Language and the brain

Linguistics, Language

Language and the brain Many people assume the physical basis of language lies in the lips, the tongue, or the ear. But deaf and mute people can also possess language fully. People who have no capacity to use their vocal cords may still be able to comprehend language and use its written forms. And human sign language, which is based on visible gesture rather than the creation of sound waves, is an infinitely creative system just like spoken forms of language.

But the basis of sign language is not in the hand, just as spoken language is not based in the lips or tongue. There are many examples of aphasics who lose both the ability to write as well as to express themselves using sign-language, yet they never lose manual dexterity in other tasks, such as sipping with a straw or tying their shoes. Language is brain stuff--not tongue, lip, ear, or hand stuff. The language organ is the mind.

More specifically, the language faculty seems to be located in certain areas of the left hemispheric cortex in most healthy adults. A special branch of linguistics, New medical imaging techniques such as PET and fMRI have allowed researchers to generate pictures showing which areas of a living brain are active at a given time. In the past, research was primarily based on observations of loss of ability resulting from damage to thecerebral cortex.

Indeed, medical imaging has represented a radical step forward for research on speech processing. Since then, a whole series of relatively large areas of the brain have been found to be involved in speech processing. In more recent research, subcortical regions (those lying below the cerebral cortex such as the putamen and the caudate nucleus) as well as the pre-motor areas (BA 6) have received increased attention.

It is now generally assumed that the following structures of the cerebral cortex near theprimary and secondaryauditory cortexes play a fundamental role in speech processing: * Superior temporal gyrus (STG): morphosyntactic processing (anterior section), integration of syntactic and semantic information (posterior section) * Inferior frontal gyrus (IFG, Brodmann area (BA) 45/47): syntactic processing, working memory * Inferior frontal gyrus (IFG, BA 44): syntactic processing, working memory * Middle temporal gyrus (MTG): lexical semantic processing The left hemisphere is usually dominant in right-handed people, although bilateral activations are not uncommon in the area of syntactic processing. It is now accepted that the right hemisphere plays an important role in the processing of suprasegmental acoustic features like prosody. Most areas of speech processing develop in the second year of life in the dominant half (hemisphere) of the brain, which often (though not necessarily) corresponds to the opposite of the dominant hand. 8 percent of right-handed people are left-hemisphere dominant, and the majority of left-handed people as well. What can language disorders tell us about the brain's language areas? Tourette's syndrome, which produces random and involuntary emotive reflex responses, including vocalizations This type of disorder, which often affects language use, is caused by a disfunction in the subcortex. There is no filter which prevents the slightest stimulus from producing a vocal response, sometimes of an inappropriate manner using abusive language or expletives. These words are involuntary and often the affected individual is not even aware of uttering them (like " um" in many individuals) and only realizes it when video is played back.

This syndrome is not so much a language disorder per se as a disorder of the filters on the adult emotional reflex system--a kind of expletive hiccup. True language is housed in the cortex of the left hemisphere, not in the subcortical area that controls involuntary responses. Certain types of brain damage can affect language production without actually eliminating language from the brain. A stroke that damages the muscles of the vocal apparatus may leave the abstract cognitive structure of language intact--as witnessed by the fact that right hemisphere stroke victims often understand language perfectly well and write it perfectly with their right hand--although their speech may be slurred due to lack of muscle control.

We have also seen that certain disorders involving the subcortex--the seat of involuntary emotional response--may have linguistic side effects, such as in some cases of Tourette's syndrome. But what happens when the areas of the brain which control language are affected directly, and the individual's abstract command of language is affected? We will see that language disorders can shed a great deal of light on the enigma of the human language instinct. SLI. One rare language disorder seems to be inborn rather than the result of damage to a previously normal brain. I have said that children are born with a natural instinct to acquire language, the so-called LAD; however, a tiny minority of babies are born with an apparent defect in this LAD.

Certain families appear to have a hereditary language acquisition disorder, labeled specific language impairment, or SLI. Children born with this disorder usually have normal intelligence, perhaps even high intelligence, but as children they are never able to acquire language naturally and effortlessly.

They are born with their window of opportunity already closed to natural language acquisition. These children grow up without succeeding in acquiring any consistent grammatical patterns. Thus, they never command any language well--even their native language. As children and then as adults, their speech in their native language is a catalog of random grammatical errors, such as: It's a flying birds, they are. These boy eat two cookie.

John is work in the factory. These errors are random, not the set patterns of an alternate dialect: the next conversation the same SLI-afflicted individual might say This boys eats two cookies. These sentences, in fact, were uttered by a British teenager who is at the top of his class inmathematics; he is highly intelligent, just grammar blind. SLI sufferers are incapable of perfecting their skills through being taught, just as some people are incapable of being taught how to draw well or how to see certain colors. This is the best proof we have that the language instinct most children are born with is a skill quite distinct from general intelligence.

Because SLI occurs in families and seems to have no environmental cause whatsoever, it is assumed to be caused by some hereditary factor--probably a mutant, recessive gene that interferes with or impairs the LAD. The precise gene which causes SLI has yet to be located. Aphasia We know which specific areas of the left hemisphere are involved in the production and processing of particular aspects of language. And we know this primarily from the study of patients who have had damage to certain parts of the left hemispheric cortex. Damage to this area produces a condition called aphasia, or speech impairment (also called dysphasia in Britain). The study of language loss in a once normal brain is called aphasiology. Aphasia is caused by damage to the language centers of the left hemisphere in the region of the sylvian fissure.

Nearly 98% of aphasia cases can be traced to damage in the perisylvian area of the left hemisphere of the cerebral cortex. Remember, however, that in the occasional individual language is localized elsewhere; and in children language is not yet fully localized. SUMMARY Let's sum up three important facts about language and brain. First, humans are born with the innate capacity to acquire the extremely complex, creative system ofcommunicationthat we call language. We are born with a language instinct, which Chomsky calls the LAD (language acquisition device). This language aptitude is completely different from inborn reflex responses to stimuli as laughter, sneezing, or crying.

The language instinct seems to be a uniquely human genetic endowment: nearly all children exposed to language naturally acquire language almost as if by magic. Only in rare cases are children born without this magical ability to absorb abstract syntactic patterns from theirenvironment. These children are said to suffer from Specific Language Impairment, or SLI. It is thought that SLI is caused by a mutant gene which disrupts the LAD. The LAD itself, of course, is probably the result of the complex interaction of many genes--not just one--and the malfunction of some single key gene simply short-circuits the system. For example, a faulty carburetor wire may prevent an engine from running, but the engine is more than a single carburetor wire.

Many thousands of genes contribute to the makeup of the human brain--more than to any other single aspect of the human body. To isolate the specific set of genes that act as the blueprint for the language organ is something no one has even begun to do. Second, the natural ability for acquiring language normally diminished rapidly somewhere around the age of puberty. There is a critical age for acquiring fluent native language. This phenomenon seems to be connected with thelateralization of language in the left hemisphere of most individuals--the hemisphere associated with monolinear cognition (such as abstract reasoning and step-by step physical tasks) and not the right hemisphere, which is associated with 3D spatial acuity, artistic and musical ability.

Unlike adults, children seem to be able to employ both hemispheres to acquire language. In other words, one might say that children acquire language three-dimensionally while adults must learn it two dimensionally. Third and finally, in most adults the language organ is the perisylvian area of the left hemispheric cortex. Yesterday we discussed the extensive catalog of evidence that shows language is usually housed in this specific area of the brain. Only the human species uses this area for communication. The signals of animal systems of communication seem to be controlled by the subcortex, the area which in humans controls similar inborn response signals such as laughter, crying, fear, desire, etc.