Section of Neurology

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[*March* 21, 1935, *continued*]

Some Observations on Apraxia

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IN spite of the enlargement of our knowledge of aphasia and agnosia by the study of head injuries during the Great War, the doctrine of apraxia has not received any great stimulus from these observations.

It remained at the stage Liepmann arrived at in the first ten years of this century until Kleist described a new form in 1922. In this, patients who are able to perform all purposeful activities in daily life fail or have difficulty in making simple patterns with mosaics, matches, bricks, in copying drawings, and sometimes in writing—in short, in all constructive tasks.

Kleist speaks of " constructive apraxia," and Strauss, his pupil, published a large number of cases to demonstrate the independence of this from the other forms of apraxia. He also pointed out the independence of constructive apraxia from gnostic, especially visual, impairment. The close connexion with visual functions and with the cases described by Poppelreutter as optic apraxia is admitted. If one had to give the theory of Kleist in a few words, one would say: that the visual control of activity in space fails in constructive apraxia. There are relations to agnosia in space, as described by Gordon Holmes and his collaborators and by Best. The localization of the disturbance in parts of the parietal lobe, where optic, tactile and praxic functions are connected with each other, seemed to be in favour of such a theory, although a real visual dysfunction could not be proved in the pure cases by the means then available. The description of a symptom-complex by Gerstmann in 1924 brought fresh interest to the problem. He put forward agnosia of the fingers as the central symptom of a parietal symptom-complex. The symptoms of this complex are difficulty in naming and using the fingers, and in discriminating right and left, agraphia and arithmetic difficulties (acalculia).

Very soon it became clear that the Gerstmann-syndrome was occurring in the same people as Kleist's constructive apraxia and a rather extensive literature grew up in Germany. Most papers dealt with one case only in which careful investigation had thrown light on one or another side of the syndrome.

I do not propose to deal with the different theories to-night. I would only mention an outstanding paper of Lange, who summed up his explanation of a very interesting case in the statement: " The category ' direction in space ' is lost." The patient can perceive objects in space and act with the objects purposefully. But where she has to create points of relation in space and must fix directions, she fails. Finger agnosia, disturbance in discriminating right from left, difficulties in drawing and arranging, and eventually acalculia are reduced to space disturbance by Lange. In spite of its nucleus of truth this explanation seemed to some extent artificial and Lange himself has weakened its value in later publications.

Before I report the six cases which I have had the opportunity of observing during the last year in the Maudsley Hospital, while working there as a Commonwealth Fellow, I would like to mention a discrimination made by Rieger so early as 1909, which is noteworthy in this connexion. He discovered in a large number of patients with general intellectual deterioration two groups: in the first group the verbal and symbolic apparatus, as he calls it, was mainly affected; in the other group the spatial and objective apparatus was affected while speech and symbolization were relatively unimpaired. The patient could help himself in difficulties of the spatial world of objects by using familiar verbal and conceptual devices. Rieger also was the first to show the helpless behaviour of patients of the second group if confronted with simple spatial tests like arranging matches or single letters.

Although the things we have to deal with are not quite new, the relation to other dysfunctions following organic brain lesions is still difficult to assess. Opinions differ considerably as to the relation of constructive apraxia to Liepmann's apraxia and its different forms.

My contribution to this problem to-night will be a film. In it the contrast will be illustrated by a patient with Liepmann's apraxia who performed easily the constructive tests which are so difficult for my patients with constructive apraxia.

Case	Bodily findings	Memory speech	Visual impairment	Apraxia	Finger-agnosia	Right and left disturbance	Agraphia	Arithmetic	Drawing
Bo.	Spastic signs left side	Amnesic syndrome, word-finding difficulty	Visual attention impaired	Constructive slight ideomotor	Present	Present	Present	Only orally	Impossible
Ri.	Weakness left	Amnesic syndrome, lack of initiative	Visual attention impaired	Constructive slight ideomotor	Slight	Absent	Present	Only orally	Poor
Pa.	Spastic signs left, akinesis right	Amnesic syndrome, lack of initiative	nil	Constructive slight ideomotor	Present	Present	Present; can write block letters	Acalculia present	Very poor
Cl.	nil	Amnesic syndrome, later improvement	nil	Constructive	Present	Present	Slight	Acalculia slight	Disturbed
Be.	nil	Amnesic syndrome, lack of initiative	nil	Constructive	Slight	Absent	Present	Only orally	Disturbed
Ba.	nil	Amnesic syndrome	nil	Constructive	Present	Present	Very slight	Total acalculia	Slightly disturbed

FIG. 1.—Table of cases and chief symptoms.

With five of my six patients the illness began at about the age of 50. A slowly increasing mental deterioration became manifest. Memory impairment, loss of interest in things around them, inability to find their way, were the first signs observed by relatives. The patients could not read the clock-face, they lost the faculty of writing and doing arithmetic and they made gross mistakes in dealing with money. Men failed in their profession, women had to give up their housework. In only one of these five cases is there a history of slight apoplectic seizures with one-sided weakness. In all others the process of deterioration began insidiously and progressed without any acute phases.

The sixth case (Cl., *see* fig. 1), that of a woman, aged 63, showed constructive apraxia following a severe carbon-monoxide poisoning. After a year's depression during which she made several attempts at suicide, she succeeded in gassing herself. She is said to have been unconscious for over sixteen hours. But the amnesic syndrome, which was stationary or progressive in the other cases, diminished in this case, while constructive apraxia and other parietal symptoms persisted a long time.

The question of localization is far from being definitively answered. I cannot contribute much towards its solution because so far I have been able to examine the brain of only one of my patients and this showed multiple softenings in different parts of both hemispheres (Pa. fig. 1). The frontal and occipital lobes were free from macroscopic changes. A large deep area of softening was situated in the lower part of the left parietal lobe, a smaller one in the corresponding part of the right side. On microscopic examination of the corpus callosum Dr. Alfred Meyer found softenings there too.

The *neurological findings* were very few. In three cases slight pyramidal signs of the left side were found, but no definite paresis. One of these patients showed slight spasticity of the left side, but preferred to use the left hand although right-handed from childhood. There was an akinesis of the right hand which he could use to the same extent as the left if the left was fixed. Apart from these findings I discovered no disturbance of the lower motor neurone, no ataxia, no tremors and no hyperkinesis. The constructive apraxia was throughout a bilateral syndrome in my cases (as it is in nearly all the cases in the literature).

The sensory functions also were normal throughout. All modes of skin-sensation proved intact; there was no disturbance of sensibility of joints and muscles and no astereognosis, which has sometimes been made responsible for the finger agnosia of which I shall speak later.

Testing the visual functions was especially important for theoretical reasons. None of my cases showed hemianopia or scotomata. In the two most severe cases (Bo. and Ri. fig. 1) there was in some degree a slow excitability of visual attention, perhaps similar to that found in cases of parietal head injuries published by Gordon Holmes. In one of these two cases the reaction to auditory stimuli was much quicker. The other patient reacted generally rather slowly, so that the particular disturbance of visual attention was doubtful. In none of the cases was any sign of optic agnosia found, or of optic ataxia in the sense of Balint, and no disturbance of visual localization as described by Best. All the patients were able to count visually. Optic nystagmus was present in the five cases tested, but was rather difficult to excite in the two cases with attention disturbance.

With regard to the *general mental state*: all my patients had a more or less severe impairment of memory which had to be taken into consideration, especially in testing arithmetic. The form of memory disturbance showed the typical picture of early senile or arteriosclerotic deterioration: numbers and dates were most affected, and then names. In the most severe cases considerable defects of recollection of former life were present. The gassed patient (Cl.) had retrograde amnesia. Retention-difficulty was present in all patients, with no selection or preference, when tested with different sensory stimuli.

Corresponding to the degree of memory disturbance, a slight difficulty in finding unusual words was demonstrable, but in most cases only on very rare occasions. On the whole the lower and higher speech function was—in contrast to the other activities—very well preserved: there was no amnesia for colour names, and there were no difficulties of speech-perception, or disturbances of music or rhythmic sense.

As to the *form of apraxia* found in my patients, the series can be divided into two equal groups. In the first, slight disturbances in purposeful activities were sometimes

present. Simple everyday actions, e.g. lighting a candle, using pincers, scissors, hammering nails, were carried out without difficulty. Tests of greater spatial complication were sometimes impossible; e.g. tying up a parcel, putting on a shirt—especially if done without visual control—tying a bow or brushing one's hair while holding the mirror. I doubt if these failures in my first group, although apparently ideomotor in Liepmann's sense, are really to be regarded as such. The connexion with the constructive anomalies of spatial activity is obvious. The fact that these cases were those in which the disturbance was more severe, agrees with my interpretation.

The second group showed only constructive apraxia. According to Kleist's definition constructive apraxia is a "disturbance which appears in formative activities (arranging, building, drawing) and in which the spatial part of the task is missed although there is no apraxia of single movements." For example, I asked the patients to arrange matches in simple figures, such as a square, a triangle, a rhombus, a house; or as Roman numerals. Then I placed before them rectangular figures, gave them the corresponding number of matches and asked them to copy the pattern. The patients always began readily enough but, even in the mildest cases, failed if the figures were complicated. The difficulties they were struggling with were expressed in a very typical manner. As soon as the patient was unable to go on, he brought his own matches as near as possible to the pattern or tried to build his copy into it, so that he soon mixed the matches of the pattern with his own matches and became muddled.

The same difficulties and the same behaviour can be observed in tests with coloured mosaics of different shape. The patients repeat the task to themselves aloud or name the colours of the mosaics again and again in correct order, but they do not get any help in this way. They recognize their failures and begin again nearer to the pattern. One is really impressed when one sees how a patient, who is able to choose from a pile of mosaics the correct pieces to fit a given pattern, is yet absolutely helpless when he tries to arrange them in the same order as in the model. With bricks, the fact of their being of three dimensions seems to increase the difficulty.

Imitation of hand-and-finger postures is similarly difficult. Patients were able to imitate the posture of one of their own hands with the other, but in copying the position of the doctor's hand they failed, or succeeded only after long trial. Here too the tendency to come close to the pattern was evident. A striking contrast was the relatively easy and correct imitation of postures of other parts of the body. All patients imitated postures of the head, the trunk, the arms as a whole, and the legs fairly correctly and without delay. They were able to walk to any place in the room if ordered, avoiding obstacles, choosing the easiest way. They also, on request, pointed at objects or grasped them, without any error in direction and distance.

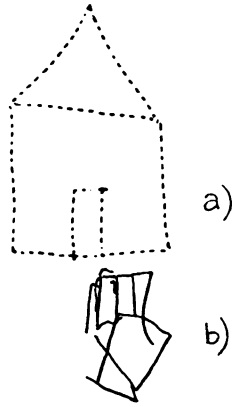
The notions of direction: "above" and "below," "in front" and "behind," were preserved; those of "horizontal" and "perpendicular" were doubtful in the three more severe cases. Four of the patients were completely, and the two others (Ri. and Be., *see* fig. 1) partially, unable to use these words and to find the directions right and left. These four were quite uncertain in naming the two sides of their own body or any symmetrical parts of it. They made random guesses. It was still more difficult for them to distinguish the sides of their image in a mirror or to do this for a person sitting opposite. The latter task was impossible for the two other patients, who had less difficulty with regard to the sides of their own bodies. It is an interesting fact in this connexion that my patients had great difficulty in using a map, especially in indicating the points of the compass.

Inability to tell the time had been observed in these patients by their relatives. Four of the patients (two of whom had not the marked right-left disturb-

ance) could not read the time from a clock or put the hands of the clock so as to correspond with another (Head's test); nor could they alter a clock in response to oral command. In one patient (Ri.) the disturbance appeared only occasionally and in another (Ba.) it was entirely absent. The patient with the least disturbance in constructive tasks was quite helpless with the clock-test, but he had a severe arithmetic disturbance. This perhaps suggests a relation to acalculia which I shall speak of presently.

A dependence of the so-called *finger agnosia* on the right to left disturbance, or vice versa, is demonstrated in my observations: inability to name one's own fingers correctly, to show single fingers if asked, or to point to the fingers of the doctor, was most marked with the four patients whose right to left discrimination was affected. Thumb-and-little-finger-tests, as other observers have noted, presented less difficulty; there were only a few failures. The more severely affected patients became really muddled with their fingers after being investigated for a short time.

FIG. 2.



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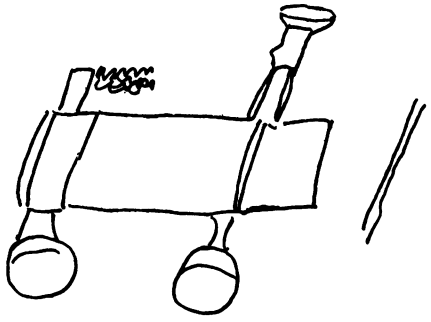

FIG. 4.

FIG. 2.—Case Bo. Drawing a square. Patient made the four strokes while counting 1, 2, 3, 4, then wrote the figure 4.

FIG. 3.—Case Cl. Copying a house: (a) pattern; (b) copy.

FIG. 4.—Case Pa. Drawing an engine. After finishing the engine patient was asked to add the tracks. He then put the two strokes alongside.

Drawing-disturbance was very marked in five of my cases and I think Kleist is right in bringing it into line with the constructive tasks. A former school-teacher refused to draw anything at all. After wearisome persuasion he drew a very small cross and circle, rather imperfectly. Others tried to draw, but with very poor results. Simple drawings were copied extremely badly; mostly the single parts were more correct than the spatial order of the parts. The tendency to come close to the pattern was again very striking; the copy was often put into the model.

The drawing-inability of a former famous artist in stained-glass whom I had the opportunity to observe was of the greatest interest (Pa., figs. 4 to 7). Although the handling of the pencil was quite normal, the destruction of his drawing faculty was almost incredible. Even his placing of the drawing on the sheet of paper demonstrated the severe spatial disturbance. Some lines and some fixed schemata in designing disclosed the professional hand, otherwise his drawings were like a child's (*cf.* Kleist). He also tended to put his drawings into the pattern (fig. 7).

Before I speak about the *agraphia* in these cases I would like to emphasize that reading was quite unaffected in all my patients. All could read with correct accentuation according to the sense, and understood what they read. Some of them occasionally lost a line, but if they were aided by a pointer this was avoided. Reading of numbers with three and more digits was impossible for the patients, who no longer knew their local value. All the patients spelled correctly and chose the single letters of a given word out of a pile of letters, but failed in putting the word together. The most striking case was that of a former teacher who proved unable to add the third letter of a word like DOG in correct position when the two first letters were set before her.

Yet the patients noticed if a letter was misplaced or set upside down, but they were, of course, unable to put it right. This "printing disturbance" is perhaps closer to the constructive difficulties than to those of writing—both defects are summated in it.

FIG. 5.

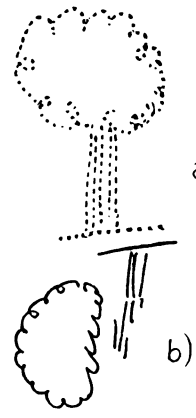

FIG. 6.

FIG. 7.

FIG. 5.—Case Pa. Drawing a tree. Patient drew the leaves. Then when asked to draw the trunk he drew the circle alongside.

FIG. 6.—Case Pa. Copying a tree: (a) pattern; (b) copy.

FIG. 7.—Case Pa. Copying a face (pattern shown by dotted lines). Patient began at once to draw actually on the pattern. He was at a loss when asked to copy it alongside the pattern and came back to the pattern; see the perseveration in his drawing.

In observing the *writing*, the patients' relatives were surprised at the arbitrary use of the space on the sheet; the patients seemed to begin anywhere. When they had begun they tried to scribble all the words within a very narrow area without regard to the space available. Experiments showed that the starting place was not chosen at random. The patients seized on some little spot, e.g. an unevenness in the paper or a watermark, as their starting point. If I made a small scribble on any point in a large sheet of plain paper or on a blackboard, I could be sure that the patient would begin his writing there. If they were urged to write somewhere else, the patients, on some occasions, approached the spot by directing the line of their writing towards it.

The agraphia is never complete. In one case (Be.) the writing disturbance was very slight—being neither literal nor verbal—but it was characterized, again, by a space factor. I would not venture to say it was *caused* by this factor. Rarer letters like *k* and *y* were ill-formed because of obvious space difficulties (*see* fig. 10). The

FIG. 8.—Case Bo. Arranging the word DOG with wooden letters.

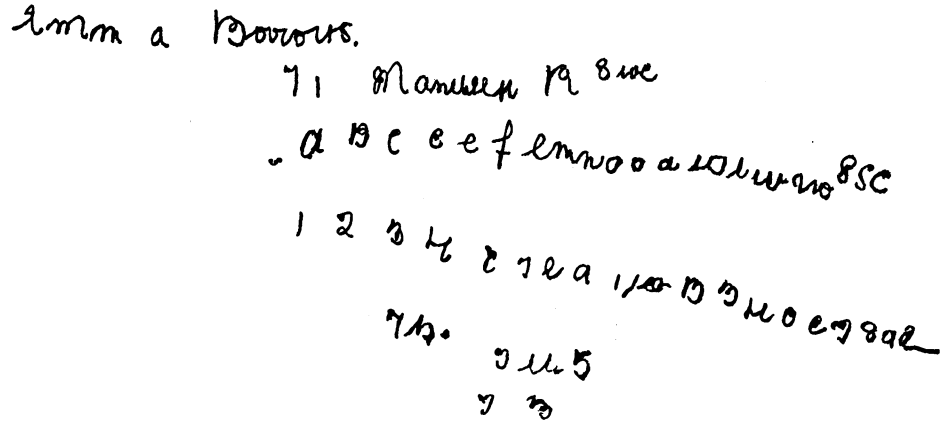

FIG. 9.—Case Bo. Writing of name, address, alphabet, sequence of numbers.

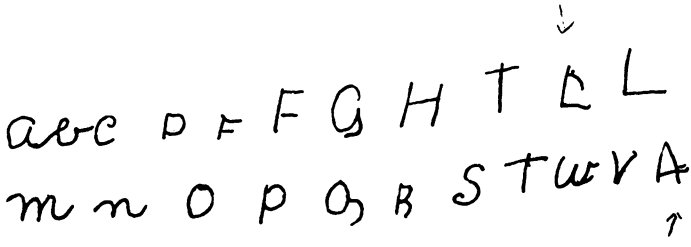

FIG. 10.—Case Be. Writing the alphabet, see failure with letters like K and Y, because of unfamiliarity and spatial difficulties.

order of letters also seemed the main impediment in writing words. Yet I am not sure how far Kleist's conception is right. He assumes a distinct constructive agraphia. The artist in stained-glass was quite skilful in writing block letters, whereas in cursive writing he failed much more often.

It impressed me as very peculiar that patients seemed less aware of their errors in writing than of their other failures. They tried to escape into writing words if they found difficulty in drawing or putting together a number of digits. This was most striking in one of my patients who regularly escaped into writing when asked to draw.

In order to illustrate the *arithmetical disturbance* which appeared in all my cases to some extent and dominated the clinical picture of one of them (Ba.), I would quote the findings in a clerk who had been an accountant in a printing firm for about thirty years before he fell ill (Ri.). He did simple mental arithmetic quite well and quickly so far as his memory defect did not interfere with this. He knew his tables, could do addition and subtraction and compute simple interest. In writing he was helpless, even with simple addition. With some help he succeeded in adding simple columns, but was not able to write down the figures in correct order. The local value of the figures was entirely lost. This patient wrote 105 as follows: 1.5. Others wrote in the word "hundred."

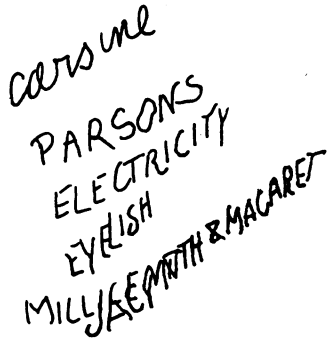

FIG. 11.—Case Pa. Writing: unable to write his surname in cursive script, though successful with block letters. Spatial difficulty leads to running words together.

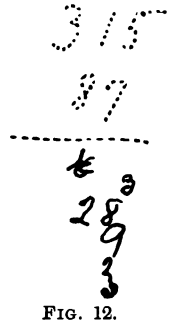

FIG. 12.

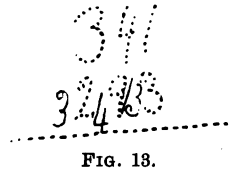

FIG. 13.

FIG. 12.—Case Ri. A written sum, single columns are added correctly but proper alignment is impossible.

FIG. 13.—Case Cl. A written sum. Correct answers misplaced.

Most of the patients could not manage money. Although they could count the number of coins they failed in handling and putting in order coins of different value and in adding them.

I must now cut short the narration of facts in order to add some remarks by way of interpretation of the syndrome of apraxia, which I have been describing. Many of the observations, thus roughly described, suggest that *space-impairment* is the cause of these disturbances; other writers have taken this for granted. I hesitated, however, to agree with this suggestion at first. Space is a very wide and vague notion; every activity, every movement, occurs in space. Any disturbance of activity can therefore be looked upon as a space-disturbance or as conditioned by some disturbed space-factor. There are anomalies in visual, auditory, tactile space and systematic space anomalies of vestibular origin. How can we specify the space-disturbance in constructive apraxia? Is it possible at all to specify it?

If we call the sphere in which every action is carried out its "activity-space" ("Wirkraum" v. Uexkuell) then activity-space is not generally affected in constructive apraxia. Purposeful activity is possible, the underlying space-perception by sensory means and the notions of space-relations seem nearly all well preserved. The disturbance is present preponderantly *in the small realm of hands and fingers* and in all performances dependent on these. Here all functions concerned with positions, movements and notions have become uncertain.

Moreover one finds here the peculiar tendency mentioned above, which has also been noted—as a casual observation—by different writers. Goldstein described it, but without recognizing its connexion with activity and apraxia. But its wide range and fundamental significance had not been established. Teleologically we might speak of a fear of empty space. During any manual performance the hand pushes away from loneliness, as it were, it tries to find company in anything that fills up the space. In rhythmic movements the hands tend towards one another. I have observed the same thing in gymnastic exercises. One patient was bending forward towards the doctor, who was showing her how to do the exercise, apparently in order to get closer to his hands. I recall the behaviour in writing, drawing, in imitating finger postures, in copying mosaics—always the hand tends to go out of the empty towards the filled space. As frightened chickens flock together, so do the active hands go closer to the pattern or anything else that fills the space. The tendency gets stronger and more manifest in proportion as the spatial task appears more difficult. The spontaneity and promptness of this symptom gives one the impression of *a primary biological protective mechanism*, like perseveration. To give a preliminary name, may I propose to call it the "*closing-in*"*-symptom*? Its occurrence seems to me an important and essential support of the interpretation of constructive apraxia as space disturbance, and makes its functional analysis easier. Looking over the literature, and considering the reported observations, one can scarcely believe in a disturbance of space as a "category." Nor does a separate impairment of direction in space seem probable. All three space qualities are affected in our syndrome—direction, extension and localization: e.g. right-left disturbance and inability to keep to the line in writing can be mainly regarded as disturbance of direction. The closing-in symptom is certainly a sign of injury in space extension; localization-factors are disturbed in copying mosaics or "printing" tests, in the loss of local value of figures, etc.

Thus the space disturbance is a general one, comprehending all qualities of space. Still it is special in so far as it concerns only the "activity-space," and this only in the sphere of hands and fingers.

Such a partial disturbance seems to be less astonishing and peculiar if one assumes that capacity for action in space reaches its finest differentiation in the activity of hands and fingers. The human hand has scarcely any spatial fixation point; it can be moved in almost all directions, and in a larger extension than any other part of the body. The movements of the eyes, which are perhaps of a comparable delicacy, take place in a more organized and controlled part of space because of the fixation of the eyes in the skull. Their co-operation with head- and

body-postures is guaranteed by numerous reflex mechanisms (Magnus and de Kleijn). Thus the highly differentiated activities of hands and fingers can be said to be the most vulnerable part of the human " activity area."

In constructive apraxia this maximum performance is reduced.

Beginning from this conception a new approach to the study of other space disturbances seems to be possible. We ought to know how far visual space impairment influences " activity-space," and how the different functions concerned with space are working together.

I conclude with an allusion to the importance of relating the results of such investigations to genetic research into the development of space appreciation in childhood and in animals.

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