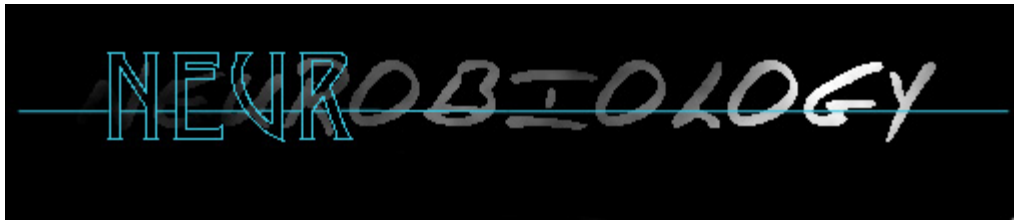

The Biological Foundations of Language

Does Empirical Evidence Support Innateness of Language?

by Bora Lee

The principles and rules of grammar are the means by which the forms of language are made to correspond with the universal froms of thought....The structures of every sentence is a lesson in logic."

—John Stuart Mill

BIOLOGICAL BASIS OF LANGUAGE

"[H]uman knowledge is organized de facto by linguistic competence through language performance, and our exploration of reality is always mediated by language" (Danchin 29). Most higher vertebrates possess intuitive knowledge which occurs as the result of slow evolution of species. However, the ability to create knowledge through language is unique to humans. According to Benjamin Whorf, "language. is not merely a reproducing instrument from voicing ideas but rather is itself the shaper of ideas. We dissect nature along lines laid down by language" (Joseph 249). In addition, the development and acquisition of language seems to be related to "complex sequential processing, and the ability to form concepts and to classify a single stimulus in a multiple manner" (Joseph 178). Antione Danchin suggests that the knowledge we

pk10@duke.edu

create through language allows us distinguish our*selves* from the rest of the world to produce models of reality, which become more and more adequate due to the "self-referent loop" which enables us to understand ourselves as objects under study. This "path from subject to object," which is common to all humans, Danchin claims, suggests the existence of a universal feature of language (29).

Biological foundation of language may contribute significantly to such universality. The issue here is not whether language is innate, for, clearly, language must be learned. Nor is the issue whether the aptitude for learning a language is inborn: it takes a human being, with a functional brain to learn a tongue. The question to explore is whether there is biological foundation at the root of organization and internal structure of language.

The scholars considering spoken language acquisition have divided over internal and external causation dichotomy. Two prototypical models of language acquisition are "selectivist" and "constructivist" models, respectively. The selectivist model, which depends on internal causation argument, can be associated with Noam Chomsky. The selectivist model assumes that "language template is pre-organized in the neuronal structure of the brain, so that the fact of being an integral part of a given environment selects the borders of each individual neuronal structure, without affecting its fine organization, which pre-exists" (Danchin 30). The constructivist model, which assumes external causation of language acquisition, follows lines drawn by behaviorists such as Piaget and Skinner. This model assumes that "language is built up constantly from a continuous interaction with a well-structured environment" (Danchin 30).

NOAM CHOMSKY'S VIEW ON LANGUAGE

Noam Chomsky basic argument is that there exists an innate language acquisition device, a neural program that prepares them to learn language (Kandel 638). Chomsky assumes the existence of a genetically determined system of rules, which he refers to as *universal grammar*, underlying all tongues. According to Chomsky, a language template is set up by the special "language organ" of the brain. Chomsky does not deny that the importance of environmental factors in language acquisition. His claim is that there exist strict biological invariants governing the function of language. In explanation of his theory on the ontogenesis of spoken language, Chomsky holds

there pre-exists in humans, a language structure that is

> one of the faculties of the mind, common to the species,[illegible]a faculty of language that serves the two basic functions of rationalist theory: it provides a sensory system for the preliminary analysis of linguistic data, and a schematism that determines, quite narrowly, a certain class of grammars. Each grammar is a theory of a particular language, specifying oral and semantic properties of an infinite array of sentences. These sentences, each with its particular structure, constitute the language generated by the grammar. The languages so generated are those that can be "learned" in the normal way[illegible]. This knowledge can then be used to understand what is heard and to produce discourse as an expression of thought within the constraints of the internalized principles, in a manner appropriate to situations as these are conceived by other mental faculties, free of stimulus control (Chomsky 12-13).

B.F. SKINNER'S VIEW ON LANGUAGE

Behaviorists view the process of language acquisition as a building process that results from interaction with the environment. In outlining his assertion that humans acquire spoken language as a result of behavioral conditioning. B.F. Skinner writes:

> A child acquires verbal behavior when relatively unpattterned vocalizations, selectively reinforced, gradually assume forms which produce appropriate consequences in a given verbal community. In formulating this process we do not feed to mention stimuli occurring prior to the behavior to be reinforced. It is difficult, if not impossible, to discover stimuli which evoke specific vocal responses in the young child. There is no stimulus which makes a child say b or a or e, as one may make him salivate by placing a lemon drop in his mouth or make his pupils contract by shining a light into his eyes. The raw responses from which verbal behavior is constructed are not "elicited." In order to reinforce a given response we simply wait until it occurs. (Skinner 31)

Skinner views the child as the "passive subject of operant conditioning in whom randomly occurring behavior is selectively reinforced" (Vocate 3).

LANGUAGE ACQUISITION AND DEVELOPMENT

John Hughlings Jackson wrote, "No child would ever talk unless he were taught; and no child could be taught unless he already possessed, by inheritance, a particular series of nervous arrangements ready for training" (Marshall 41). It is amazing how *natural* language acquisition is for children: "Language development does not begin with the child's first efforts to learn material that is linguistic" (Locke 268). Children are ready to learn even before birth: some acquisition of language, such as vocal learning, begins as early as the final trimester of pregnancy (Locke 267).

Language development begins with the infant's inclination to attend and respond to certain aspects of talking behavior. Genetic factors seem to play an important role: the infant's responsiveness to facial and vocal activity is presumed to be heavily influenced by genetic factors. Specific neural preadaptations underlie such behavior: Clinical and electrophysiological research reveals that humans have mechanisms that are similarly dedicated to processing faces and facial activity (Tranel, Damasio and Damasio, 1988 as quoted in Locke) and to voices and vocal activity (Creutzfeldt, Ojemann, and Lettich, 1989 as quoted in Locke).

These examples of specialization in of social cognition are important in language development. Tomasello and his colleagues (1986, Locke 269) found a positive relationship between the amount of time infants participated in joint attention episodes with their mothers at 15 months and extent of expressive vocabulary at 21 months. Snow (1989, Locke 269) found that vocal imitation at 14 months was related to the number of nouns and verbs produced, the total productive vocabulary, and the ratio of words produced to words comprehended at 20 months. Such evidence supports Chomsky's view of the existence of deep internal structures associated with language acquisition.

Another fascinating fact is the fast rate at which children acquire language. The table below (adapted from Kandel) points out that in children 12-18 months old, the vocabulary is about 30 to 50. In children 18-24 months, the vocabulary is about 50 to several hundred (which means, in

about six months the vocabulary more than doubled). When the child starts to walk at three years old, he has vocabulary of around 1,000 words. This means that, in a little more than a year, a child gains around nine hundred words—about 25 words a day!

Table 1. Stages of Development in the Acquisition of Language

Average Age	Language Milestones	Motor Milestones
6 months	Cooing, changes to distinct babbling by introduction of consonants	Sits using hands for support; unilateral reaching
1 year	Beginning of language understanding; one-word utterances	Stands; walks when held by one hand
12-18 months	Words used singly; repertory of 30-50 words (simple nouns, adjectives, and action words), which cannot as yet be joined in phrases but are used on e at a time does not use functors (the, and, can, be) necessary for syntax, but makes good progress in understanding	Grasping and release fully developed; walking; creeps downstairs backward
18-24 months	Two-word (telegraphic) phrases ordered according to syntactic rules; vocabulary of 50 to several hundred words; understands propositional rules	Runs (and falls); walks stairs with one foot forward
2-5 year	New words every day; three or	Jumps with both feet

	more words in many combinations; functors begin to appear; many grammatical errors and idiosyncratic expressions; good understanding of language	
3 years	Full sentences; few errors; vocabulary of around 1,000 words	Tiptoes; walks stairs with alternating feet
4 years	Close to adult speech competence	Jumps over rope; hops on one foot; walks on a line

Children do not have to *learn* to correct many of their mistakes, for some errors never happen. When an error is made and corrected, it is a *logical* error with respect to the usual syntactic structure (Danchin 32). In other words, children do not repeat mistakes which must be corrected again and again. The accuracy at which children learn new words is also amazing. Children as young as two or three years old is not taught words in terms of definition. They pick up meanings of words in context. For example, when I pick up a thick, black pen and tell them it is called a "pen," children almost always understand what I mean by a "pen." They rarely, if ever, make the mistake of thinking that what I meant by "pen" was in reference to its being black, or thick. This suggest that there must be some kind of intuitive system of "rules" regarding language.

CRITICAL PERIOD

Like other neural functions, the ability to learn language has a critical period (though this critical period may be longer compared to others). Many theoretical works have demonstrated that an "important regression of connectivity (and even of cell number) takes place as learning progresses" (Danchin 33). The brain goes through "pruning" of unnecessary connections as language development takes place. In other words, the neuronal synaptic connections are not created, or

built, as we learn language: they pre-exist: unnecessary ones merely decay as language learning takes place. Such processes occur in the formation of synapses in sensory systems. For example, in development of visual system, synaptic formation is ruled by the "fire together, wire together" principle. Early in the developmental stage, the visual system receives overwhelming amount of input and there is a high branching of synaptic connections. As some inputs become more dominant (either in number or intensity) certain synaptic connections are reinforced and other connections that are less frequently utilized decay and disappear. No one denies the existence of strict biological constraints that govern sensory modalities. If the neurological development in language acquisition is parallel to the development of sensory modality, it would be a strong evidence against the constructivist model which insists that language is *built* through interaction with the environment.

Deaf parents have a non-oral "linguistic" interaction with their children much earlier than normal parents. Serazin has made observation that the neurological development of children born from deaf parents was more normal than the development of deaf children born to normal parents (Danchin 33). Such examples suggest that although the individual performance is the result of interaction with the environment, the fundamental rules of syntax are imposed by the neuronal structure.

Another fact that supports the critical period of language acquisition and thus the selectivist model is that the ability to learn language fluently decreases with age. "Among Chinese and Korean children who have immigrated to the United States there is a linear relationship until puberty between the age of arrival and proficiency in English" (Kandel 638). The fact that this phenomenon applies so widely suggests that there is a biological basis that is universal.

LATERALIZATION

Without a doubt, language has biological basis. A multitude of neuronal structures and fiber pathways are involved in the formulation, expression, and comprehension of speech and verbal thought (Joseph 253). Close studying of the organization of language in the brain may give us important clue as to how much language acquisition is governed by biological structures.

Dr. R. Joseph asserts that the right and left half of the brain utilize different means of communication and sometimes rely on different language systems (11). There is strong evidence that information processing is carried on differently in each hemispheres of the brain. In majority of humans, the left hemisphere, is efficient at processing spoken language but has great difficulty processing social or emotional sounds. The right hemisphere on the other hand is very efficient in social and emotional sounds, but is deficient in language skills (Joseph 12).

The fact that human brain is unsymmetrical is well known. Specialization of the left hemisphere for language in right handed people, with relatively a few exceptions, has been generally accepted for more than a century (Bogen 13). Although more recent studies suggest that there is a *complementary* hemispheric specialization of language functions in the brain (as opposed to the left hemisphere being *the* language facilitator), the evidence still holds that left and right hemispheres differ in their language functions.

Studies of patients after hemispherectomy, or the "surgical removal of an entire cerebral hemisphere," support laterilzation of linguistic functions in the brain. (Code 51). Although some researchers suggest that the right hemisphere possesses some language abilities, it is clear that, in general, the function of the right hemisphere is inferior that of the left hemisphere.

LOCALIZATION

One common way of studying language function is by analyzing various language disorders and deficits. Lesions to certain parts of the cortex lead to loss or deficit of certain functions. Studying of the language performance in association with lesions in the brain has been recognized well over 100 years. In general, these studies suggest localization of language functions in the brain: a lesion to certain part of the brain may only the production of language without disturbing the ability to comprehend spoken speech. The aphasias are most commonly divided into three main types: Wernicke's aphasia which is characterized by a major deficit in comprehension; Broca's aphasia which is which is characterized by deficit in production; and conduction aphasia which is characterized by a combination of syndromes of both Broca's aphasia and Wernicke's aphasia.

The lesion in Wernicke's aphasia is to Wernicke's area and often extends to the superior portions of the temporal lobe, Brodmann's areas 39 and 40, and inferior portions of Brodmann's area 37. Wernicke's area is located in the left posterior inferior frontal part of the brain and is adjacent to the lateral sulcus. As mentioned earlier, such lesions affect language comprehension. Both visual and auditory inputs are impaired. Although speech remains fluent, some difficulties with language production exist with the more severe forms of Wernicke's aphasia: paraphasia is disorder in which the patients use the wrong word or combination of words in speech. Extra syllables may be added words as extra words may be added to sentences. Neologism refer to fabricating of a new word. Of the different parts of speech, nouns are most prone to distortion. Logorrhea refers to excessive speech. People suffering from logorrhea exhibit a phenomenon called press of speech: people may use unnecessary words in expressing their thoughts. Empty speech is the failure of conveying the ideas in mind. People who have this impairment are not aware that they have such disorder (Kandel 640).

Broca's aphasia is caused by damage to the motor association cortex in the frontal lobe, usually extending to the posterior portion of the third frontal gyrus (Brodmann's area 44 and 45), which forms part of the frontal operculum (Broca's area). In severe cases the surrounding premotor and prefrontal regions (areas 6, 8, 9, 10, and 46) are also damaged (Kandel 640).

A wide range of deficit exists in Broca's aphasia. Patients may suffer from a slowed, simple speech to almost complete muteness. Words may be omitted, plural nouns may be expressed in singular forms as verbs may be left in infinitive. Patients of Broca's aphasia are generally aware of their disorder (unlike Wernicke's aphasia). The ability to read aloud and the ability to write are also affected by Broca's aphasia.

Broca's aphasic patient Leborgne is probably the most familiar aphasic patient in history. This famous aphasic patient is known by his nickname *Tan*. "Tan" was the meaningless automatic utterance he produced most times he attempted speech. Such utterances are called speech automatisms in contemporary literature. Patients with speech automatism, usually described as "globally" aphasic, have severe deficits in the ability to utilize syntax, semantics, and phonology in "expression or comprehension in any modality" (Code 44).

The last of the three main types of aphasia, conduction aphasia, is caused by damage to the pathway connecting the to main language areas (Broca and Wernicke's). This pathway, arcuate fasciculus, runs in the white matter in the temporal lobe. Injury to the supramarginal gyrus of the parietal lobe and posterior and superior aspects of the left temporal lobe can cause damage to the fasciculus (Kandel 641).

Studies of aphasia can offer an incredible insight to organization of the brain for language. The occurrence of specific language disorders caused by lesions to certain parts of the brain further illustrate localization of functions in the brain. Given certain language disorder, we can correlate it to a physical problem in a specific region of the brain. Such evidence suggest that there are certain preexisting universal biological order in the brain. If they did not preexist, how would the many brains build synaptic connections that were similar to one another, even the brains of people that speak different languages? Localization of linguistic functions in the brain suggest that there are innate physical structure of the brain which govern our learning of language.

PLASTICITY OF NEURAL STRUCTURE

There are always exceptions to the rule. In some population of the people, the locus of language functions is completely differently organized. For example, in children that were born with, or even developed early, cortical lesions to the parts of brain that are thought to be important in language processing, it has been shown that different parts of the brain "take over" the functions of the damaged parts. In some cases where the children suffered a serious damage to the left hemisphere early in development, language deficits were not that apparent. The right hemisphere contained the language centers. Do such evidences suggest that there really are not preexisting biological conditions when it comes to language? Answer to this question goes back to the language acquisition and critical period arguments: There is evidence that suggests the regression of neuronal connectivity as language acquisition and development takes place. As stated earlier, our brain, rather than building from scratch, goes through "pruning" of preexisting synaptic connections in the brain: there are many ways in which these connections can be made. Also, the brain adapts the given conditions and function to the best of its ability. For example, we know

that the patients whose commissure has been surgically severed display a variety of behavioral deficits. However, in people with a congenital defect in which the corpus callosum is simply absent, there is little or no behavioral disorder. This suggests that the two hemispheres of the brain have adapted another way of exchanging information. Such examples merely suggest plasticity of the connections in the brain.

CONSTRUCTIONIST OR SELECTIVIST MODEL?

There seems to be enough evidence to suggest the existence of strict biological constraints behind our language function. Biological evidence supports the selectivist model, which takes after Chomsky, that plastic preorganized brain structures are shaped to their final form after a proper interaction with the environment. There exists biological constraints that regulate language function. Such claims, however, cannot exist without criticism. The biological evidence, such as the functional asymmetry of the two hemispheres of the brain, are still primarily correlational. As early as 1926, Head stated, "with language and other higher functions, there is no such thing as a topographical description; a description in functional terminology is the only one available" (Caplan 121). Or as Luria insists, Chomsky's concept of grammar and his transformational rules are limited analogies rather than accurate descriptions of the real processes involved in the formation and decoding of speech (Luria qtd. in Vocate 3).

It seems improbable that we would understand the actual neuronal basis of language any time soon. There is so little known about the brain, itself. We do not know how exactly language is processed in the brain. All the knowledge we have about the language in relation to the physical brain, or vice versa--the physical brain in relation to language, we have gained by merely assuming correlation based on evidences suggested by case studies of persons with certain brain lesions and certain speech disorder that follow that lesion. We still have very little idea concerning exactly what it is about the fine structure of different neuronal regions that makes them an appropriate habitat for the functions that are impaired after damage to those areas (Marshall 53). At the same time, there is no evidence to suggest that stimulus from the environment is the only thing of importance in mechanism of language acquisition and development. Lateralization of language

functions, organization of the language centers in the brain, and the readiness with which children learn language all point toward the selectivist model, which assumes the existence of strict biological constraints. There is simply too much evidence to disregard the idea of preexisting conditions in our brain which govern our language abilities. Until we better understand the brain and the neuronal basis of language, however, the debate is still widely open. To borrow Chomsky's very own words, "it remains to be seen in what respects the system that develops is actually shaped by experience, or rather reflects intrinsic processes and structures triggered by experience."

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