1967 (128)

SEGUNDO CONGRESO PANAMERICANO DE NEUROLOGIA

SECOND PAN-AMERICAN CONGRESS OF NEUROLOGY

22 – 28 DE OCTUBRE DE 1967

22 – 28 OCTOBER 1967

SAN JUAN, PUERTO RICO

SYNDROME OF HEMISPHERE DECONNECTION

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The general picture of the syndrome of hemisphere deconnection has been extended and elaborated in recent years by observations[5,6,7] on a series of patients whose forebrain commissures were sectioned to control severe intractable epilepsy. Favorable results in the early patients[1,2] has led to continued application of the operation which includes section of the entire corpus callosum and anterior and hippocampal commissures plus in some cases the massa intermedia—all in a single operation. The increased number of patients with the individual variations in symptoms which they present, now exhibit a wide spectrum of correlated deconnection deficits. At one extreme the first patient (W. J.) had grossly apparent extra-callosal brain damage, was oldest at the time of brain injury, the oldest at time of operation (45 years) and showed the most severe apraxic and related symptoms. Least affected was a 13 year old boy (L. B.) who had the smoothest postoperative course, relatively little brain damage before surgery, early date of brain injury (birth), was youngest at time of operation and whose left hand apraxia was minimal and transitory. In the following are briefly outlined some of the findings most common to the series as a whole.

Overall Effects: The symptoms of hemisphere deconnection tend to be concealed and compensated for to a remarkable degree in ordinary behavior. In personality, conversation, and in social situations the patient appears much as before. However, with appropriate tests the deconnected hemispheres in the human, as in the cat and monkey[4,5] can be shown to operate independently to a large extent with respect to nearly all gnostic or 'higher functions' of the brain. Each of the separated hemispheres appears to have its own private sensations, perceptions, mental associations and ideas. And each has its own learning processes and its own separate chain of memories, all of which are largely inaccessible to the other hemisphere.

Visual Symptoms: Visual material can be presented selectively to a single hemisphere by having the patient fix his gaze on a projection screen onto which pictures of objects or symbols are back projected to either right, left or both visual fields, using exposure times of 1/10 sec. or less (Fig. 1). The patients read and describe material of various

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kinds in the right half field at a level substantially the same as before surgery. When stimuli fall in the left half field, however, the patients usually report that they see "nothing" or at most "a flash of light". This is not true if objects are shown with longer exposure times, presumably because very rapid eye movements bring stimuli into both fields.

The difficulty in the left half field is not visual but one of verbal communication since the same visual stimuli which the subject denies having seen are correctly identified through nonverbal means, as by manual pointing to words, objects, or matching pictures. If a pair of objects or images are presented simultaneously, one left and one right, the left hand (but not the right) can be used to pick out by touch, from an unseen group of objects, the specific item pictured in the left half field. If then asked what he has chosen with the left hand, the patient incorrectly names what was seen in the right half field.

An object identified in the left visual field cannot be recognized as the same when it reappears in the right half field. Words or other material presented to left and right of the vertical midline are responded to quite separately. Each of the separated hemispheres seems to have its own visual images and memories, as if two separate brains were viewing left and right halves of the visual field. Only one, the dominant left hemisphere, is able to communicate what it sees through speech or writing.

Somesthetic Symptoms: Unseen objects in the *right* hand are handled, named, and described in normal fashion. By contrast, attempts to name or describe the same objects held out of sight in the *left* hand consistently fail. The same is true for stimuli applied to left and right feet. In spite of the patient's inability to name an unseen object in his left hand, identification of the same object in the minor hemisphere can generally be demonstrated by appropriate manipulation of the item to show how it is used, or by retrieval of the same or a matching object with the left hand (but not the right) from among a collection of other objects screened from sight. Specific finger-thumb postures impressed on one hand by the examiner cannot be mimicked in the opposite hand. Also, if the sample hand posture is flashed in outline form to one visual field, it can be copied easily by the homolateral but usually not by the contralateral hand. Performances that require mental associations between the different sensory modalities of vision, touch, hearing and smell, proceed readily within each hemisphere (see Fig. 2), but break down when the requisite sensory information reaches partly one hemisphere and partly the other.

Motor Function: The degree of dyspraxia is subject to large individual differences. Immediately after surgery all the patients showed some left-sided apraxia to verbal commands such as "move your left foot", or "make a fist with the left hand". As recovery proceeds, good ipsilateral control is first attained for responses carried out by the more proximal musculature. After several months, most of the patients can form a variety of hand and finger postures with either hand to verbal instructions, for example, "make a circle with your thumb and little finger," etc. The extent of ipsilateral motor control was tested by flashing to right or left visual field sketches of thumb and fingers in different postures, for the subject to mimic with the hand on the same or opposite side. Responses are poor with the hand on the side opposite the visual input, although simple postures, such as closed fist or open hand can sometimes be achieved. The deficit is especially marked when the right hemisphere attempts to control the right hand.

The capacity of either hemisphere, and particularly the left hemisphere, to control the ipsilateral as well as contralateral hand varies from one patient to another and accounts for many of the discrepancies in descriptions of the callosal syndrome as presented by various authors. Ipsilateral motor control and other less robust cerebral functions like language comprehension in the minor hemisphere appear to be more easily disrupted by extracallosal damage.

Language Comprehension in the Minor Hemisphere: Auditory comprehension of language is indicated in subject's ability to follow instruction for minor hemisphere performance as by retrieval with the left hand of objects named aloud by the examiner and located out of sight among a collection of test objects. Comprehension of printed words in the minor hemisphere is restricted, but can be demonstrated; after a printed word is flashed to the left half visual field, the subjects are often able to retrieve with the left hand the designated item from among an array of hidden objects. Control by the major hemisphere in these tests is excluded because incorrect verbal descriptions given immediately after a correct response by the left hand show that only the minor hemisphere knew the answer.

Individual Variation: The more of these patients we study the more impressive become the individual variations in symptoms. Different types of partial, sequential, or progressive lesions of the commissures and different patterns of associated cerebral damage, as well as the variability in education, age, intelligence, and related factors can be expected to result in an awesome array of diagnostic difficulties. Also, in the younger patients especially, gradual improvement in functional compensation is observed, presumably a result of self-education in the use of marginal cross-integrative mechanisms and various cross-cuing strategies. Particular care is, therefore, indicated in the application of these findings in the clinic as well as in speculation on the integrative role of the neocortical commissures.

Supported by a grant from the National Institutes of Mental Health (MH-03372) of the U. S. Public Health Service and the F. P. Hixon Fund of the California Institute of Technology.

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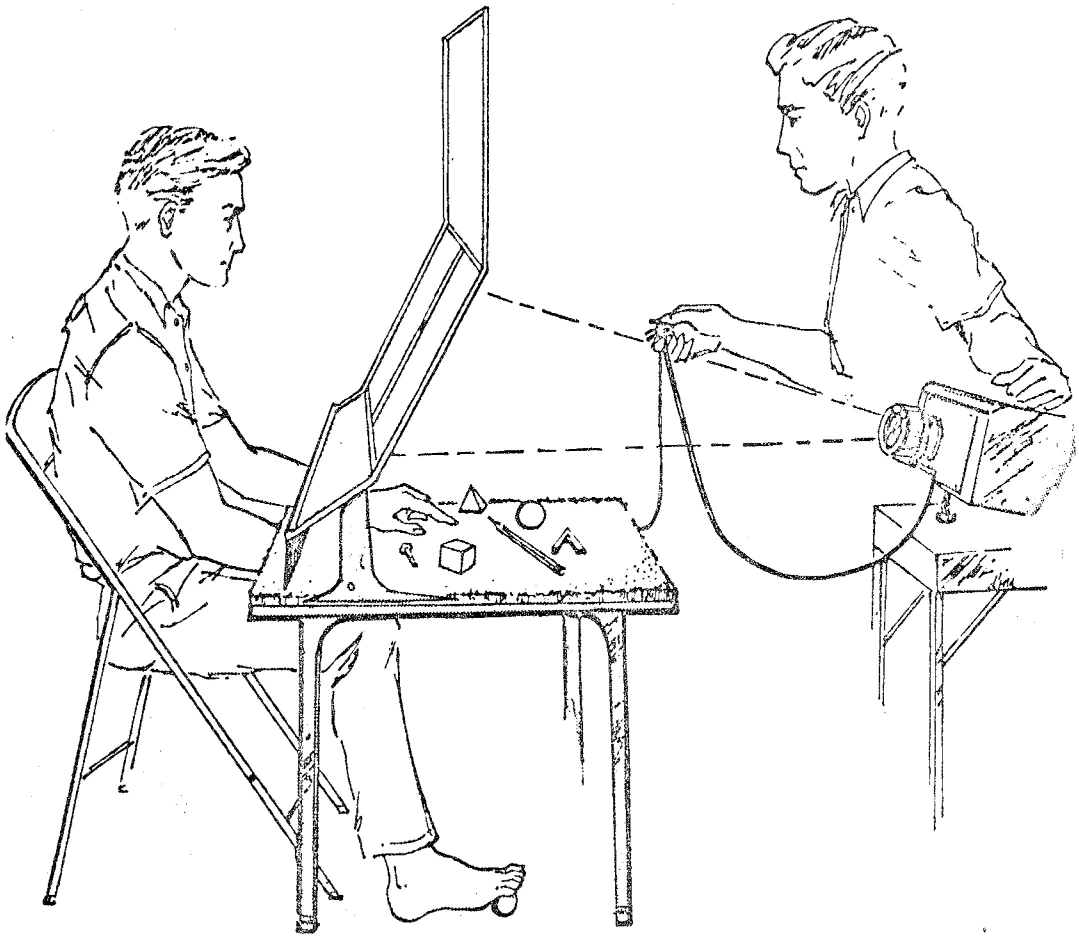

Fig. 1 General testing apparatus for studying symptoms of hemisphere deconnection.

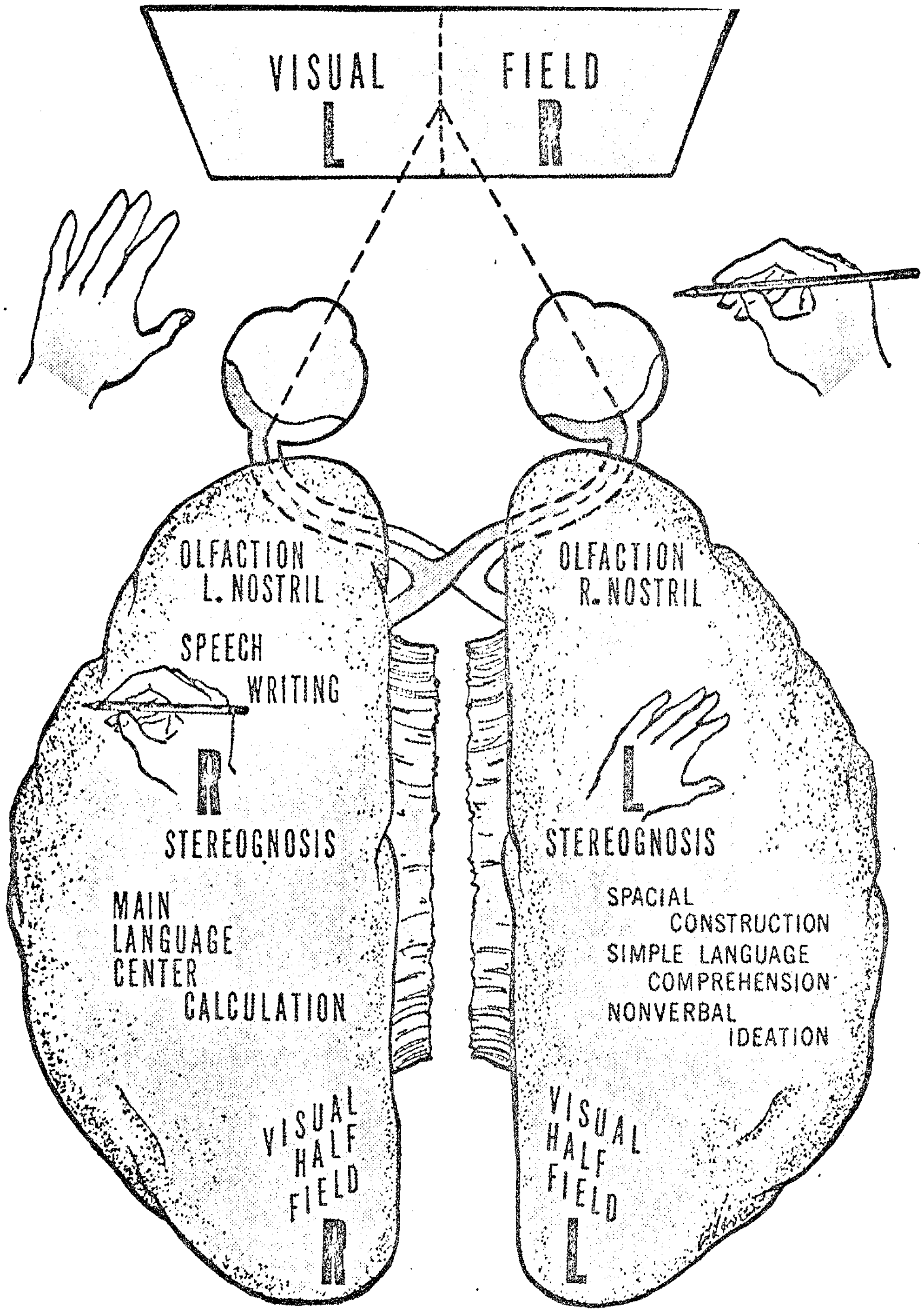

Fig. 2 Schematic outline for separate representation of cerebral functions after section of forebrain commissures.