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# A study of certain psychological functions of the human brain.

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# " A STUDY OF CERTAIN PSYCHOLOGICAL FUNCTIONS OF THE HUMAN BRAIN "

by

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I hereby declare this thesis

is my own work and it

has not been published previously.

Margaret Reinhold

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# CHAPTER I

Organic disease of that part of the human cerebral cortex which lies posterior to the central fissure of Rolando gives rise to a variety of specific disturbances of function which, in so far as they impair an individual's cognitive behaviour, might be called disorders of consciousness. These disorders are mainly concerned with vision and hearing, with the sensations of touch, pain, vibration and posture, with stereognostic sense and tactile discrimination, with language in all its aspects, the faculty of calculation, voluntary movement, and awareness of the body and its orientation in space.

Disorders of this nature have long been recognised and have been discussed by various authors since the middle of the last century. They were originally separately described as if each belonged to a specific category of dysfunction - as dysphasia, dyslexia, dysgraphia, dyspraxia, dyscalculia and so on, - although a single disorder is rarely seen without accompanying allied disturbances.

This separation into categories has led to the assumption that each dysfunction is an isolated morbid entity, which hypothesis has lent support to those authors who hold that "centres" exist in preordained, well defined areas in the cortex (and more particularly, in the case of the functions in question, in the "parietal lobe"), which control speech, writing, reading, spelling, calculation and other faculties.

An opposite view is held by other authors, who argue against such precise anatomical localisation of function.

At present, no satisfactory theory exists which defines the processes of disintegration which affect cognitive behaviour.

This work discusses the results obtained from the intensive examination of a series of patients suffering from organic disease of the brain which caused defective cortical function of the nature described above.

The following functions were disturbed:-

I. Language, which, broadly defined, includes expression and comprehension of spoken and written speech, mathematical symbols, gesture, music and song.

II. Calculation, ~~also~~ which also involves the use of mathematical symbols.

III. Voluntary movement, including the ideational and motor performance of writing, drawing, and construction in planes of two and three dimensions.

IV. Orientation of the body in space, which involves the conception of the body-image.

V. Colour gnosis.

VI. Memory.

These functions will later be analysed in greater detail. It will be shown that no single function is an isolated performance. Each depends upon the organisation and synthesis of many functions. They all depend also upon that ill-defined factor called "intelligence", and upon the previous education and the environment of the individual.

A scheme has been designed for the testing of these patients, which will be described in this work. Case notes will be included, demonstrating the practical application of the scheme.

A series of human brain preparations was examined, and a study made of the cortical patterns of the parietal lobe. A description of the findings, together with photographs and tracings of the cortical convolutions, will be given.

The conclusions reached at the end of the examination of the clinical material led to the formulation of the following hypothesis:

The disorders mentioned above are all dependent upon faulty perception, and are themselves disorders of some aspect of the processes which lead to perception.

Perception will here be defined as a phenomenon which involves a series of events but which itself is the qualitative experience of a conscious individual, evoked by a series of events, including the unconscious reception, selection, differentiation, integration and interpretation of sensory stimuli.

According to this hypothesis, a basis for the classification of the disorders of function mentioned earlier will be suggested. The hypothesis will be further developed and its application demonstrated in the following pages.

# CHAPTER II

## PERCEPTION

A sensory stimulus may give rise to sensory perception. Sensory perception is here defined, as has been stated previously, as the conscious experience of an individual which occurs as the result of the unconscious reception, selection, differentiation, and interpretation of a sensory stimulus.

While the finer interpretation of sensory stimuli depends upon previous experience, stimuli belong, even in newly born children, to well defined categories of sensation, (although we have no knowledge of the precise qualities of their differences before perception), and these may be simply stated as feeling, (which includes the senses of pain, touch, temperature, vibration and posture), sound, taste, smell and vision. At a very early age in life, stimuli are yet further differentiated. For instance, touch stimuli may be painful or pleasurable; visual stimuli may be recognised as being dim or bright. The faculty for the differentiation of stimuli develops rapidly, so that dimensions are slowly perceived, sounds are known to be voice sounds, or sounds made by particular objects, - for example the clock, the piano, and so on - taste develops, so that finer gradations of sweetness or sourness are appreciated, and touch brings awareness of texture and shape of objects. Sensory perception is accompanied always by affective states appropriate to the quality of the perception, such as fear with a painful stimulus, happiness with a pleasant one. If we accept this fundamental human property - (that is, that a sensory stimulus may evoke in man a sensory perception) - the elaboration of sensory perception may be described as follows:

When a specific sensory stimulus evoking perception has been repeated, possibly more than once, an image or memory of the experience may be formed, which embodies the characteristics and quality of the sensory perception together with its affective accompaniment. This image may belong to various sensory categories; it may be visual, auditory, gustatory, kinetic, olfactory, tactile, postural, and so on.

Multiple memory images may be formed of succeeding similar (though never quite identical) sensory perceptions. When a number of such images have been laid down, it is possible for the individual to abstract from them their common qualities and give to them symbolic representation. Symbols may take forms which have been predetermined by evolution (such as the faculty of speech in man, "background and figure" visual patterns, kinetic patterns and so on), or by the culture and civilisation of the community - its language, its songs, its poetry, - but whether the symbol is of a formal nature common to an entire society of individuals, or whether it is an image pattern of peculiar significance to a single individual, the perception of images is a matter of personal experience.

While the events which lead to a sensory perception are never exactly alike, (that is, the circumstances, the environment, the stimuli, the mood, inevitably alter from moment to moment) and therefore images of perceptions are never identical, the symbols contain all the characteristics and qualities of all the perceptions and images previously experienced in the particular category of that stimulus. That is to say, a symbol represents compound experience in a condensed form.

The symbol may later be entirely detached from the state of immediate sensory perception, and exist as an integrated complex. There will then be a state of affairs when a succeeding sensory stimulus of a certain order, or the perception of the symbol belonging to that order, will bring into consciousness the complete compound experience of that order, namely, all previous perception images and their accompanying affects.

After early infancy, then, single or isolated perception of sensory stimuli scarcely occurs. Each perception is a complex of inextricably entangled previous perceptions.

We therefore approach all succeeding sensory perceptions with highly organised prediction. For example, we see a white object upon a distant table. At once we are aware of a vast order of memory images and predetermined expectations. The white object may be a cup, a plate, sugar, a handkerchief, a piece of bread. Immediately we recognise the object clearly, we find our visual perception of it inevitably adherent to perceptions of another order, concerning its texture, weight, taste, smell and so on, images which are associated with handling or eating the object. The more familiar we are with the object and the greater the extent of our experience regarding it, the wider will be the range of our expectations and images. We will also include in our perceptions all the information we have gained regarding the object from the instruction of our parents and teachers, books, the radio, and so on.

The primary perception of the object now recedes in importance. We have taken for granted what we assume to be its concrete existence, its characteristics and qualities. The symbol, which for us embodies the whole complex of sensates which we associate with the object may, following detachment from the immediate sensory perception, persist, while the latter ceases.

We may thus imagine a state of affairs in the brain in which a system of perception images is laid down together with affective associations. We may assume also the existence of a system of symbolic complexes representing groups of memory images.

A further development may take place. The symbols may be abstracted from their position in regard to memory images and receive, as it were, an individual existence. They become highly elaborated and far removed from the original sensory perceptions.

The science of mathematics is such an elaboration of abstractions. Systems of abstractions are fundamentally dependent upon sensory perceptions, a fact which is often forgotten.

Every succeeding sensory perception is, then, to the individual throughout life, the sum of all previous experience of related perceptions with the addition of the present one.

The practical implications of the hypothetical process of sensory stimulus - sensory perception and affective state - memory image - symbolic representation - abstraction, are to be seen in regard to language, and disturbances of language in organic brain disease, in the following example:-

The word "sugar" represents to English-speaking people a very elaborate structure of images. If we hear this word, we are immediately aware of all its qualities and characteristics simultaneously. It is sweet, white or brown, granular or lump, crystalline, rough, odourless, sticky when wet, crunches between the teeth, and gives us a peculiar sensation and sound when we tread on it. We have, then, a compact bundle of associations of visual, tactile, auditory, gustatory and olfactory nature. The complexity of our associations depends, of course, upon our previous experiences, but ordinarily, to every English-speaking person who has a normal sensory system, the word "sugar" conveys all the images mentioned, and we are aware of them the instant we see the concrete substance sugar, or hear, or say the word "sugar". Furthermore, we have learned the shape of the symbols which form the written word, and when writing or reading the word, we are also aware of its sound when spoken. The words, whether spoken, or written, or read, are symbolic representations of the concrete substance, and both the former and the latter may arouse in us the conscious perception of their whole complex of associations. We know also, without personal experience, that is, in abstract form, that sugar may come from cane or beet, that these plants grow in hot or temperate climates in different parts of the world. We are

aware, too, of a thousand ramifying associations, which also occur spontaneously, such as tea, cake, shortage, ration, and so on. "Sugar" will, in addition, bear a great variety of affective accompaniments for every one of us. The final perception of sugar, ~~however~~ therefore, while having presumably a like significance for two or more individuals of a particular community, (for otherwise we could not communicate with one another by means of language), must differ considerably in its more subtle aspects from man to man. Our perceptions are the sum of our highly organised, highly individual experiences.

An organic lesion of the brain may affect the perception of "sugar" in a number of ways:-

(1) At the highest level, the existing system of abstractions and the ability to perform abstractions will be affected. A patient may thus be no longer able to understand or to remember the details of abstract associations - the significance of the ration, the world shortage, and so on. (Goldstein 1939, 1948).

(2) At another level, symbolic representations may be affected. The word "sugar", either in spoken or written form, may be without meaning for a patient. If the symbols alone are destroyed, the patient may still be aware of the complex of associations and images aroused by a stimulus, but he will be unable to express these, or understand them in symbolic form.

(3) The memory images themselves may be destroyed by disease. Thus while a patient is able to perceive the white crystals of sugar, feel its granular surface, appreciate its sweetness, he is in the position of one who experiences such sensations for the first time and cannot relate them to previous experience. He therefore does not recognise the substance "sugar". He may never be able to retain images again, so that each separate sensory perception is new, pertaining to the particular concrete situation. The symbolic forms are of course meaningless to such a patient.

(4) Sensory perception itself may be faulty - that is, there may be an interference at the juncture where the sensory stimulus becomes perceived. The patient is unable to perceive correctly the colour, or texture, or taste of sugar, or the sound of the word "sugar". While previous images and symbols still exist, the stimulus cannot be associated with them, and the resulting imperfect sensory perception is meaningless to the patient, as occurs in visual or auditory agnosia.

(5) Finally, at a peripheral level, the receptors of sensory stimuli, as the eyes, or ears, or tongue, may be affected by disease, and the stimuli may be unable to reach the cerebral cortex.

This hypothesis, that certain cortical functions are dependent upon perception, and that disturbance of such functions is due to a defect of the process of perception, will receive a clinical application later in this work.

# C H A P T E R  III

## DESCRIPTION AND ANALYSIS OF THE FUNCTIONS OF LANGUAGE, CALCULATION, VOLUNTARY MOVEMENT, THE ORIENTATION OF THE BODY IN SPACE, COLOUR GNOSIS AND MEMORY.

### I. LANGUAGE.

Defective function of language has been described since the days of Gall (1807), Bouillaud (1825), Lordat (1843), and Dax (1865). The term "aphasia" was originally used by Trousseau in 1864, although three years earlier, Broca had published some cases of "aphemia", or loss of speech as the result of cerebral destruction, which he demonstrated at autopsy. Broca was one of the first to adopt the theory that speech is controlled by a well defined cortical "centre", which he localised at the base of the third frontal convolution. In 1864, Hughlings Jackson developed the psychological, or functional approach to the problem of language. He was later supported by Pick (1909), Marie (1906 - 1917), Head (1926), Goldstein (1927), and others.

In opposition to this view were those who adhered to the doctrines of cerebral localisation, following the teaching of Broca, and such authors included Bastian (1898), Wernicke of Breslau (1874) who originally described "sensory aphasia", Henschen (1920 - 1922), Kleist (1934), and many others.

Today opinion is still divided as to whether language is controlled by a localised centre in the cortex, or whether it is, as Jackson (1864) believed, "a function of the whole brain.. Speech cannot be located in any small area of the brain. It must require a vast representation". Language will be here defined, (as has been mentioned above), as including the comprehension and expression of spoken speech, written speech, and mathematical symbols, gesture, music and song.

(i) Comprehension and Expression of Spoken Speech.

These functions depend upon intact organs for the reception and perception of sound, upon the ability to integrate and use previously learned symbols of an acoustic and kinetic nature, and upon intact organs for the production of sound. In order to express sound symbols (i.e. words and sentences) intelligible to others, the individual must also have the ability to organise "thought" - that is, he must be aware of what he wishes to say. Thinking is partly dependent upon pre-existing symbolic images. Abstract thinking is entirely dependent upon them. Thinking also depends upon the ability to abstract, and upon the ability to sort, or classify, perceptions. Expression of speech involves the use of grammar, and as with music, the rhythm, fluency, cadence and emphasis are important factors.

(ii) Comprehension and Expression of Written Speech, that is, Reading and Writing.

A. READING. Silent reading is dependent upon intact vision, (except in the case of specially educated blind persons), upon correct visual orientation, and orientation of the self in two-dimensional space, upon the ability to spell, and the ability to integrate and associate previously learned visual symbols in the form of letters, words and punctuation marks. Knowledge of grammar is also necessary. In order that the material read should have meaning for the individual, he must be able to recall what he has read in previous sentences or paragraphs. ~~Reading aloud is possible without recognition of meaning, even though silent reading may be meaningful.~~ This faculty for remembering may be described as the ability to retain visual perceptions in the form of images.

Reading aloud is dependent upon all the above factors, and also upon the factors essential for speaking aloud.

Defects of reading have been grouped under the general term dyslexia and have been frequently described in the literature

(Broadbent (1872), Kussmaul (1885), Goldstein (1910), Henschen (1925).

B. WRITING. This function is dependent upon all the factors mentioned as necessary for the function of reading and speaking, and, in addition, upon kinetic images and symbols which are concerned with the performance of voluntary movement (praxis). Constructional apraxia may be the essential factor in certain defects of writing.

Defects of writing have been grouped under the term dysgraphia (Ogle (1867), Charcot (1883), Dejerine (1835), Potzl (1928).)

C. MUSIC AND SONG also depend upon a specific system of symbols, but,in addition, require a sense of rhythm, tone and pitch. They also depend upon all the factors mentioned above as being necessary for the functions of speaking and writing speech.

Singing, however, may be, at times, an automatic performance.

Defects in the understanding or the performance of music are grouped under the term amusia (Henschen (1920), Feuchtwanger (1930), Teufer (1924), Goldstein (1927), Weisenberg (1935).)

D. GESTURE. Gesture may be automatic, as a shrug of the shoulders, or may be in the form of deliberate mime. Automatic mimetic movements may best be termed gesticulation. Deliberate mime, or pantomime, is a performance which aims at expressing an idea. Both gesticulation and pantomime may be used for the purpose of emphasising speech, or as a substitute for speech. Certain races are more apt to employ gesture than others. The Latins, for example, use gesture more freely and readily than the Nordic peoples. This is probably due to their traditions and culture rather than to inherent racial characteristics.

Pantomime may be sufficiently expressive to enable strangers to communicate with one another, who have no knowledge whatever of each others languages.

Gesture may be stylised, and follow strict conventions as in the Deaf and Dumb sign language, or it may have a very precise symbolism, as in oriental dancing.

Both spontaneous automatic gesticulation and pantomime may be affected by organic disease of the brain. Patients suffering from aphasia may have a relative poverty of gesture. Apraxia may prevent the performance of pantomime. In rare cases of jargon aphasia, gesture may be exaggerated. (Critchley (1939), Goldstein (1948).)

It must be emphasized that the mechanical division here of language into categories of function does not intend to imply that language consists of many separate functions. It may be said rather to be the synthesis of multiple complex aspects of a single function.

Not all aspects are covered by this classification. Certain indefinable qualities belong essentially to language, including the sense of poetry, of religion, of humour, of race and culture, endeavour and creation.

## II. CALCULATION.

The use of Mathematical Symbols involves all the factors mentioned above for the speaking, and writing, and reading of words but the essential symbolic images are in the form of figures, specific signs as $+, -, \times, \div$, and specific geometrical designs and algebraic formulae.

Calculation itself is probably a particular faculty apart from the mere ability to understand and use the symbols involved. Mathematical symbols are of a very abstract nature. Defects of calculation are grouped under the term dyscalculia. The varieties of dyscalculia are as diverse as the varieties of dysphasia or amusia.

## III. VOLUNTARY MOVEMENT.

Voluntary movement is partly dependent upon (1) the perception of superficial and deep sensation, and (2) motor power and co-ordination.

In order that movement may be performed at will, therefore, there must be the ability to organise and integrate images and symbolic patterns of kinaesthetic and kinetic nature. Voluntary movement also depends upon intact orientation in space in two or three dimensional planes, and upon the will to perform a purposeful movement.

Disorders of voluntary movement have been grouped under the term apraxia. Many classifications of apraxia have been suggested, none wholly satisfactory. (Liepmann (1900), Heilbronner (1910), Goldstein (1927), Sittig (1931), Kleist (1934), Gooddy (1949).)

Kleist (1934) described a specific type of apraxia which may exist as an isolated entity. This he termed Constructional apraxia.

IV. ORIENTATION IN SPACE.

Correct orientation of the body in space depends upon the following:

(a) The knowledge and understanding of the relationship of the parts of the body of the individual to the whole - that is to say, the proper orientation ~~of~~ to ~~the~~ its internal environment of the self. This is related to the conception of the body-image, which has been defined by Critchley (1949) as the "mental idea which an individual possesses as to his own body and its physical and aesthetic attributes". The conception of the body-image has been described by Head and Holmes (1911-1912), Schilder (1935), Lhermitte (1939), and others.

Defective conception of orientation within the self is seen when organic cortical lesions give rise to the symptoms of right and left disorientation, finger agnosia, or agnosia for different parts of the body (autotopagnosia), or neglect or unawareness of one or other side or a portion of the body, as is sometimes the case in hemiplegia.

The body-image depends of course on an intact sensory system - that is, an intact system of sensory images and symbols.

Such phenomena as tactile or visual inattention may perhaps be disorders of the body-image due to impairment of sensory perception, sensory images, or sensory symbols. (Bender (1945), Critchley (1949).)

(b) Relation of the self to the external environment. Time is relevant in this connection, as orientation may be defective either regarding previous experience (that is, past time), or regarding immediate environment (present time).

Defective orientation in past time implies that an individual is unable to recall previously learned topographical data, - for example, of his house, street, town and so on. He is unable to orientate himself correctly in regard to past situations. This is a defect of previously experienced perceptions now existing in the form of images. Defective orientation in present time implies that an individual cannot learn to find his way about in unfamiliar surroundings however long he remains among them; for example, a patient who is never able to recognise his own bed in hospital (Goldstein, 1928). This is a defect of sensory perception. The individual is unable to form memory images of his surroundings because he perceives in a faulty manner and objects appear unfamiliar.

(c) Relation of objects in the external environment to one another in two and three dimensional planes. Visual disorientation may play a large part in disorders connected with disorientation in the external environment. Visual perseveration, and poor visual acuity with hallucinations, may also be a cause of such disorientation.

Nevertheless, patients with moderately good vision may be disorientated regarding objects in their surroundings. The difficulty may be one concerned with the faculty of abstraction. The patient may be unable to comprehend the meaning of such terms as nearest, farthest, north, south, beyond, and so on, although his speech is not otherwise affected. Such a patient may be incapable of judging distance and quantity, relative heights, depth, and the differences between geometrical shapes.

Cases of patients who suffered from disorientation of the body in space have been described in the past by many authors - Pick (1922), Minkowski (1923), Gerstmann (1924 & 1932).

V. RECOGNITION OF COLOURS.

Recognition of colours in a person not congenitally "colour blind" seems to depend upon a special faculty. The defect is unrelated to "colour blindness". Colour agnosia may occur in a patient who has moderately good vision, and who has no nominal dysphasia. It is essentially a disorder of the recognition of colours. It may accompany dyslexia. Colour agnosia has been described by Lewandowsky (1913), Sittig (1921), and others.

Goldstein and Gelb (1924) have described a case in which there was difficulty in naming colours in the abstract, possibly due to a specific dysphasia.

VI. MEMORY.

Memory is dependent upon sensory perceptions, images of perceptions, symbolic images, and the ability to organise and integrate these images. That is to say, it is not a specific function. Hughlings Jackson (1915) laid stress on the importance of recognising that there is no such thing as the faculty of memory. ...."The use of the word 'memory' in the sense of its being a distinct faculty is likely to lead to confusion". "There is no faculty of memory apart from the things remembered".

If a perception is in any way faulty, an imperfect image of it may be formed - or no image at all may be retained, if the perception is without meaning for the patient. Thus if a sensory perception is impaired early in life, say in one particular sphere, memory of events in that sphere of sensation will be poor; for example, a child with congenitally defective vision will have a poor visual memory. A child with congenitally defective auditory perception (i.e., auditory agnosia,) will have no auditory memory. He will be quite unable to repeat correctly words said aloud to him

(because of the imperfect perception of word sounds), and he will later be quite unable to recall what was said to him, even if he did appreciate its meaning at the time with the aid of visual and tactile associations. He will not have at his disposal a store of standard word symbols, but may make constantly changing sounds which have a significance, but only for himself, (idioglossia), and have no permanent system.

When perception is faulty later in life, patients may have a good memory for distant past events, retaining perhaps an intact system of previous images and symbols, but they may not "take in", nor remember, events in the recent past. Thus a patient with acquired auditory agnosia may not be able to understand a single word said to him, but may be able to talk to others perfectly well, using the store of well-formed word symbols, which existed before the onset of disease.

Destruction of images of perception and symbols causes faulty memory of past events in every sphere. Aphasia may be described as defect of memory in this sense.

Inability to integrate images and symbols may cause faulty memory, as occurs perhaps in senile dementia, or other kinds of organic dementia - that is, the difficulty may be a purely conceptual one.

All the functions described above depend upon "memory" in the sense that they depend upon the ability to organise and integrate previously acquired images and symbolic forms.

# CHAPTER IV

## THE SCHEME FOR TESTING THE DEFECTS OF FUNCTION

A series of patients suffering from organic disease of the brain was investigated regarding their ability to perform the functions described above. Examples of performance in response to testing, together with case histories, will later be given.

Here the routine method of testing will be described in the form of a scheme, without clinical examples. The scheme demonstrates the outline of procedure adopted for patients suspected of suffering from relevant disorders of function. Whenever a defect was recognised, in a patient, as belonging to a particular category of function, testing was carried out in a much more elaborate and intensive manner than suggested in the following scheme, as will be seen in the later case notes.

Testing of the patients was never completed at a single examination. The tests were carefully repeated many times, often being carried out over a period of weeks or months on a single patient.

The following factors were recorded in the case of each patient, (apart from the routine essential facts regarding age, sex, occupation and so on):-

(1) Level of education - age on leaving school, and standard reached; examinations passed (Higher School Certificate or Matriculation); whether university student.

(2) Right or left handedness; family history of manual preponderance; any disorientation between handedness and ocular dominance.

(3) Native language.

(4) Habitual language.

(5) Other languages acquired by the patient.

The list of complaints and the history of the disease were carefully recorded in the patient's own words, if at all possible. If this was not possible, (on account of the patient's difficulty with speech, or his dementia), a history was recorded as related by the patient's closest relative or companion.

A routine neurological examination was then performed, and the findings recorded. Vision was tested with particular care. The cortical types of sensation were carefully examined, - that is, touch, vibration and postural sense, two-point discrimination and stereognosis. Also tests for visual and tactile inattention were carefully performed and recorded (Bender (1948); Critchley (1949)). A simple test of "intelligence" according to the Wechsler-Bellevue scale was performed.

The special functions were then tested as follows:-

I. LANGUAGE

A. Expression of spoken speech.

(i) Spontaneous speech was noted. If faulty, a verbatim record was made.

(ii) Nominal phasis was then tested. A number of common objects were shown to the patient, and he was asked to name them without touching them. For example: keys, comb, pencil, watch-winder, spectacles, scissors, blanket, button, apple, hairbrush. If the patient was unable to name an object, he was allowed to handle it, and it was noted whether this improved his ability to name it.

(iii) The patient was asked to recite the days of the week, months of the year, and numbers from 1 - 20. This tested his "automatic speech". He was also asked to recite some poetry with which he was familiar, if this was at all possible.

B. Comprehension of Spoken Speech.

(i) The patient was first asked to ~~perform~~ comply with certain simple, spoken commands. (It was of course obvious if a gross defect of comprehension existed before testing began). These commands were

as follows:-

"Give me your hand; take this pencil from the table; put out your tongue; tear this paper into four pieces".

If autotopagnosia were present in addition to dysphasia or apart from it, the patient would, of course, be unable to understand terms which applied to different parts of his body. Apraxia was also considered, for even if the patient understood commands he would be unable to perform them if voluntary movement was impaired.

(ii) The patient's response to simple questions was noted. If expressive dysphasia was present, he could not reply, but it was sometimes possible to be certain, by the patient's facial expression and his active response, that the patient was able to comprehend a remark or question, although he could not speak.

C. Recall of spoken speech.

The patient was asked to read, first silently, and later aloud, single letters of the alphabet, simple and difficult words, sentences, and paragraphs, written by hand, and also in typescript. He was then asked the meaning of words or paragraphs which he had read, and he was later asked to recall what he had read in his own words.

He was asked also to read numbers and poetry. The latter tested his understanding of rhythm and rhyme.

Results were recorded.

Reading aloud depends, of course, on the ability to talk aloud.

D. Writing.

(i) Spontaneous writing was recorded. Steps were taken whenever possible to secure a specimen of the patient's purely spontaneous prose, e.g. a letter written to one of his relations. The patient was asked to write his name and address, a more automatic form of writing.

(ii) The patient was asked to write the letters of the alphabet.

(iii) The patient was asked to write to dictation single letters, words, (simple, and difficult), sentences and paragraphs.

Spelling and punctuation were noted in addition to the patient's ability to write.

(iv) The patient was asked to copy single letters, words, and sentences given to him.

Any defect of voluntary movement was recorded. Dysgraphia is, of course, present under such circumstances, even if language is intact.

E. Music and Singing.

Patients were asked to sing some well-known tune, such as "Auld Lang Syne". In this performance the patient's accuracy was noted both as regards melody and words.

If the patient had a knowledge of music, this was tested in the same manner as speech, either with script or played upon an instrument.

Results were recorded.

F. Gesture.

Gesture is dependent upon praxis and motor power. If either of these are defective, the ability to use gesture will be impaired.

Gesture may, however, be affected in dysphasia without other defects being present.

The patient was asked to perform certain symbolic gestures: e.g. waving goodbye; shaking his fist; shrugging his shoulders, and so on.

He was also asked to perform certain simple acts in mime: e.g. he was asked how he would make the movements of playing the piano, opening a door, lighting a cigarette, and so on.

A description of the patient's performance was recorded. In addition, all spontaneous movement was observed, all facial expressions, gestures or mime. Poverty or absence of these was noted, or, on the other hand, exaggeration, as may occur rarely in certain forms of aphasia (jargon aphasia).

II. CALCULATION

The patient was asked to write to dictation:

(i) Numbers.

(ii) Arithmetical symbols as " + , − , × , ÷ ".

He was asked the meaning of arithmetical symbols.

He was asked to perform simple calculations on paper and in his head. For example: "7 x 7 = "; "14 - 3 = "; "9 + 2 = ". He was asked to perform the "100 - 7" test, and a note was made of the time taken and all inaccuracies.

Results were recorded. If dysphasia were present, the understanding or expression of numbers and symbols would, of course, be affected.

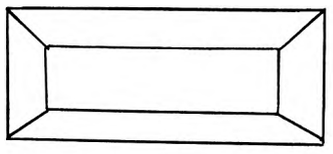
III. VOLUNTARY MOVEMENT

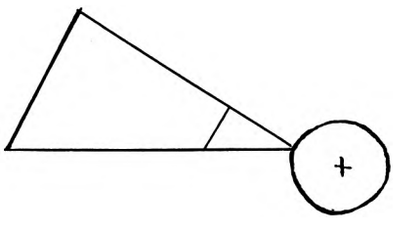
Spontaneous voluntary movement was noted.

(a) The patient was asked to perform simple tasks such as: opening an envelope; lighting a cigarette; passing a matchbox; buttoning his jacket.

Defective understanding of commands would, of course, be responsible for failure in the performance of these tests, and dysphasia was taken into consideration.

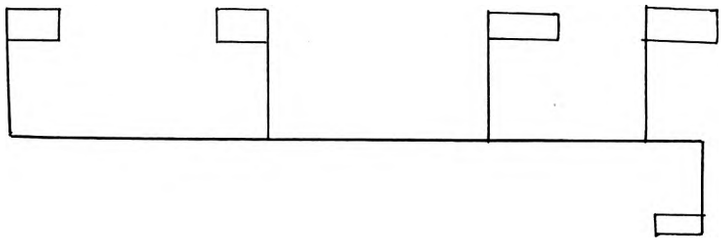
(b) The patient was given a pencil and paper and was asked to copy two simple designs:-



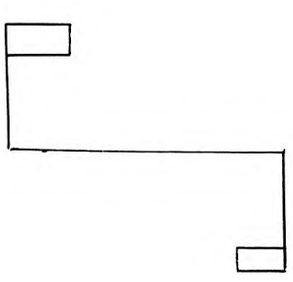


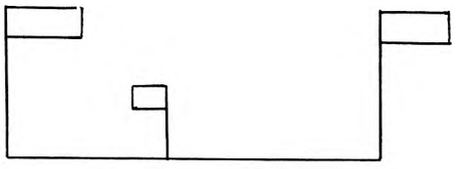
(c) He was asked to divide a given line into halves and quarters, to draw a triangle, a square and a circle.

(d) He was asked to copy the following figure:-



(e) He was asked to draw from memory the following figures:-





He was asked to draw from memory a bicycle, Paterson & Zangwill (1945), and a daisy head.

These tests also gave some information regarding the patient's orientation in space. If he tended to neglect one side of personal or extra-personal space, he might omit one half of a drawing.

(f) The patient was asked to copy patterns made with sticks, (Goldstein stick test).

(g) He was asked to copy patterns with Koh's blocks - which also tested his colour sense.

(h) He was asked to perform Raven's matrices test.

The rate and manner of performance of the above tests were noted.

Thus movement in two and three dimensions was tested.

IV. ORIENTATION OF THE BODY IN SPACE

A. Understanding of the parts of the body, right - left orientation, and the conception of the body-image were tested as follows:-

1. Give me your right hand.

2. Touch your left ear.

3. Show me my left ring finger.

4. Put your right index finger on your left eye;

and so on.

Commands were either simple or complicated according to the condition of the patient. Finger agnosia, agnosia for the parts of the body, and neglect of one or other side of the body were recorded.

The ability of the patient to dress himself correctly was noted. He was asked to put on a pair of gloves, and a pair of slippers. Such facts as whether the patient shaved or washed one side of his face and neglected the other were noted and recorded. At times it was found useful to enquire from the Sister of the ward, from other patients, or from relatives of the patient about such everyday performance as the patient's behaviour at table, or in the bathroom; his ability to play cards or other games, and so on. Any deviation from the normal was noted.

B. Orientation of the patient in relation to his environment was tested.

(a) Visual orientation.

(i) The patient was asked to touch the examiner's hand, which was placed in varying positions in both halves of his field of vision, while he looked straight ahead at the examiner's face.

(ii) A number of coins were spread on a flat surface, and the patient was asked to count them, first without touching them, and later, with the help of handling them.

(iii) The patient was asked to compare the heights of different objects on a flat surface.

(iv) The patient was asked to point to objects on a flat surface, indicating the nearest and farthest, the ones furthest to the right and furthest to the left, the largest, and the smallest objects. He was also asked to look at buildings out of the window and point to the tallest, and shortest, the furthest away, and nearest.

If the patient had a homonymous field defect, he was tested in the above manner in his intact field separately, as well as in both fields of vision.

(b) The patient was asked to draw a map of England, and insert the names and positions of large towns.

He was asked to draw a plan of his house, or of one room of his house, showing the arrangements of furniture, windows, and so on.

He was asked to draw a plan of some familiar area of his hometown, e.g. if London, of Piccadilly Circus.

(c) The patient was given a picture of a maze, and he was asked to show how he would make his way from entrance to exit.

If neglect of one half of space were present, he invariably took all paths and turnings in the direction opposite to the neglected side.

V. COLOUR GNOSIS

The patient was asked to name the colours of various objects in the room, and also of a set of objects placed before him. He was asked to sort objects according to their colours. He was asked to perform the wool-sorting test of Goldstein.

His ability to perceive and discriminate colours was checked by his use of Ichihara's book test.

VI. Dr. Macdonald Critchley, in a recent communication to the Royal Society of Medicine (Dec. 1950), has pointed out that one most striking clinical feature of patients suffering from defects of the nature described above is the variability of performance.
"The patient may make a gross error one moment, and give a successful response the next..... These very irregularities, variabilities, repetitions, hesitancies, changes of mind, erasions,and so on, are, I submit, important..... I regard this sort of phenomenon as characteristic".

Patients suffering from organic disease of the cerebral cortex are apt to show certain generalised patterns of abnormal behaviour. These have been noticed by several authors (Pick (1909), Marie (1917)), but particular attention has been paid to them by Goldstein, and he has described them in detail, most clearly in his latest work on language and language disturbances (1948).

These alterations in behaviour include:

I. Loss of the "categorical" or abstract attitude.

The patient loses his ability to deal with abstract situations and is confined to the concrete.

Impairment of the abstract attitude may be demonstrated by means of:

(a) Sorting tests - such as Weyl's sorting test, when the patient may be able to sort the objects according to one property, e.g. colour, but he will be unable to conceive of another manner for sorting them.

(b) Tests regarding the patient's understanding of proverbs, allegories, and abstract nouns.

II. A tendency to "catastrophic" reactions, and to a system of behaviour which will protect him from such reactions.

The patient, when faced with a task which he is unable to perform, becomes agitated, may burst into tears, be angry, sullen or aggressive. The patient is unable to control such reactions. In order to avoid them, he may isolate himself from the world, or he may become excessively orderly, placing all his possessions with meticulous care in appointed places.

The patient is often quite unaware of his deviation from the normal. His adaptations are often effected without entering his consciousness.

The patient's insight into his defects was noted and recorded. All spontaneous statements regarding defects were recorded.

A close watch was kept on the progress of patients. The findings at any operation were recorded. If the patient died and a post mortem was performed, the findings were included in the notes.

# CHAPTER V

## DESCRIPTION OF CLINICAL CASES DEMONSTRATING THE APPLICATION OF THE SCHEME

CASE 1. Dr. D. William's case. C.Y. male, 56 years old, right-handed, well-educated English-speaking business man.

This patient suffered from dysphasia, dyslexia, dysgraphia, dyscalculia, dyspraxia, disorientation in space, including right-left disorientation, and finger agnosia, visual disorientation, colour agnosia, grossly defective memory, and a defective power of abstraction. The defects were the result of syphilitic vascular disease, and the cortical lesions were probably multiple and bilateral.

On admission to hospital, the patient complained only of difficulty with vision, and a defective memory for a period of eighteen months.

HISTORY. The story of his illness was one of sudden brief episodes of disability, which partly resolved, leaving, however, some symptoms which gradually became aggravated. Two years before admission, the patient had suddenly lost control of his right hand while shaving one morning. His hand was for a short time weak and shaky, but returned to normal. His vision then became suddenly blurred six months later, while he was walking down the street. He found he was unable to see out of the right side of his eyes. He denied any accompanying symptoms. Since that time his vision was poor. He was not able to read properly and long words confused him. His memory deteriorated slowly. At the time of examination he complained "I haven't got what it takes now, and am no longer a proficient business man". He had difficulty thinking of the words he wished to say. He often forgot what others had said to him. On account of his disabilities, he retired from work. He sometimes felt very unsteady on his feet, and staggered about as if drunk. One year before admission, the razor dropped from his

right hand while shaving, the right side of his mouth drooped, and when he tried to call his wife, he could not make any sound. He managed to get to bed unaided, and within a few hours his symptoms had disappeared. He remained in bed for four weeks. He complained of no other symptoms.

ON EXAMINATION the patient appeared alert, co-operative, and friendly.

Neurological examination revealed a complete right homonymous hemianopia, and visual disorientation in the left homonymous half fields. The fundi were well defined and of normal colour, although there was some narrowing of the arteries. No haemorrhages nor exudates were seen. The pupils were irregular, the right larger than the left, and reacted minimally to light, but briskly on accommodation. There was a ptosis of the right eyelid. The cranial nerves were otherwise normal.

The patient exhibited a marked regular fast tremor of the outstretched hands and fingers, which persisted during movement. Rombergism was present, and the patient's gait was unsteady.

The reflexes (apart from the abdominal reflexes), were unobtainable. Plantar reflexes were flexor.

Sensory testing revealed a generalised patchy delay of appreciation of pinprick over the entire body and extremities. Cutaneous sensibility was otherwise normal. Vibration sense and joint position sense were defective at the toes and ankles, but normal elsewhere.

General examination revealed no abnormality except for hypertension. The blood pressure was 210/100. The heart was not enlarged.

The patient was found to have a strongly positive Blood Wasserman and Kahn, for which he was later given intensive treatment. The cerebrospinal fluid was normal, with negative Wasserman and Kahn. The Lange showed no change. X-rays of the skull and chest were normal. The electroencephalogram was inconclusive, showing generalised intermediate slow activity.

Further examination disclosed the specific defects of function mentioned above. Detailed descriptions are here recorded.

I. PHASIS.

A. Dysphasia. The patient's spontaneous conversation was somewhat disjointed. He said "Want to say something - can't think of it - got everything I want to say, but just can't say it - then goes out of my mind". During conversations he frequently used the wrong word, e.g. said "dentist" for doctor, and showed a slight tendency to jargon.

He was asked to name several objects.

| OBJECT | PATIENT'S RESPONSE |
|---|---|
| Pencil | Correct. |
| Matchbox | Long pause, then the patient said triumphantly: "Box of matches. Took me some time to think it, there it is". |
| Match | Correct. |
| Head of the match | "Thats the ... the ... I've used it many a time - say it, will you? I know it but I can't think it out... Matchbox - box ... Directly you'd mention it I'd say Yes, that's it, or I'd say No, it isn't ... matchbox ..." |
| Asked "Is it the matchstick?" | "Yes ... No ... box ... case ... match case ... directly you'd tell me I'd agree or I wouldn't agree. At the moment I can only think of matchbox ... Give me a matchbox." |
| Asked "Is it phosphorous?" | "Yes - but we never call it that". |
| Asked "Is it the match head?" | "Yes" - rather doubtfully. |
| Glass of water | "Can't do it - glass - glass of - oh, common thing like that ... glass of water". |
| Tea in a cup | Correct. |
| Ash tray | "Matchbox ... match ..." |
| Asked "Is it an ashtray?" | "Yes ... that's it, ashtray..." |

Handling of the objects did not assist the patient to name them.

The patient thus showed some difficulty with the naming of objects, and some perseveration of speech.

He was asked to define the meaning of the word "accident". He said: "Somebody falls off a door, breaks their neck".

He was asked: "What is a door?" He replied: "Of course not a door that opens and closes, a chair, a chair, I mean".

The patient's response showed he understood the meaning of the word "accident", but only in its concrete application. He could not define it as an abstraction.

B. Comprehension. The patient was asked to perform some simple tasks.

(1) "Take the ashtray and put it next to the lamp". He did this correctly.

(2) "Sit down". The patient did so.

(3) "Fold this piece of paper neatly and give it to me". The patient was able to do this, although he folded the paper clumsily.

He could thus understand simple words and sentences.

When asked to do more complicated tasks, however, or to define more difficult words, he became confused. He complained "he could not understand".

He thus suffered from a moderate defect in the comprehension of speech.

II. WRITING.

The patient showed considerable dyspraxia for all forms of movement in the right hand. His writing is shown here.

Charles Joseph Yates

G g B R M V I S L ? (TO DICTATION)

G g B R M I S L F

Reading [READING]

Business [BUSINESS]

Cat Bag House [CAT, BAG, HOUSE]

Divide [DIVIDE]

CASE C.Y WRITING AND SPELLING - (TO DICTATION)

III. SPELLING ALOUD.

The patient was asked to spell the following words aloud:

| WORD | PATIENT'S REPLY |
|---|---|
| Basket | B A S C A T E |
| history | correct |
| saucer | " |
| difficult | " |
| scissors | " |
| divide | " |

The patient thus suffers from dysgraphia. Spelling aloud is only slightly defective.

IV. READING.

A. Letters.

Patient read A, B, F, E, H, G, correctly, but very slowly. When shown "D", patient said "A", hesitated, said "My heavens above", and finally said "D".

B. Words.

Cat: patient read this as CART - CUT.

Bag: patient read this as "BAS. Oh dear, what is it"?

After training, patient could read this as BAG.

House, Game, Lame, Cake; patient could read all these very slowly, sometimes confusing the letters, for example, "S" for "M".

C. Sentence.

"I went into the garden". Patient read this as "I wilt into the garden".

The patient was able to explain the meaning of the words he read.

The above testing demonstrated a mild dyslexia.

V. GESTURE AND MIME.

The patient did not use his right hand for any spontaneous gesture.

When asked to shake his fist and wave goodbye, he was able to do so, although very awkwardly. Similarly, any pantomime,

(such as showing how he would play the piano, comb his hair, and so on), was very clumsily performed. The patient seemed to have the correct idea, however, of what he was expected to do.

VI. SONG.

The patient could sing "God Save the King", and "Auld Lang Syne", with approximately correct tunes. He could not manage to sing all the words, however, and often substituted a hummed note or two in place of them.

VII. CALCULATION.

The patient could correctly write and say aloud numbers 1 - 10.

He could correctly calculate in his head "Three multiplied by five equals fifteen", and other very simple sums. His written performance of calculation, however, was as follows -

CASE C.J. CALCULATION

$4 + 7 = 28$

$3 \times 6 = 18$

$2 + 9 = 18$

$3 - 1 = 3$

PROBLEMS SET PATIENT'S RESPONSE

He was unable to perform more difficult problems mentally. For example -

| QUESTION | ANSWER |
|---|---|
| How many pennies in half-a-crown? | 28. |
| Take 7 from 100? | 97, no, let me see, 91. |
| And 7 from 91? | 86. |

The patient therefore showed asymbolia for mathematical symbols and some dyscalculia.

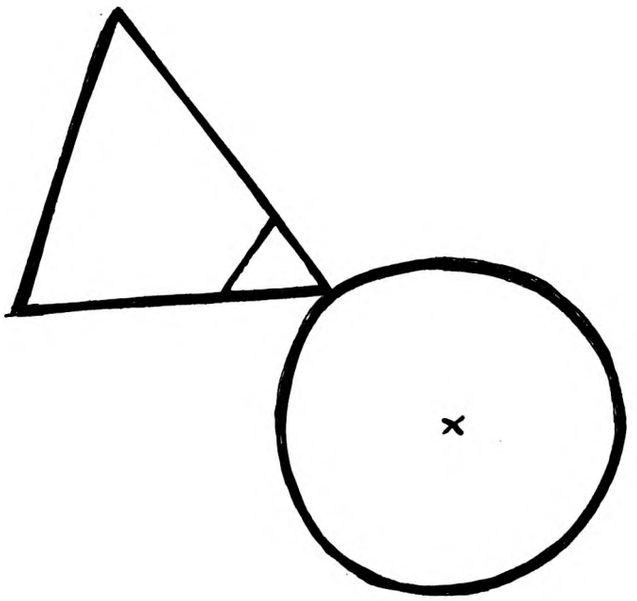
VIII. VOLUNTARY MOVEMENT.

A. The patient was noticed to be extremely clumsy with his right hand. He complained spontaneously that he had great difficulty with dressing. He said "I always do things the wrong way ... I have a tendency to cross over ... my right foot goes on my left foot ... all that nonsense that you know is wrong, but just can't seem to do right".

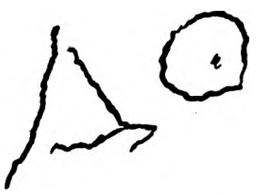
The patient was unable to put on his dressing gown correctly. He fumbled, and tried to put it back to front. He was unable to tie the cord of his gown, and could not button his pyjama jacket. He put on his spectacles upside down.

He thus suffered from dressing apraxia.

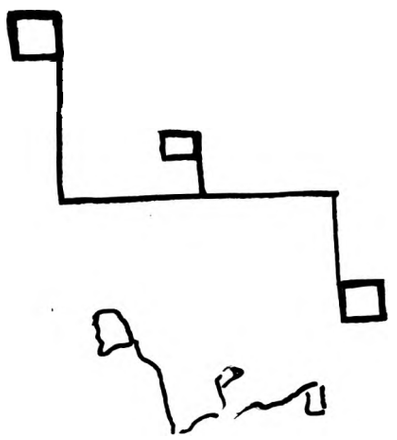
B. Writing and Drawing. The patient complained that his writing and drawing ~~was~~ were all performed on a very small scale, which he thought was part of his trouble. "Why I do it that way, but there it is ... I have to do it crowded, small ..." Examples of his writing have been shown above. Examples of his drawing are now included.



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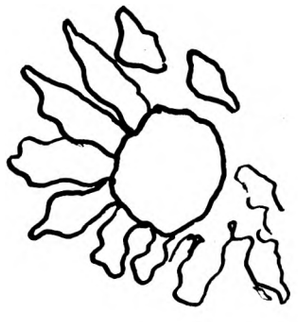


CASE C.Y. PATIENT'S COPY OF DESIGN

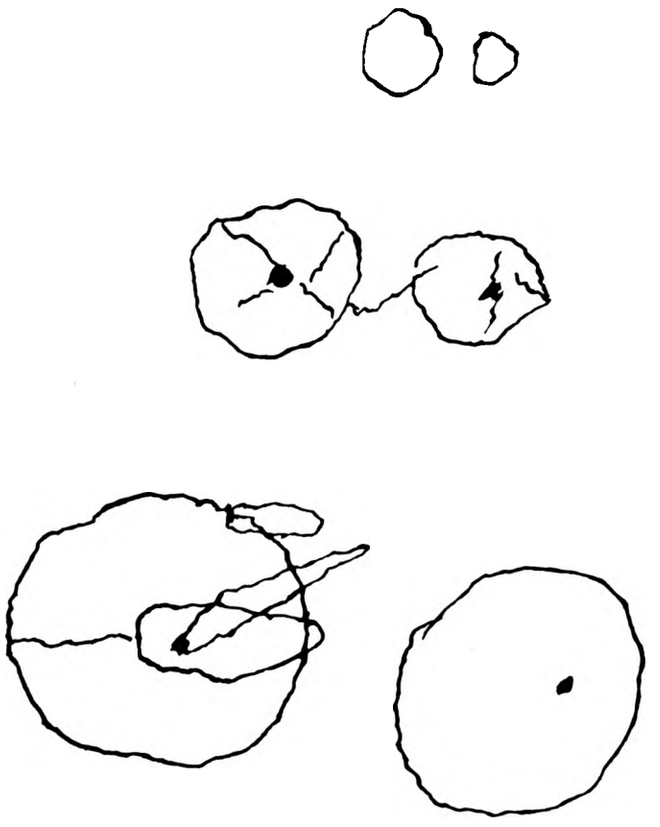


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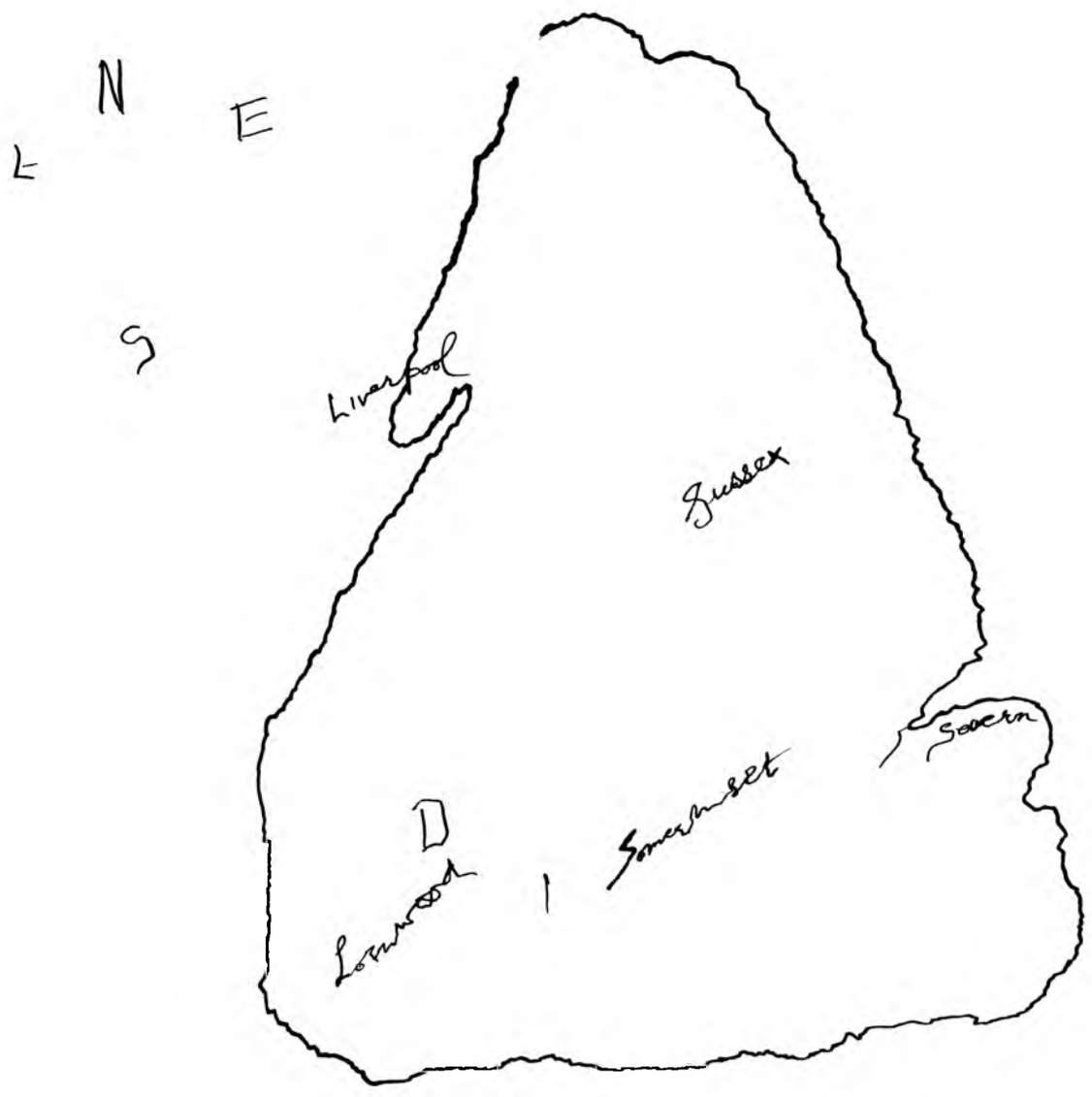
2. PATIENT'S COPY.



CASE/C.Y. PATIENT'S DRAWING OF A DAISY HEAD.



CASE C.T.J. ATTEMPTS AT DRAWING A BICYCLE




CASE/C. J. Y. PATIENT'S MAP OF ENGLAND.

C. Construction.

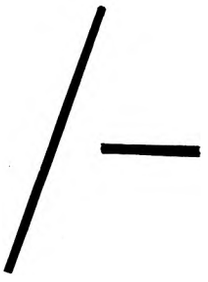
I. Goldstein Stick Test.

(a)



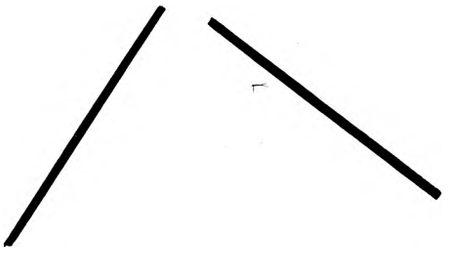
The examiner chose a stick of a certain length. The patient was asked to choose from a number of sticks one of similar length, and place it in the position shown on the left. He was quite unable to choose a stick of correct length.

(b)

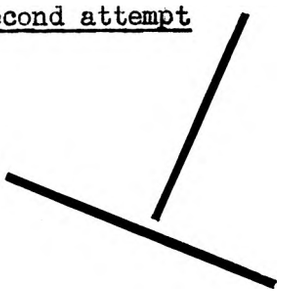


The patient was asked to copy the pattern shown, which was placed in position by the examiner. The patient chose sticks of incorrect length, and tried to put his sticks on top of those of the examiner. Then he placed them in this manner:-

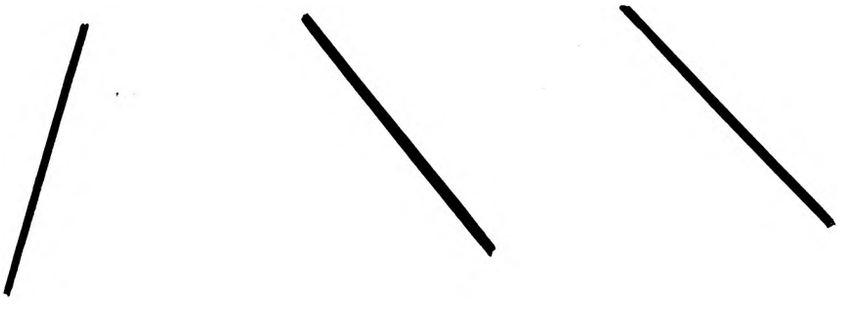
First attempt



Second attempt

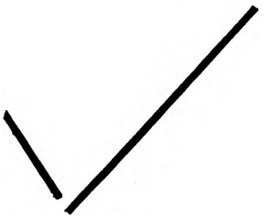


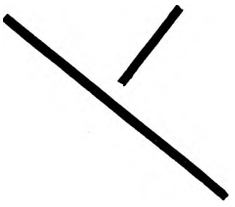
He was told to take one short stick and one long one. He took a third long one, and made the following pattern:



(c) 

He was then given two sticks of the correct length and told to copy the pattern shown here. The patient made an attempt:



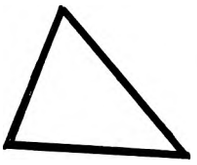
(d) 

The patient was again asked to choose two sticks from the pile and copy the pattern of the examiner, which is shown here. He chose two long sticks and placed them thus:



The above test demonstrates <u>dyspraxia</u> and <u>visual disorientation</u>.

<u>II.</u> The patient was asked to name certain shapes made with sticks.

(a) 

The patient ran tentatively through the following list of names:- Parallelogram, Isoceles triangle, three-sided square. He then enquired with charm "Is there such a thing as a three-sided square?"

He was asked "Is this a triangle?"

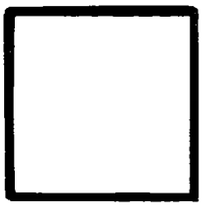
He replied "Yes" with great enthusiasm.

(b) 

The patient called this "A four-sided square - no - not quite".

He was then asked "Is this a rectangle?"

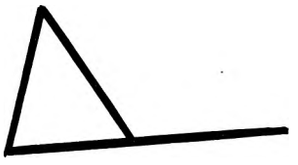
He replied "Yes".

(c) 

The patient called this a "Four-sided square".

(d) He was then asked to construct a triangle with sticks.

He made the following pattern:



This test demonstrates dysphasia and dyspraxia.

III. Kohs' blocks.

The patient was quite unable to perform even the simplest forms of this test, partly on account of dyspraxia and partly because he was visually disorientated and suffered from colour agnosia. In attempting to perform this test, the patient placed his blocks on top of the pattern he was asked to copy.

IV. Raven's Matrices.

The patient was unable to perform more than the first two of the progressive matrices and these only with great difficulty, after several explanations and demonstrations of what he was supposed to do.

IX. COLOUR GNOSIS.

Colour matching was better performed by the patient than colour naming, but several errors were made in both tests. Thus a dark red was on one occasion matched to a dark green, and occasional confusions were made between grey, light blue and light green.

Colour naming was very poorly performed, the patient being quite confused, calling a blue colour red, or green, or black, and so on, without any consecutive consistence.

When asked how many colours there were in a bowl of flowers, (there being three, white and yellow petals, and green leaves), the patient said "Half a dozen", very boldly, and then added "It's an absolute guess, you know".

The patient thus suffered from colour agnosia.

X. PICTURES.

On being shown pictures, the patient was able to grasp the whole of certain scenes, e.g. a race course; but on being shown a map of England, he recognised it only in portions, thus demonstrating simultanagnosia.

He was not able to grasp the meaning of cartoons or pictured jokes without captions.

XI. ORIENTATION OF THE BODY IN SPACE.

A. The patient's knowledge and understanding of the parts of his own body and his orientation as regards right and left.

The patient was unable to tell which was his right and which was his left, and admitted he "couldn't really say. If I were to say, it would just be a guess". He was also unable to tell which finger was which on either hand. For example, when asked to show which was his right index finger, he showed his left ring finger, and so on.

He thus suffered from right-left disorientation and finger agnosia.

The patient was asked to touch his right ear, his nose, his left eye, his right wrist and other parts of his body. He responded in a confused manner, often making mistakes, e.g. when asked to touch his nose, he touched his eye, when asked to touch his ear, he touched his mouth. His mistakes were partly due to his defective comprehension, and partly to agnosia for different parts of the body.

Even when he did understand the meaning of what he was asked to do, he hesitated, was very uncertain, and sometimes confessed he could not think of the correct position of the part of the body he was asked to touch. He frequently perseverated - that is, when asked to touch an ear, he touched his nose. When asked then to touch an eye, he again touched his nose. He thus suffered from autotopagnosia.

B. Orientation of the patient in relation to his environment.

i. Visual orientation. The patient complained spontaneously that there was something wrong with his eyesight, but he did'nt know what it was. He said on testing, he could see only half things, but that in life, he saw everything whole, including people's faces. He had a right homonymous hemianopia, as has been stated above. He was unable to localise the position of stimuli correctly in his left field. This was tested with solid objects, e.g. the examiner's hand, and also with a bright light. The patient failed to localise the stimuli in both cases.

ii. The patient was asked to count a number of objects scattered on a table before him. (The objects were within his left field of vision). There were 10 objects, but the patient repeatedly counted 12, 14, 7, and was unable to gauge the correct number. If he was allowed to touch and remove each object as he counted it, he was able to give the correct number.

iii. The patient was asked to choose the nearest to him, the furthest from him, the furthest on the left, the furthest on the right, of a number of objects scattered on a table before him

(all objects being within his left field of vision). The patient was very hesitant, and finally said he was unable to understand the meaning of the expression "nearest to himself". He chose various objects quite at random, with no relation to the correct situations, and confused right with left again.

iv. The patient was asked to sort a series of objects according to their shape - triangles, diamonds, circles and squares. He was unable to do so by vision alone. When allowed to handle each object carefully, he was able to sort them accurately.

XII. MEMORY.

A. Auditory memory.

The patient was asked to memorize the following words, which were said aloud to him, and which he was able to repeat aloud correctly: "PENCIL, BLUE, and TWELVE PICCADILLY". After an interval of fifteen minutes, during which he was occupied with other tests, he was asked to recall the above words. He said "Not the faintest idea". He was asked "Was one word a colour?" He replied "No". He was asked "Was one word 'blue'?" He said "No". He was asked "Was one word 'pencil'?" and answered "I couldn't say". He then suddenly said "Twelve Piccadilly". The above test was repeated at intervals during the next hour or two, and again next day. The patient failed at all times to remember all words correctly.

He thus suffered from defective auditory memory.

B. Visual Memory.

The patient was shown a simple design drawn on paper, and asked to look closely at it for a few moments. The design was then withdrawn, and the patient was asked to reproduce it. As he suffered from dysgraphia and dyspraxia, the results were of course poor, but in addition, a defect of visual memory was obvious. The patient made several attempts to reproduce a design which he had previously been able to copy, but was unable to do so accurately.

He was also unable to recall words he had previously read, although, at the time of reading, he had said he understood the words.

He was asked to repeat the Babcock sentence. He still made various errors after the sixth attempt.

He was asked to name the present King and the previous Kings of England. He said (a) "George V"; (b) "The rascal who went off"; - and could name no others. He knew the name of the Prime Minister.

XIII. INTELLIGENCE TESTING.

This was performed on the patient by the hospital psychologist, Dr. Macfie. The report read as follows:-

"The patient's vocabulary, still well preserved, indicated a previously very superior intelligence with an I.Q. of the order of 140. Other performances were impaired by his special disabilities: similarities, and digit span, by his dysphasia; picture completion by his dysgnosia; arithmetic by his dyscalculia; and block design by dyspraxia".

XIV. CONCLUSIONS.

The above tests indicate the patient suffered from dysphasia, dyslexia, dysgraphia, dyscalculia, dyspraxia, disorientation in space, including right-left disorientation and finger agnosia, visual disorientation, colour agnosia, and a grossly defective memory.

CASE 2. Dr. Critchley's case. R.C. male patient, aged 55 years. Right handed. Captain, Royal Navy.

This patient suffered from the effects of a gliomatous cyst of the right cerebral hemisphere, situated posterior to the central sulcus, which was later removed at operation. Before operation, he was found to have the following defects:

(1) Left homonymous field defect, with visual inattention, and visual disorientation in this field.

(2) Gross spatial disorientation, which could not be accounted for by visual disorientation alone.

(3) Neglect of the left side of space.

The patient complained spontaneously that he had difficulty in judging distances, had on this account frequently knocked himself against tables, cupboard doors, and other objects which he could see perfectly, and had been unable to park his car properly. At times he had had great difficulty finding his way in places which should have been very familiar to him.

Neurological examination revealed no abnormality, apart from the visual defects, and a slight weakness of the left hand. The patient showed a tendency to walk to the left. He suffered from dressing apraxia, in that he neglected one side, and put two socks on one foot.

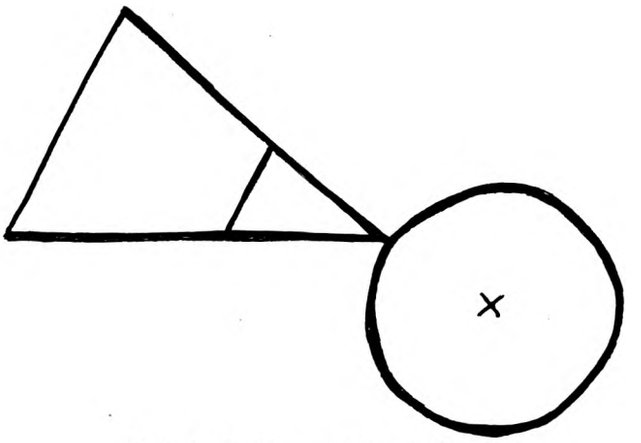
The patient's disorientation in space and his neglect of the left side of space are demonstrated by his performance in the following tests:-

(1) The copying of stick patterns , and the copying of designs.

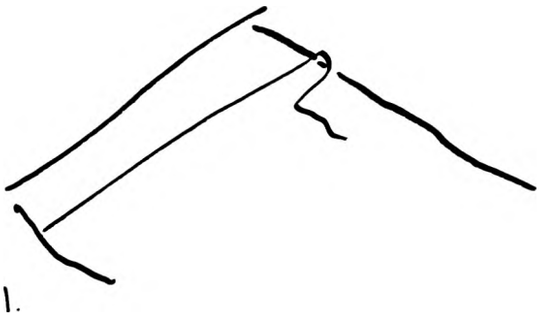
(2) The drawing of a bicycle.

(3) The map of Piccadilly Circus.

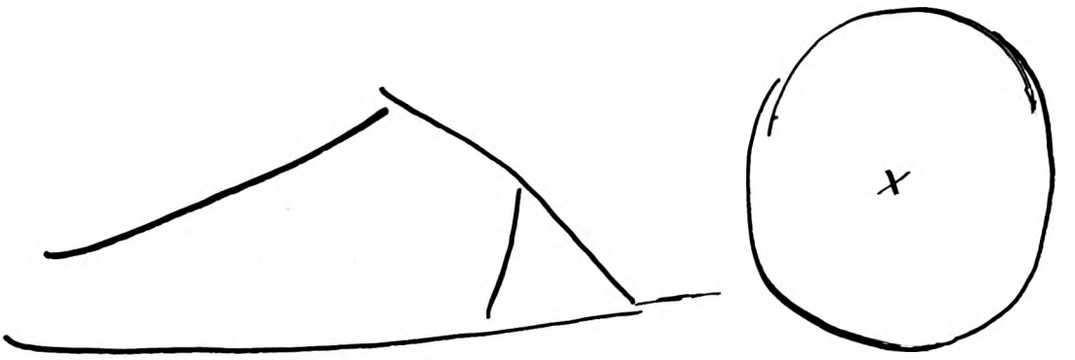
(4) The drawing of a daisy head.




CASE R.C. DESIGN TO COPY

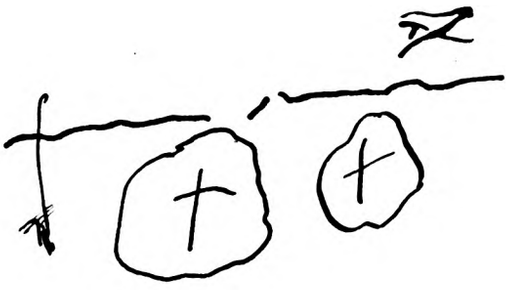


1.

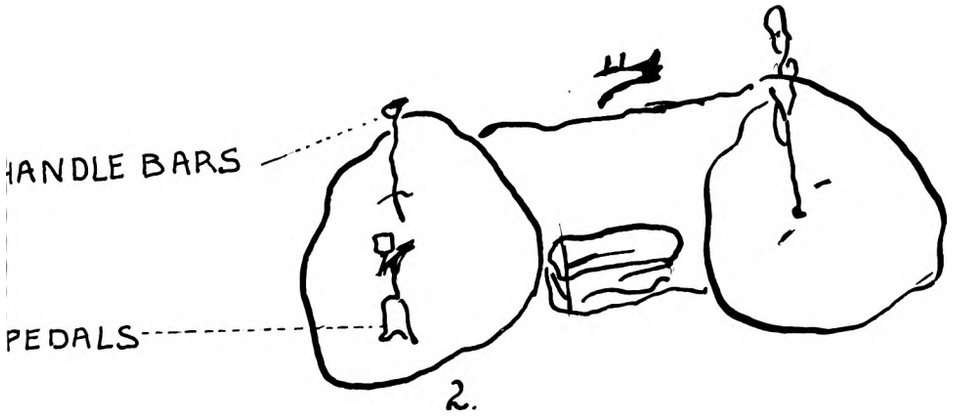



2.

PATIENT'S ATTEMPTS TO COPY DESIGN.



1.




2.

CASE R.C. PATIENT'S ATTEMPTS TO DRAW A BICYCLE



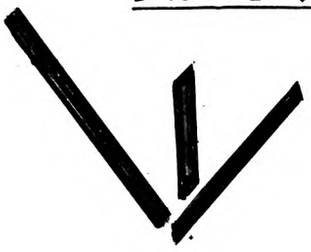
CASE R.C. PATIENT'S DRAWING OF A DAISY HEAD.

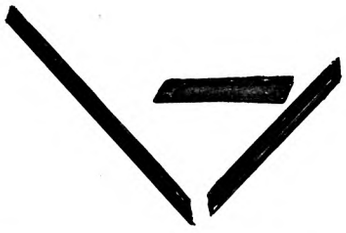
DESIGNS TO COPY

PATIENT'S ATTEMPTS TO COPY DESIGNS

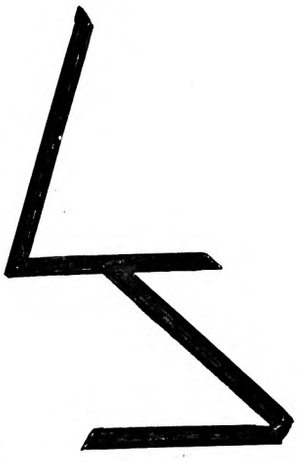
1

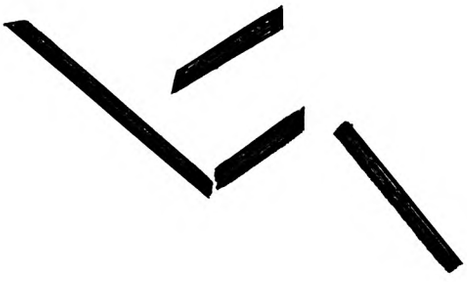






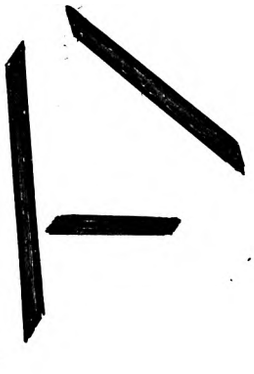
2.





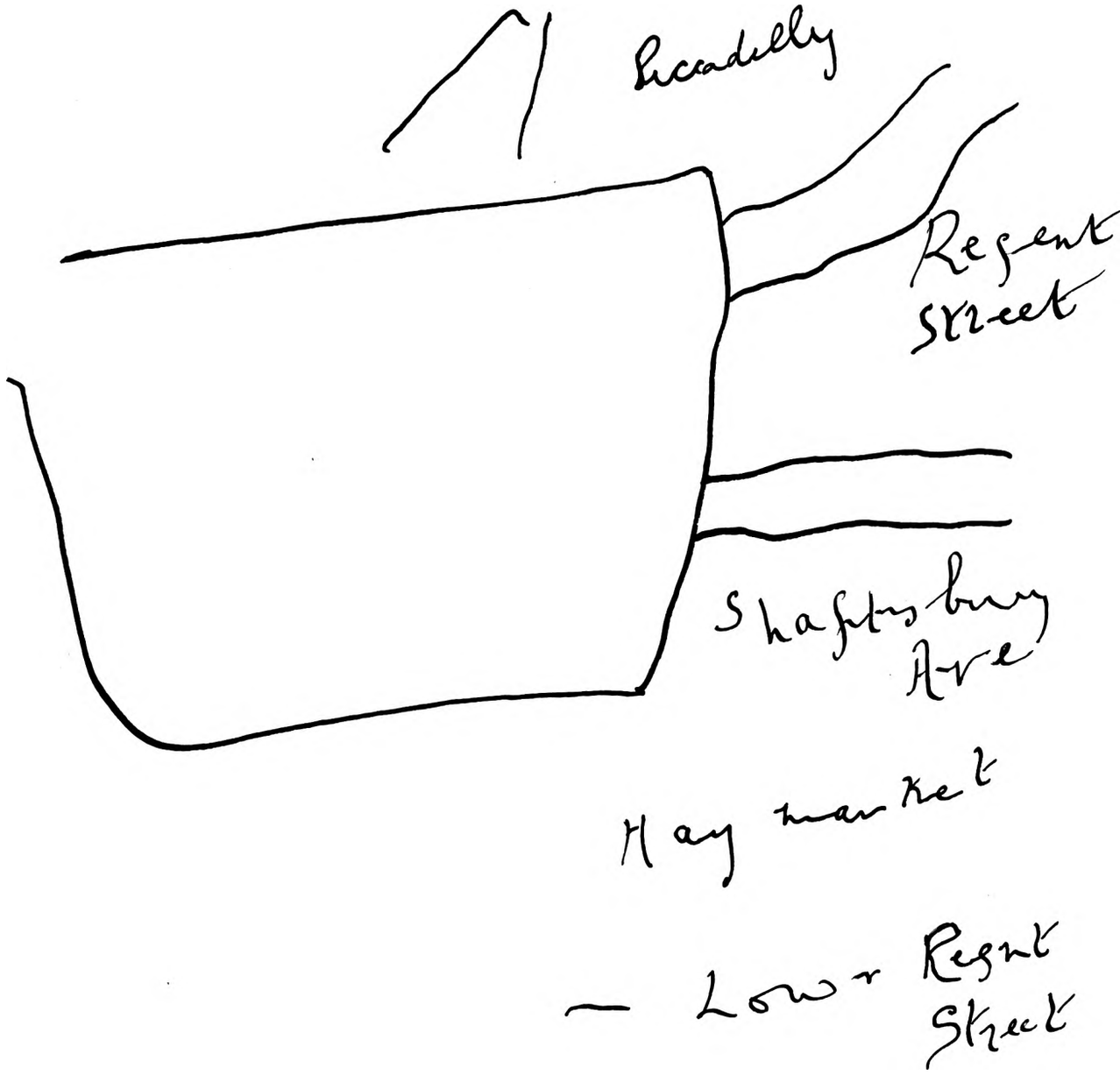


3.





CASE R.C. **STICK TEST**




CASE R.C. MAP OF PICCADILLY CIRCUS.

(NOTE NEGLECT OF LEFT SIDE)

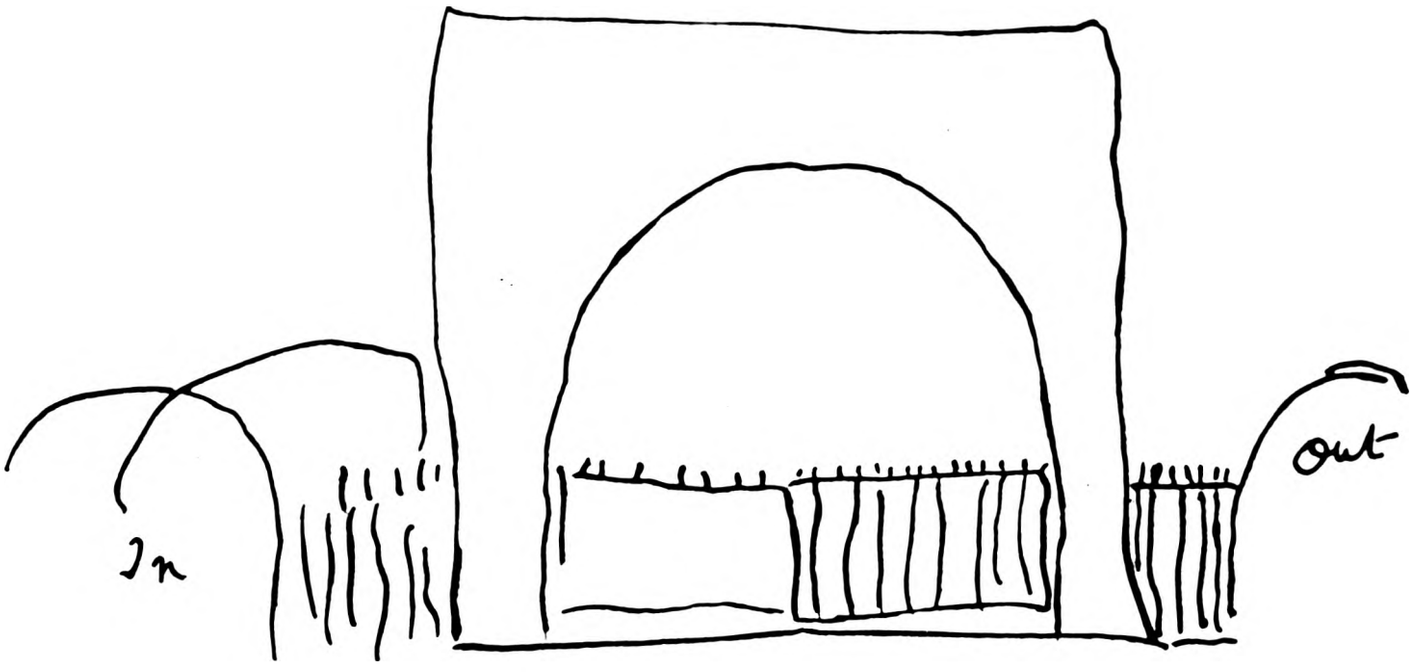
CASE 3. Dr. Critchley's case. G.W. male patient, aged 69 years. Right handed. Engineer and Surveyor.

This patient suffered from a vascular lesion of the right cerebral hemisphere, resulting in dressing dyspraxia, disorientation in space, neglect of the left side of space, weakness of the left hand with some sensory impairment - namely, diminished sense of touch and loss of postural sense, and tactile inattention on the left. The visual fields were full.

The fundi were normal.

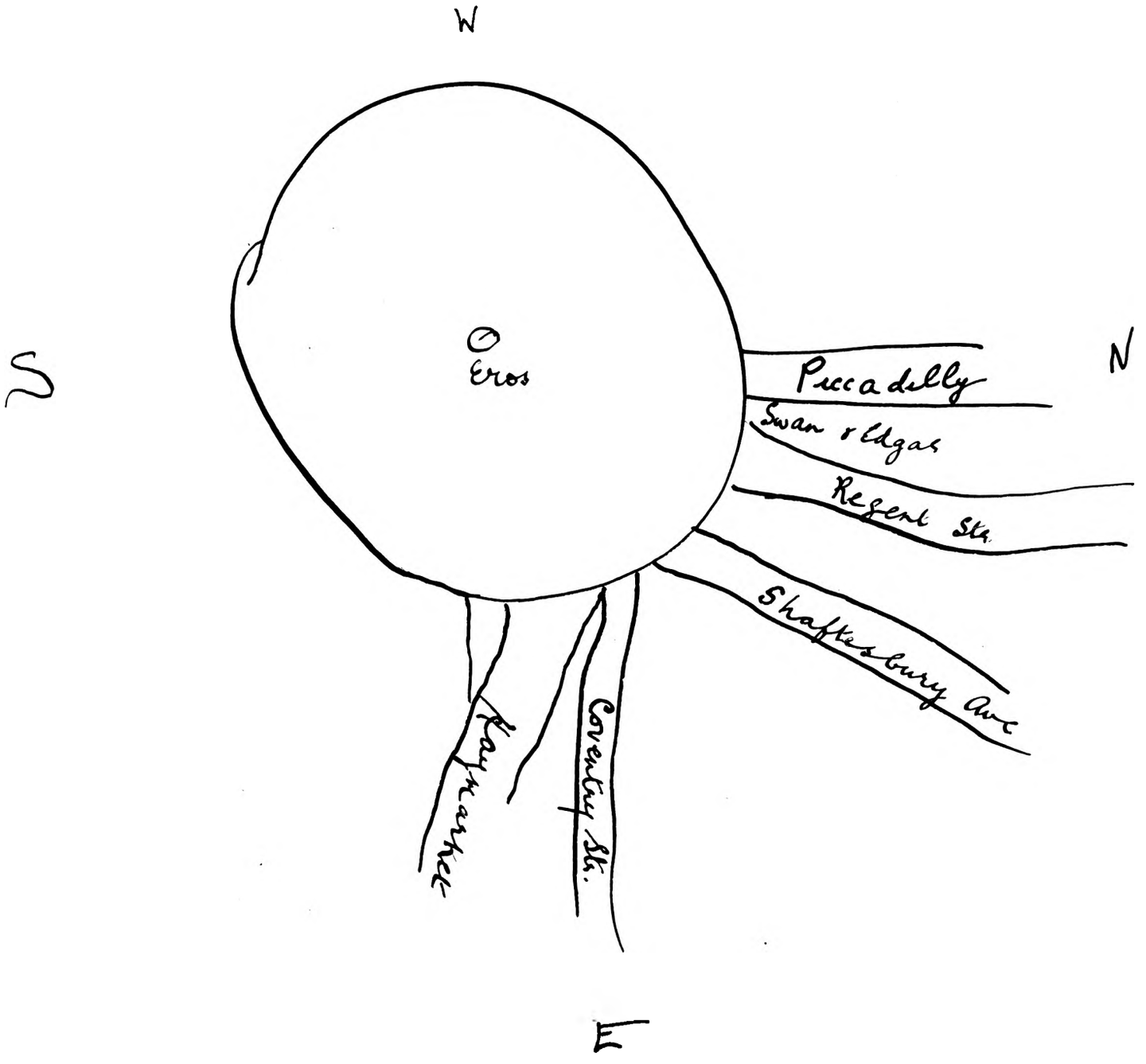
Neurological examination revealed no further abnormalities apart from a mild left hemiplegia, more marked in the arm than in the leg. The reflexes were brisker in the right than in the left arm. The Blood Pressure was 180/95. The E.E.G., X-Ray of the skull were normal. X-Ray of chest revealed hypertrophy of the left ventricle.

A selection of the patient's drawings are shown, which indicate his neglect of the left side of space.

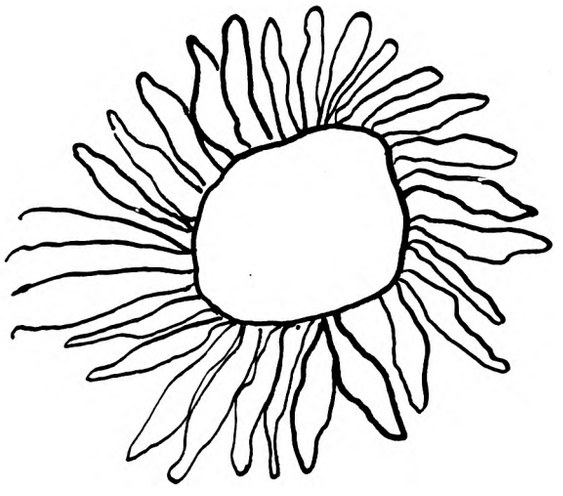



ASE G.W. PATIENT'S DRAWING OF MARBLE ARCH

NOTE NEGLECT OF THE LEFT SIDE

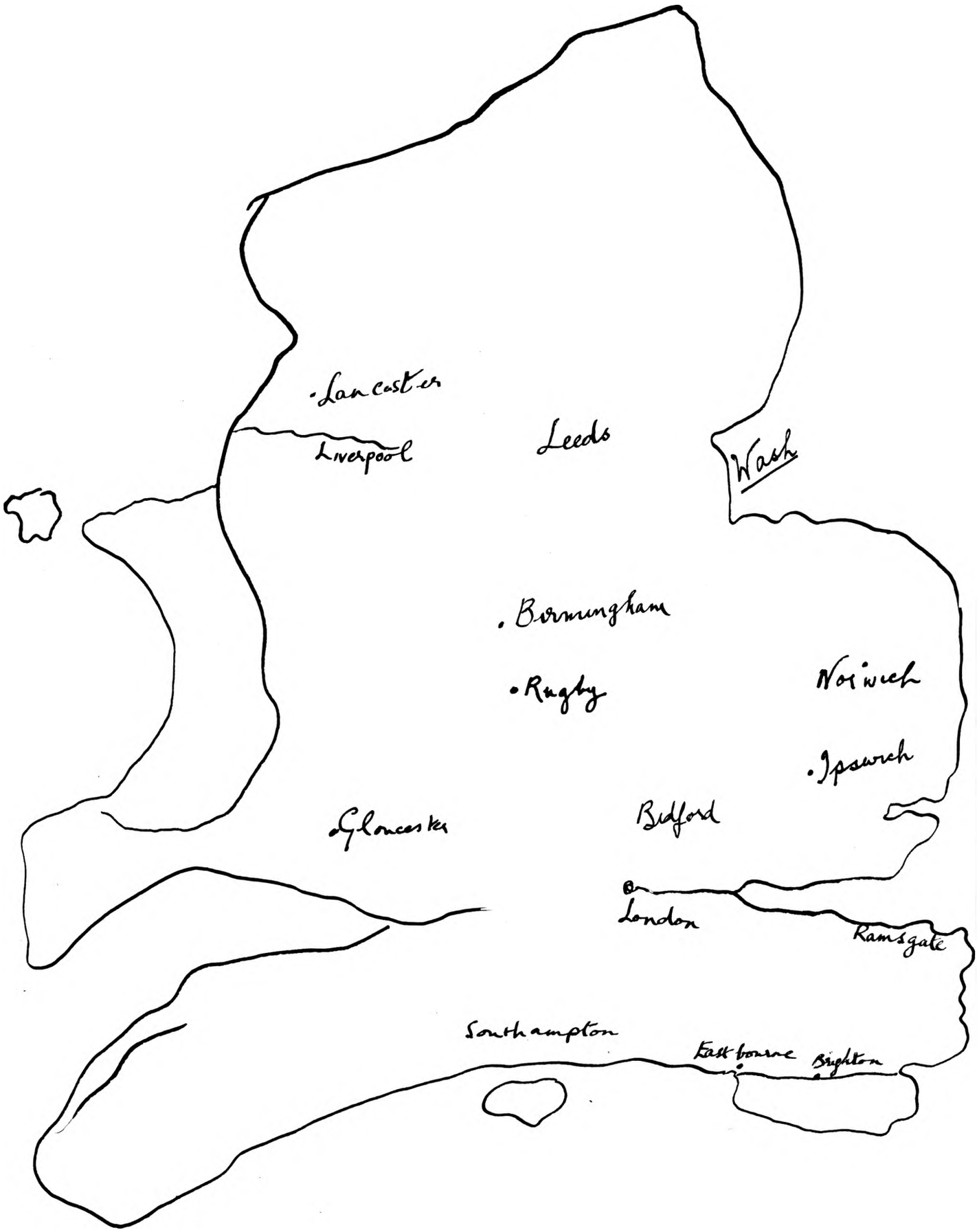



CASE G.W. MAP OF PICCADILLY CIRCUS



CASE G.W. PATIENTS DRAWING OF A DAISY HEAD.

BOTH DRAWINGS INDICATE NEGLECT OF LEFTSIDE




CASE G.W. PATIENT'S MAP OF ENGLAND

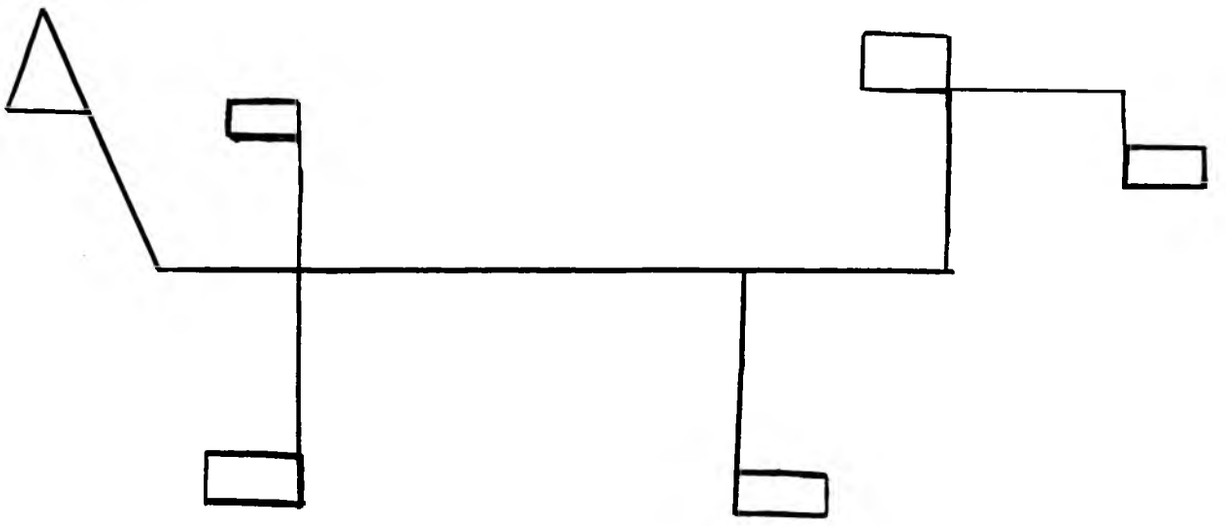
The patient stated he had forgotten how to draw the outline

On the left

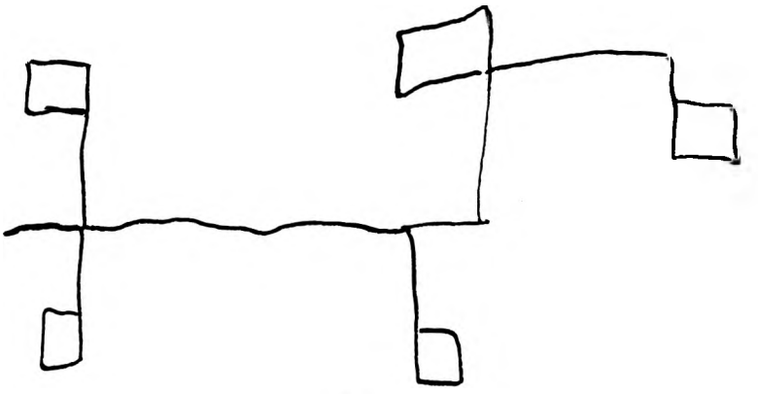
CASE 4. Dr. D. William's case. J.F. female, aged 37 years. Right handed. School teacher.

This patient suffered from the effects of a right temporo-parietal glioma, resulting in weakness of the left hand and leg, (so that she had a hemiplegic gait), and mild sensory impairment on the left side of the body. She showed a gross neglect of the left side of the body, with tactile inattention even for such a crude stimulus as a hand grasp. There was an attention defect in the left field of vision, but, to confrontation tests, both visual fields were full. No papilloedema was present.

The neglect of the left side of space is demonstrated by the patient's copy of a given design. She omitted entirely the left hand figure.



DESIGN TO COPY



CASE J.F PATIENT'S COPY.

NOTE OMISSION ON LEFT SIDE.

CASE 5. Dr. J.K., male patient, aged 52 years.
Right handed. Research physicist.

This patient, a highly intelligent mathematician, was admitted to hospital complaining that for the previous five months he had slowly, but progressively, been finding his work increasingly difficult; his speech had become halting, and he could not always express himself clearly; his memory had become more and more defective.

Neurological investigation revealed a weakness and clumsiness of the right arm and leg, (more marked in the leg), and diminished sensory appreciation for all forms of sensation on the whole of the right side of the body. There was tactile inattention to a marked degree on the right half of the body.

In addition the patient showed a pronounced defect in the understanding and use of abstract symbolic forms, such as mathematical figures and signs, letters, punctuation marks, and so on.

The patient's speech was slow, and he tended to stutter. From time to time he was silent for several moments, saying he could not think of the correct word to use, or again, he could think of the word, but had difficulty "bringing it out".

His handwriting had become childish, and his spelling was defective

The patient complained spontaneously that his greatest difficulty in speech was with the letters "S" and "F". He complained that these letters also were difficult to write, and he became confused regarding the difference between "ph" and "f" in the spelling of a word.

Examples of the patient's writing are given here, demonstrating:-

(1) The childlike quality of the handwriting.

(2) Defective ability to spell and punctuate.

Other tests are included which demonstrate the patient's inability to use mathematical symbols, with which he was previously very familiar.

The patient's defective power of abstraction is also shown.

| | |
|---|---|
| Sissors | [SCISSORS] |
| Büsiness | [BUSINESS] |
| Scarlet | [SCARLET] |
| Discision | [DECISION] |
| Precise | [PRECISE] |
| Precision | [PRECISION] |
| Physician | [PHYSICIAN] |
| Trumph | [TRIUMPH] |
| Fic | [PHYSICS] |
| Physics | [ " ] |
| Phyic | [PHYSICIST] |
| Fluesence | [FLUORESCENCE] |
| Polyglot | [POLYGLOT] |
| Discussion | [DISCUSSION] |
| Monarcy | [MONARCHY] |

CASE J.K. PATIENT'S WRITING AND SPELLING
[TO DICTATION]

The patient was asked to punctuate several paragraphs such as the one quoted here:-

it is strange said the professor that there
are only seven students here today where
are the others lost i fear said the boy

The patient inserted quotation marks as follows:-

"it is strange," said the professor,' that there
are only seven students here today where are the
others; "lost i fear" said the boy.

The patient was asked to write the letter "A" as a capital letter and as a small letter. He was able to write a capital "A". When he came to write the small letter he hesitated some time. He then wrote down the word "and" in small letters, looked at it, and copied down the letter "a" separately.

The patient was asked to write the word "cat" first in brackets and then in inverted commas. He wrote cat); cat" .

Mathematical symbols. The patient was somewhat confused regarding the meaning of the signs
He could not always read them correctly nor write them down to dictation. He was asked to write down in symbol form seventy four divided by a hundred.
He wrote

74 ÷ ξ 100

74 | 100

74

100

He was asked to write the sign for division.
He wrote

He was asked to write 'x cubed' in symbol form.

He wrote $X^3_{3\,1}$, after a long pause for thought.

The patient was unable to read aloud correctly the following equation:-

$$(A^2 + B^2)^3 \times G^2 - X^4 = S.$$

The patient was asked to write "4" in Roman figures. He could not at first think what Roman figures are, then drew a clock face and wrote

$\overline{VI}$ IV (in place of the IIII usually present on clock faces)

The patient was asked to name the common factor in the following equation:-

$$(27A - 3B)(X^2) + \frac{(48M - 27B)(X^2)}{74} = \frac{(17\ \ 46)(7R - X)(X)}{62}$$

He was unable to do so. When asked if it were (X ) he said "Yes, of course". With simpler equations he could correctly name the common factor.

The patient was asked to make as many three-letter words, and as many four-letter words, from the following letters:-

R I I S E M Y T A . The patient wrote TEA, SIT, MET, TEAM, REST . He could not manage to write any others. This took him twenty minutes.

The patient was asked to re-group the following letters, so as to form intelligible words:-

(1) M B A L .

After a long pause the patient was able to write BALM, and also, again after some time, could write LAMB.

The patient was asked to re-group

(2) H S U R B to form a word (BRUSH).

He was unable to do so; after ten minutes struggle, he gave up the attempt.

He was asked to re-group the letters:-

(3) T S E A L to form three words.

He was able to write STEAL and LEAST, but not SLATE.

CASE 6. Dr. MacArdle's case. A.R. female, aged 52 years. Right handed.

This patient was admitted with no complaints except headaches, which had begun a few months before admission, and poor memory. She lacked insight into her other defects.

On examination, she was found to have bilateral blurring of the discs, and incomplete left homonymous hemianopia, slight impairment of the sense of position in the left big toe, and slight increase of the left knee and ankle jerks. There was also slight astereognosis in the left hand, without impairment of position sense or two-point discrimination.

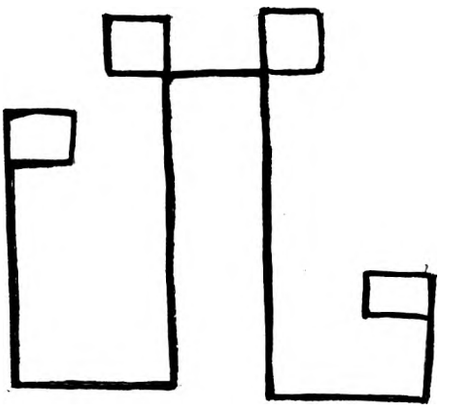
She showed marked spatial disorientation, readily lost herself even in familiar surroundings, and even had difficulty in finding her own bed in the ward, which she only identified by seeing her possessions on the locker beside it. She had difficulty in judging the relative distance of objects, especially if they were far away. She also had great difficulty with any constructive work which involved spatial relationships, especially where three dimensions were concerned. She made numerous mistakes in drawing cubes, triangles, and other figures, and also in copying more complicated patterns. She was quite unable to draw a map of areas previously very familiar to her.

The patient was examined by the psychologists Mr. Zangwill and Dr. Macfie, who reported: "Verbal tests showed the patient to have been of high-normal intelligence with an I.Q. about 125. Tests for learning ability, verbal retention, and the tendency to patterning in her performance of Weigl's sorting test, indicated a mild degree of organic deterioration".

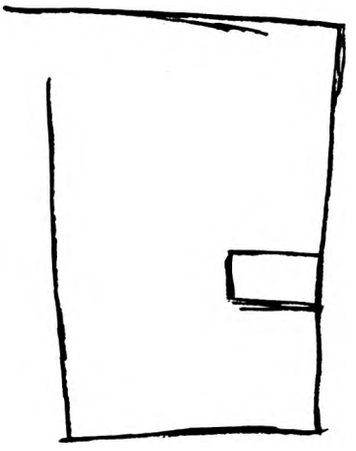
The patient was found to be suffering from a large parieto-occipital tumour, which was removed at operation, and proved to be a meningioma.

She made a good post-operative recovery, although she continued to show some disorientation in space thereafter.

The patient's difficulty in coping with spatial relationships is shown in the following tests.



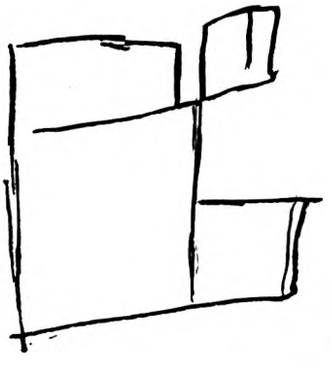
CASE A.R. DESIGN TO COPY



1.

PATIENT'S ATTEMPTS

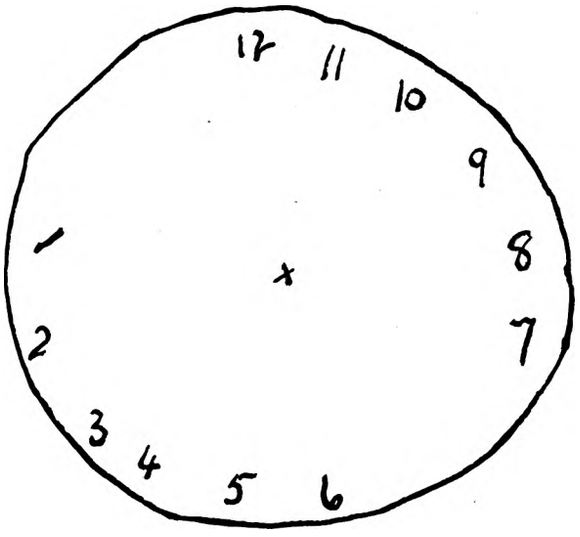
TO COPY THE DESIGN.



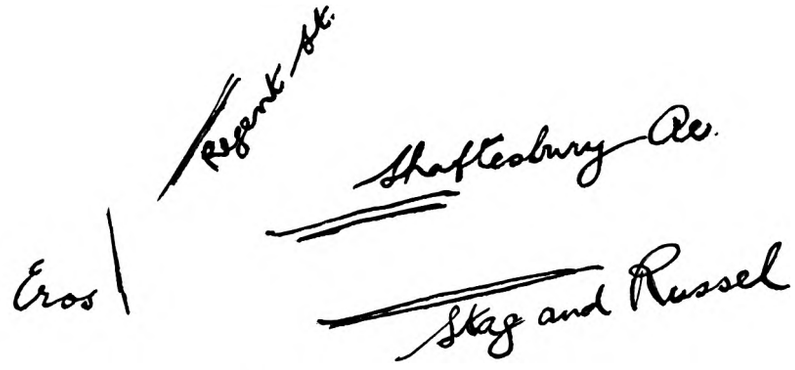
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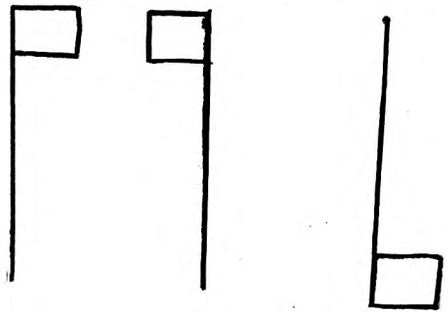
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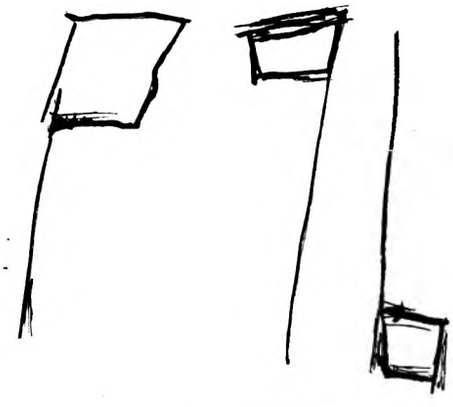

CASE A.R. PATIENT'S DRAWING OF A CLOCK FACE




CASE/A.R. PATIENT'S MAP OF PICCADILLY CIRCUS.



CASE/A.R DESIGN TO COPY



PATIENT'S COPY

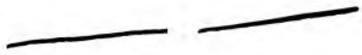
Sccissors
decision
decisive
business
laughter
manslaughter
wrestle

CASE A.R. WRITING AND SPELLING
(TO DICTATION)

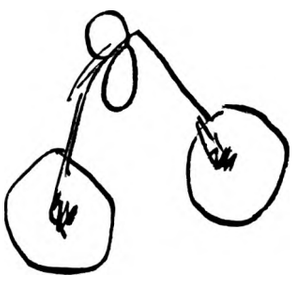
CASE A.R. PATIENT'S DRAWINGS:-



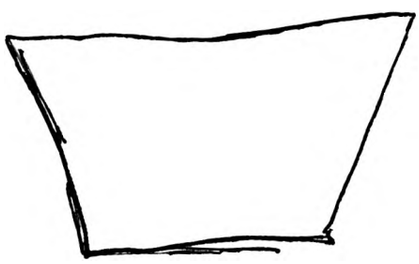
A TRIANGLE



TWO PARALLEL LINES



A BICYCLE



AN EQUILATERAL TRIANGLE.

CASE 7. Dr. MacArdle's case. F.P. male patient, aged 49 years. Right handed. Business-man.

This patient was admitted to hospital with the history of progressively increasing difficulty with speaking, writing, reading, and calculation. The symptoms were first noticed some five months before admission. He was discovered to be suffering from the effects of a tumour in the left temporo-parietal region of the brain, which proved to be a glioma.

Neurological examination revealed few abnormalities, apart from dysphasia, dyslexia, dyscalculia, and defective orientation in space. The patient was markedly dysphasic, often at a loss for words to express himself, constantly making excuses, being tremulous, nervous, and emotional. He often used a wrong word, sometimes a jargon word. He also suffered from a mild defect of comprehension of speech.

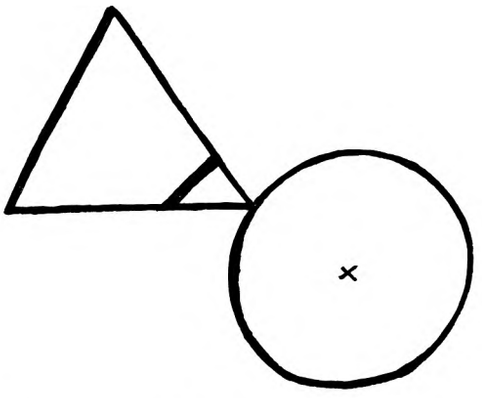
The following tests indicate his defective writing, spelling and calculation. His defective orientation in space is also demonstrated by his drawing of the Map of England, and the mistakes he made with compass directions.

$3 \times 4 = 12$

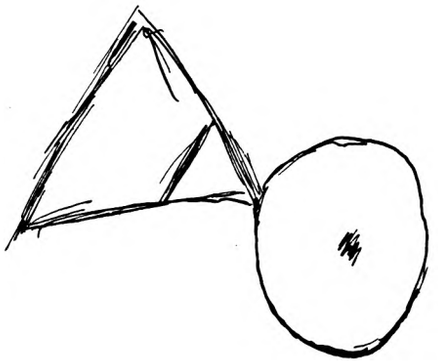
$7 \times 7 = 14$

$3 + 4 = 12$

CASE F.P CALCULATION.



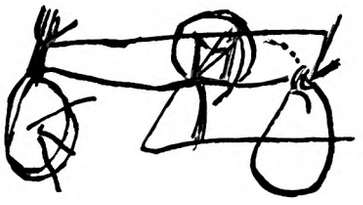
CASE F.P DESIGN TO COPY



PATIENT'S COPY.

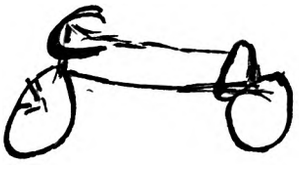
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CASE/F.P. PATIENT'S WRITING AND SPELLING
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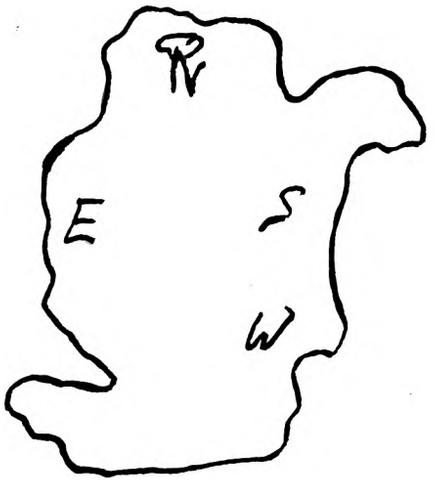


1.

CASE F.P. PATIENT'S ATTEMPTS TO DRAW A BICYCLE.



2.




CASE/F.P. PATIENT'S MAP OF ENGLAND.

# C H A P T E R  VI

## ANATOMY OF THE PARIETAL LOBE CORTEX

Many of the functions which have been mentioned above are generally stated to be controlled by the cortex of the parietal lobe of the human brain. (Textbooks of Neurology - Russell Brain, Jeliffe and White, Oppenheim, Wechsler).

A study of the anatomy of this area was therefore made. A series of brain preparations was examined in the Anatomy Department at University College Hospital, (with the kind permission of Professor J.Z.Young).

The parietal lobe is an ill defined area, situated posterior to the central sulcus of Rolandi, anterior to the occipital lobe, and superior to the temporal lobe. According to Villigers Anatomy, (1925), the parietal lobe is said to present two special convolutions, the gyrus supramarginalis, and the gyrus angularis. ..."The gyrus supramarginalis encloses the ascending terminal stem of the ramus posterior of the Sylvian fissure, and is bounded by the sulcus intermedius primus behind. The gyrus angularis surrounds the ascending end of the superior temporal sulcus, and is bounded in front by the sulcus intermedius primus, and behind by the sulcus intermedius secundus".

Such a precise statement of anatomical pattern could not be confirmed. Great difficulty was experienced even with the identification of the central fissure. The supramarginal and angular gyri, (which on the left side are said to be mainly concerned with the functions of language), could only rarely be identified as well defined structures.

Tracings of convolutional patterns and photographs of the cortex were made, and examples are given here. The gross variability of the anatomical structure is clearly demonstrated.

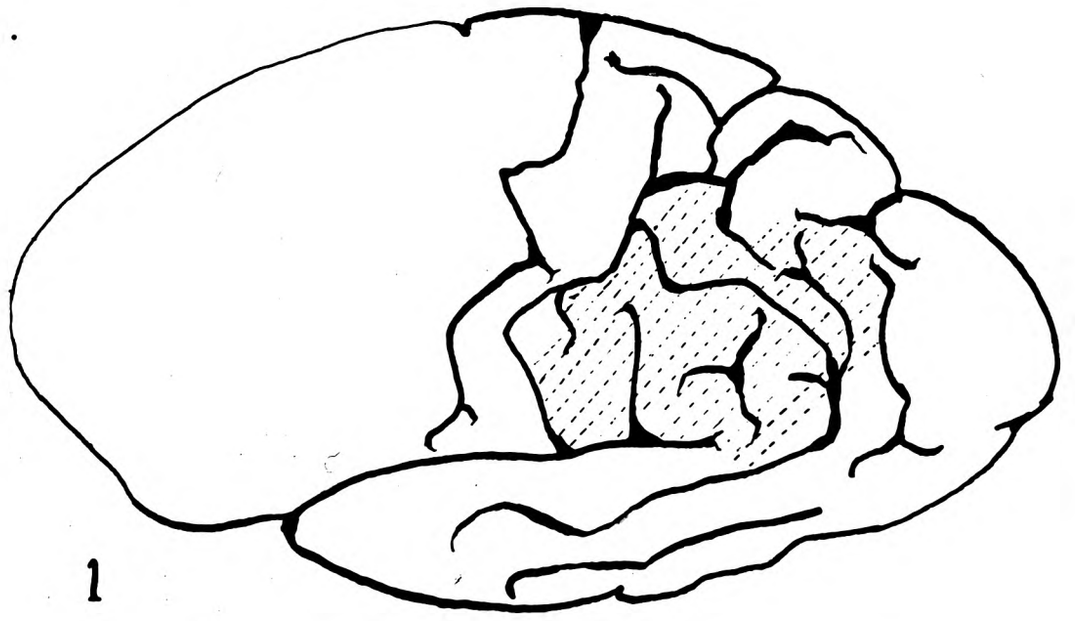
Such variability in cortical relationships suggests that precise anatomical localisation of function, at least in relation to sulci and gyri, can scarcely be possible.

Other methods for dividing the brain into well defined areas of precise functional activity have been suggested. Localisation of function according to cytological organisation (or cyto-archictectonics) began with the work of Campbell (1905), Vogt (1903), and Brodmann (1903).

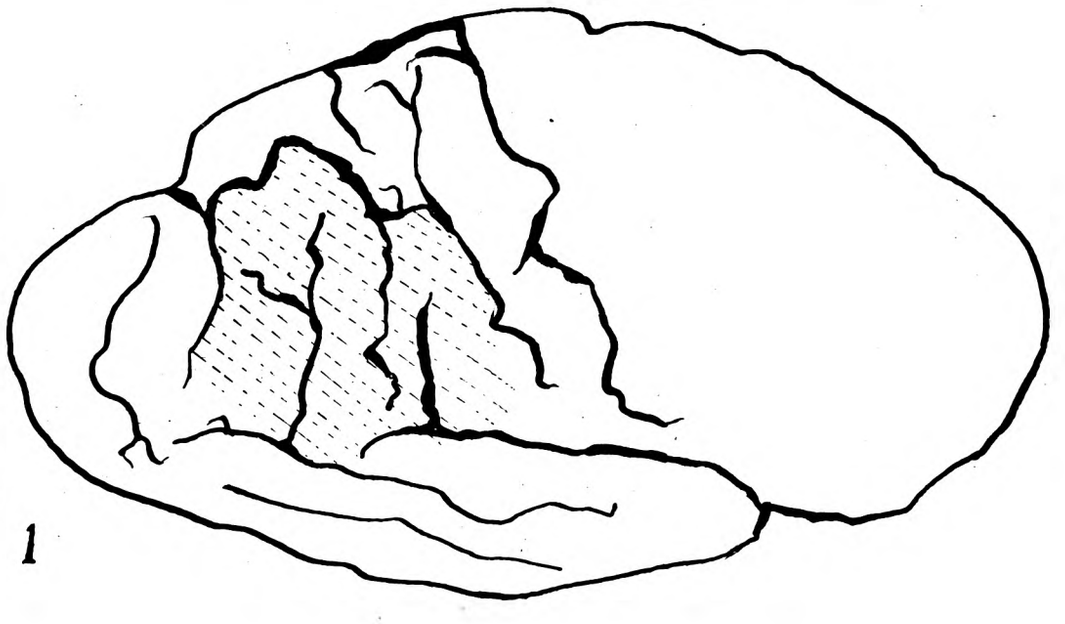
Many different areas of the cerebral cortex in man and mammals have been described, and a much confused terminology has arisen. (Brodman (1909), Vogt & Vogt (1919), von Economo & Koskinas (1925), Fulton (1938), Lorente de No (1938)). These workers hoped that functional delimitation would correspond with anatomical differences in neuronal arrangement of the cerebral cortex.

It has not proved possible to assign separate function to each isolated area of the cortex. Strict localisation of function has been opposed by Jackson (1878), Pick (1909), Goldstein (1927), Lashley (1928 & 1940), Bailey (1950), and others.

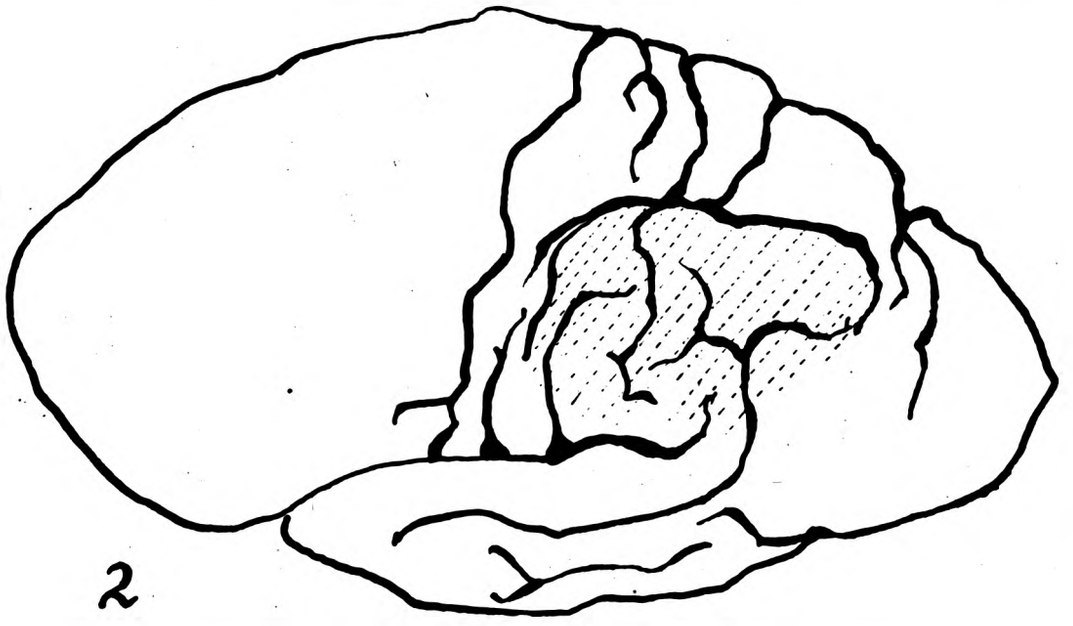
No definite conclusions may as yet be drawn regarding this problem.



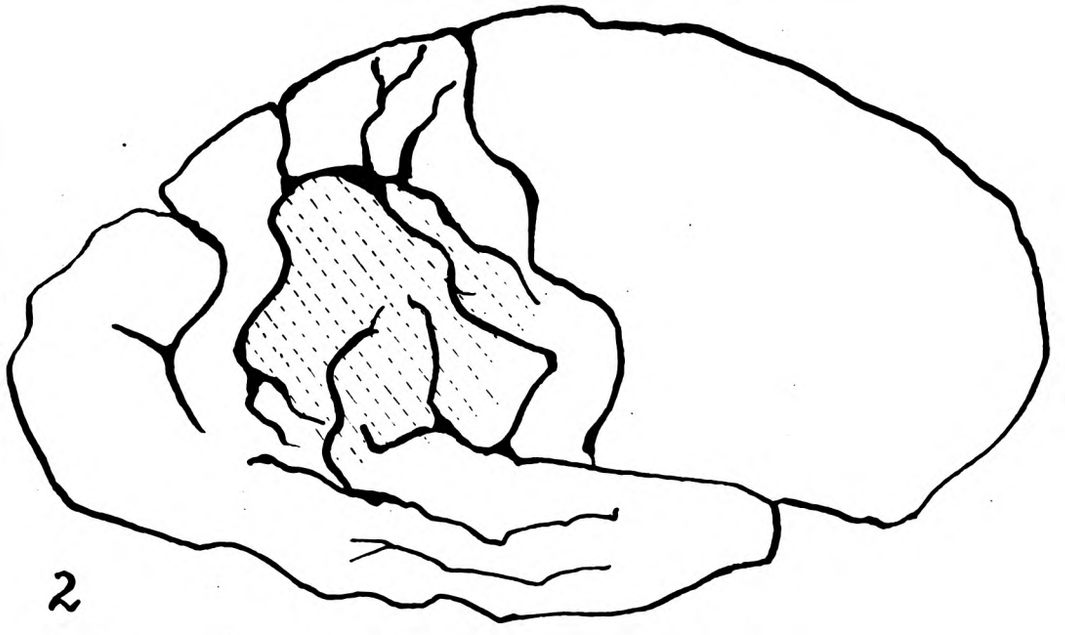
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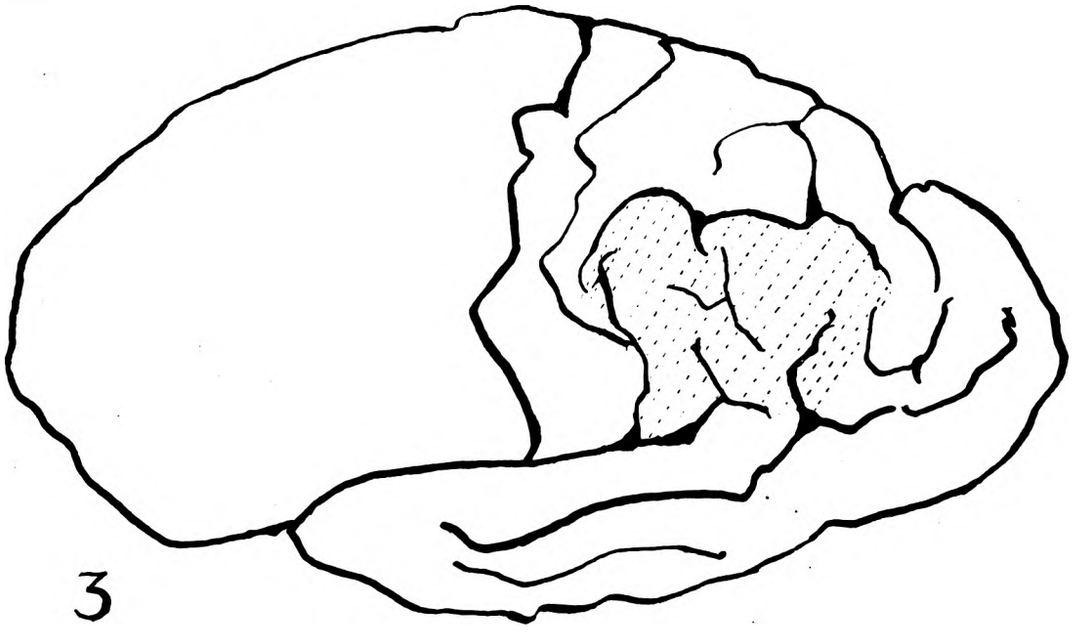
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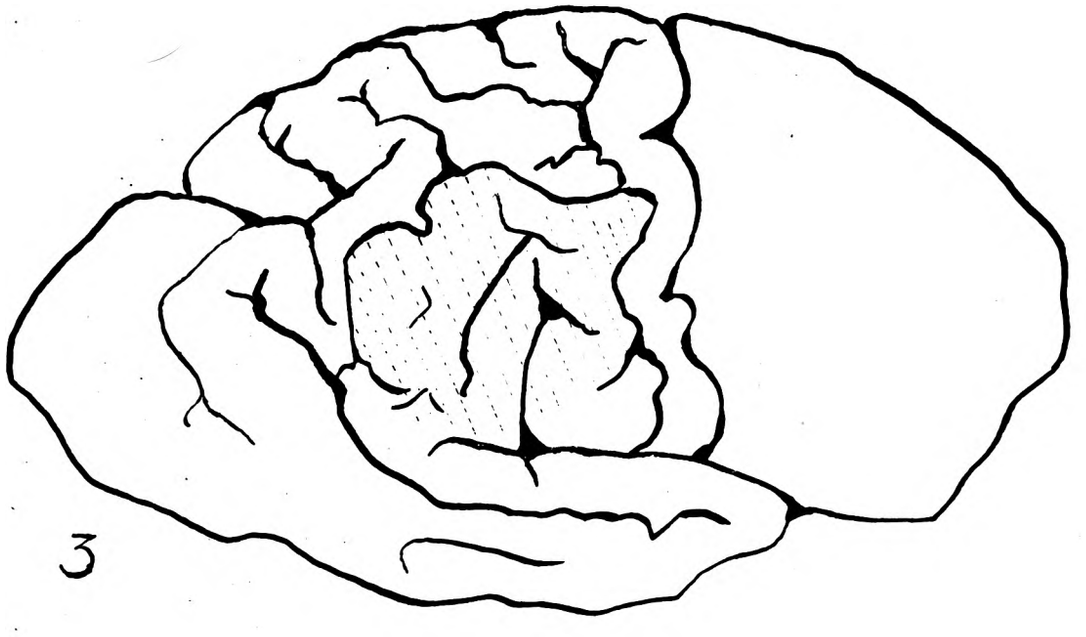
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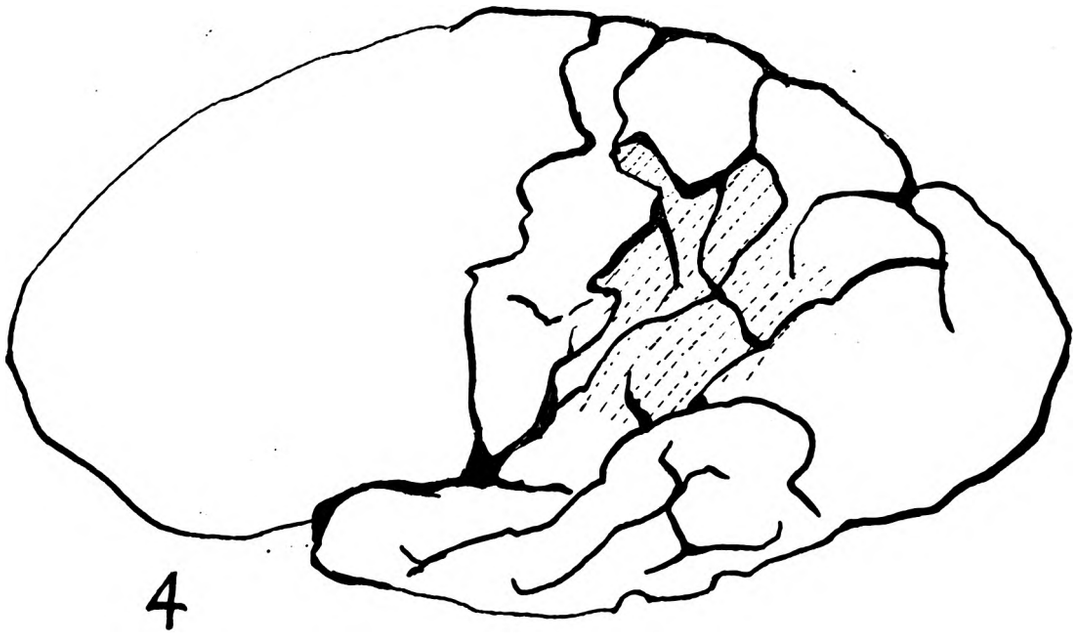
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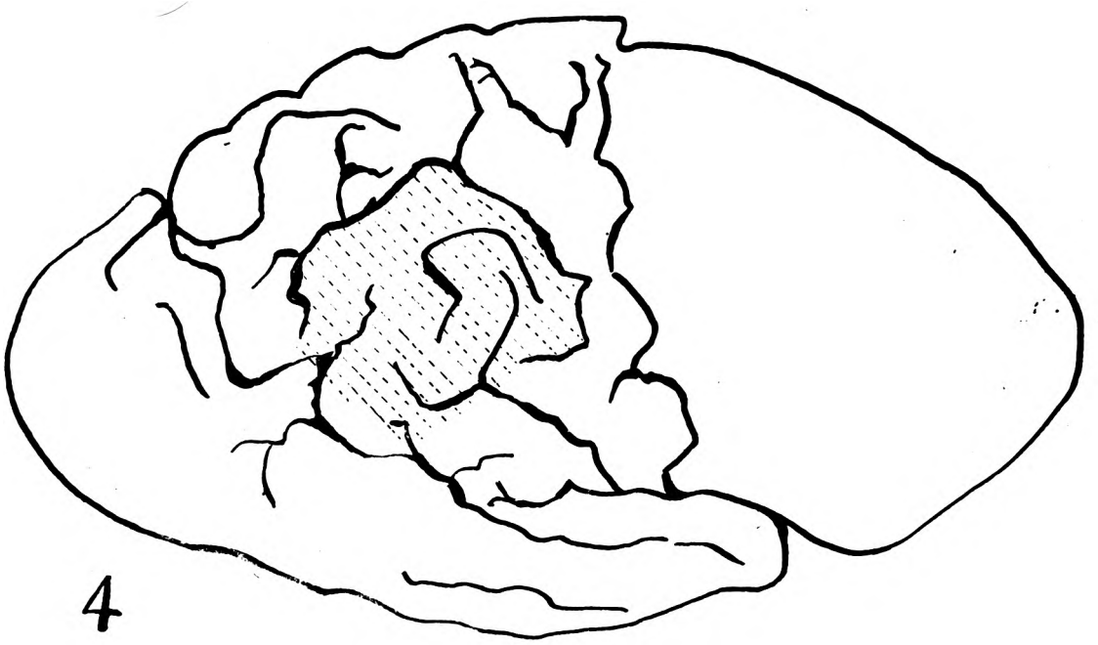
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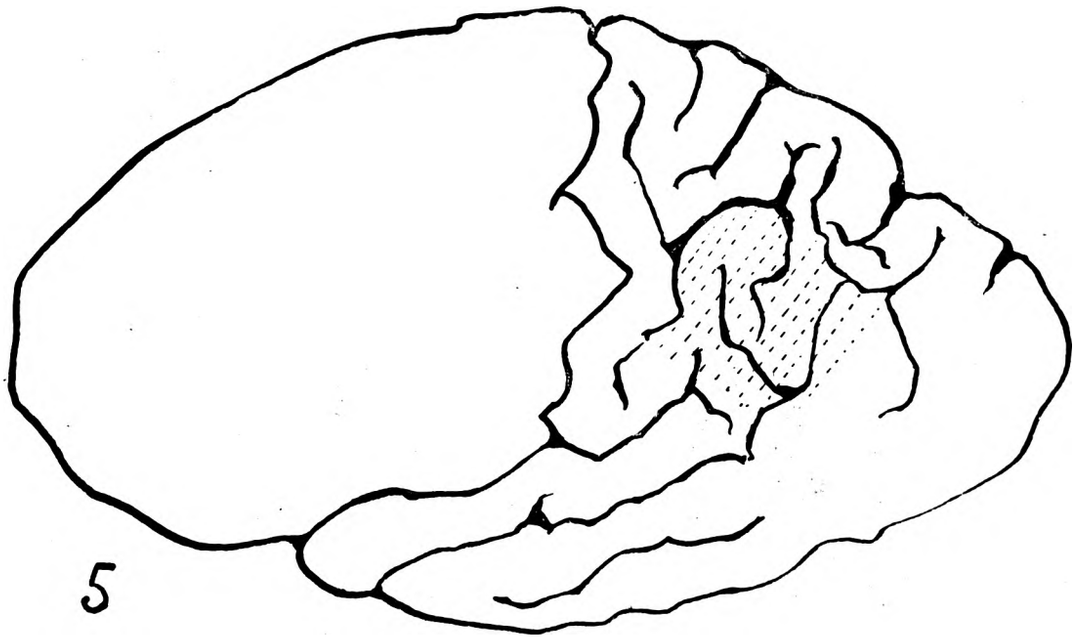
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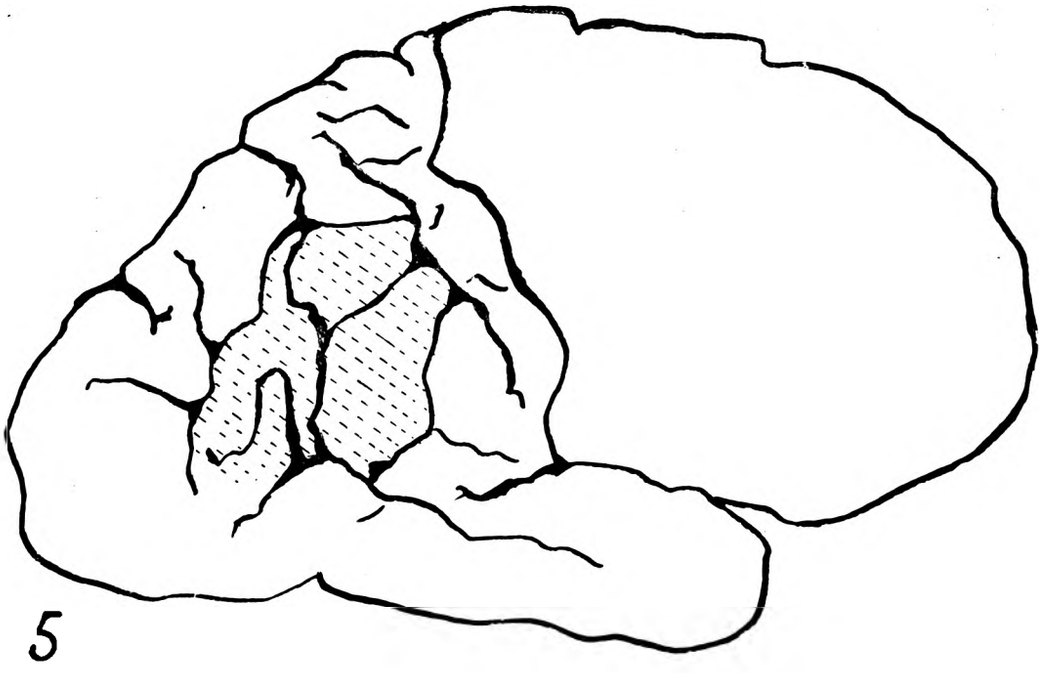
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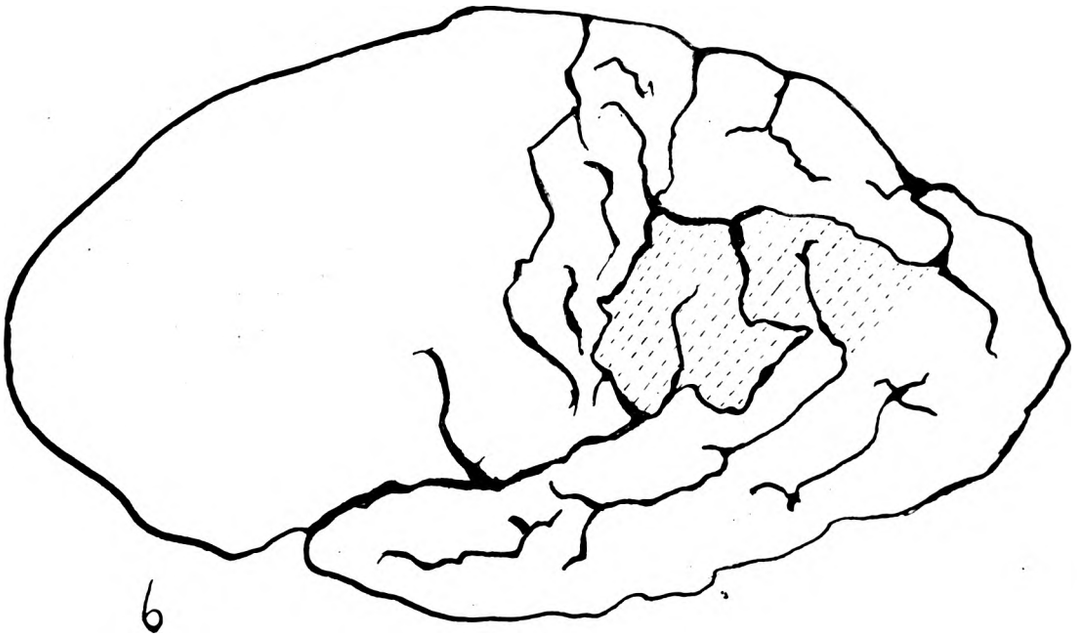
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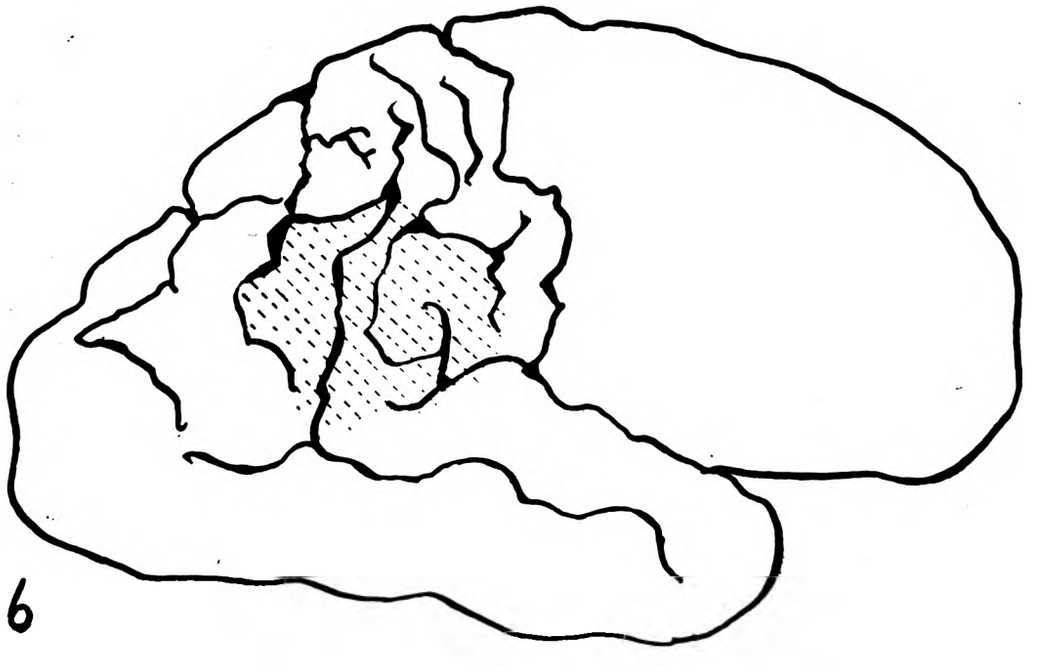
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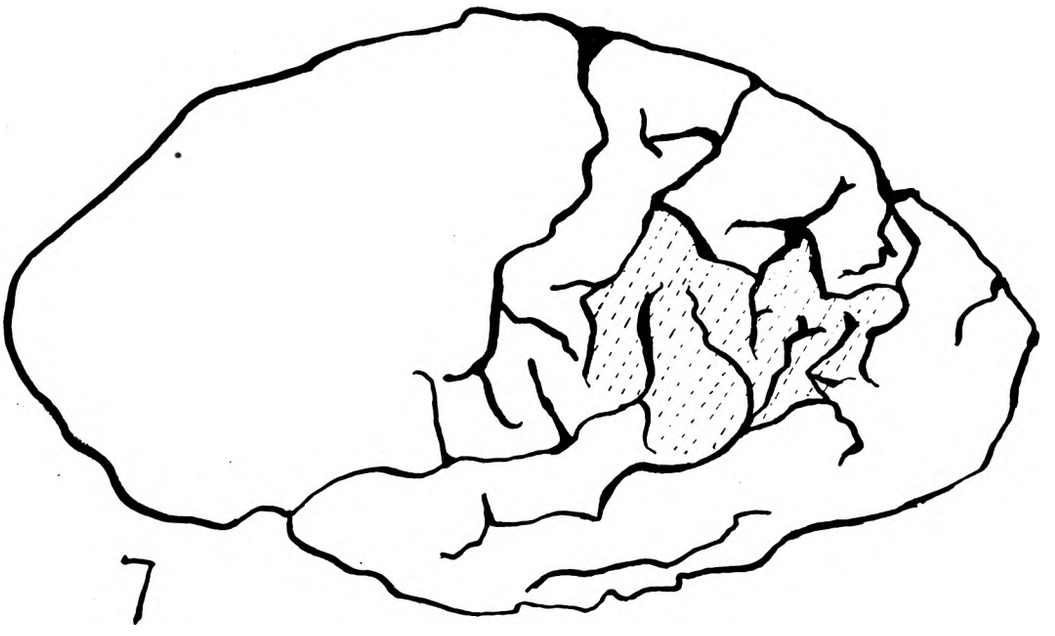
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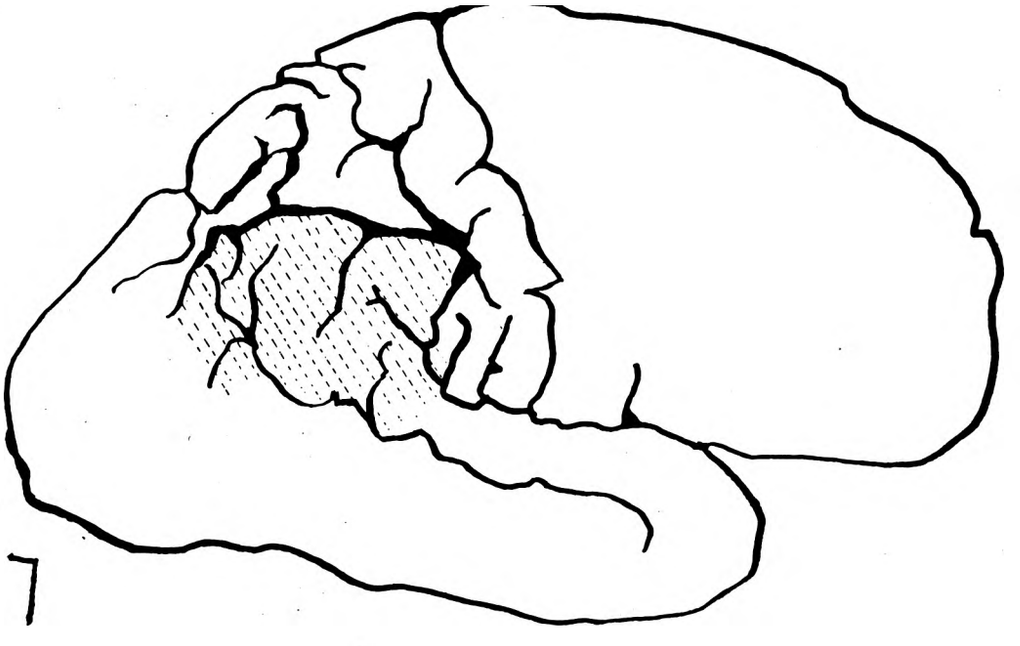
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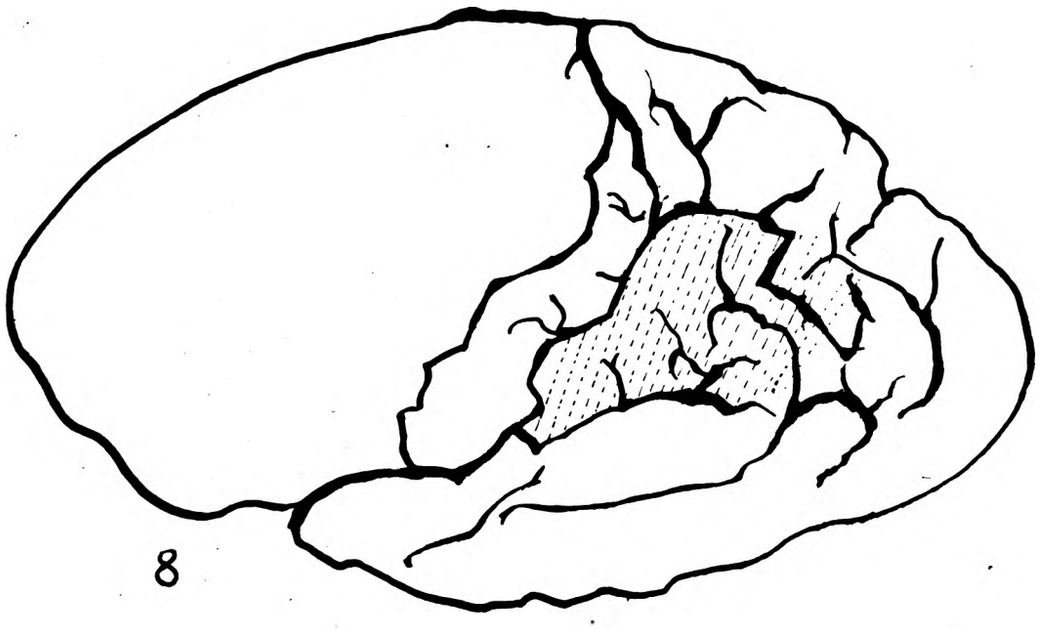
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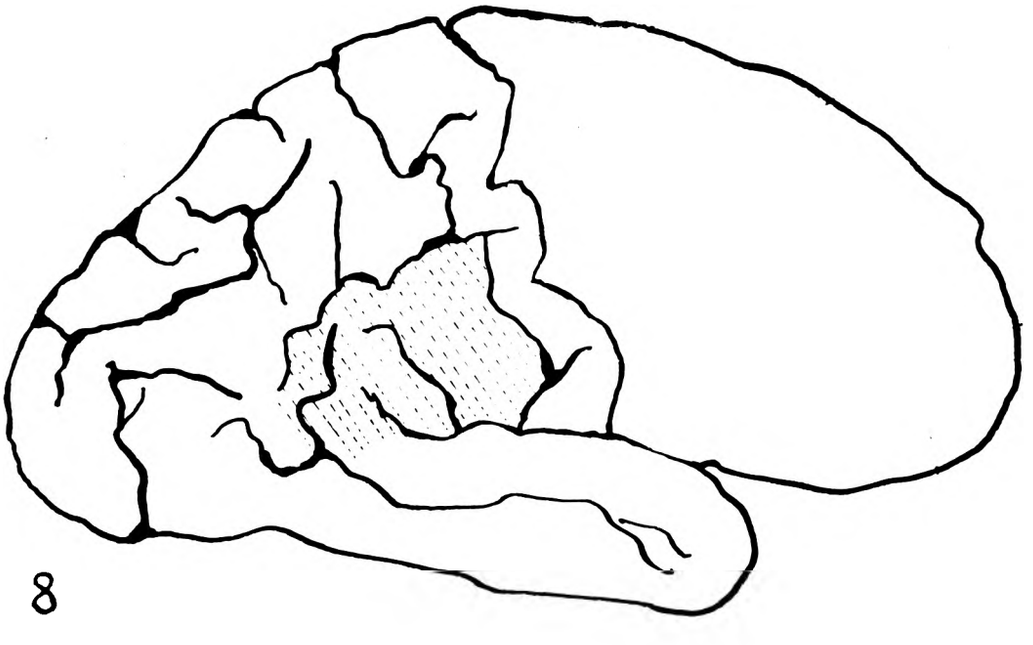
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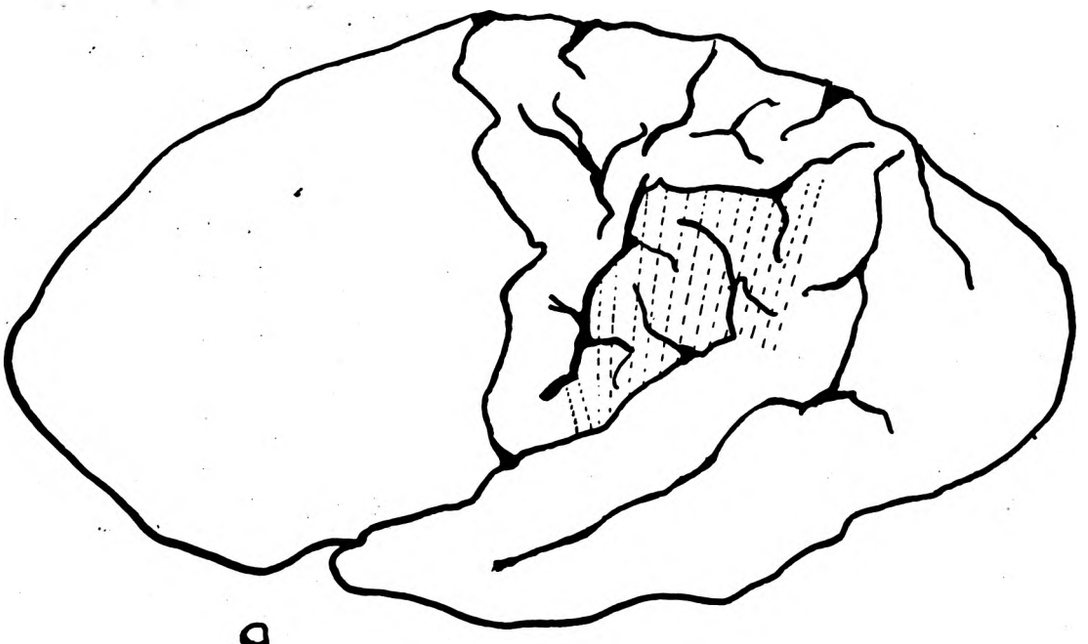
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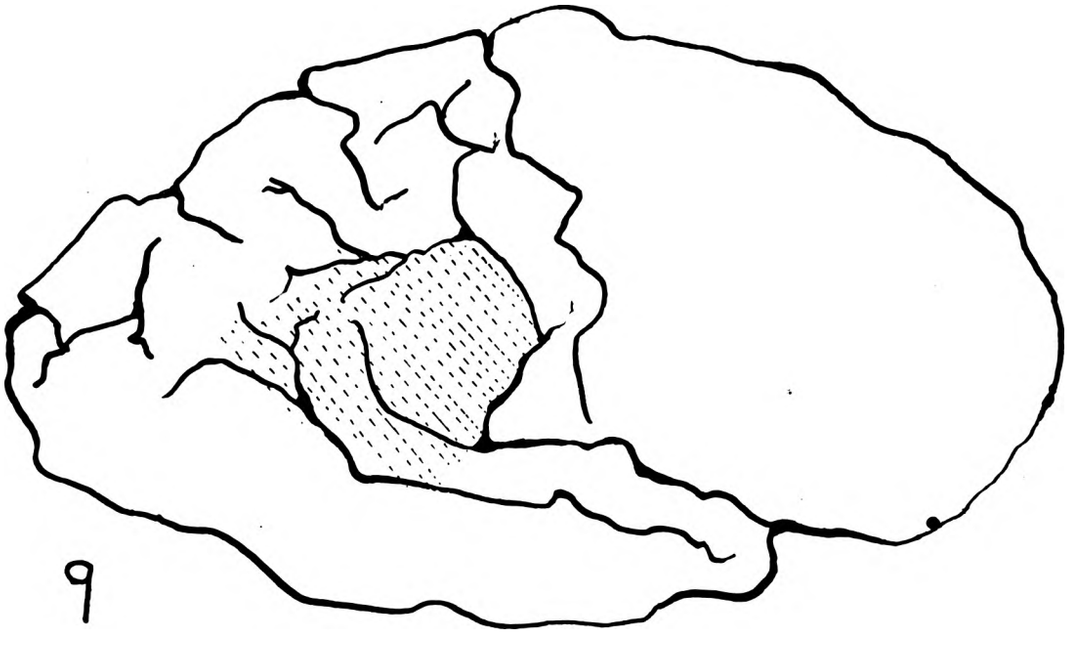
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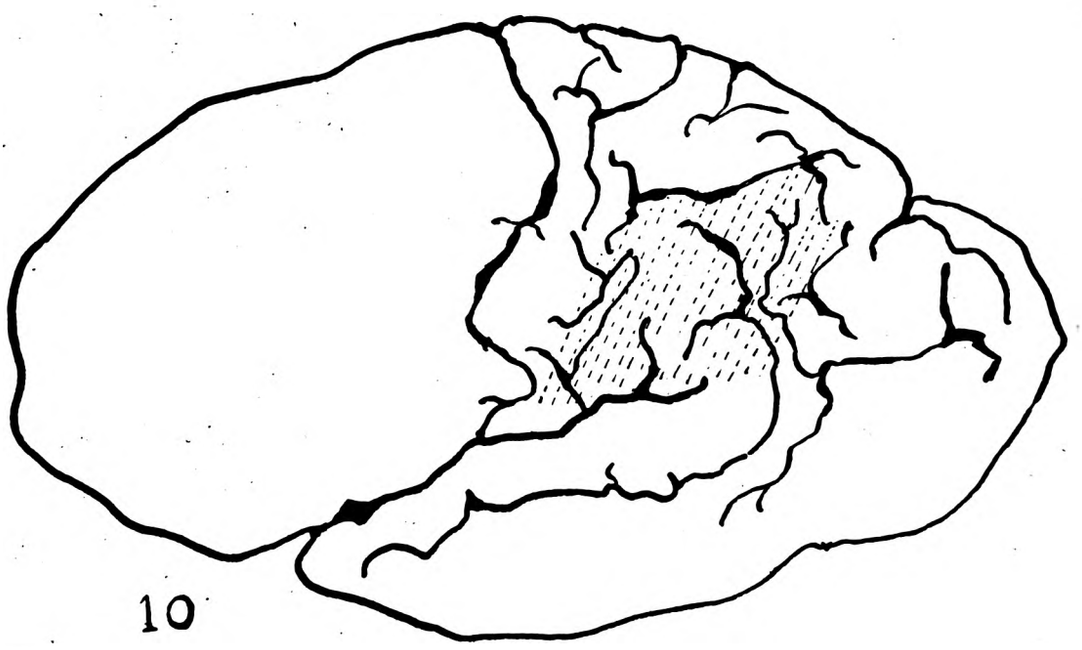
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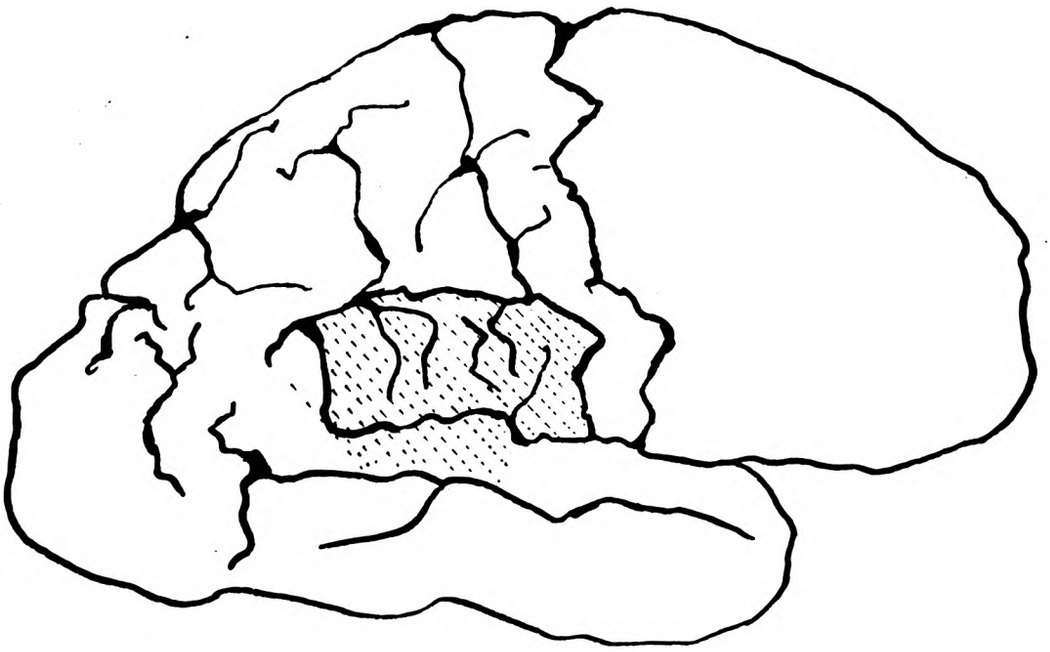
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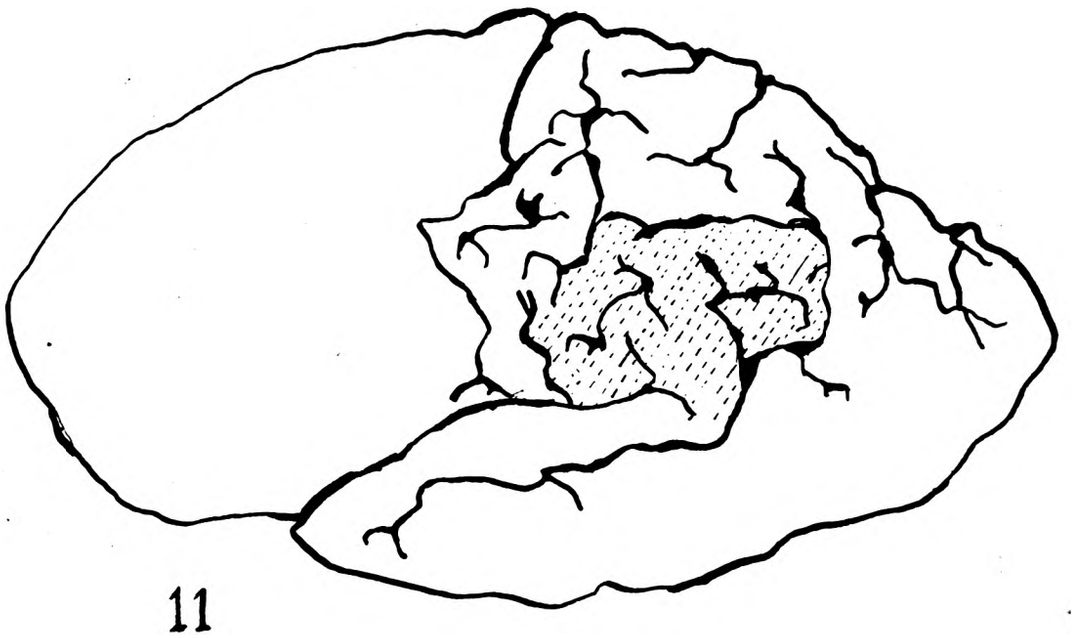
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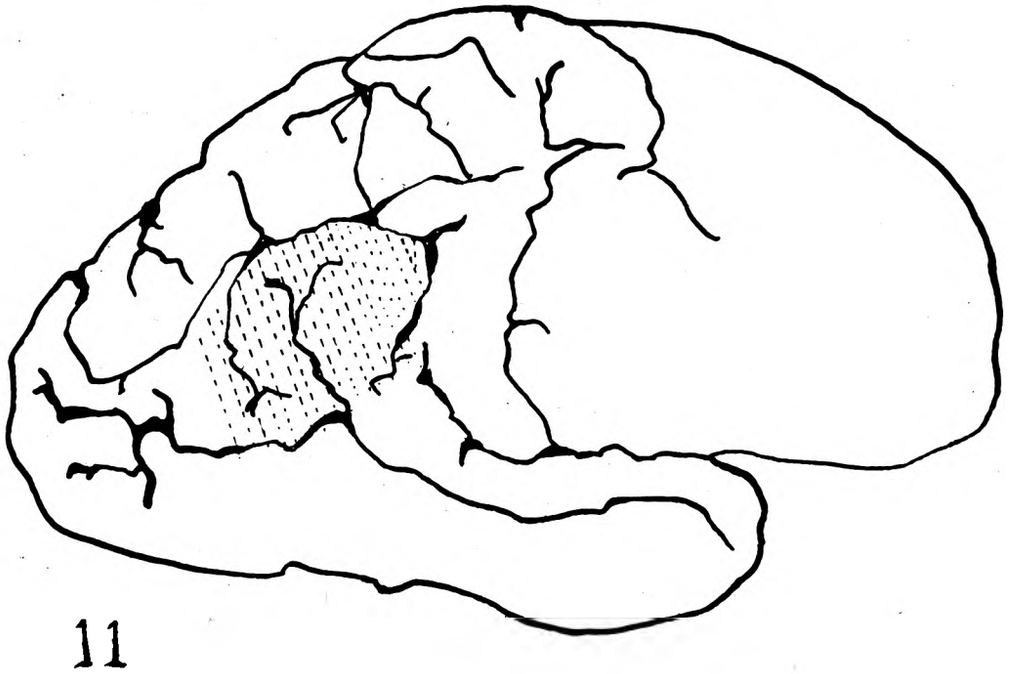
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# C H A P T E R VII

## DISCUSSION

It has been stated earlier that the functions which have been described are dependent upon perception, which phenomenon includes immediate sensory perception of sensory stimuli, the formation and integration of (1) images of sensory perception, (2) the symbolic representation of such images and (3) systems of abstractions derived from symbols. Perception itself, however, is an individual experience. Each of the functions mentioned above involve perceptions, images, and symbols, of multiple categories of sensation. Language involves them all, being the means by which man attempts expression of all his experiences, and communication with others who would express their experiences to him.

If the various types of dysfunction which have been described are examined in the light of their being disorders of aspects of perception, it is suggested that the nature of the dysfunction may be expressed in terms related to perception, as it has here been defined. That is to say, the defect of function may be referred to:-

(1) Imperfect immediate sensory perception.

(2) Defective images of perceptions.

(3) Defective images of symbolic representation.

(4) Defective images of symbol abstractions.

(5) Defective power of integration, and association of abstractions.

For example, the disorders of function may be expressed in the following terms:-

(1) "Nominal" dysphasia may be the result of destruction by disease of word symbol images. Primary sensory perception may be unimpaired - perception images may be intact. The patient may

"Know what he would like to say but can't think of the word". He recognises objects but cannot name them.

(2) "Jargon" dysphasia may be the result of destruction of perception images while word symbols are retained. The patient thus uses a flood of meaningless and unassociated symbols.

(3) "Auditory agnosia" may be the result of defective immediate perception of sound.

(4) "Dyspraxia" may be caused by destruction of kinetic and kinaesthetic images and symbols, or the inability to organise and integrate such patterns.

(5) Destruction of the symbol system used in mathematics may give rise to one form of dyscalculia.

(6) Destruction of visual and kinetic images and symbols may cause disorientation in space.

The presence of schema or patterns of activity in the brain has been suggested by Russell Brain (1950).

The classification of functions in terms of the integration of formed images and symbols is, however, one aspect only of the problem. This aspect is the chemical or physical one, the mechanistic organisation of material processes.

The major essential, however, the experience of perception, cannot be expressed in terms of physical or chemical behaviour. It is possible to suppose sensory stimuli conducted by physical or chemical means to the brain. It is also possible to suppose images of perceptions and symbolic forms represented in a spatial pattern - that is, having a localisation in brain tissue. We may then suppose a machine like correlation and integration of such patterns, and finally a high level of abstraction. These processes would be capable of measurement by an outside observer. That is to say, a scientific experiment in the modern manner might be performed in regard to them. They might be expressed in terms of events and quantities. They are related, therefore, to matter.

Perception, however, cannot be so expressed. It cannot be measured by an outside observer. Perception belongs to the individual who perceives. It is not a quantitative but a qualitative phenomenon.

The affective states are similarly not susceptible of measurement (although their accompanying physiological changes might be so), for they also are part of individual experience.

These qualitative phenomena are independent of space and time, although evoked by events which do have spatial and temporal attributes.

Such phenomena belong therefore to a different category than do material phenomena, and they cannot be said to have "localisation" in brain cells. This statement applies both to the immediate sensory perception experienced by an individual as a result of his earliest sensory stimulus and to the later more complex perception, which is the sum of previous experiences in the form of images, symbols and abstractions. To suppose the existence of "centres" for speech, reading, writing, music, or other functions is to assume, therefore, anatomical or material shapes of non-material phenomena.

# C H A P T E R  VIII

## SUMMARY

The disorders of function which result from organic disease of that part of the human brain cortex which lies posterior to the fissure of Rolando were discussed. These disorders were stated to be related to the perception of stimuli concerned with vision, hearing, the sensations of touch, pain, posture and vibration, stereognosis, tactile discrimination, language in all its aspects, calculation, voluntary movement, the awareness of the body, and its orientation in space.

The faculties of language, voluntary movement, calculation, the orientation of the body in space, colour gnosis, and memory were analysed and discussed.

A scheme for the testing of these functions was suggested, and its application demonstrated with clinical examples.

A study of the anatomical configuration of the cortex of the "parietal lobe" of the brain was described, and tracings and photographs of convolutional patterns were included.

The hypothesis was put forward that the functions discussed above depended upon perception, and it was suggested that each dysfunction might be related to a particular aspect of disordered perception. Perception was defined as a phenomenon which involves a series of events which may be scientifically described, but which is itself the qualitative experience of an individual.

## ACKNOWLEDGMENTS

I wish to express my thanks to Dr. Macdonald Critchley for his valuable advice and encouragement.

I would also like to thank the Medical Committee of the National Hospital for permission to use the clinical material.

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