

# Langage and Brain

-Reading Kuniyoshi Sakai's "Language and Brain Science"-

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When children are growing up this is accompanied by the increasing ability to talk about lots of things and they gain the understanding to express themselves in more complex words. We are in no doubt about the increasing ability of using language, we think this is only acquired naturally. This, being the path followed in my own case, is probably followed by virtually everyone, and therefore is a very normal process.

However, when we try to consider "what are language?", the thing which we believed to be a quite normal process is in fact found to be not so simple. So what is likely to be meant in general by language?

There are at least four functions related to language(words). Words are said to be the transmission function through which we conduct the business of our daily life, the social contact function developed to maintain human relations, and the function which appreciates the enjoyment of words themselves, and what is more it is the operation which helps rational judgment which is accepted as the thought-process tool. The actions we carry out unintentionally such as understanding words and speaking, in order to see and understand these various functions is not a simple activity but an action which is an advanced neural activity. What brings about words is a function of the brain.

However, the problem of "how the brain generates words" has come to challenge the frontiers of brain research and is accepted as a major difficulty even among big problems. The solution to brain functions with respect to language is one of the final frontiers as far as science is concerned.

The first reason for this is however is that language is an advanced brain function, and is therefore at the zenith of the mental function called recognition or thought - volition - emotions. The meaning of what is called zenith is because of the ability to express these mental functions through language, even if not everything. Isn't the fact of children chatting, which is accomplished by an ability to understand, likely to be a phenomenon filled with absolute wonder in their development?

Secondly, it is because language is an ability which only human beings are endowed with. According to Chomsky, human speech is said to be a phenomenon peculiar to humans having been enabled due to the speech organs of the brain, while not even the first signs of such similar things exist in other animals. Consequently there is a big limitation regarding research methods to deal with the human brain, and this will make it even more difficult to solve what has always been a difficult problem.

Thirdly, because language is connected intimately with various other cognitive functions, research to extract only the language functions is surely a difficult aspect.

Therefore, whether or not we could say "these particular cells in our brain exist only in humans" is a problem whose solution would solve this language mystery.

Recent imaging diagnosis methods, in other words conversion of brain functions into images, is the advanced technology for "seeing" brain activity patterns, based upon the development of the brain function imaging technique, whereby the breakthrough in solving language functions by brain science has emerged.

In brain science, because the traditional localised reduction theory concept asserts that it is one function localised in one part of the brain, speech is grasped as "the brain function module", while the author also affirms that language is incorporated in the brain system as an independent module form like modules such as perception, memory, consciousness, and are formed as independent modules. Simultaneously, they are interconnected and work interactively.

The Broca field, the Wernicke field, the angular gyrus and the supramarginal gyrus are cited as the language fields which carry out the language activities. A part of these fields is called the Broca aphasia which occurs as a difficulty in uttering something, and the Wernicke impediment which appears as a difficulty in understanding meanings and in choosing words when about to utter something. Following these discoveries and the associated research into speech impediments, their existence and their localisation in one part of the

brain has been shown. If so, these four fields such as the Broca field, the Wernicke field, the angular gyrus and the supramarginal gyrus may divide the work, each providing it's own function.

In 1999, a brain function imaging experiment using fMRI to compare the grammar process and the meaning process, was reported by an American group. Then, an assertion appeared to the effect that the Broca field appeared to be bound with the grammar process. However, in this experiment, it was claimed that the distinction between the grammar process and the meaning process was not clear, therefore, there was insufficient evidence to conclude that the Broca field was solely responsible for the grammar process when the researchers made comparisons between the grammar and meaning processes. However, recent research results showed that the grammar process facilitates the activities of the whole language fields but needs to support the activity of the Broca field extremely. Therefore the author suggests that this result indicated that the Broca field specialises in the grammar process, with the discovery that the grammar process is localised as the brain function.

However, the location in the brain which relates to language is not only the Broca field, Wernicke field, the angular gyrus and the supramarginal gyrus field, but also the cerebellum, the cerebrum and thallamus activities are understood. In spite of these activities being recognised, how are we to consider language as being localised in one part of the brain?

Between the reduction theory of the brain science concept and the opposing totalitarianism theory, in other words, isn't there any possibility of considering language function in terms of the concept of one

function being carried in the whole of the broad area of the brain entirely?

The question of how language acquisition occurs in children shall be considered here. It is commonly held that the neurological foundations of language are set by the age of between eight and twelve. It is therefore doubtful that prior to that, localization in the brain is of any relevance. It is also suggested that a mature brain and a developing brain do not necessarily function according to the same principles. It has gradually become clear in recent years that findings gained through examination of adult brain injuries might not be applicable to the neuro-psychological maturation of a child who is still going through its developmental stages. There have also been interesting reports on the plasticity of brains. How can these issues be elucidated from the language localization perspective?

Karmiloff-Smith points out that "Modularization in human development is not predetermined but occurs as a result of development." It is necessary to study these issues from the perspective of language acquisition in children.

Recently, the need for inter-disciplinary study encompassing the brain and the mind has become increasingly pressing and out of this need, cognitive brain science has emerged. The objective of cognitive brain science is to understand the mind in terms of the workings of the brain and it investigates the workings of the mind from a brain sciences approach, an approach to which the author subscribes.

The author defines the mind as a 'sense-memory-consciousness' totality that is part of the workings of the brain, and considers that the

relationship between language and mind is reflexive: the mind gives rise to language, which is uttered and then returns to be comprehended by the mind, in a cyclic process. The author considers that, when seen as a whole, linguistic function is integrated within the brain system in close relation with the workings of the mind, the the whole of 'sense-memory-consciousness'. In other words, the author claims that there is a hierarchical 'brain-mind-language' structure. When asked to describe in a word what language is, the author replied that until the difficult question of "how the brain generates language" is resolved, no one can give a "correct" answer, but added, "Language is part of the mind."

Another scholar who regards language as 'a part of mind' is Noam Chomsky, who revolutionized linguistics. According to Chomsky, there are four central issues in the study of language. Firstly, what is the knowledge that enables us to speak and understand language; what is inside the mind and brain of a language speaker. Secondly, how is this knowledge acquired; how is the knowledge system formed in the mind and brain. Thirdly, how is this knowledge utilized. And fourthly, what are the physical mechanisms underlying the expression, acquisition and utilization of that knowledge. The theory put forward by Chomsky to elucidate these questions is called "nativism". Nativism claims that language is not acquired entirely through conditioning and education after birth. Instead, it is claimed that the mother language is "acquired" through innate linguistic abilities. Chomsky hypothesizes that humans have innate linguistic abilities, which he terms the "language acquisition facility". He considers that humans are innately equipped with universal principles of grammar. Furthermore, he hypothesizes that there

are modules of language, namely syntax, semantics, and phonemics, and that these modules exchange information with, and complement, each other. He emphasizes the modular nature of grammar. According to Chomsky, the universal grammar function is a uniquely human linguistic function.

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Directly opposite to Chomsky's nativism is the

behavioralist approach. Behaviorists such as Skinner claim that language can be explained in terms of a general "learning" mechanism. The pivotal mechanism for behaviorists is called "operant conditioning", that is, an associative learning in which there is a contingency between the response and the presentation of the reinforcer. Skinner regards language as an example of operant conditioning. He regards language to be not essentially different from other human abilities and focuses on the learning aspect. He claims that acquisition of language is strongly influenced by the environment and places particular emphasis on imitation behaviors. Chomsky claims that such behavioristic mechanisms cannot fully explain the language phenomenon.

The dispute between nativism and behaviorism in the research of language acquisition is long standing. In recent years, however, the results of brain sciences research have produced more support for nativism. As the author points out, localization of grammatical processing in Broca's center, which was discovered through brain function imaging, suggests Chomsky's grammatical module hypothesis is right, and provides further support for his theory.

It is, however, probably not possible to determine definitively that nativism is right and the "learning" theory is wrong. It is a fact that the learning theory alone cannot answer questions of language acquisition such as the Plato problem. However, nativism might not have all the answers. It asserts that infants can acquire linguistic abilities despite a paucity of linguistic stimuli and experience because they have innate and abundant knowledge. However, there is the case of a hearing child born to deaf parents, who had little contact with

English speaking adults and was exposed to English conversation only through television. When enrolled in a pre-school program it was found that the child had very limited linguistic abilities. The child was put under the care of a language therapist and made remarkable progress. Within a few years his language abilities had developed to within the normal range. This example shows the importance of the environment, which is discredited in nativism, and it throws doubt on the validity of nativism in the question of language acquisition. It is possible that both innate linguistic abilities and the linguistic environment work together as a system of language development. The author suggests that if linguistic acquisition sits somewhere between complete instinct and complete learning, everything is relative. He suggests that past disputes failed to recognize that language acquisition is multi-phased. According to the author, language acquisition progresses from the initial neonatal phase,

where the hereditary instinct is dominant, through the intermediate phase, to the final phase where learning is dominant. In the final phase of language acquisition, the learning mechanism completes the process by increasing vocabulary and concepts. The author also hypothesizes that, as both hereditary and environmental factors play their parts in the acquisition of language, both factors are represented in the final individuality of personal language. The author names this hypothesis the "multi-phase hypothesis of language acquisition".

As pointed out above, two radical approaches, namely nativism and learning theory, have been engaged in a dispute. What needs to be resolved is not the question of which theory is right, rather, the question of what is the mechanism by which language is acquired. It is expected that future progress in the brain sciences will provide further clues to the understanding of language.