THE PHYSIOLOGY AND PATHOPHYSIOLOGY OF LANGUAGE FUNCTIONS AS ILLUSTRATED BY MEASUREMENTS OF THE REGIONAL BLOOD FLOW IN THE CORTEX OF THE BRAIN

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By measuring the blood flow in small regions of the brain (Xenon-133 injection via the internal carotid artery), an increase in flow is seen that corresponds to an increase in metabolism and neuronal function in the same region (Lassen et al. 1978). Typically the regional flow increases by 30%. Simple sensory perception or motor performance activate the well known respective primary and secondary areas.

When one listens to speech, is speaking oneself, or reads aloud, then 2, 3, respectively 6 regions become simultaneously active in both hemispheres (minor side-to-side differences appear to exist, and will be commented upon).

When listening to words, the 2 active areas are I: The temporal lobe, superior-posterior part (on the left side, comprising Wernicke's posterior speech center), II: an inconstant activation over the inferior frontal region (on the left side, comprising Broca's anterior speech center). This region overlies the basal ganglia and hence it cannot be decided if this area is cortical or subcortical. The inconstancy of the activation could mean that even at rest, the thought processes involve (inconstantly?) an activity in this area.

When speaking, the 3 active areas are I: The temporal lobe (see above), II: The primary mouth area in the central region, III: The supplementary motor area high in the frontal lobe (Penfield's superior speech area). In automatic speech in the form of counting to twenty repeatedly, we see little hyperactivity in the lower frontal area. But in fluent normal speech this area is very often active.

When reading a simple text aloud, the 6 active areas are: I: The temporal lobe (comprising on the left side Wernicke's area), II: usually the inferior frontal region (probably comprising Broca's area on the left side), III: The motor mouth area, IV: The supplementary motor area (Penfield's superior speech area), V: The visual association cortex, VI: The frontal eye field.

All these changes are bilateral. We do not see the primary visual cortex (it is supplied from the vertebral artery). But animal studies clearly show this area also to become activated during visual perception. Hence, during reading, even with the coarse resolution (1 cm^2) of our method, reading can be said to involve the collaboration of (at least) 14 discrete cortical areas, 7 in each hemisphere.

The lecture will comment on the differences between listening to noise and to words. Consideration as to the changes in aphasia as well as to the possible contribution of the right hemisphere to language functions ("emotional colour", prosody) will also be discussed.

References

Lassen, N.A., D.H. Ingvar, and E. Skinhøj (1978): "Brain function and blood flow", Scientific American 239, 62-71.