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Annotation

The Role of Right Hemisphere Dysfunction in Psychiatric Disorders

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In 1861 Broca, a Parisian surgeon, reported a post-mortem he had carried out on a man who had lost his ability to speak 20 years previously and who in the intervening period had only regained the use of one phrase: "Tan-tan". Broca found that this man had an old infarct in his left hemisphere, affecting the posterior portions of the second and third frontal gyri.

In 1941 Brain, probably the most eminent British neurologist of this century, reported six cases of what he called "visual disorientation" – five of whom had a lesion in the posterior region of the right hemisphere. Three of these, including the single case with a left hemisphere lesion, had problems in localising objects in their contralateral field (not an original observation). The other three, however, all with a right hemisphere lesion, had a pervasive disorder of spatial manipulation, never previously described, encompassing both fields, but particularly affecting the left side of their body and visual space.

In 1969 Flor-Henry, a French-Canadian psychiatrist working at the Maudsley Hospital, reported a series of psychotic temporal lobe epileptics, and claimed that those with a left-sided focus tended to have a schizophrenia-like psychosis, whereas those with a right-sided focus tended to have a manic or depressive picture.

These three reports are the main landmarks establishing the importance of lateralised brain lesions in determining specific neurological and psychiatric syndromes. As with most major scientific discoveries, subsequent writers on the subject have disputed the originality of the claims. The first reference to the lateralisation of the speech centre is now sometimes attributed to Dax (1836), but he merely presented a paper, not published until after Broca's, on an association between disorders of memory and weakness of the right side of the body, at a medical meeting in Montpellier. A handful of German neurologists in the 1920s and 1930s (notably Pötzl, 1928; Lange, 1936) remarked that the right hemisphere might have some role in spatial perception or in providing a backdrop to our world view, but presented no real evidence to this effect. In the 19th century, there had been considerable speculation on the part that disequilibrium between the two hemispheres might play in generating madness (see Harrington, 1985), but no substantial proposal was ever formulated.

The most striking feature of the three claims on laterality mentioned above is how recently, relative to the long history of most scientific ideas, they were made. It is the purpose of this article to assess the three claims, especially Flor-Henry's, from the vantage point of the 1990s, and to summarise my own views (Cutting, 1990) on the role of lateralised brain dysfunction in the psychoses.

Current neuropsychological knowledge of the functions of each hemisphere

Both Broca and Brain were substantially correct in respectively localising speech to the left hemisphere and visuospatial perception to the right hemisphere in the large majority of individuals. The fact that the first rule does not apply to all left-handed people and the fact that the left hemisphere can achieve moderate visuospatial perception (if the task in hand can be translated into categorical terms – right, left, up, down) does not detract much from the generality of those rules.

What has been most remarkable in the 50 years since Brain's observation is the continual discovery of more and more hemispheric differences in mental functions. At first, these were subsumed under various dichotomies: verbal functions housed in the left hemisphere, non-verbal in the right; later, analytic linked with left, global or gestalt with the right hemisphere. More recently, however, it has become obvious that this Procrustean approach cannot accommodate the manifold differences that have come to light.

Take attention, for example. It is now established that the right hemisphere assumes a dominant role in attention across both visual fields and over both sides of the body (Weintraub & Mesulam, 1987). Moreover, the left visual field and left side of the body are entirely dependent on the integrity of the right hemisphere, as the left hemisphere controls only its contralateral field and body. The right side of the body and the right visual field, on the other hand, enjoy dual manning. This explains why anosognosia (denial of a hemiplegia) and unilateral visuospatial neglect are almost always for the left side of the body or left half of the environment.

Take language and thinking. Broca's observation about the lateralisation of speech to the left hemisphere was generalised, by some commentators, to mean all aspects of language. This is false, as some of the highest and most human aspects of language have been shown to be more affected by a lesion in the right than in the left hemisphere: metaphor (Winner & Gardner, 1977), humour (Wapner *et al*, 1981), proverb interpretation (Benton, 1968), creativity (Diggs & Basili, 1987), and even pragmatic or common-sense communications (Foldi, 1987).

Progress in understanding psychotic disorders has always been hampered because the essential deficits in, for example, schizophrenia – e.g. annihilation of the will (as in catatonia), disordered self-image (as in delusions of control), delusional misidentification (as in Capgras' syndrome) – have never had a sound basis in mainstream psychology, and certainly have never had a neuropsychological underpinning in terms of some focal brain representation for the hypothesised intact function. The most exciting aspect of all in the growth of understanding about hemispheric differences is that those aspects of the mind previously considered only worthy of 'armchair speculation' for philosophers, but of crucial relevance to psychiatry, are now being shown to have a focal representation.

Take will, for example. Until recently, it would have been considered ludicrous to suggest that one part of the brain represents a subject's will to call up other functions in other parts of the brain. But this is exactly what the following experiment (Coslett & Heilman, 1989) showed. Eighteen subjects – nine with a right-sided and nine with a left-sided middle cerebral artery infarct (paired for size and location on computerised tomography) – were each asked to raise their left then their right shoulders. The elevation was measured and it was found that patients with a right hemisphere lesion were more impaired in raising the contralateral shoulder than those with a left hemisphere lesion. The crucial point was that what they called the 'intention' to raise the right shoulder via the motor area in the left hemisphere was impaired by the right hemisphere lesion. (All results were independent of actual hemiparesis.)

Take the notion of ego boundaries. Bogousslavsky & Regli (1988) reported 11 instances, all in patients with an acute cerebrovascular accident affecting the right hemisphere, of what the authors called "response-to-next-patient-stimulation". Patients would obey commands, such as to open their mouth, which were in fact addressed to patients in the bed next to them. Clearly, there was a loss of the boundary of self under these conditions.

Consider Capgras' syndrome. Although it was originally described in the context of a functional psychosis, more and more cases are being linked with focal or demonstrable generalised cerebral dysfunction, particularly right-sided lesions. In a literature review Feinberg & Shapiro (1989) found 26 cases with definite evidence of brain damage – 16 bilateral, eight right-sided, and only two left-sided.

If proverb interpretation, will, self-image, and capacity for appreciating identity are the province of the right hemisphere, and all these are particularly affected in schizophrenia, then one might consider it worthwhile to examine right hemisphere functions in schizophrenia.

Hemispheric imbalance in schizophrenia

Unfortunately for my thesis, Flor-Henry's (1969) observations suggested that, if unilateral hemispheric dysfunction does occur in schizophrenia, it is the left hemisphere which is the more abnormal, although the validity of his observations has been contradicted by other evidence.

In Flor-Henry's original report, there were 28 patients with a schizophrenia-like psychosis: 19 had a left-sided lesion and nine a right-sided one. But in a reanalysis (Roberts *et al*, 1990) of a different sample of the cohort of psychotic temporal lobe epileptics from which Flor-Henry drew his sample (Maudsley/Queen Square cases) the overall difference between the number of schizophrenic-like pictures with a left-sided lesion and those with a right-sided lesion were 15 and 10 respectively (non-significant difference). Moreover, there was a subset of epileptics who had become psychotic only after their lobectomy, and there the numbers were five right, four left; there was also a subset of four epileptics who had become free of psychosis after their lobectomy, and these all had a left-sided focus. This pattern – both active left-sided temporal foci *and* right-sided lobectomy linked with schizophrenia – is seen in two studies by Trimble (Perez *et al*, 1985; Mace & Trimble, 1991): in the first there were seven patients with left-sided and two with right-sided active foci in the schizophrenia-like group; in the second there were five right-sided and no left-sided lobectomies. A study by Parnas *et al* (1982) is also illuminating in that although there were 12 patients with left-sided and six with right-sided foci in a broad group of non-affective psychoses, 11 of the 12 with a left-sided lesion were correctly classified as paranoia or paranoid–hallucinatory state (leaving only one 'Bleulerian schizophrenia'). In the group with right-sided lesions there were three cases of paranoia or paranoid–hallucinatory state but three with 'Bleulerian schizophrenia'.

From the evidence of temporal lobe epilepsy, therefore, it is fair to conclude, unlike Flor-Henry, that a left hemisphere lesion is not an overwhelming association with schizophrenia. On the contrary, it appears that excising a right temporal lobe is more important in generating schizophrenia than excising a left temporal lobe, and, if anything, excising a left temporal lobe in someone already suffering from schizophrenia ameliorates the condition. There is still a preponderance of instances of active left as opposed to right temporal lobe epilepsy in association with a schizophrenia-like psychosis, but it is possible that this pattern is accounted for by the predominance of hallucinatory–delusional states, rather than true schizophrenia, in the left-sided cohort. Finally, although Perez *et al* (1985) claimed that first-rank symptoms of schizophrenia were more common along left-sided than right-sided temporal lobe epileptics, it may be that an active left-sided focus exaggerates left hemisphere activity, resulting in the same pattern of overall hemisphere imbalance (left exaggerated, right diminished) which I claim occurs in ordinary, non-demonstrably organic cases of schizophrenia (see below).

What of the other evidence on hemispheric dysfunction in schizophrenia? Does this support Flor-Henry's case? Some of it does, some of it does not, and much of the purported evidence is methodologically unsound.

There are neuropathological findings from post-mortems on schizophrenics, studies using neuro-radiological measures (computerised tomography and magnetic resonance scans), cerebral blood flow, positron emission tomography (PET) and single-photon emission computerised tomography (SPECT) neurophysiological claims (based on electroencephalography, galvanic skin conductance, evoked potentials), results from neuropsychological tests, and reported post-mortem biochemical changes. It is impossible to review all this in a short article. To give a flavour of the direction of evidence, the pathological findings point to a preponderance of left-sided pathology (e.g. Brown *et al*, 1986; Crow *et al*, 1989); neuro-radiological measures are either negative or reveal lateralised changes in the density of white or grey matter which are difficult to interpret (e.g. Largen *et al*, 1984; Reveley *et al*, 1987); cerebral blood flow, SPECT and PET studies support, on balance, increased left hemisphere blood flow or metabolic activity in the left hemisphere coupled with reduced flows or activity in the right, particularly in unmedicated subjects (Gur *et al*, 1987; Buchsbaum *et al*, 1987); neurophysiological claims are, in my view, equivocal (e.g. Flor-Henry *et al*, 1979; Stevens & Livermore, 1982; Morihisa *et al*, 1983); and most neuropsychological tests are, to date, unsound, because they have been devised according to the outmoded notion of a verbal–non-verbal dichotomy between the hemispheres. Where tests which are specific measures of one or other hemisphere's function, according to up-to-date notions, were employed – for example focusing attention on the left hand (Scarone *et al*, 1987) or attention on the left visual field (David & Cutting, 1990) – a right hemisphere dysfunction has been demonstrated. Post-mortem biochemical changes have mainly been confined to the left hemisphere (Reynolds, 1983; Kerwin *et al*, 1988), but in Reynolds' study there was an increase of dopamine activity, consistent with a relatively overactive left hemisphere. This may appear to the reader not only a cursory glance at a vast mass of literature, but a rather biased one. I admit the charge, but would refer the reader to a fuller review for a more unbiased evaluation (Cutting, 1990). Certainly, the evidence is not overwhelmingly in favour of left hemisphere dysfunction in schizophrenia.

My own approach has been to compare the phenomena of schizophrenia with those seen in patients with identifiable lateralised brain damage – mainly head injury or stroke – and to argue that focal damage in the right hemisphere produces phenomena remarkably like those seen in schizophrenia, whereas damage in the left hemisphere produces very little that resembles a schizophrenic phenomenon.

In the sphere of language, for example, left hemisphere damage affects mainly the 'nuts and bolts' of language – the phonemes, the grammar, the formal semantics – producing what we call aphasia. Right hemisphere damage, on the other hand, affects mainly the communicative value of an utterance (van Lancker, 1987), prosodic intonation (Ross, 1981), and its figurative meaning (Brownell *et al*, 1984). The latter three aspects are entirely in keeping with the problems schizophrenics display – poor appreciation of social nuances (Cutting & Murphy, 1990), impaired use of prosody (Murphy & Cutting, 1990), and a tendency to select non-figurative rather than figurative meanings (Cutting & Murphy, 1991).

In the sphere of perception, someone with a posterior right hemisphere lesion displays problems in facial perception, particularly in appreciating facial expression (Ley & Bryden, 1979), coupled with a drawing style marked by a preoccupation with details at the expense of overall form (Levy-Agresti & Sperry, 1968). A left hemisphere lesion has little effect on facial perception and, although it may cause a constructional apraxia, this is characterised by a paucity of detail but preservation of overall form (Warrington *et al*, 1966). In schizophrenia, impaired

perception of facial expression is common (Gessler *et al*, 1989), and drawing styles conform to the former pattern – accentuation of detail and fragmentation of representational form (Reitman, 1950).

In the sphere of thinking, right hemisphere lesions have been shown to produce incorrect proverb interpretation (Benton, 1968), impaired ability to estimate the cost of common objects (Smith & Milner, 1984), a tendency towards overcategorisation of objects (Grossman, 1981), and incoherent and tangential speech (Joanette *et al*, 1986). Left hemisphere lesions primarily affect conceptual thinking (Lezak, 1983), cause a reduced ability to categorise objects (McFie & Piercy, 1952), and may accentuate the ability to see the figurative meaning of something. Again, schizophrenic thought patterns resemble those of right hemisphere damage much more than they do left hemisphere damage – with impaired proverb interpretation (Phillips *et al*, 1980), overinclusion (Payne & Friedlander, 1962) and derailment (Andreasen, 1979) as some of the most characteristic features. There is little support from these comparisons for the existence of left hemisphere dysfunction in the condition.

Hemispheric imbalance in other psychiatric conditions

Although the thrust of laterality research has been into schizophrenia, there is a growing literature on its possible relevance to other psychiatric disorders – particularly depressive illness, mania and infantile autism, and, to a lesser extent, neurotic conditions.

Depressive illness

Again, Flor-Henry should be given the credit for alerting us to the role of lateralised dysfunction in depressive illness. His original comments (Flor-Henry, 1969), linking depressive illness with right hemisphere dysfunction, have proved, however, to be only partly true. The current situation, revealed through neurobiological, neuropsychological, and clinical studies, is that a depressive condition can arise from either left or right hemisphere dysfunction, and that each has a different clinical picture.

According to Robinson, who has studied secondary affective disorders consequent on cerebrovascular disease, a left anterior and largely subcortical lesion is most closely linked with a psychotic depression, whereas a right posterior lesion produces what in DSM–III terms would be a minor depressive disorder (Starkstein & Robinson, 1989). Certainly, left anterior hypoperfusion is consistently revealed in cerebral blood flow or PET studies on psychotic depressives (e.g. Baxter *et al*, 1989). According to Finset (1988), the clinical picture of someone with a depressive state consequent on a right hemisphere lesion is more specific than suggested by the term 'minor depressive disorder': he describes it as accompanied by "a generally lowered mood level with little specifically depressive symptomatology often with a certain degree of inertia and lack of initiative. An alternative term might be organic inertia."

As in the case of schizophrenia, there are numerous conflicting studies on the matter, but the direction of evidence (Cutting, 1990) is consistent with the presence of left hemisphere dysfunction in the most severe form of depressive illness. Not only is this the opposite of what Flor-Henry originally proposed, but it is the opposite of what, according to my reading of the evidence, obtains in schizophrenia. If these opposite patterns of cerebral dysfunction do in fact occur, this will prove to be the best evidence to date for the validity of Kraepelin's separation of dementia praecox from affective psychosis. There has been a recent resurgence of interest in Griesinger's (1845) notion of a unitary psychosis, spearheaded by Crow (1986) and certainly apparently supported by his study with Johnstone (Johnstone *et al*, 1988) showing that neither neuroleptics nor lithium have a treatment specificity for their supposed target psychosis. I do not accept that this lack of specificity necessarily supports the theory of a unitary psychosis. It could merely mean that there is a final common pathway for the emergence of delusions, hallucinations and formal thought disorder which neuroleptics act upon without affecting the primary and specific mechanism in each of the major psychoses.

Mania

Of the three major psychoses, lateralised hemispheric dysfunction has been least studied in mania. Most of the studies that have been carried out are invalid because they have used a collection of 'affective' cases – including depressive and sometimes even schizoaffective patients. What evidence that there is is consistent with left hemisphere overactivity (Cutting, 1990), although it is not certain that there is a true hemispheric imbalance, as the right hemisphere may also be overactive.

Infantile autism

Laterality research has only just started on this condition. From a theoretical point of view there is

much reason to suppose that right hemisphere dysfunction may play a part (Cutting, 1990), but the few neurobiological and neuropsychological studies to date are inconclusive.

Neurosis

Curiously, hysteria was the first psychiatric condition to be the focus of laterality research rather than mere speculation. According to Harrington (1985) several 19th-century physicians noted the tendency for conversion symptoms to affect the left side of the body rather than the right side. These observations were lost among more improbable speculations but have been confirmed by several investigators (Stern, 1977; Trimble, 1986). Anxiety and obsessional neuroses have also been the subject of a handful of laterality studies recently (e.g. Garber *et al*, 1989; Fontaine *et al*, 1990), resulting in some evidence that right-sided dysfunction may play a part in both.

Conclusions

Research into the role of hemispheric dysfunction in psychiatric conditions is one of the most potentially valuable avenues to be explored this century. Moreover, the so-called 'minor', 'non-dominant' right hemisphere is looking more important in this respect than its so-called 'major', 'dominant' partner. The field is littered with pitfalls and false conclusions, mainly because the role of each hemisphere in normal mental function is continually being revised, and psychiatric studies are usually based on an outmoded view of what each hemisphere does. The most astonishing and exciting aspect of this research, however, is that each new discovery or reformulation of normal hemisphere function makes the role of hemisphere dysfunction in the major psychoses more likely. Functions of the mind such as the appreciation of identity, will, even common sense, hitherto only suspected because of the existence of psychopathological entities in which they were assumed to be disordered, are now given not only psychological status but neuropsychological representation. For too long psychiatrists have been trying to force their psychopathological categories into whatever current model of the mind psychologists happened to have constructed. Now psychologists will have to tailor their own models to accommodate what psychiatrists have been telling them for nearly a century.

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