that mixing was reasonably uniform in normal people. Briscoe *et al.* (1951) came to a similar conclusion, using this principle applied to the progressive rebreathing of an air/helium mixture, in that they found some subjects in whom the results suggested some inequality and that the fact that they were unable to allow accurately for the effect of the dead space might conceal a degree of departure from the principle of uniform distribution.

During recent years the development of methods which enable the concentration of the reference gas to be measured, expiration by expiration, has greatly refined the application of this technique. These methods employ either the nitrogen-meter (Lilly, 1946; Lilly and Hervey, 1948) or a mass spectrograph. Using the latter, Robertson *et al.* (1950) found that all of 18 healthy people of varying ages breathing oxygen had successive concentrations of expired nitrogen such that their logarithmic plot did not fall along a straight line, but seemed to be fitted by at least two straight lines.

A third method of investigating this problem has been by the continuous analysis of a single expiration, also using the nitrogen meter. This represents a great advance on the relatively laborious methods of sampling successive portions of an expiration such as used by Krogh and Lindhard (1917), Aitken and Clark-Kennedy (1927), and Armitage *et al.* (1949). Whatever the method employed, there has always been found a slight but significantly lower concentration of the reference gas in the last expired portion of the exhalation. In our studies we interpreted this to be due to the contamination of the earlier samples by part of the preceding inspiration trapped in the dead space artificially difficult to wash out because of the clipped nose. Fowler (1949) has, however, interpreted this to be due to what is termed segmental ventilation, in which certain areas of the lung fill before and empty after other areas. This process results in a preferential distribution of the respiratory dead space gas to those regions which fill first on inspiration.

The outstanding physiological defect that is present in disease processes which partially occlude air passages or which, as in emphysema, are accompanied by gross reduction in lung elasticity is reduction of alveolar ventilation. The result is an abnormally low alveolar oxygen tension and high CO₂ tension, leading to arterial unsaturation and CO₂ retention—that is, anoxaemia and hypercarbaemia.

In conclusion, therefore, I would emphasize that pulmonary function and dysfunction in respect of alveolar ventilation and exchange across the alveolo-capillary membrane is explicable on the basis of simple physical laws.

[The second lecture, with a list of references, will be published in our next issue.]

The passing of the National Health Service Act, which placed hospitals in the public charge, made it at once more important and more feasible to try to assess the adequacy of hospital facilities provided in relation to a defined community. Since 1946 a few such assessments have been undertaken, five of them in Scotland. The first were the Nuffield surveys of hospital-treated sickness in Stirling (1948-9) and Ayrshire (1950); then came Fraser and McKinlay's in the Northern Region; the Eastern Regional Hospital Board surveyed the Dundee region in connexion with the projected new teaching centre (though the results have not been published); and the most recent relates to the sickness treated by the hospitals under the control of the Board of Management for the County and City of Perth General Hospitals during 1952. This report, by Dr. William Mackie, the medical superintendent of the group, gives a comprehensive picture of the services offered and the use made of them. Copies of Dr. W. Mackie's report: "The County and City of Perth General Hospitals: A Survey of Hospital-treated Sickness in 1952," may be obtained from the Nuffield Provincial Hospitals Trust, Nuffield Lodge, Regent's Park, London, N.W.1, price 2s. 6d. (post free).

PERSONIFICATION OF PARALYSED LIMBS IN HEMIPLEGICS*

BY

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The phenomenon of anosognosia for paralysis (or "nosoagnosia" as some prefer to call it) is a neurological commonplace. The clinical background is commonly made up of (1) a transient loss of consciousness; (2) hemiparesis or hemiplegia of abrupt onset (hence anosognosia is commoner with vascular and traumatic lesions of the brain than with space-occupying lesions); (3) a state of post-ictal confusion, not necessarily intense; (4) a left-sided paralysis, in the case of a right-handed subject; and (5) an associated defect of sensibility over the affected segments indicating an involvement of the parietal lobe.

Unawareness of the fact of being paralysed is generally a transient feature, though not always so. As a rule it is not a strictly isolated defect of insight, for the patient usually betrays other comparable traits. Thus he may make light of the severity of his illness and talk of resuming his work, or journey, or holiday in a day or two; he may not even realize that he is a sick man at all; he may be disorientated in several spheres; he may be incontinent without registering any distress or proffering any comment.

Should the paralysed patient happen also to be afflicted with a recent blindness, then it is often found that he ignores or neglects or even denies this symptom, as well as the paralysis. This is not invariable, however. The patient may be aware of some aspects of his total disability. For example, he may mention that he has become dysarthric or that his face is crooked. But the paralysis of the left arm and leg—manifestations which one would imagine were all-obtrusive—are not mentioned at all by the patient. When anosognosia embraces several associated bodily defects, including paralysis, it may be capable of experimental enhancement. Thus Guthrie and Grossman (1952) immobilized the intact right arms of two of their patients with anosognosia for a left hemiplegia. The result was that the artificially imposed restraint affecting the normal limbs now also shared in the phenomenon of denial, for the patients minimized their helplessness and tried by various excuses to explain away their non-performance.

Cause of Anosognosia

There has been no complete unanimity among neurologists concerning the nature or causation of anosognosia. Briefly there are three chief opinions about the matter: (1) That anosognosia is a specific "parietal" syndrome; furthermore, that it is the expression of disorder of the minor hemisphere; and that the minor (non-dominant) parietal lobe is more concerned with the integrity of corporeal awareness (body-image) than is the dominant half of the brain. (2) That the all-important factor is not so much the *site* of the lesion, or even the *side* of the lesion, as the degree of accompanying confusion and the nature of the previous personality. (3) That anosognosia for hemiplegia is merely the most striking and most easily recognizable

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instance of what is indeed a common and even characteristic feature of cerebral disease in general—namely, a failure to realize or admit the presence or extent of disability resulting therefrom. In other words, anosognosia is but one example of the ordinary “denial syndrome” of a neurological patient. These three conceptions constitute the main uncertainties which surround the topic.

Although the three hypotheses mentioned are often discussed as though they were mutually exclusive, this is not necessarily true. In other words, it may be a fact that anosognosia for hemiplegia is more often seen with lesions of the parietal lobe than with lesions elsewhere in the brain—though clinical exceptions may perhaps occur. Secondly, a certain type of personality existing before the hemiplegia may well play some part in determining the patient's subsequent attitude towards his disability. In other words, a denial of illness had perhaps been a lifelong pattern (Guthrie and Grossman, 1952). Thirdly, it may well be that anosognosia for hemiplegia cannot exist with a perfectly clear sensorium. Fourthly, anosognosia can also follow lesions of the dominant half of the brain—though less readily identifiable.

This last point needs closer examination. The notion that the integrity of corporeal awareness is bound up with the normal function of one cerebral hemisphere is, on the face of it, a challenge—faintly shocking to those who take a more holistic view of cerebral function.

This is not to deny that to-day many neurologists, neurophysiologists, and even psychologists still tend to parcellate cerebral function, and to relegate speech to one hemisphere and corporeal awareness to the other. Perhaps this school of neurologists is fighting what is more and more certainly a losing battle.

Defective Insight

In the matter of corporeal awareness, verbal description on the part of the patient is almost a *sine qua non* if we are to detect and record adequately the clinical phenomena of defective insight. It is indeed difficult to gauge just how much awareness a patient possesses of the nature, extent, and social implications of his disability if at the same time he is deprived of the means of communication by articulate utterance or by writing. With such aphasic patients it is only by a very shrewd appraisal, based upon close observation of behaviour, that one can glean something of their subjective attitude towards their incapacity. But aphasia is not always severe in cases of left parietal disease, and when the speech faculties are adequate, evidence suggesting anosognosia for a right hemiparesis may be detectable. A number of such cases can be quoted from the literature. Some neurologists believe that the two hemispheres are equipotential in respect of corporeal awareness and insight, and that anosognosia can be identified in right hemiplegics provided that special clinical methods of study are adopted. One can refer particularly to the observations and opinions of Dattner (1950) upon this subject.

The only attempt at a numerical survey of unawareness of hemiplegia has been carried out by Nathanson, Bergman, and Gordon (1952). From a series of 100 consecutive cases of hemiplegia, 28 patients showed various degrees of anosognosia. In 23 of these there was a firm and consistent denial of paralysis, with claims that the affected limbs could be moved. As to the sidedness of the paralysis, it transpired that 19 of the 28 (69%) were cases of left hemiplegia; 6 (or 21%) were cases of right hemiplegia with no loss of speech. There were 48 patients who showed no symptoms of denial (18 left hemiplegics, 17 right hemiplegics with aphasia, and 13 right hemiplegics without aphasia).

I have already suggested that anosognosia for hemiplegia is generally a temporary phenomenon. How long it endures depends partly upon the depth and duration of the post-ictal confusion. But it also depends to some extent upon environmental circumstances. The part played by nurses, relatives, and doctors is very important, for the hard fact of paralysis may be brought early to the attention of the

patient; or, on the other hand, it may be glossed over or minimized for a considerable time, perhaps until the eventual return of strength to the affected limb.

It is possible to discern a number of different mental reactions on the part of the patient during the convalescent stage. As awareness of the disability gradually dawns upon the patient (or after the disability has repeatedly been brought to his notice by his attendants) we may witness diverse types of behaviour. Most abnormal of these are the various degrees of organic repression: the patient may not only be unaware of the paralysis, but he may, when questioned, even deny the fact that he is paralysed. Though these two attitudes are indices of the two very different psychological defects—the one being far more serious than the other—the same term “anosognosia” is applied to both. From denial of paralysis, the patient may even proceed to a denial of the actual ownership of the paralysed limbs. Thence he may go on to a confabulation, and he may proclaim that the paralysed limbs belong to someone else—real or imaginary; dead or alive (= personification anosognosia: somatoparaphrenia).

Some Phenomena

Nathanson *et al.* have mentioned an unusual phenomenon in this connexion, one which I personally have not yet observed. The patient may betray a disorder of language, but only when the affected left limb is under discussion. Ordinarily in no way aphasic, the patient may be at a loss for the right word, fail to carry out commands, become mute, or else use neologisms or gibberish, but only so long as the left side is being tested. This perhaps corresponds with what Weinstein and Kahn (1952) have called “non-aphasic language disturbances” or “non-aphasic misnaming” in cases of organic brain disease with denial of illness.

Much commoner, and far less abnormal, is a slow and progressive development of awareness of the paralysis. The patient may reluctantly admit that the arm and leg are weak, and then immediately go on to rationalize, and to try to explain away the cerebral dysfunction on the grounds of a non-significant peripheral defect (a sprain, an old fracture, rheumatism, sciatica). This pseudo-explanation may have a basis in fact, or it may not. In either case it is in reality quite inadequate to account for the loss of function. The patient prefers to accept a peripheral, extracerebral excuse. Or at any rate he talks that way, for how far he is fooling himself as well as trying to deceive his entourage is debatable.

Another common phenomenon of the convalescent patient who originally showed anosognosia is for him to accept the fact that he is paralysed; to concede it for what it is—namely, a hemiplegia of cerebral origin—but to make light of it. He is not euphoric in the ordinary way, but he treats his paralysis with insouciance and cheerful acceptance, even jokingly. This striking but less well-known mental attitude has been called anosodiaphoria (Babinski, 1914).

(I apologize for these terms. I know that they are offensive to some. But the alternative is worse. To coin a phrase of pure Hellenic descent, to define it clearly at the outset, then to apply it strictly and exclusively to the phenomenon under scrutiny is far better than to borrow a term which is already in common parlance, and then to torture and twist its meaning in a Procrustean fashion so as to suit one's immediate purpose. The result is then only too often ambiguity, non-comprehension, and finally error. This latter practice constitutes a grievous fault within the language of psychology and of philosophy. We ought to keep well in mind the dictum of Sir William Gowers, who said, “. . . I do not like new words—indeed, I dislike them—but if we have a conception for which no name exists, which we need frequently to speak of, it is not wise to shrink from an attempt to give it a name.”)

Anastasopoulos (1954) has noted another curious phenomenon within the realm of corporeal awareness,

one which seems to him specifically to involve the limbs of the *right* side, whether that be the side originally paralysed or whether the hemiplegia be on the left. This consists in a mistaken idea that the strength of the right arm and leg has recently *increased*, so that they have now become more robust than before the stroke. Such an accession of power may be a restoration of function after a right-sided weakness; or it may be an over-development within the *intact* limbs (the left being paralysed). A previous transient unawareness of the paralysis, whether right- or left-sided, seems always to have been present. The patient's mood is typically one of euphoria coupled with unrestrained conduct. Anastasopoulos believes that the two cerebral hemispheres, when diseased, show two different types of disorder within the sphere of corporeal awareness. Exaggerated ideas of the power of the right arm are bound up with the greater functional role of the right arm in dextrad subjects, as a tool connecting personal with extrapersonal space. In his pathological cases, the right arm now changes so as to constitute "almost a part of the surroundings"—as he put it—"rather like an external object."

A Common Reaction

In this connexion I would like to describe a very common reaction which the parietal patient may display towards a long-standing and severe hemiplegia. It is an attitude which comes about long after an initial anosognosia. In some ways it can be regarded as a diametrically opposite attitude, an over-compensation perhaps. The patient has now come to accept the fact of paralysis as being present, but he appears almost detached about it, something of an onlooker. The paralysed arm and leg are regarded almost as something apart from the rest of the anatomy, like a foreign body. The crippled and useless limbs are referred to as though invested with a personality or identity of their own, but in a semi-facetious proprietary fashion, as one might look upon a plaything or a pet. The patient speaks of his arm and leg in a sort of baby-talk. He may refer to the paralysed limb as "she" or "it," while a female patient may speak in terms of "he" and "him." More often nicknames are applied to the affected limbs in a childish fashion. I have personal knowledge of patients who have called their limbs "George," "Toby," "silly-billy," "floppy Joe," "baby," "gammy," "the immovable one," "the curse," "lazy-bones," "the nuisance." The patient recently recorded by Gilliatt and Pratt (1952) would often refer to her paralysed arm as a "poor little withered hand," and she would often pick it up and kiss it. Maybe this phenomenon of personification is commoner than we neurologists realize; and practitioners, physiotherapists, and the confidants of hemiplegic patients can perhaps tell us more about this state of affairs. It is strange that it has not been described before this in the literature.

Personification of this kind often coexists with some degree of anosodiaphoria, or lack of concern over the existence of the hemiplegia. Probably in every instance unawareness of the hemiplegia came first, perhaps also a temporary denial of the paralysis. As in the case of anosognosia, a left hemiplegia is commoner than a right hemiplegia, though I have encountered at least one such case in a man who was a right-handed subject with mild dysphasia and a right-sided paralysis.

Perhaps one may seem to be labouring the argument, but the point is that, apart from hemiplegics, patients rarely adopt this curiously detached attitude towards their extremities when paralysed or otherwise afflicted. An exception is the case of the gouty librettist, W. S. Gilbert, who was in the habit of addressing his troublesome limbs as Labouchère and Clement Scott, after the respective editors of *Truth* and *The Theatre*. Amputees sometimes personify their phantom limbs. Perhaps the most bizarre non-neurological example, however, is Dr. P. Nathan's patient who used to speak of her colostomy as "George."

Still other disorders of corporeal awareness may be noted at times in hemiplegic patients, but they need not be dis-

cussed here. Such include the feeling of nothingness affecting one side (hemidepersonalization, hemiaschematia); and also the illusion as though the limb were moving; as well as the phenomenon of the supernumerary limb (phantom third arm).

Dislike of the Paralysed Limbs

Finally, it is necessary to mention yet another mental reaction upon the part of the patient towards his paralysis. Occasionally we find a patient displaying a veritable dislike of the paralysed limbs which evoke feelings of disgust, dismay, and even horror. The paralysed arm may be kept covered by the bedclothes or a shawl so as to conceal it. Or the patient may keep the gaze averted from the affected side—an attitude which is not so much an unwilling deviation of head and eyes away from the limbs as a deliberate act of revulsion: a phenomenon in the realm of psychopathology rather than physiology. To direct inquiry the patient may speak of the limbs as being horrid, ugly, unnatural, heavy, like a block of wood or a piece of dead meat. The patient may even talk as though the physical properties of the limb had actually changed, becoming shrunken, discoloured, wizened, or corpse-like.

R. S. Allison's (personal communication) patient would often involuntarily clutch with her paretic left hand the cot sides of the hospital bed. With her intact right hand she would repeatedly strike her paralysed limb, telling "it" to release its hold. Though not denying ownership of the arm, she regarded it as endowed with a perverse will of its own.

Some such reaction was displayed by a hemiplegic patient—under the care of Dr. Leonard Cox, of Melbourne—who, while I was examining her limbs, suddenly proclaimed, in the words of St. Paul, . . . "O wretched woman that I am! who shall deliver me from the body of this death?"

We are reminded of the linguistic taboo met with in many languages whereby the left hand is spoken of as something sinister or unlucky. Whereas the adjectival "right" is often synonymous with "right"—that is, the opposite of "wrong"—in some languages the left hand receives an appellation which also means "old," "weak," "tired," "crooked," "mutilated," "withered," or "flaccid" (Bonfante, 1946).

In such cases of morbid dislike of the paralysed extremities we are witnessing hypochondriacal ideas which border upon the delusional. Here we may perhaps trace the operation of an acquired cerebral lesion upon a susceptible pre-morbid personality. Such a patient has probably always been a candidate for hypochondriacal trends by reason of an innate preoccupation with bodily efficiency and physical fitness. Perhaps the patient was once a man of exceptional muscular prowess and of athletic proclivity. By easy stages this may in later life predispose to a certain faddiness or crankiness. The sudden development of a hemiplegia in such a subject will then constitute an affront to the *amour propre*, one which could scarcely occur in the case of the cracked pitcher, the weakling of indifferent physique. The novelist Christopher Morley was shrewdly correct in the statement which he put into the lips of Kitty Foyle: "When anything goes wrong with a man he sure lets you hear about it. If they've been athletes I guess they just think of bodies as something to have fun with, until the works begin to gum up. They don't realize, the way women have to, that it's a dam complicated piece of doings."

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