis of the right pontile arteries, producing a lesion of the fibers of the facial nerve where it bends around the nucleus of the sixth nerve, the abducens nucleus, a part of the ribbon of Reil and the levogyre before its decussation.

DENNIS, Colorado Springs.

ON THE EXCITATION PROCESSES OF THE CONSCIOUS AND SUBCONSCIOUS MIND. W. BURRIDGE, J. Ment. Sc. **75**:371 (July) 1929.

This interesting article is written so concisely that it does not lend itself well to abstraction; it should be read in the original. Burridge bases his reasoning on extensive researches on the excitability of heart muscle. He states that the maximum contractile effort of the heart is a constant which can be accurately measured. Living tissues have two independent sources of the potential termed excitability—the electrolytes and the state of colloidal aggregation. Interaction between the two sources of potential provides the excitation process, which in turn provokes a response; the response and excitation process take place in different structures—they possess "composition" as well as size. The composition—i. e., the relation between the colloidal and ionic activity—determines the tissue's capacity to react to its environment, which is something different from the "size" of the response.

Applying these conclusions to cerebral activities, Burridge hypothecates two sources of energy for framing the excitation processes of nerve cells. Experiments with alcohol suggest that electrolytes mediate "higher," and states of colloidal aggregation "lower" forms of behavior. "In any group of nerve-cells two levels of activity are presumed: the one serves to conduct or frame an ordinary excitation process; the other frames excitation processes which have greater ionic efficiency, to excite conscious activity of the responding organ. Excitation processes of the first level belong to the subconscious, those of the second level to the conscious."

Application is then made to mental phenomena of the principle that excitation processes and responses have composition as well as size and that the composition determines behavior. On this basis the author suggests certain new views concerning sleep, anesthesia, inhibition, etc.

SINGER, Chicago.

THE TRANSVERSE SINUS AND ITS RELATION TO CHOKED DISK. GEORGE W. SWIFT, Arch. Ophth. **3**:47 (Jan.) 1930.

This article contains a discussion of the embryologic development of the cranial sinuses from their fetal anlage. Anomalies of the cavernous and petrosal sinuses are extremely rare. Anomalies of the superior longitudinal sinuses and of the transverse sinuses (size, course and location) are common. The presence or absence

of choked disk with increased intracranial pressure depends in part on the normal or abnormal drainage of the sinuses, one into the other, on their shape, whether triangular or semicircular, and whether they are subject to direct or indirect pressure by reason of their locations. Occlusion of the jugular bulb will not cause a choked disk in the presence of a normal developed system of these venous sinuses. A marked choked disk will develop, however (with occlusion of the jugular bulb), at first unilateral and later bilateral, in the absence of the left transverse sinus or with a marked decrease in its caliber. Choked disk will not develop in the presence of cerebellar or cerebellopontile angle tumors of the left side unless there is a true symmetrical development of the sinuses of that side. Tumors situated in the cerebral fossa do not cause occlusion of the transverse or sigmoid sinuses except through indirect pressure. This indirect pressure occurs only when tissue presses directly against the sinus walls, causing first a stasis and later an obliteration. This presupposes that there has been an obliteration of the cerebrospinal fluid cushion. Two illustrative clinical cases, with the results of examination, diagnoses and autopsy reports, are included. The original paper was read at the 1929 meeting of The American Medical Association, Section on Ophthalmology, and its rather valuable discussion is also included in the ARCHIVES.

SPAETH, Philadelphia.

AORTITIS AND CONSTITUTION IN DEMENTIA PARALYTICA. BERNHARD PATZIG, J. f. Psychol. u. Neurol. **39**:455, 1929.

In sixty patients suffering from dementia paralytica, clinical and roentgenologic examination showed definite aortitis in 60 per cent, definite and questionable in 80 per cent, aortic insufficiency in 39.6 per cent, and aneurysm in 6.2 per cent. In 16.6 per cent of the cases, the diagnosis of aortitis could be established only roentgenologically. The average age of patients with aortitis was 45 years. The interval of time between the infection and the onset of aortitis was nineteen years, and that between the infection and the appearance of the dementia paralytica sixteen years. Only one of the patients with aortitis had received energetic antisyphilitic treatment; 45.8 per cent had received some treatment. Three of the twelve patients without aortitis were not treated and four were treated energetically. The tendency of patients with dementia paralytica to develop aortitis (probably a constitutional susceptibility) is unusually great, certainly up to 80 per cent, and possibly more. It would seem that in a large number of cases of dementia paralytica the relatively young age of the patients and treatment are factors that prevent the development of aortitis. In 36.7 per cent of the cases there was a definite change in the sella turcica. Ninety-five per cent of all patients with dementia paralytica examined by the author had an unusually well developed musculature (athletic). Of fifty-four patients, 68.5 per cent were unusually good scholars; 27 per cent average scholars and 3.7 per cent poor scholars. Fifty-eight per cent of the patients were burdened with a more or less poor heredity, and seventeen patients had alcoholic fathers. Five patients with dementia paralytica had passed through schizophrenic episodes; twenty-six patients (43.3 per cent) had taboparesis, and in 8.3 per cent of the cases there were evidences of dementia paralytica and cerebral syphilis.

KESCHNER, New York.

PITUITARY TUMORS AND NASAL DISCHARGE OF CEREBROSPINAL FLUID. A. P. FRIEDMANN, Arch. f. Psychiat. **88**:358, 1929.

In reviewing the literature on the phenomena of nasal discharge of cerebrospinal fluid, the author finds that in most cases reported the condition was associated with tumors of the pituitary gland. He reports three cases of his own.

Case 1 was that of a woman, aged 57, with advanced general arteriosclerosis, who came to the clinic because of a hemorrhage in the region of the internal capsule. During the second week after admission to the hospital, she began to have a spontaneous discharge of cerebrospinal fluid from the nose (both nares). This lasted for three days and then disappeared. This patient did not die. Cases

2 and 3 were those of patients with pituitary tumors, verified by operation. In both cases there was an extensive discharge of cerebrospinal fluid from one side only. The third patient came to autopsy, and definite erosion of the cribriform plate was found.

The author concludes that the existence of a discharge of cerebrospinal fluid from the nose must be considered as a definitely established fact. Examinations of this fluid showed that it was similar in consistency to that of cerebrospinal fluid obtained by lumbar or cisternal punctures. He is of the opinion that this symptom occurs most frequently in cases of tumor of the pituitary gland, and because of that is valuable as a diagnostic criterion. The prognosis in such cases is poor because of the establishment of a connection between the nasal chambers and the subarachnoid space. The danger of meningitis is therefore great. The symptoms of intracranial pressure, however, disappear as soon as the discharge begins, for it affords a natural decompression.

MALAMUD, Iowa City.

RECENT RESEARCHES ON THE ETIOLOGY AND PATHOGENESIS OF MENTAL CONFUSION AND OF DEMENTIA PRAECOX. V. M. BUSCAINO, Encéphale **25**:48 (Jan.) 1930.

The author first reviews his previously published observations in dementia praecox of formations, in continuation with the adjacent tissue, yielding metachromatic qualities to aniline dyes. These are located particularly in the white matter and in the basal ganglia. Repeated investigations appear to have demonstrated that these are not artefacts. They are believed to be due to the toxic action of substances absorbed probably from the intestinal tract. In rabbits intoxicated with histamine, these plaques have been found; they have also been found by Rosenthal with guanidine, and by Luzzatto and Levi with vinylamine. Other animal groups have been investigated with similar results: parathyroidectomized animals; animals suffering from enteritis, from avitaminosis and from experimental peptone intoxication, etc. The author summarizes thus: these plaques are particularly frequent in the brain intoxicated by amines, either by experimental introduction of these substances in the general circulation or after their passage into the circulation from the intestines.

The reaction productive of a black precipitate in the urine when treated with boiling silver nitrate is also discussed. Its high incidence is shown in syndromes of dementia praecox and mental confusion. It is considered to be due to the same metabolic disturbance, so that some organic base is excreted in the urine — probably of the general type of histamine. The conclusion of the whole matter is that the idea that the toxic origin of dementia praecox is the action of a nervous system partly predisposed by an amine of intestinal origin is reasonably well grounded.

ANDERSON, Los Angeles.

RETROBULBAR NEURITIS. E. B. DUNPHY, Arch. Ophth. **3**:208 (Feb.) 1930.

A review of the literature is given, covering the etiology of a definite symptom-complex consisting of a rather rapid loss of vision associated with central scotoma and usually normal, but at times varying, peripheral fields. The ophthalmoscopic picture is usually normal, but in some cases the disks are blurred with some congestion of the vessels. One or both eyes are attacked, and there is a definite tendency toward recovery; recurring attacks are not infrequent. In some cases sight is irreparably lost.

In this paper the author discusses the possible causes of this syndrome and the different views held by various physicians as to the correctness of these etiologic possibilities. Sinus disease and its relationship are considered in some detail. Abnormalities of the optic foramen are mentioned as a possiblity. Focal infection from the teeth and septic emboli are included as possibilities. Considerable discussion is presented relative to multiple sclerosis. Chiasmal neuritis is included.

The retrobulbar neuritis of intracranial pressure of the frontal lobe is considered. Other causes presented are malaria, acetonuria, intestinal toxemias, cerebrospinal meningitis, diabetes and various acute toxic conditions, as those caused by tobacco and alcohol.

The author's conclusions are as follows: Inflammation may be communicated to the nerve from adjacent structures; the toxins may be carried by the blood stream as from foci of infection or through tobacco and alcohol; it may be a local manifestation of a general disease such as a gumma or a tubercle, and involvement of the nerve may be part of a disease of the general or central nervous system as in Leber's disease, multiple sclerosis and intracranial pressure.

SPAETH, Philadelphia.

OBSERVATIONS ON THE ETIOLOGIC RELATIONSHIP OF ACHYLIA GASTRICA TO PERNICIOUS ANEMIA: II. THE EFFECT OF THE ADMINISTRATION TO PATIENTS WITH PERNICIOUS ANEMIA OF BEEF MUSCLE AFTER INCUBATION WITH NORMAL HUMAN GASTRIC JUICE. WILLIAM B. CASTLE and WILMOT C. TOWNSEND, Am. J. M. Sc. **178**:764 (Dec.) 1929.

Experiments made by the authors have added to the probability of the hypothesis that the obviously defective peptic digestion of the patient with pernicious anemia might be the basis of a virtual dietary deficiency, in the presence of a diet adequate for the normal man. When 300 cc. of gastric juice alone was given to one patient for ten days there was no effect on the red blood cell count. When 300 cc. of gastric juice and 200 Gm. of finely divided beef muscle, thoroughly mixed, was given, there followed a significant clinical improvement. The two constituents were then given separately in four cases, the gastric juice in the afternoon and the beef muscle in the morning. In two cases no change was observed; in one there was a slight effect, and in the other a distinct improvement.

From the experiments it would appear that an interaction between beef muscle and fresh human gastric juice produces, from these two relatively inactive constituents, some substance capable of causing a significant effect on the red blood cells. Thus the relationship of the human stomach to the function of the bone-marrow is demonstrated. The ineffectiveness of the gastric juice itself is against its being considered a water-soluble extract of a highly cellular organ. Finally, the authors postulate that addisonian pernicious anemia is caused, in the last analysis, by defective gastric juice of the patient, which is incapable of elaborating the preventive substance which is formed by the action of normal gastric juice on beef muscle.

MICHAELS, Detroit.

THE RANGE OF EFFECTIVE IODINE DOSAGE IN EXOPHTHALMIC GOITER. W. O. THOMPSON, E. G. THORP, P. K. THOMPSON and A. C. COHEN, Arch. Int. Med. **45**:420 (March) 1930.

By administering constant doses of iodine every day to a series of patients with exophthalmic goiter and by recording the basal metabolism daily, Thompson and his colleagues were able to study the effective range of this drug. They established a relationship between the size of the dose and the clinical result, and demonstrated that there is no "all or none" effect. They used compound solution of iodine of such strength that a drop carries 6 mg. of iodine. A drop of this compound solution will, they discovered, bring about maximum reduction in metabolic rate. Smaller doses are less effective, and a daily dosage of less than 1.5 mg. of iodine is inadequate to produce any effective lowering of the basal metabolic rate. There is also a relationship between the size of the thyroid gland and the amount of iodine demanded. Mild cases of exophthalmic goiter are more sensitive to this drug than severe cases. Doses of less than 0.75 mg. of iodine are usually inadequate to produce any clinical effect, although they do not interfere with the subsequent administration of larger amounts. Thompson finds a fourteen point fall in the metabolic rate on a daily dosage of 3 mg. and a twenty-seven

point fall when 6 mg. was used. The latter amount affected more cases than did the 3 mg. dose. In most cases the maximum fall in metabolic rate occurred by the seventh day. The final conclusion of Thompson and his colleagues is that the early use of an adequate excess of iodine is more desirable in preoperative medication than the administration of early small doses.

DAVIDSON, Philadelphia.

SENILE MULTIPLE SCLEROSIS. KEN TAGA, Arb. a. d. neurol. Inst. a. d. Wien. Univ. **31**:163, 1929.

A woman, aged 74, developed at 65 weakness of the lower extremities, pains in both hips radiating to the thighs and difficulty in walking. These symptoms progressed during the next five years, at the end of which she was admitted to the hospital. Here she showed: slight ataxia of the upper extremities, absent abdominal reflexes, complete spastic paralysis of the lower extremities with flaccid atrophic musculature, patellar and ankle clonus and a bilateral Babinski sign. Deep sensibility was disturbed in the toes of the left foot. In addition to this, she had a large decubitus ulcer over the sacrum. Occasionally she had urinary incontinence. Only toward the termination of the illness did she develop slight nystagmus on looking to the right and less on looking to the left. The examinations of the blood and cerebrospinal fluid gave negative results. She died of pneumonia and sepsis from the decubitus ulcer.

A necropsy revealed: isolated lesions of multiple sclerosis in the white substance of the brain, purulent ascending leptomeningitis and lesions of disseminated sclerosis throughout the entire cord, most marked in the central portion. Histologic examination showed two types of lesions: (1) a typical multiple sclerosis and (2) a process due to senile changes in the blood vessels, which affected not only the normal tissues but also the sclerotic foci. The paper is concluded with a discussion of the pathologico-anatomic differential diagnosis between the lesions of multiple sclerosis and those due to senile vascular changes. The difficulty of making this differential diagnosis clinically is also emphasized.

KESCHNER, New York.

ON THE MANAGEMENT OF THE SPASTIC COLON AND MUCOUS COLOPATHY, ESPECIALLY IN HYPERVAGOTONIC PERSONS. LLEWELLYS F. BARKER, Am. J. M. Sc. **178**:606 (Nov.) 1929.

Barker reviews the physiology of the motility of the colon, showing that the motility is dependent on an intricate set of neuromuscular mechanisms. The study is limited to the movements of a spastic colon which is either a part of a general hyperexcitability or is a neurosis, mostly manifested in a local colonic spasm. Three factors must be dealt with in this physiologic study: (1) the spasm of the distal colon, (2) the increased peristalsis and antiperistalsis in the cecum and (3) the increased production of mucus.

The major subjective symptoms of colonic spasm are abdominal pains, constipation and frequent stools which are unsatisfactory. Roentgenograms reveal the site of spasm, and indicate the hypermotility and ascending stasis due to antiperistalsis. Signs of increased parasympathetic tonus occur in domains other than the intestinal sites. Serious organic disease should always be ruled out. The treatment resolves itself into that of the attacks and that of the interparoxysmal periods. Codeine, atropine and rest should be used in the treatment of an attack. A bland diet, tincture of belladonna, or the administration of Collip's parathyroid hormone along with calcium lactate, warm baths and local heat to the abdomen, are factors in the treatment between attacks. Finally, sensible psychotherapy will help the condition to a great extent since a neurotic constitution is common to many of the patients with spastic colon and mucous colopathy.

MICHAELS, Detroit.

REMARKS ON PSYCHO-ANALYTICAL THERAPY. MARTIN W. PECK, Ment. Hyg. **14**:67 (Jan.) 1930.

Before the introduction of the freudian technic, psychotherapy was an individual method varying with different physicians, modified by their personality and presenting no definite characteristics by which it could be taught to students. One of the merits of the method of Freud is that it presents a standardized technic, minimizing variations in the physician's personality and readily adaptable for the purpose of teaching. The original method required only a small amount of guidance by the physician, but in its modification by Jung, some degree of leadership and guidance were demanded. Still greater activity is expected of the physician in the variation of psychoanalysis suggested by Rank. In all of these technics, however, transference is emphasized. Thus, a hate, which must remain subconscious if it attaches to its original object, may by transference to the indifferent personality of the physician be openly expressed. Since the analyst is susceptible to neither insult nor flattery, these transferences are, at first, safe. There is some danger in their being allowed to continue to an emotional extreme, and relief from this transference is one of the ultimate aims of the analysis. The practitioner hopes, by means of psychoanalysis, to dislodge the inadequate elements of the unconscious mind; to reduce the fear and guilt that attach themselves to such complexes; to arouse in the patient a desire for independence; to awaken in him a realization of the futility of seeking to satisfy infantile desires in an adult world, and finally to achieve some degree of genuine emotional insight.

DAVIDSON, Philadelphia.

A CASE OF THE PROGRESSIVE HYPERTROPHIC POLYNEURITIS OF DEJERINE AND SOTTAS, WITH PATHOLOGICAL EXAMINATION. R. S. DE BRUYN and RUBY O. STERN, Brain **52**:84 (April) 1929.

The authors add another case of progressive hypertrophic polyneuritis to the seventeen that have been reported and which they accept as genuine examples of this condition. In four pairs of cases of this group, a familial history was present. Only one case showed Argyll Robertson pupils despite the common belief that it is a characteristic sign in this disease. This patient had had syphilis six years previously.

The case described was that of a man whose illness began at the age of 49. The polyneuritic symptoms, both motor and sensory, progressed rapidly and were associated with severe and intractable diarrhea. The pupils were small and reacted sluggishly to light. The cords of the brachial plexus and the peripheral nerves were easily palpable and thought by some observers to be thickened. Death occurred three years after the onset of the illness. The pathologic changes were mainly in the peripheral nerves and spinal ganglia. In the peripheral nerves both the interstitial and neural elements were hypertrophied, while in the distal portions there was considerable loss of myelin. The most characteristic observation in the nerves was the presence of masses of nonnucleated tissue which appeared to arise from the sheath of Schwann, which by fusing formed larger masses. The presence of these structures has not been described before and it was suggested that they might represent an early stage of the disease.

A complete and useful abstract of the reported cases is included.

BECK, Buffalo, N. Y.

DIAGNOSIS AND TREATMENT OF POST-ENCEPHALITIC PARKINSONISM. FREDERICK L. PATRY, J. Nerv. & Ment. Dis. **69**:617 (June) 1929.

Epidemic encephalitis is regarded as an infectious disease, the toxic products of which have a special affinity for the gray matter of the central nervous system, causing widely spread lesions. The parkinsonian syndrome is found chiefly in adults. It behaves like a chronic disease. Its onset may be acute or insidious.

There are a multitude of different symptoms due to the widespread nature of the lesions. The disease may be dormant for from weeks to years, becoming active again in the striking parkinsonian picture. Reduction of strength, weariness, insomnia, greasy face, fixed expression, staring eyes, sialorrhea, muscle tremor and rigidity, with muscle palsies, myoclonus and pupillary abnormalities are the most characteristic symptoms. Early symptoms, such as neuritis, neuralgia, cutaneous hyperesthesia and irregular pyrexia or mental symptoms, may precede the development of the parkinsonian state. In children the effects are chiefly in the psychic sphere; the intensity and type or duration of the acute phase seem to have no correlation with the severity or character of the mental or physical sequelae. No special treatment is known, but hyoscine hydrobromide, given in increasing doses from $\frac{1}{200}$ to $\frac{1}{50}$ grain (0.00032 to 0.0013 Gm.) three times a day, both by mouth and subcutaneously, gives the greatest relief. Ultraviolet light, physical exercise and occupational therapy are also valuable. Foci of infection should be sought and removed. The improvement from hyoscine continues only as long as the drug is given, but no untoward symptoms are noted, even over a period of years.

HART, New York.

A CLINICAL STUDY OF MENINGOCOCCUS MENINGITIS: AN ANALYSIS OF 190 CASES OBSERVED IN A PERIOD OF EIGHTEEN MONTHS. MAXWELL P. BOROVSKY, Am. J. M. Sc. **179**:82 (Jan.) 1930.

In 190 cases of meningococcus meningitis, 132 (69.5 per cent) occurred in males; the age of the youngest patient was 3 months and the age of the oldest 62 years. Rigidity of the neck, Kernig and Brudzinski signs were found in every case, except in infants under 1 year of age. A bulging fontanel was present in every infant in whom the fontanel was still open. The outstanding sequela was deafness, in 16 (25.4 per cent). Twelve of the patients had bilateral, total eighth nerve deafness and the other 4 had unilateral deafness.

The mortality was 48.9 per cent, being highest in patients under 1 and over 50 years of age. The lowest mortality was found in patients between 10 and 12 years of age among whom no deaths occurred. Organisms were not found in the spinal fluid in only 13 (6.76 per cent) of the cases. The average cell count in the spinal fluid was 11,780; the average leukocytosis was 23,700. Through the administration of polyvalent antimeningococcus serum it was learned that in each case the agglutinating power of the serum should be tested with the strain of organism causing the infection so as to employ the most specific serum. Intraspinal injection of the serum was given daily until the fluid became clear with a diminution of the cell count to a few hundred. Cisternal punctures were resorted to only when the opisthotonus was so marked as to prevent spinal puncture.

MICHAELS, Detroit.

LOCALIZED BULBAR CISTERNA (PONTILE) MENINGITIS, FACIAL PAIN AND SIXTH NERVE PARALYSIS AND THEIR RELATION TO CARIES OF THE PETROUS APEX. WELLS P. EAGLETON, Arch. Surg. **20**:386 (March) 1930.

After investigating the mechanism of Gradenigo's syndrome, Eagleton concludes that the susceptibility of the sixth nerve is due not to its long course but rather to its primitiveness, which results in an intimate relationship with the mesoblastic tissues at the base of the cranium. The caries of the petrous pyramid may spread enough to cause a localized pontile cisternal meningitis. When this is so, it is signalized by a syndrome which Eagleton believes to be pathognomonic. This consists of a tendency of the patient to assume a supine position with the eyes closed, and to lapse into a stupor from which he can readily be aroused, to show, intermittently at least, vertical nystagmus. If the infection pulls on the dura of the middle fossa, there will be pain behind the eye due to involvement of the ophthalmic branch of the fifth nerve. For prog-

nostic and therapeutic reasons it is essential to distinguish between the serious conditions associated with caries of the petrous pyramid and the relatively benign features following simple congestion. In the latter cases, sensory branches associated with the geniculate ganglion are irritated by the osseous congestion, causing a referred temporofacial pain.

DAVIDSON, Philadelphia.

THE RESULTS OF TREATMENT OF DEMENTIA PRAECOX WITH MALARIA. I. A. YAKUBOVSKY, Rev. Neurol., Psychiat. & Reflex. (Leningrad) **4**:161, 1929.

The author began to treat his patients with malaria in 1925. For a period he ceased to use this method, then again in 1928 resumed the treatment. Four patients were treated in 1925 and eighteen patients in 1928. The quotidian type of malarial plasmodium was used. In the first four cases, all of which were of the catatonic type, only one patient showed some improvement; the patient in that case had active tuberculosis and the author expressed the belief that it was the fever caused by the tuberculosis, with the accompanying emotional instability, which resulted in clinical improvement. The eighteen patients treated in 1928 were divided into two groups; nine were catatonic and nine showed symptoms of confusion. Six patients had an acute onset of the disease and were recent cases; the other twelve were chronic cases. Thirty per cent of the cases showed social recovery, but the author states that these are probably remissions and not true recoveries. The improvement occurred in the recent cases with a fairly acute onset, although one patient, who had been ill for four and a half years, was able to leave the hospital. The author believes that malarial therapy should be attempted only in early cases. The mechanism of action as well as the results cannot be explained, but it is apparent that it is different from the mechanism of recovery in dementia paralytica.

KASANIN, Boston.

THE PARIETAL FOSSA AND RELATED STRUCTURES IN THE PLAGIOSTOME FISHES. H. W. NORRIS, J. Morphol. & Physiol. **48**:543 (Dec. 5) 1929.

The parietal fossa or pit is situated in the middorsal line between the ear capsules. From its floor, four (sometimes only two) apertures lead into the ear capsules. The anterior apertures are the foramina of the endolymphatic ducts; the posterior ones are the fenestrae. Through the fossa each endolymphatic duct passes from its foramen to its external aperture in the dorsal integument, describing in its course a loop with the convexity directed anteriorly. The part of the duct involving the loop is enlarged into an endolymphatic pouch. Into the angle of this loop a small muscle is inserted which is a continuation of the anterior trunk muscles, or one taking a more lateral origin from the edge of the fossa. The fenestra may or may not be closed by a definite fenestral membrane. The posterior semicircular canal (posterior utriculus) bears a peculiar relation to the fenestra. The endolymphatic pouch, like the sacculus, contains otoconia, and sometimes siliceous sand grains. Various functions have been assigned to the endolymphatic organ. There is no convincing experimental evidence as to its significance.

WYMAN, Boston.

ON THE SIGNIFICANCE OF DOUBLE NERVE SUPPLIES. W. BURRIDGE, J. Ment. Sc. **75**:404 (July) 1929.

Comparing current views on the nervous control of the heart with that of a coachman who holds in his horses while perpetually flogging them, Burridge points out that such views take into consideration only the "size" of the excitation processes. Consideration must also be given to the "composition" of the excitation in terms of the activity of ionic and colloidal components. The vagus decreases the capacity of calcium to interact with colloids. The positive charge, as conveyed by the H-ion, for example, is as potent a decalcifier of heart muscle as is an oxalate.

The negative charge, on the other hand, increases the capacity of calcium to act. The vagus, then, decreases the efficiency of the ionic element in excitation processes; the sympathetic increases the part played by colloidal aggregation. There is thus provided a mechanism for altering the "composition" of the excitation processes. Without altering the level of activity, it should be possible for the organ at one time to be rendered susceptible to the action of a particular hormone and at another to be steeled against its action. One should note also that the same nerve may possibly affect ions in one organ and colloids in another.

SINGER, Chicago.

A CASE OF ARTERIOVENOUS ANEURYSM BETWEEN ARTERIA CAROTIS INTERNA AND SINUS CAVERNOSUS (EXOPHTHALMUS PULSANS). HOLGER EHLERS, Acta psychiat. et neurol. **4**:151, 1929.

Ehlers reports the clinical history and pathologic observations in a case of arteriovenous aneurysm between the internal carotid artery and the cavernous sinus. The condition is not uncommon, but there were several unusual features in the case reported: (1) The right carotid had ruptured into the left cavernous sinus; such a condition has not been described previously. (2) The condition remained unaffected by compression of the carotids in the neck, probably because of the marked hypertension associated with arteriosclerotic rigidity of the arterial walls. (3) Many patients recover spontaneously or remit as this one did; death in this case probably was due to degeneration of the heart.

PEARSON, Philadelphia

HALLUCINATIONS; THEIR NATURE AND SIGNIFICANCE. C. MACFIE CAMPBELL, Am. J. Psychiat. **9**:607 (Jan.) 1930.

Hallucinations may be divided into a group of impersonal or peripheral manifestations, and into a group of more intimate personal experiences. The former type is represented by the hallucinosis of drugs and intoxications, or of coarse organic lesions such as tumors. The more intrinsic hallucinatory experiences are associated with the functional psychoses. These demand not merely a consideration of the stimuli (which would be adequate for the peripheral group), but also an understanding of the cultural and emotional background, imagination and intelligence of the patient. Some of these are based on conscious preoccupations and some on trends dissociated from the main personality.

DAVIDSON, Philadelphia.

THE VASCULAR SYNDROMES OF THE OPTIC THALAMUS. UMBERTO POPPI and ALCESTE CONTI, Riv. di pat. nerv. **34**:826, 1930.

This paper deals with the clinical problem of localization of foci of softening in the optic thalamus, according to the vascular distribution. The authors believe that it is possible to recognize in patients the syndromes produced by diseases of the thalamogeniculate, thalamoperforate (medial), and pallidothalamic branches supplying those parts. Besides furnishing original anatomopathologic data on the subject, they describe two clinical cases of thalamic syndrome, one of the medial type and the other of the lateral. They also call especial attention to certain definite motor disturbances, which they designate as cramplike contractions.

VINCIGUERRA, Elizabeth, N. J.

ON OPERATIVE TREATMENT FOR CERTAIN CASES OF MENINGOCELE (OR ENCEPHALOCELE) INTO THE ORBIT. WALTER E. DANDY. Arch. Ophth. **2**:123 (Aug.) 1929.

Pointing out that pulsating exophthalmos may arise from arteriovenous aneurysm of the orbit, brain or cavernous sinus, or from a defect in the roof

of the orbit, Dandy suggests that the treatment is necessarily dependent on the cause. He presents a case of congenital absence of the roof of the left orbit, with the symptom of pulsating exophthalmos. He succeeded in covering this defect with a transplant of bone taken from the outer table of the skull, presenting a curvature like that of the orbital roof. His patient presented a meningocele, secondary to the bone defect. The results, both cosmetic and functional, were satisfactory.

GANGLIONEUROMA OF MEDIASTINUM REQUIRING SURGICAL INTERVENTION FOR RELIEF OF OBSTRUCTIVE SYMPTOMS. T. F. RIGGS and L. P. GOOD, Arch. Surg. **19**:309 (Aug.) 1929.

An unusual case of a ganglioneuroma, arising from the cervical sympathetic trunk, is reported by Riggs and Good. A boy, aged 4, with difficulty in breathing and fulness in the right anterior part of the neck, as well as a Horner's syndrome on that side, was admitted with a diagnosis of large thymus. A roentgenogram showed displacement of the trachea and a mass in the upper thorax. At operation, a mass attached to the thyroid and sympathetic trunk was removed; pathologic study proved this to be a mass of nerve fibers studded with ganglion cells. The patient died a year and a half after the operation. Mediastinal tumors are rare, and those arising from the sympathetic nervous system are the most rare.

TRAUMA TO THE CENTRAL NERVOUS SYSTEM. A. BLALOCK and H. B. BRADBURN, Arch. Surg. **19**:725 (Oct.) 1929.

To investigate the mechanism of fall in blood pressure frequently found in operations on the central nervous system, Blalock and Bradburn operated on a series of dogs. The dura was opened and the brain traumatized. To be certain that their results were due to trauma and not to hemorrhage, the authors established certain criteria of these agencies. It was found that the diastolic pressure increased during bleeding, but fell during trauma. Cardiac output fell more under trauma than under hemorrhage. The conclusions were that trauma of the central nervous system did not alter the oxygen metabolism or body temperature; but that it did cause the pulse rate to increase, and, later, was responsible for a fall in blood pressure and cardiac output. The fall in blood pressure affected both systolic and diastolic readings. The effects were greater when the brain was injured than when the trauma was limited to the spinal cord.

CEREBROSPINAL FLUID IN MYXEDEMA. WILLARD O. THOMPSON, P. K. THOMPSON, E. SILVEUS and M. E. DAILEY, Arch. Int. Med. **44**:368 (Sept.) 1929.

The protein content of the spinal fluid is usually high in myxedema, and a course of thyroid therapy will reduce this concentration pari passu with an increase in the metabolic rate. At the same time, the chloride concentration is reduced following successful treatment with thyroid. The authors take issue with the contention of Frazier and Peet that the rate of flow of spinal fluid is decreased after medication with this gland, believing that the rate of flow is substantially unchanged. The conclusions are based on seventeen cases which are presented in tabular form.

DAVIDSON, Philadelphia.

Society Transactions

GERMAN NEUROLOGICAL SOCIETY

DR. W. J. BERNIS, Rochester, N. Y., *Abstractor*

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O. F. FOERSTER, M.D., *President*

DEUTSCHE ZEITSCHRIFT FÜR NERVENHEILKUNDE **110**:208 (Dec.) 1929

INFECTION AND THE NERVOUS SYSTEM. H. PETTE, Hamburg.

In speaking of acute infections of the nervous system, in a narrower sense, one means those diseases which clinically begin acutely and histologically show the classic characteristics of inflammation, in which the extension of the process depends on the kind and virulence of the inciting agent, especially its affinity for particular parts of the nervous system. With the acute infectious diseases in a narrower sense, therefore, cannot be classed the diseases that are limited to the meninges, nor those processes which appear as complications of inflammatory-suppurative diseases in other bodily organs. Further, there must be excluded those infections which are capable at the same time of producing lesions in other organs: tuberculosis and syphilis. Neither do diseases caused by toxins, such as tetanus, diphtheria and botulism, belong in this group, that is, those diseases which affect primarily other organs while the nervous system is affected only secondarily and indeed by the toxin.

For the consideration of this problem there remains a group of diseases in which the agent attacks in an inflammatory and irritating manner the nervous system exclusively, damaging it either temporarily or permanently and causing a train of symptoms which often overlap considerably in the different diseases, but in which careful analysis during the course permits one to recognize that each specific infection shows to a certain extent a distinct major symptomatology.

Pette divides the diseases into two groups: (1) acute inflammatory diseases involving mainly the gray substance, and (2) acute inflammatory diseases involving mainly the white substance. With the former he classes herpes encephalitis, encephalitis epidemica, poliomyelitis, lyssa and Borna's disease. To these he adds herpes zoster, certain forms of neuritis and Landry's paralysis. With the second group he classes diffuse disseminated encephalomyelitis, acute multiple sclerosis, and certain forms of diffuse sclerosis. Transitions from the one group to the other do not take place when one considers biologic facts in addition to the anatomic processes.

BIOLOGY, CLINIC AND HISTOLOGY

1.—*Acute Inflammatory Diseases Involving Mainly the Gray Matter.*—Many investigators, including Pette, have established that herpes encephalitis is a prototype of real neural infection. The epidermal vesicular eruption on the skin and mucous membranes in herpes simplex is in itself a nonspecific process, for it is found in zoster, chickenpox and variola. Herpes simplex is to be distinguished sharply from zoster.

Grüter, in 1912, showed experimentally that the content of the herpes vesicle can be transferred to a rabbit's cornea, and produce there a herpetic process. In 1919, the same author showed that this experimentally produced herpes can again be transferred successfully to the human eye. Doerr and Vöchting, in 1920, observed that the corneal herpetic process by no means remains local, but that more often it passes on to the central nervous system and produces there an inflammatory process, which with great regularity may spread further to the cornea

or the cerebrum. This furnished evidence for the presence of encephalitogenous properties, and established the principle of neurotropism of the herpes virus for the animal organism.

When the scarified rabbit's cornea is inoculated with the contents of a herpes vesicle, there develops, generally within forty-eight hours, a more or less marked keratoconjunctivitis. The process spreads to the nerve centers of the cornea, that is, the ganglion ciliare, and further to the gasserian ganglion. From here it extends to the pons, in the area of the trigeminus root, and, unless it becomes exhausted, spreads quickly to other centers and tracts. The extension of the encephalitic process can be recognized by the clinical symptoms: cerebellar disturbances as an expression of involvement of the neighborhood of the trigeminus roots, and convulsions as an expression of cortical disease. The early appearance of a pleocytosis in the spinal fluid reflects the meningeal involvement. When the herpes vesicle content is inoculated directly into the brain, there likewise develops an encephalitis which may resemble the encephalitis caused by corneal inoculation. If the inoculation is performed in a peripheral nerve, a myelitis develops primarily in the nerve centers of the region of the inoculation, especially their segments. From here the process may spread to the entire central nervous system. The extension of the process in neural inoculation is inward: peripheral nerve, spinal ganglion, cord. A similar propagation may take place in intramuscular, intramucous, and even after subcutaneous inoculation, except that such neural infection is more difficult to bring about.

Many investigators substantiated the fact that the herpes virus extends by the nerve route, an extension by the vascular route being an exception, if it occurs at all. The question whether the virus travels along the lymph sheath of the nerves is as yet unsettled. The process is characterized by ectodermal and mesodermal involvement. The histologic picture of the process differs fundamentally from those caused primarily by bacterial agents, especially the cocci.

Herpes simplex is an entity. It can always be produced by the same agent. That it is a living organism, that is, that it is of the nature of a virus, is indicated by the facts that it is possible to perpetuate the herpetic process on the human skin and in the neural tissue of certain animals and at the same time even to increase its virulence. As yet the virus has not been cultivated from the blood or fluid. However, Gildemeister and Heuer recently were able to demonstrate occasionally the virus in the blood stream of a rabbit inoculated subcutaneously with herpes virus.

These biologic observations regarding the herpes virus — its increase in the neural tissue and its effectiveness — are also the main characteristics of other types of virus (poliomyelitis, rabies and Borna's disease). They permit absolutely the right to speak of "neurotropism." The nature of this neurotropism is not known. All explanations, morphologic as well as chemical, remain mere hypotheses.

The surest route for transmission is the neural one, whether the virus is inoculated in the brain or in a peripheral nerve. In other modes of infection it follows also the neural route of extension, since a damaged nerve in the inoculated area transmits the virus centralward.

The diseases mentioned show not only a biologic relationship, but also a similar histologic kinship, without identity of the morphologic substrate in the individual diseases. Each disease possesses characteristics of its own. The entire group has in common the tendency to affect mainly the gray substance of the brain and cord without, however, sparing entirely the white substance.

Results obtained from comparative animal investigations are even more striking than those obtained from human pathology, indicating that the differentiation is to be found in the development and course of the actual disease process. A classic example is herpes encephalitis in lower animals. Although it must be admitted that in severe diffuse herpes encephalitis, especially in myelitis, necrosis nearly always develops in the gray as well as in the white matter, yet by employing a less virulent strain the disease process can be limited largely to the gray substance and necrosis may be entirely absent. The diversity of the disease is best

shown by the employment of different stocks of herpes, especially from human herpes vesicles at different phases of eruption. Recent experiments by Levaditi and Lépine and Schoen on monkeys have shown that herpes encephalitis in this animal bears more the character of an inflammatory disease, affecting mainly the gray substance.

All diseases in group 1 have in common that, by a mesodermal reaction in the form of meningeal and vascular infiltration, there is more or less local glial proliferation, mainly of the Hortega elements. This is more pronounced in poliomyelitis. It is therefore to be assumed that the damage to the parenchyma and the glial reaction are the direct primary results of the effect of the virus, and that the mesodermal changes, even when they appear early, are an accompanying phenomenon. The meningeal inflammatory reaction is usually limited. The spinal fluid shows an increase of cells. In the early stages there may be an increase in the leukocytes, which is more noticeable in poliomyelitis and herpes encephalitis.

The involvement of the ganglion cells differs in the various diseases. They are affected most in poliomyelitis and least in herpes encephalitis, especially myelitis. Neuronophagia appears early in poliomyelitis. In addition to the histologic picture, apparently each of the diseases in this group has its own characteristics as regards the distribution of the process over definite areas in the central nervous system.

Pette believes that he is justified in including epidemic encephalitis in this group. There seems no doubt any longer that this disease is caused by a specific agent. The symptomatology, indicative of the involvement of the midbrain, the gray matter near the third ventricle and the aqueduct, indicates the nature of the disease. Atypical cases do not speak against it, since the other diseases in this group are subject to the same variation.

Herpes Zoster and Certain Forms of Acute Neuritis, Such as Landry's Paralysis: Clinically, herpes zoster presents a picture in which the subjective and objective symptoms are limited mainly to the corresponding homolateral posterior sensory roots. According to histologic observations, it is undoubtedly an inflammatory disease brought about by a specific virus. Wohlwill has shown that the histologic substrate may show extraordinary variations. The process along the spinal ganglia is usually constant. Lymphocytic and plasma cell infiltrations indicate a true inflammation, which is observed clinically in the form of a cell increase in the spinal fluid. A marked glial reaction gives an indication of the ectodermal character of the process. The extension of the process was studied by Bielschowsky, Lhermitte, Marinescu and Dragenescu, and H. Freund. Wohlwill has shown that the process may extend to the nerves going and coming from the ganglia. It is known that the process may involve sympathetic ganglia and parts of the cord, especially the posterior and lateral horns. Lhermitte and Nicolas have spoken of a "zoster myelitis." On the basis of careful biologic experiments, it can be said that the zoster virus and the virus of herpes simplex are identical.

If it is assumed that the zoster virus attacks centrally it will offer an explanation for the pathogenesis of the zoster vesicle of the skin in the fact that the neurotropic virus has the ability to travel along the peripheral nerve. There is a close relation between the development of the process centrally and peripherally, both being produced by the same agent. This conception is supported by the fact that the zoster vesicles develop in groups, which gives the idea that the vesicles represent end-stations of individual nerve branches. Also in favor of this is the fact that the vesicular formation is not always on the skin, that more often, as Kyrle has shown, the process (on the end-station of an individual nerve fibril?) appears as a circumscribed cutaneous infiltration without reaching a vesicular stage. It is more difficult to reconcile generalized zoster with this conception. The fact that at times the virus is present in the blood is supported by the work of Kundratitz. He found that by inoculating nurslings with the zoster virus, they repeatedly had outbreaks of chickenpox which spread over the entire body, entirely independently of the supply of the nervous system.

Clinical and histologic facts render it certain that the different forms of zoster—infectious, toxic and traumatic—are brought about through the same agent.

Acute plexus neuritis resembles zoster closely in its symptomatology. Marked neuralgic pain may be associated with motor and sensory disturbances and very often shows a segmental, especially a radicular, distribution. In the sensory sphere there may be present, as in zoster, hyperesthesias with hypesthesias. These disturbances coupled with vasomotor and secretory disturbances lead to the conclusion that the sympathetic elements are involved. The temporal and local accumulation of these cases as well as the appearance of inflammatory products in the spinal fluid permit the assumption that this too is an acute infection, the exciting cause of which is a specific agent. As to the kind of agent, nothing is known. Analogies permit the assumption that it belongs likewise to the group of neurotropic virus.

In including certain forms of Landry's paralysis in this group, Pette does not have in mind the types described by Landry, namely, the toxic degenerative types, which anatomically are analogous to those caused by bacterial toxins: botulism, diphtheria, tetanus and dysentery. Nor does he include diseases which histologically are recognized as diffuse myelitis. Pette has in mind only those forms of Landry's paralysis which bear the character of acute polyneuritis. From recent works by Walter, Gordon Holmes, Guillain and Barré, Margulis, Marinescu and Draganescu, and on the basis of his own observations in a case, Pette comes to the conclusion that while the polyneuritis is a diffuse process, it is none the less accentuated locally and indeed affects chiefly the intradural roots. The spinal ganglia may show more or less diffuse inflammatory changes; on the other hand, changes in the sympathetic ganglia are comparatively of minor nature. The process has largely an ectodermal character. A mild inflammatory reaction may extend to the meninges, to the parenchyma of the cord and to the brain. The spinal fluid may show an increase of globulin without a lymphocytosis. The histologic and inflammatory observations make it likely that this form of polyneuritis is brought about by a uniform infectious-inflammatory agent. Neither biologically, epidemiologically nor histologically is it justifiable to identify the acute polyneuritis virus with the virus of poliomyelitis or of epidemic encephalitis.

To sum up the clinical and histologic characteristics of the diseases discussed, it is found that: 1. The symptoms appear acutely and reach a maximum intensity in a short time. 2. The symtomatology, especially the observations in the spinal fluid, permits one to conclude that it is an inflammatory process, brought on by a specific agent. 3. Histologically, in all these forms of disease, the process is characterized by an ectodermal and mesodermal reaction, which differs quantitatively in the different diseases. 4. The process attacks mainly the gray matter, including the ganglia, without sparing entirely the white matter. 5. It permits the assumption that the individual process depends on a special affinity of the virus for particular parts of the nervous system.

2. *Acute Inflammatory Diseases Involving Mainly the White Matter.*—Acute inflammatory diseases mainly of the gray matter are to be differentiated sharply from those mainly of the white matter. In attempting to group this type of diseases (diffuse, especially disseminated encephalomyelitis), Pette is aware of the difficulties. The diseases do not fulfil individually the requirements for group formation in the same measure as do the diseases of group 1. There is also lacking here the biologic basis, so far that up till now it has not been possible to transmit any of these diseases to lower animals. Comparatively often, also, the process extends up to the gray matter and in some (especially in postvaccinal encephalitis) it is even a question whether the process may be spoken of as mainly of the white matter. None the less, Pette argues that in this group the process formation differs entirely from the type involving mainly the gray substance. Collectively, the individual diseases offer a number of clinical, histologic and pathologic characteristic entities, so that regardless of the individual etiology it is justifiable to speak of them as an individual group.

Clinically, these diseases are characterized generally by an acute onset of symptoms with a marked tendency to retrogression. The symptomatology of the individual disease often depends on the age of the patient. In a large number, pyramidal symptoms are most prominent.

The histologic picture of the diseases in this group is marked by a loss of myelin, diffuse or focal, while the axis cylinders are generally less affected and at times entirely spared; acuity and intensity of the process dominate the histologic structure. There is also mostly a mesodermal reaction indicating an inflammatory process.

Postvaccinal Encephalitis: The disease develops from eight to fourteen days after inoculation, with fever and general cerebral manifestations. The symptomatology may be manifold, depending on the diffuse extension of the process in the central nervous system. The symptomatology depends to some extent on the age of the patient. Children and infants may show epileptiform attacks, which are rare in adults. Hemispastic and hemiflaccid disturbances complicated by paralysis of the basilar cranial nerves including the optic nerve, may appear temporarily or remain permanently. In some cases the cerebral symptoms disappear completely, leaving a more or less marked myelitis, partly diffuse and partly segmental. In some patients there is a complete paralysis of all the extremities with loss of consciousness. There is a tendency to rapid recovery in a large percentage of the cases; 30 per cent of the cases have a fatal ending, usually within a few days after the onset of the symptoms.

Histologically, all cases show a similarity although individually they may differ greatly in the degree and distribution of the process. The white matter is mainly involved, although the gray matter is not entirely spared; especially is this true of the basal ganglia which may be considerably involved. The cortex and the gray matter of the cord may similarly be involved. Near the dilated blood vessels, especially the veins, the myelin sheath shows destruction while the axis cylinders are proportionately less involved and occasionally are well preserved. In the same area the glia shows a marked proliferation, involving in the first stage mainly the Hortega elements. In the most severe cases the subependymal medial round zone is also involved. The ganglion cells show acute changes in the affected areas. Neuronophagia is seldom observed. The intensity of the mesodermal reaction varies from case to case.

Similar disease processes with similar clinical manifestations have recently been observed in increasing numbers in children after acute infections, especially after measles. Two cases reported by Wohlwill and one by Greenfield showed histologic changes identical with those found in postvaccinal encephalitis.

Cases of diffuse encephalomyelitis were observed in children independent of vaccination or any infection. Such epidemics were reported by Stooss and by Bessau and Hässler. Since these reports, similar types of inflammatory diseases of the brain and cord have been observed in adults, at times following an acute infection and at times without any apparent cause. The observation was made by various investigators, Redlich, Albrecht, Ley and van Bogaert and van Gehuchten (See Spiller, W. G.: Encephalomyelitis Disseminata, ARCH. NEUROL. & PSYCHIAT. **22**:647 [Oct.] 1929). The disease appears more or less in an acute form, either cerebral, spinal or in a mixed form. It is often accompanied by optic neuritis. The symptomatology often resembles that of acute multiple sclerosis, from which in some cases the distinguishing points are the acuteness of onset and the rapidity of the course.

The symptomatology in acute encephalomyelitis of children varies considerably. There are types of cerebral hemiplegia, of pontile or medullary encephalitis or of a myelitis of any level. Even types of acute ataxia were observed. Occasionally the symptomatology is limited to isolated ocular muscle disturbances. In the first stage the spinal fluid shows signs of inflammation, such as pleocytosis with a slight increase of globulin. The cases reported so far followed an acute course, often terminating in complete recovery; others again left some defect, mainly spastic symptoms, and again others showed a tendency to relapses. The mortality was comparatively low. The sexes were equally affected. The pre-

dominant age was from 15 to 25. Redlich recently called attention to a number of abortive cases of acute encephalomyelitis. In addition to the cases reported by Redlich, Pette would add a number of isolated cases of optic neuritis, the etiology of which is not clear. He deduces this assumption from the fact that, like the cases of retrobulbar optic neuritis of unknown origin, cases occur in which a similar optic neuritis takes place with cerebral spastic or medullary symptoms, and also because in some cases of optic neuritis of unknown origin there have been occasionally remissions and after the second or third attack the picture was that of encephalomyelitis. Finally, another form of acute encephalomyelitis is the so-called neuromyelitis optica.

The histologic picture in these cases, both the juvenile and those occurring in older people, is marked by a diffused demyelination with quantitative changes in the axis cylinders and diffuse glial proliferation, in the first stage affecting mainly the Hortega elements and later the Cajal cells. The spinal fluid may show a mild degree of inflammation with proliferation of lymphocytes, especially plasma cells. When the gray matter is also affected, the ganglion cells show distinct signs of acute involvement. Neuronophagia is seldom observed.

On the basis of the clinical course as well as the histologic observations it seems reasonable to assume a similarity between cases of acute encephalomyelitis and the so-called acute multiple sclerosis, which Marburg first called attention to in 1905. As to the relation between so-called acute multiple sclerosis and classic multiple sclerosis, it may be said that both diseases are special forms of a nosologic entity. This has been substantiated by many prominent investigators, including Wohlwill, Siemerling and Raecke, Rönne and Wimmer, Nonne, Fraenkel and Jakob, Henneberg and Bielschowsky and others. In cross-section, multiple sclerosis shows the same disturbance as that which is observed in encephalomyelitis. The difficulty of differentiating the diseases on a clinical basis was pointed out by Redlich. An acute encephalomyelitis can never exclude the possibility of a beginning of multiple sclerosis.

According to Wohlwill, classic multiple sclerosis is a distinct focal process, embracing individual blood vessels over a limited area. But this is not true of all cases of multiple sclerosis. Marburg, Jakob, Wegelin and Henneberg showed that, in addition to the old circumscribed and receding process, it is not uncommon to find fresh diffuse lesions that cannot be distinguished from those observed in encephalomyelitis. Even histologically no sharp distinction can be made between the two diseases.

As to the relation of acute encephalomyelitis to acute multiple sclerosis, the distribution of the lesions in the nervous system is not without significance. Especially is it true as regards the involvement of the basal ganglia. This is supported by clinical observations. A parkinsonian syndrome is unknown in multiple sclerosis, but there are always other typical pictures which give expression to the classic forms of multiple sclerosis.

The peculiarity of the distribution of the process is undoubtedly not alone to be explained by the vascular supply; most likely, chemicobiologic properties of the neural tissue or the effects of a toxin are also to be held responsible. As to how this is brought about, present knowledge of the biologic relations between the organism and the disease agent offers no solution. Yet the study of acute inflammatory diseases mainly affecting the gray matter has proved fruitful. Spielmeyer called attention to the fact that the variety of the individual lesions in multiple sclerosis depends on differences in the glia fibers in different areas, that is, a local factor is to be considered.

In the group of inflammatory diseases mainly of the white matter, Pette would also include cases of diffuse sclerosis. Heubner, in 1897, described an independent disease, an encephalitis coming on in early childhood with progressive spastic paralysis and psychic disturbances that included dementia. Since Schilder, in 1912, described two cases of "encephalitis periaxialis diffusa," a large literature has developed on this subject. A number of investigators are of the opinion that it is caused by an ultravisible virus. Even in his first work, Schilder called attention to the close histologic relation between this disease and multiple sclerosis.

A number of transitions exist between the diseases. An attempt to subdivide diffuse sclerosis into groups has not been successful clinically or anatomically. Histologically, the various types, like multiple sclerosis, show a tendency to spare the axis cylinders; it is only in exceptional cases that this is not observed. The partial disappearance of axis cylinders, which is nearly always observed in the area of the lesion, is also observed frequently in secondary degeneration of the pyramidal tracts in the cord. The degree of the involvement of the axis cylinders depends on the severity of the general process.

In severe cases of diffuse sclerosis, there is a tendency to gelatinous softening with cavity formation; this is not unusual in acute forms of disseminated encephalomyelitis, described by Henneberg as "malignant sclerosis." Another thing in common is the connective tissue proliferation; this is uncommon in any marked degree in genuine multiple sclerosis; this is another indication that the acuteness of the process has a striking effect in determining its structure. Other factors common to the two diseases are the sparing of the fibrae arcuatae and that the lesion not uncommonly attacks the cortex.

The largest number of reported cases of diffuse sclerosis gave all the indications of an inflammation: infiltration around the blood vessels, near the lesions and occasionally at some distance from it, while the meninges were comparatively seldom markedly infiltrated. This process is reflected in the spinal fluid. As in all encephalomyelitis belonging in this group, the tendency to unusually marked granular cell proliferation as a reaction to the myelin sheath destruction forms the chief distinguishing point. On the other hand, there is here found also an intense increase of protoplasmic proliferated glia with many atypical forms, especially monster cells, and also a tendency to an early sclerosis of the individual lesions.

The disease attacks mainly children, but older people are not immune. As in encephalomyelitis, here too the symptomatology is largely dependent on the age of the patient. This is reflected in the anatomic and histologic observations. In most cases death follows within a few months, yet remissions are not uncommon and may extend over many years.

Diffuse sclerosis may come on after acute infections, especially after measles.

In summarizing the characteristic observations in acute inflammatory diseases affecting mainly the white matter, Pette says: 1. The diseases come on mostly acutely, at times without any known cause, and again after an acute infection (measles, chickenpox, vaccinia, variola, typhus, angina, gastro-enteritis, etc.), always a definite time after the primary manifestations of the infection. 2. The symptom pictures may vary in the different diseases, but are not without some rule. The symptom of medullary sheath involvement, especially of the pyramidal tract, controls the picture. In the severe diffuse types in children it is not uncommon to find symptoms involving the basal ganglia. The optic nerve may be involved. 3. The individual disease manifestations have a predilection for definite ages, but do not exclude any age. Their appearance is not dependent on space and time. 4. The symptom pictures depend to a considerable extent on the age of the patient. There is a tendency to a quick and far-reaching retrogression of the symptoms and again to relapses. 5. During the acute stage, clinical (spinal fluid) and histologic indications of a genuine inflammation are seldom lacking. 6. Histologically, there is demyelination, either circumscribed or diffuse, with more or less damage to the axis cylinders. Breaking up of granular cells, with reactive glial proliferation is observed in the later stages. 7. Acuity and intensity of the process influence strongly the histologic picture. In one case all varieties, from lesions of the myelin sheath to gelatinous softening, may be observed. 8. A classification of these diseases is possible only in classic cases. In a number of cases it is not possible to draw a sharp line clinically or anatomically.

ETIOLOGY

1. *Acute Inflammatory Diseases Involving Mainly the Gray Matter.*—It is agreed by all investigators that the inciting agent in all of these diseases is not of a bacterial nature. Rosenow's specific cocci do not stand the proof. Levaditi

has shown that cultures of this type are the result of a mixed infection. The possibility that there may be an unrecognizable ultramicroscopic virus must be admitted, even though so far it has not been demonstrated. One is therefore justified in speaking of an ultramicroscopic or filtrable organism. The nature of the filtrable organism is not known. It is known that although the different inciters possess many common characteristics, yet each disease has a biologic individuality; therefore the law of constancy of kind is also applicable here. The adaptabilities are similar to those of bacterial limitations. Repeated cultures and changes of the nutrient mediums, that is, of the host organism, never cause new species, but only degeneration which is always characteristic and specific to the particular species.

Such conceptions as virulence, increase and variability of the individual types have the same importance here as in the bacterial types.

Morphologically and histologically, the infections are characterized by particular cell-containing bodies found in the diseased area. These intracellular bodies lie near the nucleus. It can be said that they are not the inciters of the disease. Many facts suggest that they are merely the result of the reaction of the protoplasm against the attacking agent. They are found in herpes encephalitis, epidemic encephalitis, rabies (Negri bodies) and Borna's disease (Joest-Degerin bodies).

Though the individual types of virus are specific, they possess common biologic characteristics which permit them to be classed as a group. They are resistant to low temperatures, to drying and to the ordinary disinfectants, especially to glycerin. Poliomyelitis virus may remain active for years; Rhoads demonstrated that it may remain active for eight years. Another property common to the different types of virus is that they cannot be grown artificially on ordinary bacterial nutritive mediums. The propagation of each virus and its ability to maintain itself as a type depends on living cells, and indeed on cells of ectodermal origin — cornea, cutaneous epithelium or the neural elements. Its effect will depend on the quantity and virulence of the virus.

The virus is markedly neurotropic. This affinity is recognizable by the fact that it does not affect the entire organism but more often affects only the nervous system (except in the herpetic disease). The nature of the neurotropism is undoubtedly dependent not alone on the properties of the inciters, but also on the organism incited. Neurotropism, therefore, merely represents a special form of organotropism, a phenomenon common to all infections.

Recent studies in neurotropism have shown that the surest way of infection is along the nerve route, regardless of whether the virus is injected into the central nervous system or into a peripheral nerve. There is more prospect of success when an opportunity is offered for the virus to come in contact with nerve tissue, regardless of whether it is in the skin, the mucous membrane or a muscle.

That the virus is individual is shown also by the fact that only certain animals are susceptible to a definite virus. Thus, the herpes virus affects especially the rabbit, and less so the guinea-pig; only particular types of monkeys can be infected. On the other hand, the monkey is the animal most susceptible to the poliomyelitis virus; the rabbit is practically immune and the guinea-pig only slightly susceptible.

The characteristic distribution of the disease process does not depend solely on the location where the virus enters; it depends much more on the affinity of the virus for particular centers. Pette calls attention to experimental work which he and Demme carried on along this line. Injecting poliomyelitis virus into the brain of a monkey caused the development of a myelitis mainly of the sacral and lumbar cord; in another monkey it caused a diffuse myelitis of the entire cord. In both cases the brain showed only a few lesions in the gray matter. In the second case the lesions were in the basal ganglia, near the third ventricle. There was no direct relation between the formation of the lesion and the point of inoculation. When the virus is inoculated into a peripheral nerve, there appear with great regularity manifestations of a primary disease of the segmental nerve centers corresponding to the inoculation; in a short time this is followed by symptoms of severe poliomyelitis. To a lesser degree this holds true for the

virus of rabies and that of Borna's disease. Local factors for the distribution and intensity of the process also play a part in the individual segments, especially in the nuclei. In poliomyelitis, in both the human being and the experimental animal, by the side of badly damaged and destroyed ganglion cells there are often found intact or slightly damaged cells.

The question whether the virus, in reaching the central nervous system, passes through the lymph tract or through the axis cylinder remains undecided. It can, however, be accepted that the progress from the periphery centralward is bound up with the nerve tract. There is no objective basis for the assumption that the lymph path in general, that is, outside the neural tissue, can serve for the distribution of the virus. When the virus has reached segmental centers it is carried further by the spinal fluid-lymph stream, which depends on mechanical factors, as was shown by H. Spatz. But the mechanical factors can have only a secondary consideration. For the determination of the localization of the process there always remains the affinity of the virus; with its extension to the next nearest centers by the spinal fluid-lymph stream, that is, neurotropism in a narrower sense. How the virus reaches the organism has been determined only partially in infections of human beings, although experimentation has accomplished much more.

Rabies is transmitted to man almost always by the bite of a dog. Schaffer, as far back as 1887, was able to show that the centers corresponding to the area bitten are first to be involved. The conditions in poliomyelitis and epidemic encephalitis are more complex. Concerning experimental poliomyelitis Pette said: 1. So far it has been shown that the virus is present in the blood of freshly inoculated monkeys. 2. There is proof that the virus is present in the nasopharyngeal mucous membrane of sick and of well people in the environment of a poliomyelitis patient. 3. An infection is possible from the nose or pharynx, as well as from the gastro-intestinal tract. 4. Infection does not succeed through an intact mucous membrane. It must be preceded by acute damage to the mucous membrane. 5. Nasal or gastro-intestinal inoculation causes a disease picture that cannot be distinguished from poliomyelitis produced by cerebral or intraneural inoculation. 6. Examination of the spinal fluid shows an early pleocytosis; paralysis develops later. 7. There is a definite incubation period between the infection and the appearance of the symptoms, regardless of whether it be cerebral, neural, nasal or gastro-intestinal. 8. The parenchymal process in its course is independent of the location and kind of inoculation. The neuronophagia follows acutely and reaches its maximum within from six to twelve hours.

From investigations by Landsteiner, Leiner and Wiesner, Flexner and Lewis, Levaditi, Kling, Wernstedt and Petersson, Römer, Demme and Pette and many others, it is found that the natural process of infection with poliomyelitis virus is through the mucous membranes (as a result of attachment to the nerve endings?). Furthermore, after the virus reaches the central nervous system it requires a certain length of time before it is capable of producing its destructive effect on the ganglion cells. Finally, after this period, the process of acute neuronophagia sets in and reaches its maximum in a very short time. Everything speaks in favor of the fact that after it has reached the corresponding centers the virus spreads to other segments.

The same principles hold true for rabies and Borna's disease, but each of these diseases has its own incubation period.

Biologically, the virus of herpes simplex, of poliomyelitis, of rabies and of Borna's disease are known, but nothing is known as regards the virus of epidemic encephalitis, or of zoster and the neuritic processes. There may be certain morphologic resemblances between the herpetic process and that of epidemic encephalitis, but the conclusion cannot be drawn that there exists an intimate biologic relation between these two types of virus.

2. *Acute Inflammatory Diseases Involving Mainly the White Matter.*—All attempts to find a specific agent as the inciter of these diseases have proved fruitless. During the last few years there has been a lively discussion concerning the inciting agent of the types of acute encephalomyelitis following vaccination and other acute infections (measles, chickenpox, angina and gastro-enteritis).

Experimental investigations have given no basis for the assumption that these diseases can be produced by the causative agents of vaccinia, measles, chickenpox, etc. The investigations of Winkler, Demme, Paschen, Walthard and others can be accepted as proving that the vaccinia virus cannot produce a true encephalitis. The assumption of Levaditi and his school, especially of Nicolau, that the vaccinia virus should be added to the group designated by Levaditi as "ektodermoses neurotropes," must be denied on the basis of more recent knowledge. Pette's own investigations have shown that double infections have no demonstrable influence on the character of the morphologic substrate of the infections: inflammatory diseases mainly of the gray matter. The influence can be only quantitative and never qualitative.

Concerning the causative agent of multiple sclerosis, Steiner reported the observation of argentophile substances. So far, only Müller (Vienna) has reported similar observations. Recently, Nishii, from Marburg's institute, reported that he had found the same lesions, but he did not accept them as the inciting agent of multiple sclerosis. Recently, Pette and Demme investigated eleven cases of multiple sclerosis, using the method employed in Steiner's laboratory; the patients were of different ages. While they occasionally observed argentophile fragments, they never observed undisputed spirochetes. They inoculated multiple sclerosis material into monkeys, rabbits and guinea-pigs without any results. This was substantiated by a recent paper by Guillain and by the careful studies of Hassin.

Concerning why it has not been possible to demonstrate biologically a virus responsible for the acute inflammatory diseases involving mainly the white matter, it must be pointed out that no diseases are known in the entire lower animal kingdom that can be compared with acute diffuse or disseminated encephalomyelitis, especially acute or chronic multiple sclerosis. This permits one to assume that all forms of diffuse or disseminated encephalomyelitis of unknown etiology are of importance only in human pathology. It is also to be remembered that the hypothetic agent of acute encephalomyelitis which has so far expended its virulence in the stage in which it is to be transmitted may be no longer capable of infection; it may have become "autosterilized," a term which Levaditi coined. Another possibility to be considered is that the experimental animal may be in a definite biologic immune stage. The appearance of encephalitis after measles and after vaccination might indicate this.

PATHOGENESIS

1. *Acute Inflammatory Diseases Involving Mainly the Gray Matter.*—Epidemiologically, these diseases are characterized by a certain dependence on locality and season of the year, but individual epidemics never assume the character of epidemics of the type of grip. Comparatively seldom are many cases of the same disease observed in the same family at the same time. Apparently contact alone is not enough to bring on the disease, even when the virulence of the disease has reached its maximum. There are other factors in addition to the infection. In animal experimentation with poliomyelitis, Pette and Levaditi never observed a case due to contact infection. In epidemic encephalitis, contact infection was observed a few times by Stern, Netter, Stiefler and others. From animal experimentation it is known that infection with a neurotropic virus is generally possible only when opportunity is given for the virus to come in contact with parts of the nervous system.

Knowledge gained from clinical and biologic experimental facts that these diseases are the result of a true infection, but that the transmission of the producing agent alone from man to man by no means causes the disease, permits the conclusion that for the development of the infection, in addition to the virulence of the specific agent, other complex factors must be responsible. These factors must have their basis in the age, sex, characteristics of biologic immunity of the organism and other constitutional conditions. Many exogenous influences must play a part, such as territorial, climatic, etc. Considering these factors, the onset of an infection is the result of a change in the biologic equilibrium in which, in

addition to the virulence of the inciters, the natural resistance of the organism must be considered.

Wernstedt, who observed poliomyelitis epidemics in Sweden, where the disease is endemic, was able to show that during an epidemic the population in the affected district became immune, so that during a later epidemic the disease failed to attack them. This was noted likewise by Kling and by others in Germany and Roumania. These observations are supported by biologic experiments, namely, that poliomyelitis confers a permanent immunity and that there are abortive cases of poliomyelitis which do not result in paralysis. A similar condition is observed in other infections, such as measles, scarlet fever and diphtheria.

Studies of the duration of immunity in this group of diseases, as learned from experiments on animals, have shown that while the immunity may not be permanent, it varies with the different diseases and in some persists for a long time.

2. *Acute Inflammatory Diseases Involving Mainly the White Matter.*—The factors responsible for bringing on these diseases are complex: (1) because the biologic substratum is not known, and (2) because only few epidemiologic investigations have been made. Terburgh, in studies of postvaccinal encephalitis, found that the cases appear in large numbers at certain periods; certain districts may be entirely free, while in other sections, especially in sparsely inhabited areas, more cases are observed.

While scattered cases of postvaccinal encephalitis occur throughout the world, some countries are more severely affected; others again are entirely free from this disease; furthermore, the appearance of the disease as regards the season of the year varies from district to district. The morbidity curve of postvaccinal encephalitis does not correspond with that of any other inflammatory disease of the central nervous system, especially not with epidemic encephalitis. Postvaccinal encephalitis is not, as was assumed, a new disease. Sporadic cases occurred before 1922; this is shown by the report of the English government; Mader also reported an undoubted case in 1912.

There are not many reports on the occurrence of encephalomyelitis following infectious diseases (measles, chickenpox, angina, grip, catarrh of the upper respiratory passages and acute gastro-enteritis), hence epidemiologically no conclusions can be drawn. Here too, isolated cases occurred some time ago.

Summing up the occurrence of encephalomyelitis, it can be said: 1. Diseases of this type have lately occurred in greater frequency, but formerly also occurred sporadically. 2. Epidemiologically, there is no basis for the assumption that etiologically they have any relation with the acute inflammatory diseases of the former group, especially not with epidemic encephalomyelitis. 3. The diseases follow vaccination as well as acute infections of manifold type; they also occur without any primary observable infection.

The differences between the disease as it occurs in children and as it occurs in adults are essentially in the degree of the symptoms. The basis for the degree of the manifestations is not known. Biologic immunity factors are to be considered first, and then the local factor that in early childhood the cord and brain have not yet reached full myelinization. There is no difference of principle in the course of acute encephalomyelitis in children from that in adults. There is a difference in the symptoms, but not nosologically.

If clinical and anatomic observations support the assumption that multiple sclerosis belongs to the group of acute encephalomyelitis, it should be studied whether there are not also pathogenetic analogies; that is, establish whether this disease as such is more common in recent times and whether it cannot be shown that infectious diseases were present in the previous history in cases of multiple sclerosis. Pette answers both questions in the affirmative. P. Marie, Kahler and Pick, as far back as 1884, called attention to the importance of infectious diseases in multiple sclerosis. Later, Oppenheim, Schultze, Redlich and others expressed the same opinion. Marburg stressed the relation of this disease to measles.

The fact that in multiple sclerosis there is often a history of certain infectious diseases leads to the assumption that the inciter of each of the infectious diseases

is also responsible for the multiple sclerosis. But the increasing number of cases of postvaccinal encephalitis points to another interpretation. (Hassin and Geiger reported a case of postvaccinal encephalitis with the pathologic changes. They believed that it is due rather to a toxin. [Hassin, G. B., and Geiger, J. C.: Postvaccinal Encephalitis, ARCH. NEUROL. & PSYCHIAT. **23**:481 (March) 1930].) The fact that in postvaccinal encephalitis the first symptoms appear mostly between the ninth and tenth day after vaccination, that is, at the height of the vaccination process, makes it most probable that allergic activities give an impetus to the development of encephalitis.

Pette therefore comes to the conclusion that postvaccinal encephalitis is the result of particular reactions brought on by the vaccination which cause the organism to become allergic to the unknown morphologic and biologic agents of acute encephalomyelitis.

The "activation hypothesis" finds support in many clinical observations. One recalls the frequent occurrence of pulmonary and pleural complications following grip, and the occasional development of tuberculosis after measles, angina, etc.

Pette calls attention to his reported "Bipolarphenomenon" (*Zentralbl. f. Bakteriol. Orig.* **114**:188, 1929; **110**:432, 1929). He showed experimentally that acute infections may cause an organism to become pathogenic when before it was apathogenic, even though postvaccinal encephalitis is not bacterial. Pette is still of the opinion that the bipolar phenomenon is of importance; so-called activation processes are observed in infections in which the agent is ultravisible or filtrable (herpes febrilis, and neuritic diseases after other primary infections).

The factors mentioned form only a part of the important conditions for pathogenesis. In addition there are endogenous factors which may be of considerable importance. Terburgh has shown that in some cases of postvaccinal encephalitis there were familial factors. In one of his cases, the children of two sisters contracted the disease in a period of three years; in another, two sisters were affected in a period of two years, each soon after the vaccination. Similar observations are reported by English observers. In multiple sclerosis similar observations have been made, and this is also true of diffuse sclerosis. Another factor is the generation processes (pregnancy, parturition, abortion and menstruation).

It can therefore be said that the momentary constitutional condition of the organism is a factor in the development of the process; under this must also be included factors that are specific to the organism in a biologic and immunologic sense. Here must be mentioned the possibility of an alternating partial immunization in certain diseases against one another. The study of the pathogenesis of the individual diseases shows them to possess many points in common.

To return to the group of diseases under discussion, it may be pointed out that activation possesses also an especial importance for the neuritic and polyneuritic diseases. Polyneuritis often follows an acute infection, especially the so-called colds. Similar observations have been made in poliomyelitis. The teaching that the poliomyelitis virus reaches the organism through the mucous membranes runs contrary to the more recent observations. The disease is characterized by its elective affinity for the nervous system, that is, for ectodermal tissue, just as are all other infections belonging in the former group. Animal experimentation has never succeeded in producing a true poliomyelitis from a pharyngitis or an angina. Pette considers such manifestations as angina and gastro-enteritis to be unspecific, that is, not conditioned by the specific poliomyelitis agent. The prodromal stage of poliomyelitis, the rheumatic manifestations (pain in the head, neck and back), as well as the general prostration, are the result of a local or diffuse meningitis caused by the breaking down of ganglion cells that precedes the manifestations of paralysis.

PATHOLOGIC ANATOMY. W. SPIELMEYER, Munich.

1. In all types of bacterial infection it is observed that one and the same kind of noxa may produce different changes in the central nervous system. There occur the three main syndromes of general pathology: (1) regressive parenchymal

damage, (2) circulatory disturbances and (3) inflammation. In the entire complex of inflammatory diseases there are present, in addition to the local reactive, exudative infiltrative processes, also circulatory and alterative changes. In a disease which according to the main symptoms appears to be inflammatory there may be present, in addition, local independent circulatory disturbances with their results and independent degeneration of the nerve substance.

Inflammatory manifestations have a special quality in the central nervous system. In other organs the local reactive processes take place around the connective tissue — the vascular system; in the nervous system the glial interstitium takes part with the mesenchyma in this stroma function. With the leukocytic and lymphocytic elements and the mesenchymal histiocytes there are mixed particular types of glia. Reactive glial proliferation in infectious diseases also takes place more or less independently of mesenchymal leukocytic and lymphocytic infiltrations. The glia itself is capable of producing local reactions. Formerly, Spielmeyer considered them "special glial reactions" and held them to be a functional stimulation caused by the injury. The inner connection between the processes of the vascular-connective tissue apparatus and the vascular-attached glial lesions indicate a kindred function. The glia is a stroma and as such has a stroma function (Askanazy). With the mesenchyma it has in common important organization similarities. One should not consider the glia as parenchyma, as Pette does. As an interstitial tissue it reacts to the functional stimulus, which is often produced by infection with its characteristic proliferation, especially with the formation of detached cells.

2. (*a*) In the attempt to utilize the established facts in etiologically known infections of the nervous diseases, it is necessary first to answer the important question: Is anatomy, with all the means at its disposal, in a position to undertake an etiologic systematization concerning the nature of unknown processes? The temptation to interpret an anatomic substrate as a result of a definite infection is contrary to fundamental observations. The same cause can bring about the most diverse etiologic pictures, and anatomically similar changes are often the result of altogether different causes. The chief consequence of the foregoing consideration was the renewed proof of how fundamentally different a lesion may be when the infection reaches the central nervous system. An infectious genesis cannot be denied in independent degenerations and circulatory disturbances, and likewise it cannot be asserted in inflammatory diseases. For inflammations may also be produced by various poisons; especially may they be brought on by endogenous processes, as secondary or "symptomatic" local reactions. Thus the infectious character of multiple sclerosis cannot with certainty be shown from the anatomic substrate and the changes following cowpox vaccination and measles do not have to depend on the effectiveness of a germ on a structure. Pette's belief in the presence of living inciters is contradictory to the facts.

(*b*) Pette brought forth the conception that the tissue changes caused by invisible noxae are different from those due to visible noxae. By the latter the parenchyma is affected; the essential changes are in the glia, while the infiltrative, especially the mesodermal, manifestations are rather secondary.

The first point is not a deciding characteristic. There has always been a lively discussion regarding the conception of inflammation, the attitude of the "affectio" to "reactio." The infectious noxa damages the function-carrying tissue and brings on an increase in the defensive arrangements. These reactive changes are the real inflammation. It can therefore not be a differential mark between the processes caused by visible, from those caused by invisible, noxae.

Concerning the glial reaction and its relation to the parenchymatous involvement, the actual relations are contrary to Pette's assertions. There is no difference in the course, that the invisible viruses, in opposition to the bacterial damage, produce a glial reaction and that the mesenchymal manifestations are secondary. To support his contention Pette assumes that when similar processes are present in bacterial infections, not the bacterium itself but a toxin formed by it is to be held responsible. Here, also, the facts do not coincide. Weiman has found

staphylococci present in pure glial proliferation and Gamper and Gruber found *Trichina* in pure glial lesions. Herpes febrilis cannot be grouped with the so-called poliencephalitis. Anatomically they are far apart.

The conclusion is untenable that "the encephalomyelitides, from the acutest form of postvaccinal encephalitis to the encephalomyelitis that occurs in relapses, possess a group relationship, especially with reference to their causative agent." Accordingly, multiple sclerosis should be caused by an invisible virus, and this group relation should also hold with other encephalomyelitides. It is not true that in the postvaccinal and postmeasles encephalitis the alleged inciter possesses an affinity mainly for the myelin sheath while the axis cylinder is largely spared. The glial proliferation does not keep pace with the myelin sheath disintegration; it bears no relation to the disintegrated materials. The essential thing is the detachment from the glia of macrophages (polyblasts).

Spielmeyer agrees with Wohlwill that these diseases differ from multiple sclerosis. Redlich, on the contrary, stated that from a clinical standpoint, multiple sclerosis cannot be separated from disseminated encephalitis. Against this it is to be observed that no disease produces lesions with greater similarity to multiple sclerosis than does dementia paralytica. Should the conclusion be drawn that, in addition to the spirochetes, there is also present an ultravisible virus that bears a group relationship to multiple sclerosis, disseminated encephalomyelitis and postvaccinal myelitis?

(*c*) Study of the similar anatomic diseases under discussion aids in knowledge of general pathology and the teaching of special diseases. As regards general pathology, it shows the similarity in the tissue formation in fundamentally different infectious diseases and at the same time the deviation in similar causative processes. It may be observed how limited are the number of anatomic syndromes, even as far as local reactive manifestations. When a disease produces an abnormal increase in the defensive mechanism of the animal, the resulting tissues formed are fundamentally the same, regardless of whether the cause is a visible or an invisible noxa, infectious toxic products, exogenous or endogenous poisons or even metabolic and disintegrated products. It is always the same defensive apparatus that is brought into activity.

A constellation of factors is active in the stimulation of inflammatory defense. In these, the cause is only one among many. The actual organ and tissue formation follows rather pathogenetically all the different endogenous and exogenous factors which are present in the complex of the constellation. In addition to the cause, there are factors depending on time and location, and besides quality and intensity of the noxa there is above all the reaction condition of the organism. For the factors relating to time and location the following diseases may be mentioned: poliomyelitis, typhus, coccus infections, trichinosis, epidemic encephalitis, postvaccinal encephalitis, etc. For the pathogenetic influence of the reaction condition of the organism, the observations in sepsis, galloping dementia paralytica and violent cases of epidemic encephalitis can be pointed to. In these experimental studies it can be noted that in pathology there is no longer a search for a similar relation of the inciting agent to the tissue activity. The variable reaction condition of the organism gives importance to the alternating cell picture which appears in defense against similar noxae. In principle it is the same cellular process which destroys the germ and the poison. Phagocytosis and storing of poison are not divisible by principle.

In special histopathology, it is again found that no single symptom can be decisive for the grouping and diagnosis of diseases. The mistake made through the earlier discovered staining methods was the overestimation of individual morphologic manifestations. For anatomic diagnosis and for classification of diseases one must depend on the entire histopathologic picture.

DISCUSSION

Dr. Hans Hoff, Vienna: Experimental studies were carried on, partly in association with Professor Silberstein, to determine the causative agent in encephalitis. Rabbits and dogs were given intravenous injections of streptococci. In these

experiments there was seldom a true sepsis from which the animals died; most often they showed only an increase in temperature for a few days and then recovered. Clinically, there were no indications in these animals of cerebral or meningeal involvement. But the spinal fluid in the animals, from three to five days after the infection, regularly showed a meningeal irritation. The cell increase was between 10 and 100. After a few days the cell increase disappeared. At this time a few streptococci were found in the fluid; they could be cultured with difficulty and disappeared, the fluid becoming normal again. We assumed that the increase in the cell count was a defensive reaction of the meninges and of the central nervous system against the inciting agent. An attempt was then made to injure the defense function. This was accomplished by giving quinine (0.01 Gm.) orally and intravenously several days before and immediately after the infection with the streptococci. In this group, which included one dog and all the rabbits, definite cerebral manifestations developed after two days: mild rigidity of the neck, turning of the head to one side, gastric movements, running spasms, chewing spasms; the attacks became more frequent and death took place in from two to eight days. In the brain there were no macroscopic indications of meningitis; marked hyperemia alone was present. Histologically there was a typical picture of encephalitis with rich vascular infiltration and also destruction of groups of ganglion cells, mainly of the area of the deeper lying nuclei and in the basal ganglia. Bacteriologically, the streptococci could not be found or cultivated; yet a typical encephalitis could be transmitted from animal to animal. The brains were kept in glycerin and even then the condition was transmissible. The brain pulp was passed through a filter, and even then typical encephalitis developed. It was therefore an ultravisible virus. The next question was: When does this virus disappear? Aseptic brain punctures were made at different times. It was observed that cerebral manifestations appeared when streptococci could be found in the brain, which kept increasing considerably. On the first day of the cerebral manifestations, the streptococci remained unchanged in number. On the second day, considerably fewer bacteria were found in the brain; they were difficult to cultivate and were easily destroyed. On the third, and certainly on the fourth day, the brain was entirely sterile. These observations permitted the thought that the inciter of encephalitis must be a substance that also destroys the streptococci. One therefore thought of d'Hèrelle's bacteriophages. According to this view, a substance must be set free in the brain which acts inimically to the streptococci of the strain which brought on the infection. Test for this succeeded surprisingly. After adding filtered brain pulp to the cultures the bacteria disappeared. The bacteriophages could be cultivated through many strains. These investigations indicate that a body closely related to one of d'Hèrelle's bacteriophages is to be considered as the inciter of the encephalitis in the experimental animals. By adding portions of the diseased brains to cultures it was possible to bring about decomposition and clump formation of the bacteria; it was then possible from the bacterial base to culture in a typical manner a bacteriophage which could be passed through many strains. Finally, bacteriophages were obtained that could readily be cultured and that showed typical dissolution properties for streptococci. These bacteriophages were injected into the central nervous systems of healthy animals, and in no case was it possible to produce encephalitis. The animals (dogs and rabbits) were then subjected to various injuries. One effect of the bacteriophages was observed only when the animals had previously been weakened by many attacks of fever or when an Eck fistula was produced to interfere with the liver circulation, or finally when the liver was damaged by mild phosphorus poisoning. Many weeks later or even after several months a retarded encephalitis gradually developed. For weeks the animal kept the head inclined to one side; then it had a convulsive attack and was free from it for months; then there came many convulsions; the picture of encephalitis gradually set in, from which the animal eventually died. The virus gradually grows more virulent; the incubation period becomes shorter and finally a strain of encephalitis virus develops that shows 100 per cent potency. In considering how much relation this mechanism, gained from experiments, bears to human pathology, it is found that encephalitis

occurs mostly after a lowered vitality; it occurred after the World War in many countries. Most often an infection, such as grip, precedes an epidemic of encephalitis. In the initial stage in grip, when the patients suffer from headache, the spinal fluid always shows an increase in the cell count. Each epidemic is marked by its own characteristics, yet they all have things in common. There develops a kind of ferment in the central nervous system which is similar in its properties to the bacteriophages; it destroys the inciter of grip and at the same time attacks the brain. This mechanism, however, preconditions the coming in contact of living bacteria with living cells. There is then circumstantial proof of a mechanism similar to that which takes place in the experimental animal. With all that has been said, consideration must be given to the many difficulties and pitfalls in drawing conclusions from animal experimentations.

DR. H. SPATZ, Munich: I have attempted to classify encephalitis according to the extension of the process. This includes cases in which an inflammatory reaction is not present. Such pseudo-encephalitis includes encephalitis congenita of Virchow, poliencephalitis hemorrhagica of Wernicke and the encephalitis subcorticalis of Binswanger. Likewise, a division can be made of those in which an inflammatory reaction is present, but does constitute the main symptom; the symptomatic encephalitis of Spielmeyer can be mentioned here. Among the remaining true encephalitis, six types may be distinguished according to the extension of the process: (1) Meningo-encephalitis: Example, meningo-encephalitis in syphilis, tuberculosis, anthrax, and meningitis epidemica. (2) Metastatic encephalitis: Here are found many different-sized circumscribed round lesions, preferably around the blood vessels, embracing the white and gray matter alike. Example, streptococcus encephalitis in endocarditis, pneumococcus encephalitis, etc. (3) Diffuse poliencephalitis affecting definite areas of the cortex and striatum. Example, dementia paralytica. (4) Spot-forming poliencephalitis, affecting mainly the brain stem. Example, encephalitis epidemica, the cerebral form of the Heine-Medin disease, rabies and Borna's disease. (5) Encephalitis with many small elongated lesions around the veins in the white substance, in the gray of the basal ganglia and in the depth of the cortex. Example, postvaccinal encephalitis, and encephalitis following measles. (6) Encephalitis with large, sharply circumscribed lesions, never omitting definite areas in the lateral ventricle. Example, encephalomyelitis disseminata, acute multiple sclerosis and the acute form of diffuse sclerosis. There are, however, encephalitides that do not fit in this provisional scheme. In group 1 the disease is transmitted through cerebrospinal fluid spaces: it can be produced experimentally. For the other types, knowledge is merely hypothetic.

DR. E. REDLICH, Vienna: Pette has before repeatedly called attention to a number of cases which he considered to be an acute infection of the central nervous system. Soon after, I reported on similar observations, which I grouped under disseminated encephalomyelitis because from their appearance and course they appeared to fit best under that title. Later, I reported another group of cases, which in some respects fit in the foregoing group but which, however, showed a symptom-complex of an attenuated form so that I spoke of them as an abortive type of encephalomyelitis disseminata. Soon afterward, similar reports began to come from different countries. There are the cases of encephalitis, especially encephalomyelitis disseminata following vaccination, and also those following or during an attack of measles. Recently I saw a case following shortly an acute attack of measles in which there developed polyneuritis of the Landry type that cleared up rapidly. In this case the only indications of an involvement of the central nervous system were the observations on the spinal fluid and the Babinski phenomenon. Finally, such cases were observed after chickenpox. Perhaps I should also consider in this group some cases developing after antirabies inoculation. The idea that these diseases of the central nervous system in some way are to be brought in relation with the disease epidemic encephalitis, or a modification of it, must be denied, because the characteristic manifestations of epidemic encephalitis are lacking. The histologic studies of encephalomyelitis disseminata after

vaccination or after measles, or those without preceding infection differ essentially from the anatomic histologic picture present in encephalitis epidemica. As Pette has shown, they involve mostly the white substance; there are also differences in the finer histologic details. Economo, accepting Sicard's suggestion, considered these cases as para-encephalitis, a term that I think is not justified. The fact that so far no case of parkinsonism has been observed in these cases speaks against a relation with epidemic encephalitis. Analogous observations of encephalomyelitis disseminata were observed long ago by many authors. It should be mentioned that cases in which epileptic attacks developed following vaccination may be considered probably as an expression of a mild encephalitis. Pette explained that all these diseases depend on a group-related ultravisible virus, which ordinarily is latent in the body and which under special circumstances, such as vaccination, measles, etc., becomes activated and neurotropic, or under these conditions enters the allergic reacting organism and becomes active. I agree with Pette in everything except as concerns the relation of these acute infectious diseases of the central nervous system to multiple sclerosis. I cannot agree that encephalomyelitis disseminata and multiple sclerosis, especially the acute type, present an analogous process, that encephalomyelitis disseminata can turn into multiple sclerosis. In my opinion they represent different processes. I hold a similar view as to encephalitis pontis and cerebelli. The discussion on this subject is not new. Oppenheim, E. Müller, Henneberg, F. H. Lewy, Wohlwill, Guillain, and Kretschmer are of the same opinion as myself. On Pette's side are Cassirer, Marburg, Steiner and Jakob. These divergent opinions indicate that this is a difficult problem, especially because the etiology, pathology and pathogenesis of encephalomyelitis disseminata and also that of multiple sclerosis, especially of the acute form, are in many respects yet unclear. In some cases it is difficult, even impossible, to make a definite diagnosis. Notwithstanding the principal difficulties of the subject, I submit my arguments which I consider important for my disagreement with Pette: (1) As regards the clinical relation: For a long time there have occurred a large number of cases of multiple sclerosis; in the last few years perhaps there has been even an increase in number. How is it that cases suddenly appear, even in larger numbers, which, regardless of their different etiologic-pathogenetic conditions, show in many respects such uniformity that they impress one as something possessing an entity? These cases all occur in persons who previously were healthy, and they run an acute course. That all these should be or should become multiple sclerosis is in itself extraordinary; in addition, many things about its nature are not clear or understood. It is true that acute cerebellar ataxia, transverse interruption of the spinal cord or a Brown-Séquard syndrome may be the first manifestations in multiple sclerosis, but this is not the rule. Even less is it true in cases of vaccinal encephalitis. Similar observations were made by Basch, and also by Baar, in children without a preceding infection; they do not resemble the cases of acute multiple sclerosis, such as Marburg and Oppenheim described, in which there was mostly a fatal ending, whereas these cases most often terminate in recovery. What characterizes multiple sclerosis most is its characteristic course of remissions and exacerbations. In this respect, future observation alone will decide the case. Most of the cases that I have observed are at present in the same condition as when treatment was last given. This holds as true for the severe as for the abortive cases. In a few of my cases relapses took place. Pette has found a close relation between the cases following vaccination and measles, and the cases of encephalomyelitis disseminata. The investigations by Boumann after vaccination and by Wohlwill after measles expressly indicate differences between multiple sclerosis and the material that they investigated. Pette investigated a case following vaccination and found it also to possess a relation to multiple sclerosis; he explains that his case came to autopsy later than the other cases. Exacerbations in vaccinal encephalitis have so far not been reported. Formerly, many were of the opinion that multiple sclerosis is the result of infection, but this opinion could not be substantiated, at least for the ordinary cases. E. Müller was of the opinion that the acute cases after infections, followed later by sclerotic lesions, are not true multiple sclerosis but secondary sclerosis as described

by Ziegler and Schmaus. That this is possible cannot be doubted, although I am unwilling to lay too much emphasis on Müller's conclusions. Pette is of the opinion that in these cases the effect is due to an acute ultravirus. E. Müller pointed out that one can readily understand an acute inflammatory disease to be caused by an acute infectious virus. One can even admit some possibilities of a relapse, but one cannot accept the assumption that the virus will remain effective for years or decades. Cassirer thought there were transitions between disseminated encephalomyelitis and multiple sclerosis. He was of the opinion that the normally existing equilibrium between the functional and the supporting tissue was upset; then, in its further course, either spontaneously or under some inimical influences, there will develop fluctuations in this relation bringing about new outbursts of the disease process. But the question must be raised: Can such an acute virus be assumed also in cases in which the second attack takes place many years after the first, even one or two decades after it, and then that it is followed by many relapses? In the many cases of acute encephalomyelitis disseminata that were observed there were reasons to hold an infection as the cause; is it also true for the cases of multiple sclerosis with an acute onset as the first manifestation? What is to be said of the ordinary multiple sclerosis which has a gradual onset and progresses slowly? Here there is a lacking of any assumption of an acute virus. I assume that Pette considers multiple sclerosis as a distinct disease. If it is assumed that multiple sclerosis is caused by a living virus, it is more plausible to hold in most cases that the spirochete is the causative agent. The most important things, however, are Pette's anatomic and histologic observations from which he concludes the identity of encephalomyelitis disseminata with multiple sclerosis. First it is to be noted that his material is relatively small: only two cases, which he undoubtedly considered as acute encephalomyelitis disseminata, and one case of multiple sclerosis with an acute relapse, from which the patient died. It is to be admitted that as far as the acute changes are concerned there are similarities, although in case 1 it is reported that there was also a marked destruction of the axis cylinders. But acute processes of the central nervous system are similar in many respects. Pette has pointed out similarities in the changes found in encephlomyelitis disseminata and multiple sclerosis with poliomyelitis, which I think is justified. But this does not prove that the chronic lesions in multiple sclerosis always develop from acute lesions. The acute lesions in multiple sclerosis can be easily differentiated from the chronic ones. I do not think that these important differences can be explained entirely on the duration of the lesion; the effectiveness of the causative agent plays its part. Present knowledge does not permit one to draw a posteriori conclusions from anatomic and histologic pictures on the analogy or important similarity of lesions or still better on the identical etiologic pathologic conditions. As regards the question of spirochetes being the inciter of multiple sclerosis, it is known that they have been found in multiple sclerosis. With Steiner's improvement in the staining method, I recently found the spirochetes in several cases of multiple sclerosis, among which was a case with a relatively rapid course. As pointed out by Steiner, I have found the spirochetes in lesions around the third ventricle. I also observed lesions in the cord which remind one of spirochetes, but they are not true spirochetes. However, I believe that as yet we have not reached the stage at which we may consider established that a spirochete is the inciter of multiple sclerosis. The arguments for an infectious nature of multiple sclerosis are based on its chronic progressive course with exacerbations and remissions. To be sure, such progressive course is also observed even with remissions and exacerbations in cases in which a definite toxic agent is present, as for example in ergotin poisoning, with changes in the posterior columns to which cerebral manifestations may be added. Funicular myelitis as a result of pernicious anemia is another such example showing a progressive course. Here, too, under certain circumstances there may be remissions and exacerbations over a period of many years. The assumption of an infectious nature of pernicious anemia is to be denied; the work of Ucko and Duesberg supports the theory of toxic genesis of the nerve lesions. If a spirochete is assumed to be the inciter of multiple sclerosis, one must compare the anatomic and histologic changes in

multiple sclerosis with the effect of a known spirochete on the central nervous system and that is the *Spirochaeta pallida*. Dementia paralytica and cerebrospinal syphilis can be mentioned and considered, while in tabes the changes in the posterior columns are only secondary, depending on involvement of the posterior root. The characteristic histologic observations in multiple sclerosis are the relative intactness of the axis cylinder with disappearance of the myelin sheath. While lesions showing myelin destruction may be found in dementia paralytica, they are rare. In cerebrospinal syphilis they are not found in greater number. On the other hand, they are known in lead poisoning, especially in Gombault's periaxialis neuritis. Babinski and Marburg called attention to the analogies of multiple sclerosis; the latter speaks of an encephalomyelitis periaxialis scleroticans and considers that a lecitholytic toxin is the effective agent. In Schilder's diffuse periaxialis encephalitis, in which nothing speaks for an infection, the axis cylinder is found intact in large measure. Bielschowsky recently stated that in funicular myelitis of pernicious anemia, the toxic genesis of which has already been noted, he observed a persistence of the axis cylinders which in these cases should occur only seldom. There are striking differences, however, in the location and the kind and manner of distribution of the lesions between multiple sclerosis and cerebrospinal syphilis and dementia paralytica. In cerebrospinal syphilis the lesions gradually extend along the blood vessels and lymph spaces, as one would expect from spirochetal activity; there may also be closure of blood vessels. In multiple sclerosis the lesions are different. There is symmetry of the lesions in the cord and medulla, which is most noticeable in the anterior and posterior columns. These symmetrical areas indicate a symmetrical involvement of the blood vessels and not of the lymph circulation, as Pette has stated. It would seem that the injurious agent is carried by the blood stream and exerts its influence on the parenchyma, spreading like an ink stain on blotting paper. I am aware that not all lesions correspond to vascular territories, especially in the sacral sections. But how otherwise can it be explained that certain types of lesions repeatedly correspond to vascular areas? Pette has recently assumed that certain lesions extend along the lymph tract. This symmetry is difficult to understand with the assumption of a living virus, especially a spirochete. The relation between multiple sclerosis and encephalomyelitis disseminata cannot be considered at present as established.

Dr. A. Jakob, Hamburg: On the basis of my experience I must declare myself as entirely in accord with Spielmeyer. On the other hand, I desire to call Spielmeyer's attention to the fact that the typical bacterial infections (not only the contact infections but also those in general conditions after an attack of contagious disease), lead to the ordinary meningeal infection and that there frequently appear in the parenchyma reactions of a nature similar to those in the diseases already discussed. In inflammatory infiltrative parenchymal processes with an absence of a bacterial agent it is never permissible to conclude that an ultravisible virus is present, and in diseases of unknown genesis with similar histologic reactions, without biologic support, to consider a group-related virus. The pathogenetic etiologic question is not a histologic problem and can be solved only, as Pette also indicated, on a constellation pathology. But in most of the diseases discussed this is especially difficult, since it possesses no firm foundation, either clinically, pathogenetico-etiologically, or as regards localization and extension of the hypothetic virus. Therefore, the nosologic divisions of the individual forms and the question concerning their eventual group relations meet with the greatest difficulty. Even Pette's division of the individual diseases into two main groups is subject to discussion when, for example in measles encephalitis, one does not underscore "mainly" instead of "gray and white matter." The more recent observations in measles and postvaccinal encephalitis are yet unclear, even pathogenetically; much less can one draw conclusions as regards other diseases of unknown genesis. Among themselves they are undoubtedly histologically related, but at present I do not feel justified in assuming their intimate pathogenetic relationship to each other and to multiple sclerosis. Some lesions in these diseases recall more funicular spinal diseases in which occasionally even perivascular

lymphocytic infiltrates are found. Histologically, it is not always easy to determine an acute encephalomyelitis from acute multiple sclerosis. I also believe that there are cases of acute encephalomyelitis as described by Redlich.

DR. NONNE, Hamburg: We have been told how similar histologically are disseminated encephalomyelitis and the acute types of multiple sclerosis. One assumes etiologically that both types depend on a living virus which future investigation will bring to light. (Nonne discussed the subject of funicular myelitis and presented pictures.) They all presented the same picture of demyelinization involving more or less of the axis cylinders; in some places this alone is diseased. The lesions are grouped mainly around the blood vessels. The gray substance is intact. There is no indication of inflammation. The meninges and the posterior roots are free. The process is scattered over all parts of the cross-section, but individually there is a preference at times for the posterior, the lateral or the anterior columns, but more often they are all involved. Typical and without exception is the absence of infiltration about the blood vessels and the meninges. This is entirely different from the acute infectious conditions in which one finds ectodermal and mesodermal reactions. Disease of the central nervous system in pernicious anemia is considered as coordinate with an injury to the blood system and not as a result of the blood disease. Clinical and pathologic studies teach that cases of pernicious anemia may occur without funicular myelitis, and in some cases of severe myelitis anemia may later develop.

In this disease of the cord one observes an expression of a noxa of a toxin as yet unknown.

Following Friedrich Schultze, I have observed similar disseminated lesions in leukemia (demonstration) and also in syphilis, without any indication of cerebrospinal syphilis, that can be observed either macroscopically or microscopically. I have also observed the same changes in a case of diabetes mellitus, one with carbon monoxide poisoning, two cases of scurvy, and especially in cases of cachexia caused by chronic alcoholism. These are cases in which a toxin of some kind is present in the circulation.

It is interesting that in all these cases the observations in the spinal fluid differ from those in the cases of infection described by Pette.

In the cases of alcoholism, carbon monoxide poisoning, diabetes, scurvy and syphilis, the spinal fluid is entirely normal. In anemic spinal diseases products of inflammation are not found, that is no increase in cells, but merely a mild increase in the globulin content without an increase in the globulin quotient according to Kafka. All are acquainted with Demme's studies on the principal difference in the spinal fluid between infectious and toxic diseases of the central nervous system.

Finally, I wish to call attention to cases in which only after prolonged study, and not always then, can the condition be differentiated from multiple sclerosis. Abortive cases are present in both types.

DR. O. B. MEYER, Würzburg: In 1920, I reported cases of sensory polyneuritis which occurred in the years 1919-1920. The patients complained of paresthesias in the hands and feet. The knee and achilles reflexes were either partially or entirely lost; on the other hand, there were no motor disturbances. Later, Lilienstein reported special types of neuralgias and drew the conclusion that these types of diseases were caused by the grip. I am of the opinion that Lilienstein's conclusions have much in their favor. Since that time I have seen few of these cases; at that time I saw seven cases in a comparatively short time. It is to be recalled that in those years there was an epidemic of the grip and encephalitis. It is interesting to note that in one case the knee and achilles reflex subsequently returned. I have observed two atypical cases of multiple sclerosis which showed a similar picture at the beginning.

DR. F. PLAUT, Munich: Are there supportive arguments for Pette's hypothesis, that dormant cerebral infections may become activated by a new and different infection? Pette bases his arguments on the bipolar septicemia observed by him in the rabbit following vaccination, which had been described by Pondmann and Aldershof before. Interesting as these observations are, they do not show anything

as to the genesis of infections in the nervous system, since in septicemia one cannot speak of a nervous process. On the other hand, there is a kennel contagion of a decidedly neuropathogenic character in the rabbit, the so-called spontaneous rabbit encephalitis. Many believed that it could be activated by heterogenous vaccination. This was not substantiated; even Pette expressed an opinion against it. In fact, there is no spontaneous rabbit encephalitis that cannot be diagnosed by examination of the spinal fluid. The little that is known of the influence of a new infection over an old-standing cerebral infection does not necessarily indicate an activity in the sense of an activation; rather does it point the other way.

Dr. Schaefer, Würzburg: In the last few years there have been observed a number of cases of inflammatory diseases of the central nervous system which showed great similarity to known diseases (amyotrophic lateral sclerosis, spinal muscular atrophy, multiple sclerosis, etc.), but differed from them in their peculiar course. In the majority of cases, preceding the acute onset there was a diminished body resistance (angina, getting wet, mild infections, etc.). Most often it was accompanied by an early ocular disturbance: ocular muscle paresis, neuritis optica, neuritis retrobulbaris. The accessory cavities of the eye are held to be the path of infection. The observed cases showed a tendency to recovery. In those that came to postmortem study a large thymus was found. Probably this organ exerts considerable influence on the course of the disease.

Dr. F. H. Lewy, Berlin: A purely topical classification of diseases has remained longer in neurology than in any other branch of medicine, because here, even in many cases of most probable infection, no inciter is known. Even then, the desire to advance leads to an attempt to consider clinically such heterogeneous diseases as epidemic encephalitis, poliomyelitis and rabies as biologically related. The things that they have in common are considered as neurotropism, invisibility, filtrability, etc. While this would not offer an etiologic division, it would permit a pathogenetic grouping. Some point out that such a division is yet unworkable, since there is no principal difference between the filter and the invisible virus and the bacteria; one can be carried over into the other. There are no individual spontaneous virus encephalitides in laboratory animals. As long as the genetic and biologic basis for the classification of diseases remains uncertain, it is best to keep to the clinical division of diseases of the nervous system.

Dr. Economo, Vienna: A number of cases from the large groups of non-suppurative infectious encephalomyelitis (occasionally epidemic) became clearer as a result of knowledge obtained from epidemic encephalitis. There remains, however, a number of cases that are not epidemic encephalitis and yet are acute infectious diseases of the nervous system. If a few of them are multiple sclerosis there still remain enough other cases that are not multiple sclerosis, an argument for which lies in the appearance of the condition in epidemic form. The increasing number of cases of encephalomyelitis reported by Pette and Redlich suggests that here also there is a particular infection of the nervous system. Present knowledge of bacteriology cannot explain epidemic encephalitis. In addition to bacterial factors, there probably also enters into action a new biologic principle. The reasons why at present the diseases that are not epidemic encephalitis and still belong to infectious diseases of the nervous system (para-encephalitis) are observed in increasing number may depend on the presence of this new biologic agent, which increases the susceptibility of the nervous system to infection.

Dr. Kafka, Hamburg: Difficulties are encountered in biologic studies on the problems of infection and the central nervous system in relation to animal experimentation and the immunobiologic serum phenomena. Any assistance is to be welcomed, and the investigations on the question of protective activities of the cerebrospinal fluid are not to be forgotten. Plaut and others seem to have shown that the cerebrospinal fluid has a mildly protective action but that it differs qualitatively from serum activities. A study of the globulin relation made it possible to recognize different types of cerebrospinal fluid changes. Study along this line will undoubtedly clarify many pathogenetic problems.

NEW INVESTIGATIONS ON THE CONTAGIOUS DISEASES OF THE BRAIN AND INFLAMMATION OF THE CORD (BORNA'S DISEASE) OF THE HORSE. W. ZWICK, Giessen.

The study of epidemic encephalitis in the human being gave impetus to the study of Borna's disease in the horse. There are many points of similarity in the two diseases. Borna's disease has been observed in Germany for many years. Year in and year out it appears in certain localities, with variable severity, so that in some years it spreads over larger areas. Its course is cyclic. In the first part of the year only a few cases are observed; toward the end of spring and in the summer it reaches its maximum, then gradually the number of cases diminishes; in the last three months of the year it almost entirely disappears. It is also to be noted that horses working on farm land are more often affected, while those used for city work and military purposes are more seldom affected and even then only when they are out in the country, as during maneuvers. Age, sex or race bears no influence on the onset of the disease.

So far nothing definite is known regarding the cause and conditions of Borna's disease. According to prevailing opinion the disease is not transmitted from animal to animal. It is rather assumed that the inciter is bound to definite localities and that the infection comes from without, e. g., may be from the stable or from the soil, or that it comes with the food and water. Nothing definite can be said regarding the incubation period.

The symptomatology varies, but is controlled essentially by manifestations of psychic depression. Certain gastro-intestinal manifestations usher in the disease. Among the early manifestations are fatigue, slowness and a dulling of sensibility, which in course of time comes to definite somnolence. Excitability is less often observed. More often the animals stand obliquely in the stall, the head bent deeply down to the floor, resting on the crib or against the wall. Conditions of excitation up to mania and attacks of frenzy may be observed in the early stages. In this stage there may be hyperesthesia; later an increasing hypesthesia sets in.

In addition to psychic disturbances, there develop mainly motor disturbances. Often forced movements are observed, such as riding, and movements of the upper part of the body. Disturbances of coordination and equilibrium, as well as attacks of vertigo, are often present; fibrillary and muscular twitching may be noticed. In some cases there is rigidity of the neck. In advanced cases paralysis of variable intensity and distribution develops as a result of involvement of the brain and of the cord.

The temperature curve is atypical. At the beginning of the disease it is slightly elevated, and it may not reach much above normal during the disease. The duration of the disease is usually from one to three, seldom from four to six weeks. The mortality is from 80 to 90 per cent. In cases of recovery it may be followed by chronic disturbances of sensibility, amaurosis, amblyopia or localized paralysis. Therapy has not given much assistance in this disease.

Macroscopic postmortem observation offers nothing characteristic either in the central nervous system or in other organs. Histologic studies of a case led Drexler and Oppenheim to designate this disease as meningo-encephalitis and myelitis. Joest, Degen and Semmler deserve the credit for explaining the pathologic histology of Borna's disease, making a specific histologic diagnosis possible. It is a disseminated encephalitis lymphocyterica, which is bound mainly around the blood vessels and develops in the olfactory bulbs in the caudate nucleus, and in Ammon's horn. The vascular infiltration consists mainly of lymphocytes, with polyblasts and a few plasma cells. Joest and his co-worker described, as a specific picture, acidophilic, round or diplococcus-formed nucleus-containing bodies possessing a capsule. But Joest was unable to state what these bodies are.

As regards the etiology, different investigators have agreed that the microorganisms (cocci) found in this disease are not to be considered as a factor in the etiology. More information was gained from inoculation of rabbits with the brains of diseased horses. The inoculation was successful in attenuations of

1 : 100,000. Further investigations led to the fact that the disease is caused by an ultravisible, glycerin-fast virus. Subdural or intracerebral inoculation of rabbits is nearly always successful, as in hydrophobia. The disease can also be transmitted to rabbits by corneal, intra-ocular, cutaneous, subcutaneous, intraperitoneal, intraneural and intravenous inoculation. It was also possible to transmit the disease back from the rabbit to the horse. It was possible also to transmit the disease to guinea-pigs, rats, chickens, monkeys (*Macacus rhesus*) and sheep.

It is to be noted that spontaneous rabbit encephalitis plays no part in experimentally produced Borna's disease in this animal. Histologically the conditions are entirely different. Also the constant incubation period and duration of the disease, the typical clinical symptoms, the immune biologic relations in experimental Borna's disease and finally the ability to restransmit the disease from the rabbit to the horse offer the distinguishing points between the two diseases.

The incubation period in the artificially infected rabbit is about three weeks; the disease lasts about from ten to fourteen days; in an intracerebrally infected horse, the incubation period is about from four to eight weeks; the duration of the disease under ordinary circumstances is from one to three weeks. The proportionally long incubation period in intracerebrally inoculated horses permits the conclusion that the ordinary period between infection and the appearance of symptoms is some months, similar to the observation in hydrophobia.

In regard to pathogenesis, the fact that the olfactory bulbs and tracts are always affected led Joest to conclude that the infection comes through the nasal cavities and the olfactory nerves, especially through their lymph channels. This has been substantiated by others, although later investigations show that it is not exclusive. Investigations by Nicolau and Galloway, as well as by myself, indicate that the virus of Borna's disease is not only centripetal in its course, following the nerve tracts from the periphery, but it also passes centrifugally from the brain to the entire body, following the nerve tracts. After cerebral inoculation of rabbits, the virus and the changes it causes are found in the cord, in the spinal ganglia, in the paravertebral ganglia and in the facial, trifacial, optic and other peripheral nerves. This indicates that the inflammatory process originally attacks the nerves and from there gradually extends peripherally.

The virus is carried along the nerve tracts to different organs. It is found in the salivary glands, the pancreas, the suprarenals, and the testes. Perivascular infiltrations are found in these organs. The characteristic histologic changes are also observed in the mesenteric and the aortic plexus, in the pulmonary, peribronchial and intracardial ganglia, and in the nerve cells of the intestinal wall and stomach. The virus of Borna's disease, like that of hydrophobia, brings about a generalized involvement through the nervous system, and all nerve elements, especially those of the glands of internal secretion, are affected by the virus. Nicolau and Galloway therefore speak of it as a "septicemia of the nervous system." The generalized spreading of the virus explains the presence of a number of associated symptoms in addition to the chief cerebral ones.

The natural transmission of the disease is intimately connected with the mode by which the virus leaves the animal body. Experiments have shown that the saliva from animals affected with Borna's disease contains the virus, which may be transmitted to the rabbit. Similarly, the disease may be brought on by a subcutaneous injection of the nasal secretions from affected animals. So far it cannot be told whether the virus leaves the body in any other way, except that food contaminated with nasal secretions from infected animals will bring on the disease.

Although, according to the experiments quoted, it would seem that the natural infection is rhinogenous or per os, a number of experiments contradict this assumption. After a large number of infected rabbits and rats were kept together for months with healthy ones, I found four rabbits and two rats affected with the disease after an incubation period of from thirty-three days to four months. This would indicate that Borna's disease is spontaneously transmitted from animal to animal.

Regarding immunization, I have found that rabbits and horses subjected to subcutaneous injections of brain emulsion from rabbits affected with Borna's disease acquire an active immunity, which is effective even when there is present a massive intracerebral infection; the disease develops promptly in control animals. The protective vaccination may be attained by one vaccination. The protection lasts for at least sixteen months. I have been able further to show that serum from animals immunized with Borna's virus is capable of neutralizing the virus in vitro.

Experiments carried on for therapeutic purpose have so far yielded no results.

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S. PHILIP GOODHART, M.D., *Vice-President, in the Chair*

ENCEPHALOGRAPHIC STUDIES IN THE IDIOPATHIC VARIETY OF CONVULSIVE STATES. DR. JOHN Y. NOTKIN.

The interpretation of encephalograms is difficult, since as yet no norm is established. I do not think that postmortem encephalographies on persons who died from a cause other than diseases of the brain will help to clear up the problem, particularly if the encephalographies are not performed immediately after death. I believe, however, that encephalograms of persons in whom pathologic changes in the brain are suspected but not found (cases reported in the literature) may be utilized for a comparative study. I do not think that similar studies in schizophrenia will be helpful, as the conditions observed in cases of deterioration are similar to those seen in cases with "pathologic" changes.

For this study, cases without definite neurologic signs were selected, as it was thought that it is of great importance to establish the pictures observed in this particular group known as the "idiopathic variety of convulsive states," in which the question of pathology is still a matter of controversy. The material consisted of a group of seventeen patients. All except two were more or less mentally deteriorated. Patients aged over 50 were excluded to avoid the possibility of senile atrophy of the brain.

In eight cases the encephalograms seemed normal. In four cases, striking dilatation of the ventricles and an unusual accumulation of air in the subarachnoid spaces were noted. In the five last cases, in some instances, no traces of ventricles, but large accumulations of air over the hemispheres were seen. In others again, asymmetrical ventricles or something suggestive of leptomeningeal adhesions were noted. In cases with normal pictures, practically all the air disappeared in twenty-four hours; in cases with dilated ventricles, air was still present as long as two hundred and sixteen hours after the encephalographic procedure. No correlation could be established between the amount of air injected and the degree of ventricular dilatation or between the degree of deterioration of the patients and the encephalographic observations.

Preliminary roentgenograms were taken in a number of cases. In these roentgenograms, shadows in the occipital region resembling those in the encephalograms were seen. This, however, was not constant. In all cases with accumulation of air in the region of the main pacchionian bodies, a similar shadow was always present in the preliminary roentgenograms.

DISCUSSION

DR. E. D. FRIEDMAN: My experience with encephalography in epilepsy is in large part in harmony with what Dr. Notkin has presented. I, too, have had some instances in which we were unable to demonstrate striking changes in the ventricles or in the subarachnoid spaces. All writers on the subject have mentioned

this fact, but at times—I speak from an experience covering more than fifty cases of idiopathic epilepsy—most of the cases do exhibit internal or external hydrocephalus, or both.

It is true that in a certain number of cases no air reaches the ventricles. We encounter this anomalous feature fairly often. It is not safe, however, to deduce therefrom that the foramina of Magendie and Luschka are necessarily closed; in a second encephalography, we were able to fill the ventricles from below. There may have been a sort of ball-valve action of the foramina, and the primary failure to fill the ventricles may be explained by such an anomaly.

Failure to correlate the clinical with the encephalographic observations in some instances does not militate against the value of this method, because, after all, pathologic processes do not follow with the same rate of speed in all persons. If in a large majority of the cases one observes changes in the ventricular system or the subarachnoid spaces, one may make the fair assumption that these changes are in some way related to the condition. It is important to state in this connection that the encephalographic observations in epilepsy are not greatly different from those in degenerative or vascular diseases of the brain, in encephalitis or in the traumatic neuroses. As I have said on another occasion, the similarity in the encephalographic observations in all these instances would seem to suggest a common underlying cause similar to that suggested by Spielmeyer, namely, necrobiotic changes on a vascular basis—in the case of degenerative disease from actual disease of the blood vessels, and in the other instances, from functional vasomotor changes.

The fact that vasomotor changes do occur in the blood vessels of the brain has been proved by the recent work of Forbes and Wolff, at Harvard, and has been referred to in the literature for many years (Nothnagel, Hughlings Jackson, Gowers and Pal). Sudden blanching of the brain at the onset of a convulsive seizure has been observed by Forster in Breslau, and by Foster Kennedy in this country. I believe, therefore, that vasomotor changes in the brain are responsible for the seizure, and if these vasomotor changes occur frequently enough there are changes produced in the brain, the results of which are seen in the encephalogram. Some cases may not demonstrate this final change for many years. In other cases the changes manifest themselves early in the course of the disease. In our series, there are patients who have had epilepsy for periods varying from five to fifteen years, and in 90 per cent of the cases changes in the encephalogram could be demonstrated.

The lighter areas at the vertex of the skull and in the occipital region, of which Dr. Notkin spoke, must be evaluated with great caution, because in a great many normal persons, one finds variations in the density of the bones. Most roentgenologists agree that it is hazardous to consider these lighter areas as defintely pathologic.

I can corroborate Dr. Notkin's statement concerning the disappearance of the air; within twenty-four hours, and occasionally within twelve hours, no air can be demonstrated in the subarachnoid space. This confirms the notion of Weed, Dandy and others concerning the great absorptive power of the channels on the convexity of the brain. The air remains in the ventricles for much longer periods; in one instance, air was found in the ventricles nine days after its injection by the lumbar route. It is also true that the second day plates are at times more instructive than those of the first day. One often sees more air in the ventricles on the second day; in some instances there appears to be a temporary hydrocephalus with obscuration of the normal butterfly figure. This disappears within two or three days.

I wish also to emphasize that in patients with epilepsy there are no bad effects in the wake of encephalography. In fact, most patients with degenerative disease of the brain stand the procedure well. The concomitant phenomena are few, and the after-effects, such as nausea and vomiting, are also little in evidence; usually the patient is comfortable within twenty-four hours.

I think that one must evaluate the so-called surface markings with a great deal of caution, and one must not read undue significance into them. It is a bit

premature to ascribe etiologic significance to these accumulations of air on the surface of the brain. I should be inclined rather to argue the other way around, namely, that these accumulations of air on the surface and in the interior of the brain are the results of antecedent pathologic processes and that the air collects in areas which are distended with fluid as a result of atrophy of the brain. The disease process which serves as the basis for the epileptic seizure is not yet known.

I shall show the encephalograms from a case of epilepsy made within the last week. The patient, a young man, had suffered from idiopathic epilepsy for five years or more. There were no organic signs, and yet the encephalogram showed the presence of internal and external hydrocephalus. Plates were taken both in the recumbent and in the sitting position. The former possibly showed a little greater accumulation of air in the sulci, but there was no striking difference between the two sets of plates. In this case 104 cc. of air was injected. It would seem that these are the ultimate results of a process that has gone on for some time, which I believe, eventually will prove to be angiospastic.

DR. RUSSELL G. MACROBERT: I think it would be well if Dr. Notkin would call attention more emphatically to the fact that this work was done with institutional cases; it would be more complete if he would make encephalograms in another series of patients who were not subject to epileptic seizures. He did not draw any deductions as to the cause of convulsions and probably does not care to. My opinion is much the same as that expressed by Dr. Friedman, namely, that encephalographic abnormalities are permitted by some secondary degeneration or innate defectiveness in the myelin or other tissues of the brain of the epileptic patient, and therefore are merely concomitant.

DR. M. NEUSTAEDTER: I have films of a case that may have some bearing on the question, particularly as to the so-called hydrocephalus. This is the case of a man, aged 46, suffering from typical jacksonian epilepsy on the left side, without loss of consciousness. As a child he was struck on the right parietal region and retained a scar. He had been well until four years before examination, when he suddenly became paralyzed on the left side; he did not lose consciousness. In the Neurological Hospital at that time he had two convulsive seizures limited to the left side. Since then, he has done light work at the Home as a dishwasher and waiter. About four months ago, convulsive seizures, typically jacksonian in form, again set in, being as frequent as from ten to twenty a day. He would have two or three during an examination. When first admitted, 15 cc. of spinal fluid was withdrawn and the seizures abated for a few days to about five daily. They then set in again with the usual frequency. We then withdrew 113 cc. of fluid and injected 103 cc. of air. The roentgenogram before insufflation shows a distinct parietal defect on the right side. After the injection of air the films, made immediately, showed tremendous distention of the right lateral ventricle, indicating a hydrocephalus. The distention is not as large in the erect as in the prone position, probably because the erect was taken first; then the air content expanded, because of the body heat, before the prone position was filmed. The interesting feature of the case is that ever since the insufflation of air, six weeks previously, he has not had a single attack. I believe that the thorough evacuation of the fluid from the ventricles contributed more to the cessation of the seizures than the insufflation of air. As to the underlying pathologic process, I believe that it is an old meningo-encephalitis. It is well established that enlarged ventricles do not occur on the side of the trauma. This case fully sustains the theory, although many years elapsed between the trauma and the paralysis with the epileptiform seizures. Wassermann tests with the blood and spinal fluid gave negative results, and the man said that he had had no venereal disease. The patient refused surgical intervention because the seizures stopped.

DR. CHARLES ROSENHECK: While Dr. Notkin has been very conservative in his deductions from the series of interesting plates he has shown, is it fair to make any deductions from institutional material, in which there are often late degenerative changes in the brain? If one takes a series of cases of the average patients with epilepsy, one does not find these ventricular dilatations and col-

lections of air on the surface and all the other changes which Dr. Notkin has shown so vividly in his plates. In other words, the average patient with epilepsy shows a normal encephalogram. My experience has been limited to six cases, and that is possibly too small a number to speak about, but these were essentially patients with idiopathic epilepsy, who showed normal encephalograms. If one tries to interpret plates from a patient with epilepsy who has been sent to an institution, and in whom there are marked changes in the parenchyma of the brain, one must be cautious. I do not say this in a spirit of criticism, as Dr. Notkin has already touched on that point.

Dr. Friedman observed that the average encephalogram shows initially dilatation, and then on the second or third day the dilatation is less, due to the absorption of air. In other words, he explains this as a distention of the ventricular spaces by the injection of air which should be disregarded. Is it not possible that a day or two later there is less air in the ventricles than initially? When there is less air in the ventricles one is apt to think that there is no internal hydrocephalus, and thus miss an important deduction which can be made only from the first encephalogram. I wish Dr. Friedman would touch on this point.

DR. E. D. FRIEDMAN: The normal "butterfly" figure was obtained on the first day; on the second day, this figure had entirely disappeared. The interpretation of the encephalogram depends, however, on the initial readings immediately after encephalography.

DR. CHARLES ROSENHECK: You seemed to stress that the reading was more important two or three days later. In view of the continued absorption of a fair amount of air, such an inference would not give a true estimation of the ventricular cavities, and therefore would be untrustworthy.

DR. E. D. FRIEDMAN: I referred to the distention of the ventricles on the second day. The initial reading is made from the butterfly figure. On the second day, we find that the butterfly figure has disappeared, but we do not make use of that plate for clinical deductions. The latter are made on the basis of the first plate made about thirty minutes after the injection of air.

DR. JOHN Y. NOTKIN: To answer Dr. Friedman, I think that I emphasized that we are careful in the interpretation of shadows in the occipital region. As I have stated, I saw the same shadows in the preliminary roentgenograms, but not in all instances. The shadow in the region of the main pacchionian bodies, however, seems to be always present in the roentgenograms when it is seen in the encephalograms. I again emphasize the difficulty in the interpretation of these observations on account of the complicated physical laws involved. As to the reaction of the patients during and after the encephalographic procedure, they did not always react well; sometimes they were comatose for forty-eight hours and longer; at times we were much worried over the outcome; however, none of the patients died immediately after the encephalography. I think, however, that the meningeal irritation could be diminished if a lesser volume of air were injected than the amount of fluid withdrawn, as air expands at the body temperature and thus probably adds to the meningeal reaction.

In the twenty-four hour encephalograms with the so-called normal observations, air was absent or only traces were seen. In the cases with dilated ventricles, air was still present even two hundred and sixteen hours later; in the latter cases, the twenty-four hour encephalograms were clearer than those taken immediately after the injection of air.

To answer Dr. MacRobert, I am aware of the need of a comparative study. I referred to this in my report. I pointed out that Jacobi and Winkler (*Arch. f. Psychiat.* **81**:299, 1927) reported a number of encephalograms taken in cases of schizophrenia, and in advanced deteriorated cases, the encephalograms looked exactly like those which we consider "pathologic," namely, with dilated ventricles and a large accumulation of air in the subarachnoid spaces. Comparative studies are useful, but for the time being, we are interested in the idiopathic group on account of the controversy concerning its pathology. There is also another

factor; one can secure permission to perform encephalography on patients with epilepsy but not on patients with manic-depressive psychosis.

Replying to Dr. Rosenheck, I shall repeat that not all encephalograms taken on patients with convulsive states are normal. In our group we believe that 47 per cent are normal; the rest are pathologic. I should not use the word "pathologic," perhaps, but the encephalograms certainly look different from those I showed you in the first group. I should not care to draw any conclusions or to express any opinion at present as to the pathology in the idiopathic variety of convulsive states.

PRIMARY MELANOBLASTOSIS OF THE MENINGES AND BRAIN. DR. FREDERIC J. FARNELL.

Clinical History.—A man, aged 16, passed through an uneventful childhood and early adolescence until the age of 14. Mentally, he had shown moderate retardation, as indicated by the school record and by an emotional instability. At the age of 14, he began to display minor deviations in conduct, which soon became more serious and necessitated commitment to a correctional institution. He remained there for about one and a half years when he was paroled to the care of his mother. His behavior at home was such that return to the institution was found advisable. There an abrupt change in the condition was noted. He suddenly became drowsy and subject to recurrent generalized convulsions. The body temperature rose to 101 F. A lumbar puncture revealed xanthochromic fluid, and it was thought that he was suffering from either acute epidemic encephalitis or some undetermined form of meningitis. He was transferred to a general hospital. He was drowsy and somewhat confused; in transient, more or less alert moments he complained of intense headache. Many pigmented moles were distributed irregularly over the body and extremities. Localizing neurologic signs were at first meager; they included a slight supranuclear facial weakness on the right side, depressed knee and ankle jerks, bilateral ankle clonus, depressed abdominal reflexes and absent cremasteric reflexes. These observations were regarded as manifestations of a diffuse meningeal process, as there were no signs pointing to a discretely localized cerebral or cerebellar lesion.

In the course of a few weeks, there was a rapid unfolding of the clinical picture. The patient deteriorated mentally and became apathetic and disoriented; the pupils became unequal, the facial weakness was more pronounced, the tongue deviated to the right, the knee jerks became unequal (ankle clonus disappeared) aand a tremor of the left arm appeared. Lumbar punctures were repeatedly made, and with each removal of cerebrospinal fluid the objective signs increased in number and intensity. Convulsive seizures reappeared and became more frequent. Dysarthria was followed by anarthria; internal and external ophthalmoplegia of the right eye developed. Toward the end, a mild bilateral elevation of the disks and a flaccid paralysis of the left upper and both lower extremities appeared, with complete loss of all deep and superficial reflexes. The patient died of a terminal pneumonia (four weeks after the onset of the acute symptoms).

Comment.—No definite diagnosis was made, because of the unusual clinical course and the dissemination of objective signs. A tumor of the posterior fossa, however, was predicated, though the late development of papilledema spoke against it. Tuberous sclerosis was also considered as a possibility because of the dissemination of signs, their association with convulsions and the manifestation of increased intracranial tension in a young man who was mentally retarded. Both diagnostic possibilities, though not substantiated by the necropsy, were justified, as will be gathered from the anatomic, histopathologic distribution of the lesions.

Gross Anatomy of the Brain.—The brain weighed 1,480 Gm. It was somewhat injected. The ventral surface of both cerebellar lobes was covered by a thickened pia-arachnoid. The thickening extended to the region of the cisterna magna and down over the cervical segments of the spinal cord. The thickened meninges were brownish black and of firm consistency; they covered also the ventral surface

of the medulla, pons and interpeduncular space as far as the anterior aspect of the chiasm. In the region of the cisterna magna, there was a large cystlike expansion, the size of a baseball, filled with a brownish, thick fluid. This pseudocyst collapsed on removal of the brain and was found to be little more than an expanded cisterna magna, bounded by a thickened and infiltrated arachnoid. The left lobe of the cerebellum was somewhat distorted and appeared softer than the right. The right lobe was unaltered.

Microscopic Anatomy.—Sections of the soft meninges in the region of the pseudocyst showed marked thickening; no division between pia and arachnoid could be made out. The infiltrating neoplastic tissue brought about a fusion of the two membranes and removed all lines of separation. It was possible, however, to identify in the infiltrated meninges several distinct zones such as an outer pigment layer, a zone which bore a resemblance to the histologic structure of a benign meningioma or fibroblastic endothelioma, and a third zone consisting of closely packed tumor-cell nests assuming an alveolar arrangement of a rather characteristic appearance. The infiltration of the meninges followed the extensions of the membrane into the fissures of the brain substance and along the penetrating pial vessels into the substance itself. The character of the cells which were found along the pial vessels differed somewhat from the cells in the meninges covering the cerebral surface. In the former location they assumed a cuboidal character. Where the extensions into the brain substance were only slight, as in some of the cerebellar regions, the cell type reverted more to the one described in the third zone in the infiltrated meninges.

In the brain substance the histologic picture showed also several types of alteration; in a section from the pons, there were aggregations of tumor cells of an epithelial character. They were found here arranging themselves about the small blood vessels and following the course of these vessels. In such locations pigment material was rather strikingly sparse. At a short distance from the foregoing area, an entirely different picture was found. Here were seen numerous pigment-laden cells, true tumor cells, rounded or irregular in outline. Among them there were glia cells that apparently had phagocytosed pigment material and had assembled it in the periphery of the cell body. The glia cells were easily identified first by their protoplasmic processes, and second by the arrangement of the pigment material at the periphery of the cell body; in the tumor cells the finer structure was completely submerged under a thick covering of the pigment. Occasionally, pigment cells with branching processes having the outline of a chromatophore were found in this area.

DISCUSSION

DR. S. T. ORTON: Can one definitely locate the primary source of the tumor? Dr. Farnell has presented it as primary in the meninges and brain, but he has also given a striking description of pigmented nevi of the skin over the body. These are notoriously the source of metastases of pigmented tumors. Moreover, they are notoriously apt to give rise to metastases from a relatively small primary tumor. There are four groups of primary tumors from which such masked metastases may derive: (1) in the thyroid, from which metastatic tumors are apt to arise with the primary tumor so small that it is difficult to recognize without the study of many sections; (2) in the suprarenal, where a small hypernephroma is apt to give rise to extensive metastases; (3) the tumor which Dr. Farnell has described, and (4) tumors arising from the bronchi. I performed an autopsy at the Neurological Institute recently, in which the original tumor was an oat cell carcinoma of the bronchial wall; the primary growth was about the size of the terminal joint of my little finger. It was entirely overlooked in the gross at autopsy, and was discovered only after the sections had been seen, and the gross material was again gone over. In the brain, however, there was extensive metastasis. There were two masses in the cerebellum, one on either side, which must have occupied 2 or 3 cubic inches, and forty or fifty metastatic nodules in the brain proper, which together made up a very large total mass. Consequently,

one must be a little cautious in speaking about the primary nature of these tumors without an extensive study of the pigmented moles. Dr. Farnell has not reported the histologic condition of the moles. Does he think that they were adequately covered from that standpoint?

In a discussion of tumors one is always faced with the question as to the origin of the tumor process itself. Two views may be followed: (1) That of involution, which raises the question whether or not the adult cell may revert back to a younger form. It is easily demonstrable that many cells undergo a certain degree of such a retrograde process when they respond to the stimulus of inflammation. (2) That of Cohnheim, which regards tumors primarily as the development of cells that have been left behind in an embryonic, undeveloped condition. Either of these views may explain the sequence observed in most tumors composed of cells of all degrees of differentiation.

One is prone to look on pigmented cells as chiefly residents of mesodermal types of tissue, but there are certain other cells in which pigment may occur, notably in the substantia nigra of the central nervous system, where the nerve cells are laden with a black pigment of the same type as melanin. Further, one finds pigment deposits in the true epithelial tissues of the skin in heavily pigmented races, and not only in the central sheath of the hair, which is of mesodermal origin, but also in the hair scales which are of ectodermal origin. One sees them also occasionally in the negroid intestine, where there may be a considerable degree of pigment accumulation in cells derived from the entoderm. Hence, apparently pigment may develop in cells from any of the three embryonal layers. Its production in the meninges as a primary growth, I understand, refers back to the chromatophores of the meningeal spaces. Will Dr. Farnell state whether, in his preparations from the tumor, the character of the pigment was compared chemically with the melanin characteristic of the chromatophores in the normal brain. The pictures which he showed of the brain substance of the patient were particularly interesting from the standpoint of the rather striking limitation of metastatic growth to tissues of the same origin. Where one finds a tissue of mesodermal origin invading the brain, it rarely invades anything but mesodermal structures, so it is rather suggestive of a mesodermal origin of these pigmented cells. One sees the same situation in acute meningitis in which, until the wall is broken down, the leukocytes (cells of mesodermal origin) are strictly limited to the Virchow-Robin spaces and do not get out to the ectodermal tissues until there has been degeneration of the internal limiting membrane of the glia. It would seem logical to think that this is suggestive evidence that the pigmented cell is of mesodermal origin in this case.

DR. J. H. GLOBUS: Dr. Orton has raised the question as to the primary or secondary character of melanotic tumors involving the meninges. I think that all pathologists have come to believe that primary melanoblastoma may exist in the central nervous system independently of any other melanotic tumor elsewhere in the body. There are twenty-two cases on record now which are regarded as primary melanoblastosis of the meninges. The first was described by Virchow, in 1859, who based the diagnosis of a primary melanoblastosis on the fact that he found a melanotic tumor nowhere else in the body; he supported his observations by the contributions made by two other observers that chromatophores are found in normal meninges. He looked on this type of tumor as a good example of the evolution of a malignant tumor from the normal constituents of a given structure. Peculiarly enough, most of the melanotic tumors have been described by masters in the field of pathology; a few have been studied under the guidance of an authority in pathology. Recently, a case was desribed by a pupil of Lubarsch, whose work on melanin is well known. Ribbert, at one time, expressed the opinion that most tumors that appear to be primary in the meninges are secondary to tumors elsewhere, particularly in the pigment layer of skin and eye, and in the suprarenal gland. Later, he changed his mind and inclined to the belief that primary tumors of the meninges of this type do occur, and most likely take origin from the chromatophores that normally occur in the meninges. Until recently, it

was believed that chromatophores become apparent only in postnatal life, about the age of 7 or 8 years. I have been able to find chromatophores in much earlier stages even than the one shown by Dr. Farnell (a child aged 2 months). I have found them in a fetus aged 5½ months. Apparently, chromatophore formation in the meninges occurs very early in development.

What is there to prove that this case is a primary melanoblastosis of the meninges, particularly in the presence of numerous pigmented moles? It is said that pigmented moles may appear silent and dormant, and still be capable of metastasis. There is no way of proving that they are capable of metastasis, or that they are permanently dormant. Furthermore, one can say that pigmented cells may exist in small collections without being noticed; the body is too large for anyone, even the most experienced pathologist, to see every pigmented bit so as to exclude that as an origin of a tumor. In this care, a study of the histology of the meninges, the variations in cell types in the neoplastic spread, and the variations which simulate the ordinary endothelioma of the meninges make one realize that this is a process in the meninges, the primary process having developed from cells capable of elaboration of pigment material, cells which are found normally in the meninges.

Another point mentioned by Dr. Orton was that the tumor has infiltrated the brain along the blood vessels. Practically every secondary process which reaches the meninges first and then spreads to the brain enters the brain substance in that way, along the Virchow-Robin spaces. Whether the primary tumor is ectodermal or mesodermal makes little difference; the tumor will penetrate the brain by way of the Virchow-Robin spaces.

There is one distinct point of differentiation between a metastatic melanoma of the brain and primary melanoblastosis of the brain. Secondary metastatic melanoblastomas (I prefer the term melanoblastoma since one is not sure whether they are melanosarcomas or melanocarcinomas) usually form a single, large mass without apparent involvement of the meninges. In the case of Dr. Farnell, the meninges were primarily involved. The brain showed only secondary, disseminated invasion in the form of narrow zones of pigmentation. The tumor infiltrated the brain by way of the blood vessels, and caused no single massive accumulation. From the sections shown, I am convinced that this is an instance of primary melanoblastosis of the brain and one of the few cases of this type of primary lesion of the meninges.

DR. S. PHILIP GOODHART: Do these primary lesions of the brain form metastases in other parts of the body, either in the case reported or in those previously reported?

DR. FREDERIC J. FARNELL: This primary melanoblastosis did not form secondary metastases in other parts of the body, either in my case or in the preceding ones reported.

In reply to the questions of Dr. Orton: The moles were studied carefully by three pathologists; they all came to the same conclusion, that they were inactive. The chromatophores are in the process of study at this time.

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MOSES KESCHNER, M.D., *President, in the Chair*

EPILEPSY WITH COINCIDENT VAGOTONIC SYMPTOMS. DR. E. D. FRIEDMAN.

That the autonomic nervous system is frequently disturbed in persons with epilepsy has long been known, and a large literature has grown up on this subject. Russell (1906) found cessation of the pulse at the onset of an epileptic seizure. Guillaume described dermographic skin reactions coincident with a fall in blood

pressure. Loewy (1922) considered both migraine and epilepsy as expressions of a vegetative disorder. Tracy (1906) also thought that essential epilepsy was due to a disturbance of the sympathetic nervous system. Roubinowitch and Chevany made use of the Aschner sign and obtained a slowing of the pulse in twenty-five of eighty patients. Vergara (1922) found changes in the oculocardiac reflex immediately after the seizure. Boulton (1924) also found an increased oculocardiac reflex just before and during the seizure. Felsani (1924) considered the purely epileptic person as having vagotonic symptoms, while others considered him as having sympatheticotonic symptoms. Barnes (1926) described fifteen cases in which the convulsions were associated with paroxysmal tachycardia. Lennox and Cobb thought that the changes in rhythm of the heart were the effect rather than the cause of the seizures. They found that electrocardiographic records carried out during a petit mal seizure showed no deviation from the normal. Similar observations were made by Munson and by Gibson, Good and Penney. Frisch (the most recent writer on the subject) thought that organic epilepsy, which develops on the basis of disease in early childhood, is usually accompanied by vagotonic symptoms. In the postparoxysmal state the vagus dominates, as in sleep, and the sensitiveness to epinephrine diminishes after the attack in more than half of the cases. The predominant discharge during the seizure, however, is sympathetic. In the interval between seizures one finds mixed states. Hence, one may conclude that many patients suffering from epilepsy present evidences of autonomic imbalance.

I have had occasion to observe a number of cases in which, contrary to the usual incidence of sympathetic phenomena during the seizure, the symptoms were altogether vagotonic. I am not referring to the so-called vasovagal attacks of Gowers, but rather to distinct vagotonic crises. Nor am I concerned with the symptom complex of neurocirculatory asthenia with splanchnic dilatation and faintness.

The symptoms of vagotonia include small pupils, salivation, vomiting, perspiration, bradycardia, cold clammy hands and feet, hyperacidity, cardiospasm, pylorospasm, spastic constipation, enuresis and increased frequency of urination (similar to the vagotonic state of the child with its increased "tolerance" for atropine).

Case 1.—J. B. H., a boy, aged 19, who was seen in August, 1920, was a premature infant (7 months) whose mother had been treated for syphilis. He had been delicate up to the age of 1 year. The present illness began with attacks of so-called indigestion, with severe constipation and a decrease in pulse rate to 48 per minute. The pupils were small during the seizures. The attacks were accompanied by dizziness; "things got black before his eyes," and the patient fainted. The patient also wet the bed. He had a number of these "spells." A general medical examination revealed no abnormalities except for a fetor ex ore which was more pronounced during the attacks. Roentgen examination of the skull gave normal results. There were pronounced sinus arrhythmia and evidences of status lymphaticus. A Wassermann test of the blood was negative.

Case 2.—I. K., a post office clerk, aged 19, who was seen in August, 1921, had had enuresis up to the age of 6. He suffered from attacks of dizziness and fainting every two weeks. The heart rate became slow during the seizures (60 per minute). The patient presented no abnormalities in the neural status, but medical examination revealed an extrasystolic arrhythmia and evidences of status lymphaticus. At the time of the seizures, the patient also was severely constipated.

Case 3.—M. S., a student, aged 17, who was seen in January, 1923, and whose family and previous history were without significance, had fainted at the table and experienced "chilliness," three weeks prior to being seen by me. The night before the examination, he had a similar spell. He also exhibited increased frequency of urination and severe constipation. He showed a bradycardia (pulse rate, 60) with marked vagus arrhythmia. The neural status revealed no abnormalities.

Case 4.—W. L., a student, aged 17, who was seen in December, 1929, had had rickets at 16 months, and tuberculous adenitis at 8 years of age. He had been delicate and subject to hives. For two years he had been having spells in which

he first noticed impairment of vision; this was quickly followed by headache, numbness in the right upper extremity and trembling of the right hand; it seemed as though the "face and tongue were going to sleep." The symptoms subsided and left him with a headache and mental sluggishness; he was forced to remain in bed for a week afterward. He had six of these spells. At the time of the seizures the pulse rate became very slow (50 per minute). The patient was tall and of the thymic type. At the time of examination there was slight right facial weakness and diminution of the abdominal reflexes on the right. Roentgen examination of the heart revealed no abnormalities and electrocardiographic studies gave negative results. A Wassermann test of the blood was negative.

CASE 5.—P. P., a laborer, aged 30, who was seen in January, 1930, on the neurologic service of Dr. Israel Strauss, in the Mount Sinai Hospital, gave a history of epilepsy for two years. The seizures had been more frequent during the month previous to admission to the hospital. There was a presystolic murmur at the apex. The blood pressure readings were normal. Neurologic examination revealed diminished deep reflexes. Laboratory, including serologic, studies gave negative results. Encephalography showed a moderate degree of internal hydrocephalus. While the patient's pulse rate was constantly below 70, on the day of a convulsion it was found to be 52 per minute. On Jan. 23, 1930, he had two grand mal seizures; the pulse rate that morning also was 52 per minute.

COMMENT.—It is not my purpose to ascribe etiologic significance to the attacks of bradycardia and the other vagotonic features that were present in all five cases. I wish rather to point out that, instead of the usual sympathetic discharge, the effector outburst in the autonomic system in these cases occurred in the distribution of the vagus. In four cases the administration of atropine, in addition to phenobarbital seemed to be of benefit.

DISCUSSION

DR. MICHAEL OSNATO: With experimental animals, using convulsives of various kinds, such as lactic acid and acid fuchsin, alone or in combination, one witnesses regularly disturbances of the vegetative nervous system. These disturbances are: dilatation of the pupils, increased salivation, erection of the fur, sweating of the paws and micturition. While this occurs during experiments in animals, similar symptoms of disturbed autonomic control occur also in persons with epilepsy during the convulsive state.

The increased lactic acid produced during the convulsive state is the result of the tremendous muscular energy exerted during the convulsions; in addition, the asphyxiation or apnea at the height of the seizures produces an increased concentration of lactic acid in the blood and spinal fluid, and that in turn stimulates the secretion of the suprarenal glands. This is the explanation of the sympathetic symptoms noted.

Whether the observations that Dr. Friedman has made are capable of being interpreted as due exclusively to stimulation of the vagus as a direct result of the seizure, it is difficult to say. Most of us do not have the privilege of seeing many epileptic persons in a convulsion, but would agree that such autonomic disturbances as are shown are sympathetic. I have had no personal experience with this particular type of vagotonic symptoms in epilepsy, and I would be inclined to refer to them as vagotonic seizures or perhaps as epileptic seizures occurring in vagotonic persons without particular relationship between the vagotonia and the epilepsy.

DR. IRVING PARDEE: The glandular status of these patients is of great interest to me in that, as Dr. Friedman has reported, they are of the status lymphaticus type. This type of patient has inadequate pituitary, suprarenal, thyroid and gonadal systems; in other words, there is a general hypoplastic glandular system. These patients often have migrainous attacks of pituitary origin. A short time ago, Dr. Davis reported a series of cases in which this type of patient predominated; treatment with pituitary gland extract was of value in this particular group. I do not wish to give the impression that idiopathic epilepsy is always

due to disturbance of the pituitary gland, but there are certain types of cases in which the glandular disturbances, rather than the vagotonia, are the basic factor. In migrainous attacks one frequently observes low blood pressure, slow pulse and low blood sugar at the height of the attack. Dr. Friedman has found a similar state in the cases that he has reported, and I think that one must consider the patients as of a hypoplastic type, in which the glandular status is the determining factor in the vagotonic symptoms.

DR. SAMUEL BROCK: The analysis of the convulsive state is being brought about by two sets of studies. On the clinical side are the studies of Hughlings Jackson, Gowers and S. A. K. Wilson. Dr. Friedman's study of the vagotonic element is likewise a clinical contribution. From physicochemical or metabolic studies one sees also important convulsogenic elements emerging. Those who have read Frisch's work and the excellent monograph of Lennox and Cobb must see that the epilepsies comprise: a group in which an alakalosis factor is an important element; another in which anoxemia seems to play a large part; another in which hypoglycemia (whether from too much insulin or other factors) is the dominant issue; a small group in which allergy seems to play the leading rôle; another group, which I would call the "hydrosis cerebri" fraction, in which disturbed water metabolism of the cerebrum, with water retention, is evident; and still another series — mentioned by Dr. Pardee — the endocrine group. There well may be other groups as yet unidentified. A number of these convulsogenic factors may and do cooperate in a given condition, rather than act singly.

It is well known that an increase of epinephrine in the circulating blood, as found in sympathicotonia, increases the blood sugar, while vagotonia, on the other hand, is associated with hypoglycemia. Is hypoglycemia invariably present in these vagotonic cases? May not the hypoglycemia be the convulsogenic factor in Dr. Friedman's cases?

In a recent issue of *The Journal of the American Medical Association* (**94**:860 [March 22] 1930), Nielson and Eggleston reported a few instances of convulsions in persons with abnormally low blood sugar. This is important because such cases fit in with the convulsions induced by insulin. In these cases, giving suprarenal substance by mouth, together with frequent feedings, raised the blood sugar and eliminated the seizures.

DR. NOTKIN: I am interested in the study of the vegetative system in epilepsies and have done some experimental work on a number of patients, using the pharmacodynamic method and injecting atropine, pilocarpine and epinephrine intravenously in order to obtain the immediate and whole reaction. So far I have not been able to draw any definite conclusions as to the type of the autonomic response; the signs of both systems are so intermingled that it will be somewhat hazardous, at least for the time being, to ascribe one set of responses to the activity of the sympathetic and the other to that of the parasympathetic systems. One observation that I made, however, is interesting. In one instance only, the administration of 1 mg. of atropine caused a severe convulsion in a woman who was subject to relatively mild attacks. The pulse rate went up to from 150 to 160. This was probably due to the atropine, which eliminated the inhibitory action of the vagus. Epinephrine did not produce convulsions, but even small doses (0.1 mg.) provoked severe shock. Pilocarpine gave no bad reaction except that increased salivation occurred in some cases. After injections of atropine in doses which tended to paralyze the vagus, the blood sugar content was found to be increased. The blood chemistry was done in the laboratories of the Post Graduate Hospital by Dr. Killian, so that the results may be considered accurate.

I do not think that at the present stage of knowledge one can speak of definite endocrine types among epileptic persons. Among our 200 epileptic patients we do not see more of the so-called endocrine types than in a group of 200 schizophrenic or of 200 manic-depressive patients, and probably also not more than in a group of 200 so-called normal people.

I have two patients with epilepsy who are interesting from a clinical point of view, and will mention them briefly. One has periodic edema on one side of the face, and the other has attacks of angina pectoris. I do not know if

correlation can be made between these manifestations and the convulsive states; they may be only coincidental observations, particularly if one bears in mind the paucity of such manifestations in the epilepsies.

DR. FRIEDMAN: In reply to Dr. Pardee, not all of the cases I presented showed a typical status lymphaticus. I am much interested in Dr. Brock's suggestion. I will say, however, that only in case 5 were there frank convulsive episodes. The theory of hypoglycemia would therefore apply only in this instance.

ASTROBLASTOMAS OF THE BRAIN. DR. PERCIVAL BAILEY.

I have observed a series of twenty-five tumors of similar structure, which I have grouped under the name of astroblastoma. These tumors occurred in the cerebral hemispheres of adults for the most part, the average age at the onset of symptoms being 38 years. The average duration of symptoms before operation was twenty months. The average duration of life after operation was seventeen months, making the average total length of life from the onset of symptoms thirty-seven months. The length of life in these cases is therefore intermediate between that of the astrocytoma, which is over sixty-seven months, and that of the glioblastoma multiforme, which is about twelve months.

The tumors constitute a well defined group having the following characteristics: The predominant cellular type is the astroblast, although spongioblasts and astrocytes are present in varying numbers. There is an abundance of blood vessels with hypertrophied walls and a tendency to intervascular degeneration leaving a cuff of viable cells around the vessels. This type of degeneration plus the radiation of the cells of the vascular walls has caused this tumor to be described as a papilloma or perithelioma.

DISCUSSION

DR. WILDER G. PENFIELD: It is fortunate for neurology, I think, that Dr. Cushing's carefully studied clinical material should fall into the hands of a man with so discriminating a capacity for histologic study as Dr. Bailey. It is particularly fortunate for that branch of neurology that deals with the surgery of the nervous system. With a group of tumors so rare as the astroblastomas it is impossible to discuss the survival period or the clinical aspects unless one has a large amount of material. On the other hand, in the study of gliomas, particularly since the publication of Bailey and Cushing's monograph, embryology is the key to intelligent histologic analysis.

One point particularly puzzling to many is the fact that the name spongioblast has been called in to denominate a wide variety of tumors. It should be pointed out that spongioblasts are to be divided into groups. The spongioblast is an early stage in the development of adult neuroglia. Before the vascular tree has grown into the nervous system, the spongioblasts send out polar processes, so that a pole at each end terminates on the external and internal limiting membrane, thus supporting the nervous system of the embryo. In general, up to the stage of mammals and in mammals until the time of birth, the spongioblasts send out these polar expansions from the medullary canal. This pole is first attached to the pia, and later, by natural transition, it becomes attached to the pial representative that has entered the nervous system, namely the blood vessel. Thus it comes about that there are many supportive spongioblasts with one pole attached by one end to the medullary canal and by the other to the blood vessels. Still later they retain only the vascular attachment and become astroblasts, the forerunners of astrocytes. I think that it is futile to divide these polar spongioblasts into unipolar, bipolar and tripolar spongioblasts, as cells in the same stage may show all of these forms. The polar spongioblasts are a definite stage in the development of neuroglia. The detachment from the medullary canal of the polar spongioblasts yields many astrocytes with long vascular expansions, i. e., astroblasts.

One may occasionally find a brain in which there are no astrocytes of adult type, even long after birth. I saw this most strikingly in the brain of a child from the Babies' Hospital, New York. The child died at the age of 2½ years

without having shown any evidence of mental development; it never even took food voluntarily. In this brain the astrocytes were entirely absent. No adult astrocytes were found, but everywhere throughout the brain were astroblasts: small cells with a long vascular process and small feathery processes about the nucleus. In any new-born mammal one finds many astroblasts of this type.

About the time of birth the brain requires a greatly increased supply of supportive cells and probably of cells which produce myelin—oligodendroglia. At this time there come from the medullary canal great swarms of cells with small nuclei and little nipple-like cytoplasmic processes—migratory spongioblasts. These swarms of migratory spongioblasts pass out into the nervous system and form oligodendroglia and astrocytes. Thus the migratory spongioblast is a rapidly formed and rapidly subdividing cell which differentiates less than the polar spongioblast and is found in less differentiated gliomas. The spongioblastoma unipolare, as Dr. Bailey has described it, has for its type cell the polar spongioblast with one, two, three or more polar expansions. This is a slowly growing glioma.

A little later stage of cell differentiation produces astroblasts and the astroblastoma. The point that astroblastoma is a type of glioma seems well taken, but the tumor cells are certainly not all astroblasts. The cells which are not next to vessels, and which are much more numerous perhaps, are usually of the type of polar spongioblast. Differentiation between the polar spongioblastoma and the astroblastoma is sometimes difficult, as one might expect, and it may be difficult to tell whether or not the long polar cells have vascular attachments. When these tumors form perivascular rings it is logical to consider the astroblast as the type cell, as it is the most differentiated cell, and to call the tumor an astroblastoma. The less differentiated cell is the polar spongioblast.

I can see no reason for the confusion which Dr. Bailey mentions between astroblastoma and ependymoma. The distinguishing characteristic of the latter type of tumor is the production of the ependymal-like epithelial structure, but not of cell rings about connective tissue cores.

As regards methods of staining, I have had the same difficulty in staining the perivascular expansions that Dr. Bailey mentions. I do not know anything of the Spanish method reported in the Neapolitan journal. However, if one uses the method described by Hortega for microglia, or one of its modifications, these perivascular expansions usually stain well and better than they do with the gold or other specific astrocytes stains; it is then possible to see the expansions as Dr. Bailey has pictured them tonight.

My experience with this type of tumor has been short, but these cases have progressed well after radical surgical removal of the growth.

Dr. Joseph H. Globus: It was pointed out by Dr. Bailey that the tumor that he described as the astroblastoma is different from the gliogenous growth known as spongioblastoma multiforme. The latter was first described by Dr. Strauss and myself in 1918. Shortly afterward, it was described by an independent observer in another country. About seven or eight years later, we presented a larger group of tumors. Dr. Bailey and Dr. Cushing, at the same time, described a tumor under the same name. An agreement was reached, however, later, as to what we should call our tumor and as to the name that should be given to the tumor that they described. Since then, Dr. Bailey has taken the position that the spongioblastoma multiforme has no existence and that the tumor which we had so designated should be designated as an astroblastoma. Therefore I am happy to find that Dr. Bailey has come to recognize another type of tumor as the astroblastoma and to recognize the spongioblastoma multiforme as an independent type of gliogenous growth, and that he emphasized as we did the embryologic basis for the classification of gliogenous tumors.

It is also interesting that Dr. Bailey has found the astroblastoma but little more than an advanced, more differentiated type of tumor, which is on the way to form a still more differentiated type, the so-called astrocytoma. This is true in every way, and the embryologic ground on which it is based holds true throughout the entire study of tumors of the gliogenous group. For some time I have

been designating the astroblastomas as transitional forms of gliogenous growth. It has now been recognized by Dr. Bailey as representing a definite type. In my experience, these tumors, when operated on, usually assume a more malignant character.

I have had three cases of the type that I have learned tonight to call astroblastoma. The patients were operated on, but the tumors recurred in a more malignant form, and became still more complex in histologic make-up when again operated on.

I think that Dr. Bailey has made a distinct addition to the knowledge of tumors of the brain.

DR. LEWIS STEVENSON: I have seen only one of these tumors, and have had the same experience that Dr. Penfield described: Between the vessels, the type cells were polar spongioblasts. This tumor was in the frontal lobe of an adult. It was cystic and appeared white, not yellow, on section. It was fixed in formaldehyde-bromide, and we demonstrated both types of cells, the astroblasts and the polar spongioblasts.

DR. BAILEY: When any new development occurs in the scientific world it always happens that a great many people have been occupied with the problem. A study of the gliomatous tumors in this country was begun by Dr. Globus. It was begun in France by Cornil; he was told by his professor to make a classification of tumors of the brain, and he submitted a scheme very similar to the one that Dr. Globus worked out and the one that I later published. The professor refused to accept it, and it was published obscurely in a provincial thesis, so that had he not called my attention to it I should never have seen it. I have always accepted the type of tumor that Dr. Globus isolated as a definite entity, however vast. I had wished, however, to apply to it a different name. The name of the tumor hinges on the interpretation of the cellular type. I have not believed this to be a spongioblastoma, but this question of the spongioblastomas is a private quarrel between Dr. Penfield, Dr. Globus and myself, into which I shall not enter at this time.

I do not wish to discuss the question of the treatment of the gliomas. This question is certainly not settled at the present time. Whether to attempt to remove them or not, whether to do a partial removal or whether to perform merely a decompression is at present undecided. Familiarity with necropsy specimens of such tumors convinces one that the number of cases is exceedingly small in which a tumor can be totally extirpated by removing one lobe or even one hemisphere of the brain, for they often spread through the corpus callosum to the opposite side. Moreover, to say that one removes one hemisphere is merely a manner of speaking, because even in animals it is necessary to leave the basal ganglia either in part or whole, and these tumors often invade these ganglia. Moreover, removal even of an occipital lobe cripples the patient's intelligence, and I fear that those who maintain the contrary are not keen observers. Moreover the tumors that are the most readily removed are those which grow most slowly, while those that grow the fastest almost invariably invade a wide region, so that their removal is particularly difficult. Then there is also the possibility, which Dr. Globus mentioned, that the tumor may increase in rapidity of growth after operative intervention. This fact was long ago pointed out by Tooth, and I have frequently observed the phenomenon myself.

The treatment of these tumors is therefore a difficult problem. A necessary preliminary to an adequate discussion of the subject is a proper understanding of the behavior and structure of these tumors, knowledge that I and others have been trying for a few years to acquire.

Book Reviews

DIE RICHTUNG IM SEELENLEBEN. By A. MAEDER. Price, 4.60 marks. Pp. 167. Zürich: Rascher & Cie, 1928.

The fact that in psychoanalytic investigations the problem of guilt has been found to be of predominant, even central, importance has brought the points of contact between psychotherapy and religion to play a relatively large part in recent psychotherapeutic literature. Maeder's book, "The Direction in Psychic Life," is an attempt at a synthesis of the religious and psychoanalytic attitudes.

The first part of the book is a new edition of the author's little book on "Healing and Development in Psychic Life," which appeared in 1918. The second part is entitled "Conscience and Direction," and is based on lectures given at Amersfoort (Holland). The third part consists of a reprinted paper on "Psychoanalysis and Education," which now has the title, "Direction in Education."

It is not possible to draw in sharp outline the "psychosynthetic" point of view of Maeder. For the author does not give a well rounded, precise presentation, but discusses his ideas in a more literary form in three essays which, though each is complete in itself, are closely connected. The main ideas recur in all three essays. A summary or, rather, an indication of them may be attempted as follows. Maeder's first departure from the more strict formulations of Freud was his emphasis on the "positive function of the father imago," by assuming a real "inner guidance" which he spoke of as "organization of the father libido." But he still regarded the later personal ideals of the individual that are based on the picture of the father, the father imago, as surrogates of this original father imago. He now assumes that there is a psychic agency which has the function of inner guidance. This "guidance" is the primary phenomenon; the images of the parents are only their first manifestations. Teachers, heroes and later personal ideals are only secondary manifestations of the original "inner guidance." As life goes on the primary archetype of the guiding agency develops more and more. This archetype, as the author emphasizes, is not to be confused with Jung's archetypes, which belong to the functions of the collective unconscious.

The mother imago has also a positive significance. The child lives in a familial atmosphere in which there are two poles of influence. In the midst of these influences, by processes of attraction and repulsion, of stimulation and inhibition, the natural development of the individual's own tendencies is realized. The influence of the mother favors the development of sensitiveness, affectivity, imagination, intuition, spontaneity, social, ethical and religious tendencies. The father imago wakes a sense for observation of the outer world, the tendencies to aggression and defense, energy and will, intelligence, self-knowledge and a general attitude toward life.

The term "direction" (Richtung) is the center of Maeder's conceptions. He speaks of a "sense of direction" which becomes manifest in the healing of psychic disorders as well as in the process of education. It is a fountain of hidden energy in the depth of the human psyche. In the realm of psychotherapy it is the agency which leads to self-healing and mental regeneration—considered by the author as the center of psychotherapeutic problems. In Dante's "Divine Comedy" Maeder finds a grandiose symbolization of the main facts of human development in its dependence on "inner guidance." But he finds Dante's picture incomplete. Dante's "Roman Catholic dogmatism" emphasizes too much the "negative aspect," the necessary "subjection to the law." Maeder stresses the necessity of adding to this the "positive aspects" which he finds in Goethe's "Faust." "The Nordic-Protestant mentality enriches and completes that of Southern-Catholic man in

the best way." Maeder sees the contrast in free — individual versus bound — collective tendencies.

In the transference relationship between physician and patient Maeder finds an important manifestation of the guiding agency. The patient detaches himself slowly and gradually from his personal guide, "in the measure as he recognizes in himself, in his daily experience, a principle of direction to which he learns to entrust himself." According to Maeder, the dream also has a teleologic function. He makes an analogy between the sense of the dream and the function of preparation of a child's play. It is revealed by the dream that outside the conscious life there is a guiding force, a helping agency, in the depths of the psyche. Consciousness and the unconscious together take care of the requirements of the outer situation. When the mental equilibrium is disturbed, the principle of inner guidance begins to operate. Maeder gives as an illustration the life history of Benvenuto Cellini. His vision in jail of a youth who after Cellini's suicidal attempt admonishes him to a new life is a representation of his own (homosexual) life experiences; but behind this symbol Maeder sees the typical imago of the guide, the mediator. To the vision of the youth is added later the vision of Christ, and finally when Cellini recovers he finds in himself after painful mental struggles "the inner guidance" which replaces the "external guide."

Beside the energetic factor which Jung emphasizes in his conception of the libido, Maeder wishes to stress the existence of a coordinated factor of direction (Richtung). Just as in the static point of view we distinguish between content and form, so Maeder wishes to distinguish in the dynamic point of view between flow (energy) and direction. The physician as guide becomes in the process of transference the "symbol of the inner ideal of the patient, which in his life had not been sufficiently stimulated and developed, and therefore remains still in the unconscious." After being actualized it is gradually developed so that it can be projected on to a suitable person. In this way self-guidance is finally achieved. This Maeder calls the "sense of direction" (Richtungssinn), in which, in its highest development, he sees an analogy to the Christ idea.

The author develops his conception of the "direction" of psychic life more fully in the chapter on "Conscience and Direction." Conscience operates after a wrong action. It is only the deviation which makes apparent the existence of an "invisible direction." Maeder scorns the "rationalistic" conception that conscience is socially determined. He believes that there is a great need for a special "pathology of conscience" which would have to include the theologic as well as the nosologic approach. The intrapsychic moral-religious conflict appears nowadays more than ever in the guise of disease. The ego has to defend itself against the onslaught of the instincts—as Freud has developed; but this conflict in its several forms takes place only when the ego itself deviates from the direction of higher guidance which Maeder plainly puts on a religious basis. The latter "is not only the greater, but it is the primary need; for in the state of deviation from the 'direction' the ego becomes easily the victim of the demands of the instinctive life."

The author calls his book a confession of an attitude of religious faith. It is indeed astonishing to what extent the main freudian formulations of psychoanalysis are compatible with an affirmation of religious tenets. Maeder's presentation is really in more than one sense a resuscitation of the psychopathology of Heinroth which has been practically forgotten. (B. Lewin has drawn attention to a similarity even in the terminology of Heinroth and Freud, namely, in the term super-ego used by both.) Maeder's book is interesting reading, especially because it seems to be a really sincere attempt to face problems of the "pathology of conscience" from the two angles from which they can be considered.

The author quotes the great Claude Bernard to the effect that scientist, poet and philosopher will some day speak the same language. Unfortunately, Dr. Maeder anticipates this stage of human progress by speaking this language now, at a stage when it is certainly not possible. But even so, the presentation of

his conceptions is of considerable interest to the neuropsychiatrist. For is not this blending of psychoanalytic and moralistic-religious terminology the way in which not a few intelligent patients express themselves nowadays?

HEREDITY IN MAN. By R. RUGGLES GATES. Price, $6. Pp. 385, with 87 illustrations. New York: The Macmillan Company, 1929.

This book is a complete revision of the former volume published in 1923 under the title "Heredity and Eugenics." Several chapters have been omitted altogether, and, with the exception of the introduction, the remainder has been largely rewritten and added to extensively; in fact, it is a new book. These revisions are an indication of the great advances that have been made in the knowledge of human heredity in the last decade. The book is divided into sixteen chapters; there are eighty-seven illustrations.

To one who is not familiar with the number of diseases which have a hereditary aspect this book will furnish an astonishing amount of information. The introduction and the two chapters on the general aspects of heredity in man serve as a good introduction to the subject. The author points out that in general growth, besides inherited factors, such as differences in the amount of secretion of the various glands which are concerned in determining the adult stature as a whole, other factors are believed to control independently the length of the various segments that go to make up stature. There is an excellent description of the influence of the various hormones, particularly the pituitary gland.

In the chapter on the inheritance of the color of the eyes and of the hair he points out what is not commonly known, that the color of the eyes undergoes slow changes throughout life. The chapter on hereditary abnormalities of the eye is of extreme interest, as is the chapter on albinism. There is an interesting discussion of the influence of the various endocrine glands on pigmentation of races and their characteristic physiognomies. Baldness is found to be a sex-limited trait, being inherited as a dominant character from father to son. In woman it acts as a recessive and may be transmitted as such. Baldness is no doubt more common in some races than in others. Anatomic abnormalities in the hands, feet and limbs are interestingly discussed. The inheritance of left-handedness is still uncertain. Ambidextric persons appear to have inherited left-handedness and acquired dexterity with the right hand. Left-handedness is consistently more frequent in males than in females.

There is an interesting chapter on the blood groups and another on the diseases of the blood system. Metabolic defects and derangements are next discussed. The author quotes Riebold, who concluded that goiter is inherited as a mendelian character, dominant in females and recessive in males. Allergic diseases are transmitted. In this is included angioneurotic edema. The chapter on the ears, teeth and nails is of extreme interest, and the chapter on the various abnormalities and diseases brings out the enormous number of inherited conditions. Neurologists will be particularly interested in the muscular diseases and defects. One of the most interesting chapters is on the inheritance of mental differences. The author points out that in speaking of psychic characters attention should be paid to the less readily definable traits that go to make up temperament, disposition and character. They have not yet received adequate discussion. In this chapter there is a good description of various types of feeblemindedness, mental disease, dipsomanias, epilepsy, etc. In the final chapter there is an excellent discussion of racial crossing. This chapter, as well as chapter 9 on the blood groups, has been written from the anthropologic point of view. As the author points out, great advances have taken place in the last few years in this field, most of the material in these two chapters being available only recently; some of the facts have not been published previously. Altogether, this is an excellent book.

MANUEL ÉLÉMENTAIRE DE PSYCHIATRIE. By M. NATHAN. Price, 30 francs. Pp. 319. Paris: Masson & Cie, 1930.

Nathan, in this "elementary manual of psychiatry," presents the material in three groups: (1) the nonorganic diathesis-like psychoses (as urged by Dupré in 1906); (2) the organic ones, and between the two (3) some symptomatic and toxic-infectious and visceral and endocrine disorders. The first group is treated under the following headings: emotional psychoses (simple, delusional and stuporous melancholias, and mania), the psychasthenic diathesis and psychasthenic syndrome, the mythomanic diathesis and mythomanic psychoses, the schizoid diathesis and schizoid psychoses, the paranoic diathesis and systematized delusional states or monomanias of Esquirol, and the perverse diathesis and instinctive perversions discussed according to Dupré's conceptions. There follow the hallucinoses of Séglas and Dupré, sensory, psychic and psychomotor hallucinations, and the hallucinatory psychoses, mental confusion, catatonia, catalepsy (both described as disorders of "auto-conduction"), epileptic mental disorders, neurasthenia, hysteria and mental anorexia (Sollier).

Alcohol, opiates (and dermophinization), cocaine, cannabis indica (hashish) and ether, professional and accidental intoxications, uremic diabetes, acute illnesses and visceral diseases receive attention; then the "thyroid and polyglandular psychoses" and those of hypophyseal, epiphyseal and puberal origin, and the psychoses of the critical age and the puerperal psychoses are put together. In the discussion of the organic psychoses Nathan begins with a discussion of the prefrontal lobe on the ground of the recent number of *l'Encéphale* and the discussions of de Morsier and Lhermitte and Mignard and Bergsonian preoccupations; there follow the recent discussions of tumor of the brain, abscess, syphilis, tuberculosis, chronic meningitis, encéphalitis, multiple sclerosis, hemorrhage and softening, lacunar lesions and aphasias — mostly too sketchy and determined by casual recent publications. On this background Nathan takes up dementia praecox and senile dementia.

In the discussion of these topics it is obvious that one deals more with a contact with contemporaneous French workers and literature than with a self-dependent presentation of what a student should see in work with special patients.

Treatment is discussed under the heading of medicaments (vagotonic and sympatheticotonic controls and opotherapy, and bromidia among the hypnotics), psychotherapy and isolation or commitment laws and illustrations and directions concerning restraint. A review of the freudian concepts and methods appears rather opportunistic, satisfying a demand for at least a superficial familiarity, considering the tenor prevailing in the rest of the text.

Altogether, the book is interesting as an opportunity to listen in on what occupies French contemporaries. It is not a clear detached statement of elements, but offers many stimuli inducing one to inquire further into currents of thought of French psychiatry.

LES PIONNIERS DE LA PSYCHIATRIE FRANÇAISE AVANT ET APRÈS PINEL. By DR. RENÉ SEMELAIGNE. Volume I. Price, 50 francs. Pp. 356. Paris: J. B. Baillière et Fils, 1930.

It is with a feeling of genuine gratitude that one puts down a book like that of Semelaigne after reading the sketches of the life and work of the long list of interesting dignitaries of French psychiatry — before and after Pinel. Dreary as the history of psychiatry appears in many ways — it shows how unprepared the human being was and still is in handling his own status as soon as the halo of special divine dispensations failed to work — there are evidences of efforts and sometimes of bright ideas and of sound practical sense which in the aggregate bring credit to the French people and to those who began to include the whole of man in the purview of medicine. But it is a slow advance.

From Sylvius to Pinel (whose work has been presented and discussed in a previous volume) and from Fodéré to Baillarger and Morel, Semelaigne gives a most valuable series of personal sketches. The biographies are concise, but always

with bibliographic references and, in the case of more incisive contributors to psychiatry, furnishing a helpful and understanding statement and evaluation of the real achievement. In many respects the accounts are exceedingly instructive, and through the full bibliographies are more valuable even than the exceedingly meritorious counterpart in German psychiatry by Kirchhoff.

French psychiatry, like the psychiatry of all other linguistic groups, is a mixture of individual and traditional tendencies inevitably following but a limited number of trends: philosophic, therapeutic, structural, functional, clinical — often more like hobbies even when the hobby proves to be a fertile idea. Casual groups live side by side, ignoring or fighting each other; sometimes putting each other into stronger relief, but also often obscuring each other.

This meritorious volume of documents would well deserve not only the promised completion of the series of individual biographies up to date, but a more general volume treating systematically the genealogy of the groups and their ideologies and trends.

We have reason to be particularly grateful for the accounts of some of the less frequently or less fully quoted workers like Delasiauve and the Falrets, the various Pinels, the Esquirol school and its relation to Bayle. One cannot help looking forward to the next volume with great interest.

BETAUBUNGSMITTEL UND RAUSCHGIFTE. IHRE GEWINNUNG, EIGENSCHAFTEN UND IHRE GEFAHREN. By DR. HERMANN THOMS, GEH. REG.-RAT. Price, 7.20 marks. Pp. 192. Berlin: Urban & Schwarzenberg, 1929.

This book is based on a series of fourteen lectures delivered to the students, of all departments, of the Friedrich-Wilhelm University during the winter of 1928-1929. As the subject was intended for a lay audience, the author naturally does not go profoundly into the more technical medical and chemical problems involved; albeit some of his chemical details probably would be far beyond the apprehension of the average American university student. The book covers the history, chemistry, physiologic effects and dangers of practically all the habit-forming drugs with which man is accustomed to poison himself, including the alcoholic and caffeinic beverages, the opiates, the anesthetic (ether) and hypnotic (chloral) groups, tobacco, cocaine, hasheesh and mescal. One is somewhat surprised to find included in such a collection the spices — pepper, cinnamon, etc.— although there may be some reason for considering atropine.

Dr. Thomas' literary style is pleasant, and he shows an extraordinary breadth of knowledge; the great poets, medieval and ancient history, and even the antitobacco activities of the Women's Christian Temperance Union afford him a background for the more serious physiologic and economic problems of drug addiction. In light of the acrimony of the prohibition question in this country, his unprejudiced survey of the struggle of the German people against the evils of alcoholism becomes of especial interest to American students. While obviously somewhat uncertain as to the practicability of legislative prohibition, he is evidently convinced of the necessity of some control of the rapidly rising alcoholism of his country. Equally impartial is his survey of the other great drug habits caused by the use of opium, tobacco and cocaine.

To the readers who are familiar with the German language one can heartily recommend this book as a mine of valuable information on a subject that has become of increasing importance to the medical profession during the last two decades, but about which many physicians have, as yet, only the most superficial knowledge.

DEMENTIA PRAECOX. A CONTRIBUTION TO THE STUDY OF GLANDS OF INTERNAL SECRETION. By DR. OSORIO CESAR. Memorias do Hôspital de Juquery, 1928-1929, vols. 5 and 6, nos. 5 and 6, p. 119.

The first to stress the importance of the glands of internal secretion and the physiology of the body were Claude Bernard and Brown Sequard. Raverdin

and Roder coined the term myxedema, while Pierre Marie demonstrated the relationship between lesions of the hypophysis and acromegaly. These glands of internal secretion have been invoked widely as playing a salient rôle in the causation of mental disease. In idiocy and dementia paralytica, lesions of the thyroid, ovary and testis have been frequently reported, but the conflicting conclusions of many investigations make the subject still obscure, perhaps, as Witte has said, because of the small number of cases studied. Thickening of the meninges and degenerative changes in the brain cortex have been described but cannot be regarded as pathognomonic. In Brazil, in 1900, Paulo Brillo declared that the thyroid gland was always altered in cases of dementia praecox, a declaration based on the examination of eight cases. Witte detected three stages of testicular atrophy in his series of cases, and Münzer discovered crystals in the canalicular cells of the testes together with large quantities of lipoid. Corresponding changes in the ovaries have not been reported. Witte reported his investigations in 134 cases, confirming the belief that atrophy of the testis, surpassing that found in senile and paralytic cases, occurred in from 45 to 60 per cent of the cases. Absent or incomplete spermatogenesis was found in most of the cases. He used as controls persons who had died from accident.

After this lengthy review of the literature, Cesar reports eleven cases, diagnosed as dementia praecox, in which complete autopsies were made but without controls. The time elapsing between death and autopsy is not mentioned. Sections made of the glands of internal secretion showed lipoidal degeneration, sclerosis and diminution of interstitial cells in the testes, adenomas or scleroses in the thyroid, and irregular and inconclusive observations in the suprarenals.

CLINICAL EXAMINATION OF THE NERVOUS SYSTEM. By G. H. MONRAD-KROHN, M.D., F.R.C.P. Fifth edition. Price, $2.50. Pp. 222. New York: Paul B. Hoeber, Inc., 1930.

The fifth edition of this book differs from its predecessor only in the fact that minor additions and alterations have been made chiefly in the newer mechanistic methods for the diagnosis of intracranial conditions and in the uses of hypertonic salt solutions for the reduction of intracranial pressure. It is an interesting commentary on the progress of neuropsychiatry that the only additions made by the author are in the realm of neurosurgery.

NERVOUS AND MENTAL DISEASES. SERIES 1929. Edited by PETER BASSOE, M.D., Chicago. Price, $2.25. Pp. 440. Chicago: The Year Book Publishers, 1930.

The 1929 review of "Nervous and Mental Diseases" edited by Peter Bassoe, like its predecessors, contains an excellent summary of the literature in the field of nervous and mental diseases. Such a review necessarily reflects the point of view of its editor. Neuropsychiatrists are particularly fortunate in that this work for many years has been under the supervision of one of the keenest minds in American neurology.