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Neurobiology of brain asymmetry in man

Although an indication of anatomical asymmetry of the brain has been demonstrated already in some animals (apes, monkeys, and particularly in birds), it is the human brain which exhibits morphological as well as functional asymmetries between the two hemispheres in a gross scale. This asymmetry is partly due to the fact that in most cases, the left temporal planum - which surrounds the speech center - is larger than the right one. With computerized tomography, it has been also shown that this asymmetry is present even in the human fetus, suggesting that an inherent anatomical asymmetry may initially favor the left hemisphere (in 95 % of all humans) for the development of language functions. Interestingly, however, the right ("mute", "minor") hemisphere as a whole, is larger than the left. - In addition to being asymmetrical, the two hemispheres differ in their capabilities. This functional asymmetry has been studied in detail in patients undergoing to neurosurgical ("split-brain") procedures. (In certain population of epileptic patients, a life-saving operation is to transect the main connection between the two hemispheres, the corpus callosum, and the anterior commissure: studies of these patients show that each separate hemisphere is capable of functioning independently.) The sodium amytal test - by which one's left or right hemisphere can be unanesthetized, while the other is awoken - is another possibility to study lateralized functions, as speech and, partially, also mood. - Results from several indirect, noninvasive methods were particularly useful in obtaining a detailed distribution "map" of different

cognitive and other, "unconscious" functions in the two hemispheres. In one test, where tachistoscope is used, very brief visual stimuli are presented to the right or left visual hemifield of the eye. The nature of the visual pathways is such that the image of a visual stimulus that is restricted to one visual field is projected first to the opposite hemisphere. Another technique is applying dichotic auditory task, in which lateralization is assessed by simultaneously presenting different auditory stimuli to both ears and determining which ear (and, because of the mostly crossed auditory pathways which contralateral hemisphere) is better at recognizing the auditory inputs.

As a result of the combined studies, we may think of our brains (in a greatly oversimplified, but didactically useful way), as consisting of a left hemisphere (LH) that excels in intellectual, rational, verbal and analytical thinking, and a right hemisphere (RH) that is better in emotional, non-verbal and intuitive thinking, and is better in visuo-spatial processing. The LH appears to do best at tasks involving declarative memory, while the RH is more specialized for tasks involving reflexive memory. LH-processing is characterized as sequential, serial, temporal and analytic, RH-processing as parallel, gestalt or holistic. LH is superior in judgments of temporal order and the production of temporal sequences, which ties neatly with LH superiority for language skills. It is still unclear, however, whether these language skills depend on temporal processing or vice versa. In contrast, the minor hemisphere, although it is able to comprehend both written and spoken words

to some extent, cannot express itself verbally. At the same time, RH is superior to the "major" LH in tasks involving spatial performances - it is clearly better in geometry, whereas LH is superior in mathematics (algebra).

Finally, it has to be emphasized that although the "emotional brain", the ancient limbic system is both structurally and physiologically symmetric, the expression and cortical realization of emotion becomes asymmetric, with a greater involvement of RH. As a consequence, it is only the RH which possesses sense of humor (if developed at all), and, importantly, deals with new, so far unknown and incomparable information. The logical LH is processing and stores only "familiar" information, most of them taken over from the RH. This shows an important aspect of the unified brain: a close cooperation of the two, functionally different hemispheres. This cooperation - through the corpus callosum, made up of 200 million interconnecting nerve fibers - together with the existing competition between LH and RH (for which examples will be also given) is the main factor in the establishment of the human personality.