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Speech and the Right Hemisphere[1]

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Two facts are well recognized: the location of the speech centre with respect to handedness and early brain damage, and the involvement of the right hemisphere in certain cognitive functions including verbal humour, metaphor interpretation, spatial reasoning and abstract concepts. The importance of the right hemisphere in speech is suggested by pathological studies, blood flow parameters and analysis of learning strategies. An insult to the right hemisphere following left hemisphere damage can affect residual language abilities and may activate non-propositional inner speech. The prosody of speech comprehension even more so than of speech production—identifying the voice, its affective components, gestural interpretation and monitoring one's own speech—may be an essentially right hemisphere task. Errors of a visuospatial type may occur in the learning process. Ease of learning by actors and when learning foreign languages is achieved by marrying speech with gesture and intonation, thereby adopting a right hemisphere strategy.

The site of the peri-Sylvian language zone may vary according to handedness or the presence of early brain damage (Basser, 1962; Zangwill, 1967; Segalowitz and Bryden, 1983) (Fig. 1). The factors which determine cerebral dominance are presumably either genetic or, in the event of brain damage at an early age, the plasticity of the cortex as described in Goldman's competition hypothesis (1972). The purpose of the present discussion is to examine functions of the non-dominant right hemisphere with regard to speech which are not included within the ambit of the peri-Sylvian language zone.

Luria (1963), Dahlia Zaidel (1990) and others have asked what happens when a person recovers from aphasia. Is the recovery attributable to changes in the damaged hemisphere, to changes affecting both hemispheres, or does the right, non-dominant hemisphere take over? Nielson (1946), for example, has shown that right hemisphere damage, sustained 9 years after recovery from aphasia with right hemiplegia, could produce mutism and aphasic writing. Kinsbourne (1971) described three patients with non-fluent aphasia after left cerebral infarctions. In each case, injection of amylobarbital into the left carotid had little effect on the residual language abilities, but, in two of the patients, a right carotid injection resulted in mutism. Mutism has also

	L. hemisphere	*Bilateral*	*R. hemisphere*
R. handers	95.5%	—	4.5%
L. handers	61.4%	19.9%	18.8%

FIG 1. Language lateralization. Segalowitz and Bryden (1983).

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been associated with epilepsy or experimental stimulation of the right hemisphere (Penfield and Roberts, 1959).

Ellis *et al.* (1989) described a patient who had sustained a subarachnoid haemorrhage at the age of 57 with a left temporal lobe haematoma, right hemiplegia and aphasia. She remained grossly aphasic but after 5 years showed considerable improvement with only occasional word finding difficulties. At the age of 63 she suffered a mild stroke with a left hemiparesis. CT scan showed a new area of infarction commensurate with the clinical picture. She began to complain of numbness in the left arm and leg and of auditory hallucinations. These vocalizations, or natterings as she called them, consisted of fragments of hymns or prayers learnt in childhood; also, repetitions of recent thoughts or heard speech. They were not of a schizophrenic type, did not speak to her or give orders, they were in her own voice and clearly acknowledged to be internal in origin. Thus she provides an excellent example according to van Lancker (1990) of intrusive, automatic or non-propositional inner speech activated by brain injury. The press of language was such that she could not describe the natterings in detail and in that sense they would also fit with Yamadori *et al.*'s (1990) concept of hyperlalia with right hemisphere lesions. This is not a new concept, Anastasopoulos (1959) found that a lesion of the minor hemisphere temporal lobe was followed by logorrhoea coupled with a reluctance to listen to the speech of others.

The ability of some aphasic patients to produce recurrent utterances or automatic speech, suggests the persistence of a phylogenetic older mechanism for speech, probably bilaterally represented and similar to that underlying the calls and cries of animals, which on occasion can be under hormonal influence (Critchley, 1987). Hughlings Jackson (1874) wrote that the right hemisphere is the one for the most automatic use of words, and the left the one in which automatic use of words merges into voluntary use of words—into speech. There is greater blood flow through the right hemisphere during serial counting; contrasting with the greater flow through the left hemisphere during propositional speaking (Larsen *et al.*, 1978). Graves and Landis (1985) reported greater openings on the right side of the mouth for spontaneous speech, repetition and propositional tasks; with greater openings on the left for automatic speech activities such as overlearnt rhymes and singing.

Broca (1865) and Jackson disputed the origin of recurrent utterances. Broca argued that such utterances resulted from the faulty coordination of the sequence of movements for oral language production; whereas Jackson (1878) and more recently Blanken *et al.* (1990) associated speech automatisms with the presence of a partially intact phonological system after propositional speech had been lost as a result of global aphasia. This view would appear to be supported by the hypothesis that "these insignificant spars remaining from the shipwreck of speech" often represent the last utterance before the catastrophe (Macdonald Critchley, 1977); and by similar phenomena observed among deaf-signers after left hemisphere strokes (Underwood and Paulson, 1981). Recurrent utterances are most likely in older aphasics with larger anterior lesions (Blunk *et al.*, 1981) and non-propositional speech may be retained after left hemispherectomy (Smith, 1966). A further pointer to the right hemisphere nature of these—often very limited—utterances is that the speaker can inflect and embellish them with prosodic meaning. The last days of Lenin were marked by the recurrent utterance "chort", which means devil. By varying that utterance he was able to hold all about him in awe and make known his intentions.

Little was known about speech not involving the peri-Sylvian language zone until the advent of stereotactic operations. From these stereotactic studies we are aware that the thalamus has an asymmetric role with regard to linguistic functions. Perseveration, anomia and reduced word fluency can occur. Thus the dominant thalamus may be involved in language: activating specific contact areas of the cortex, mediating or participating in verbal memory and semantic selection processes. Thalamic aphasia is a transient phenomenon. However, there may also be a bilateral role in alerting and initiating speech production. Thus stimulation of either ventro-lateral nucleus can give rise to speech arrest, hesitation, slurring, tachylalia or affect the loudness of speech. Whether the thalamus has a primary or secondary role in the prosody of speech is uncertain.

Stuttering can result from degenerative disease such as Parkinsonism and Alzheimer's disease or follow brain damage. It may be a consequence of loss of inhibition in normal motor sequencing or in some cases due to a psychological reaction to the trauma. Stuttering is less likely following right hemisphere damage than left but bilateral lesions are necessary for permanent or prolonged stuttering (Helm *et al.*, 1978).

Gestures, defined as movements to colour, emphasize or embellish speech, are also bilaterally represented. Lesions of either hemisphere reflect the fluency or non-fluency of the corresponding aphasic injury (Ross, 1981).

The fact that blood flow studies show very little asymmetry, even with propositional speech, would indicate a sizeable right hemisphere contribution to language. Whether this can be totally explained, in terms of the prosody of speech, as suggested by Ross, is uncertain.

Monrad-Krohn (1947) defined three types of prosody:

an intrinsic prosody of standard prosodic patterns inherent in the language—the localization of this form of prosody has yet to be examined;

a propositional or stress prosody which serves the need of expressing various subtle shades of meaning—there is evidence for and against a left hemisphere preponderance in this respect;

and an emotional prosody which may convey emotions.

Weintraub *et al.* (1981) found that those with right hemisphere damage had greater difficulty than aphasics in decoding paralinguistic cues of emotion; and Blumstein and Cooper (1974) demonstrated a left ear advantage in the perception of intonation contours of sentences. Thus there may be a dissociation between the perception of prosody and of words, and also a dissociation between the emotional and propositional processing of the utterance. Monrad-Krohn (quoted by Ross, 1990) surmised that disorders of prosodic comprehension occur which are complementary to the more obvious disorders of prosodic production. Indeed many clinicians believe that the emotional content of a sentence facilitates speech understanding by aphasic subjects. But whether emotional prosody is bilaterally represented or essentially a right hemisphere function is uncertain.

The interpretation of prosody needs to be approached with caution:

(1) Alterations in volume, pitch and tempo may reflect the speaker's mood if the speaker is fully conversant with the language he is using; but the loud, even violent diction of the unsure foreigner may be wildly misinterpreted (Macdonald Critchley, 1981).

(2) Dialect accents often deepen with ageing. Sometimes following brain damage a patient may appear to assume a foreign accent. According to Professor Alajouanine (quoted by Macdonald Critchley) during convalescence from a stroke an educated Frenchman may talk like a foreigner—English, German or Belgium—in that order. Following a court settlement after a road accident in 1980 the press made considerable play of the financial award which compensated a Londoner for the development of a Welsh accent.

(3) The self-monitoring of speech is rarely discussed. In the 1960s Kevin Murphy experimented with a mechanism whereby the playback of one's own speech was slightly delayed with consequent disruption of the output of speech. Distortion of feedback mechanisms may explain the reason why prosody is lost with right hemisphere damage.

The majority of polyglots recovering from aphasia do not show any differences in the rate of recovery for different languages and when a second language is acquired at an early age the normal rules of cerebral dominance tend to be followed. But study of the minority with a differential recovery has led to the supposition that there may be anatomically different centres for certain languages depending upon such acquisition parameters as handedness, age, gender, and the manner and modality of second language acquisition; in effect that the language organization of the average bilingual may be more ambilateral than that for the monolingual (Albert and Obler, 1978).

The less usual patterns of polyglot aphasia (Fig. 2) could have an

(commonest) 1. Parallel—similarly impaired and restored
2. Differential—one or more slower to recover
3. Successive—one after the other
4. Selective—one or more not restored
5. Antagonistic—one regresses, others restored
6. Mixed—systematic mixing of two languages

Other Hypotheses:
Mother tongue most stable—Ribot's rule (1881)
That acquired to highest degree—Pitre's rule
Affect—Minkowski's rule
Appropriate to environment
Visualisation—written rather than dialect.

FIG. 2. Polyglot aphasia: patterns of recovery (*Pitres, 1895*).

anatomical explanation but this appears unlikely. There is no evidence that presumed cortical modules of memory have clearly defined loci. It is more probable that the unrecovered language is not lost but inhibited thus permitting its rapid return; and many suppose that there is a locus in the brain, probably in the supramarginal gyrus of the dominant hemisphere, which acts as a switch mechanism between languages in everyday life and on recovery from aphasia.

A person's attitude alters remarkably in his use and treatment of different languages. Furthermore the behaviour or personality of the speaker may alter when speaking a different language. A different stress, a different syntax, the acceptable use of gesture and the directess of address—using familiarity clauses, polite expressions, religious symbolism and swear words—varies considerably. All these make the use of a right hemisphere strategy very likely. Although there has been much variation, many studies based on dichotic listening and tachistoscopic tests appear to reinforce the view that the strategies of second language acquisition as an adult require significant right hemisphere participation, at any rate at the early stages of learning.

Let us consider the adoption of a right hemisphere strategy for learning in other situations.

It would be interesting to explore the grey area between propositional and overlearnt speech. What strategy is adopted by a Shakespearean actor, an operatic singer or a concert pianist in learning? For such highly trained performers the ease of learning is enhanced when a piece can be learnt in an empathic context: exploring the emotional content, mannerisms and gestures required in which to fit the words, notes or melody.

Does the right hemisphere have a role in initial language learning?

Blau (1946) stated that reversals or transpositions of letters, sounds, or words are seen in the initial stages of language acquisition and are related physiologically to the learning process. Money (1962) and others have tended to relate spoonerisms and mirror speech to visuospatial hypotheses. From a study of reversals in typing among first and second year pupils and comparing the types of errors made to those made in the World speed typing contests of the 1920s I found (1968) that errors involving reversals and transpositions persisted in typing beyond the learning period. There would appear to be a gradient of sophistication for the kinaesthetic mechanisms: those used for reading and writing are less precise than those involved in music but are more precise than those used for touch-typing or proofreading. In speech, the tendency to make reversals, is seen best in 2–4 year old children before auditory discrimination has fully developed.

The right hemisphere is involved in certain cognitive functions abutting upon speech including verbal humour, metaphor interpretation, spatial reasoning and abstract concepts (M. Critchley, 1962; Eisenson, 1962). These are examined in detail by Ellis and Young (1988) but may be said to represent higher level linguistic functions rather than speech functions (Fig. 3).

The reception of speech is as important, if not more so, than executive

word-finding	sentence completion
novel learning	abstract concepts
problem solving	story recall
creative literature	spatial reasoning
metaphor interpretation	punch-line selection
disordered articulation	verbal humour

FIG. 3. Supra linguistic functions of the R. Hemisphere
Cognitive-affective disorder rather than linguistic disorder.

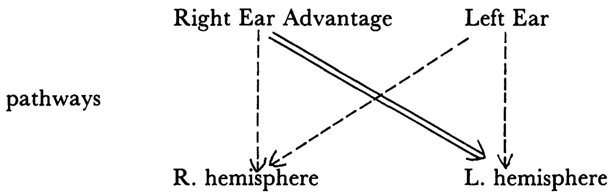

FIG 4. Dichotic listening

capacity. To quote the Stoic philospher Epictetus, "Nature has given man one tongue, but two ears, that we hear twice as much as we speak".

The right hemisphere has a role in conveying information as to the identity of the voice and the affective component of speech; but there is a right ear—left hemisphere advantage in listening to speech and a pre-eminent left hemisphere phonetic pathway for the accurate perception of rapidly changing acoustic signals in speech (Fig. 4). In *word deafness* (Auerbach *et al.*, 1982; Ellis and Young, 1988) (Fig. 5) this rapid pathway is disrupted but the disability can be overcome if the rate of speech is reduced permitting the use of slower, bilateral acoustic analytical systems. Presumably the non-fluent linguist is also forced to rely on the slower bilateral analytical systems to decipher words spoken in a foreign language. The reception of speech seems to present the only situation in which a unilateral fast system is predominant. In music, parallel systems are involved: the global contour of the melody is analyzed by the right hemisphere and the intervallic structure of the melody by the left (Peretz, 1990) (Fig. 6). If this is indeed correct, we presumably analyze a tune by breaking up the sounds and examine their integral features as perceived at two different rates. Our present lack of knowledge as to hemispheric preference and musical abilities does not permit a serious discussion of the interplay of musical and linguistic functions. We are left with a conundrum, as has been stated by Macdonald Critchley (1972): "If we talk with our major hemisphere and sing with our minor, by what cerebral legerdemain do we continue to cope with those intermediate vocalizations such as chanting and recitative?"

lh phonetic system
can: read, write, speak, hear non-speech sounds
cannot: repeat, understand
vowels perceived better than consonants
corrected by: slowing speech to lower rate using RH auditory analysis system
(Auerbach *et al.*, 1982)

FIG. 5. Pure word deafness.

R.H. Dominance for musical execution, e.g. Mann's amusia RH F2 (1898).

A variable dominance for musical perception R.H. to L.H. with increased sophistication
Receptive amusia L.H. more than R.H.
(Damasio and Damasio, 1977)

R.H. global contour of the melody L.H. interval-lic structure of the melody
(Peretz, 1990)

Blood flow maximally increased in R.H.
(Phelps *et al.*, 1982)

Either side: musical hallucinations, epilepsy triggered by music, impairment of rhythm.

FIG. 6. Cerebral dominance for music.

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