IV. LANGUAGE PROPERTIES OF SPECIAL INTEREST TO NEUROBIOLOGY

Before we can hope to understand the relationship between brain and language, we must know what are the most important properties of language to be accounted for. The great neurologists of the nineteenth century were good observers and anatomists, but they were totally disinterested in the growing science of linguistics. They never asked themselves just what language is, because the answer seemed obvious to them. In recent years, however, linguistics has made giant strides, especially in the attempts to provide formal and exact descriptions of grammatical regularities. There is a burgeoning literature on this subject, with several different models of grammars to choose from. Computer models were not considered at the Work Session, but the linguists present discussed a number of aspects of modern linguistic theory.

Is the Theory of Generative Grammar Relevant to Neurobiology? D. T. Langendoen

Generative grammar as originally conceived by Chomsky (1957, 1965) is not of primary relevance to neurobiology. Langendoen thought that grammar is a systematization of how well-informed speakers of a language make judgments as to the grammaticalness of sentences. Generative grammar is an abstract system that has affinity with cognition, according to Langendoen, but it is not directly relevant to the processes of language understanding and language production as it actually occurs. These processes have their own laws and regularities, and it is these that should be the primary target of investigation in a general biology of language. This is also reflected by the fact that the child learning to speak first acquires skills in comprehension; skills of production always lag behind comprehension. Skills for making grammatical judgments are the very last to develop.

Langendoen gave a technical demonstration of how the rules of speech production go through a long series of developmental stages, starting with very general, comprehensive rules and ending up with a definable set of highly specific phonological rules. He used for an example the child who pronounces *rag* as *wag*, yet is able to tell these words apart when they are spoken to him. The child's production is governed by a process according to which [r] becomes [w] before a vowel. To learn to speak the English of his parents, he must eventually discard this general process. Indeed, the very young child's production is governed by a large number of such processes, which can be thought of as biologically determined filters through which the adult language model must pass before it gets out of his mouth. As the child is able to bring his production into line with what he hears, those processes that do not characterize the adult language are discarded, those that characterize it in part are retained in part, and those that characterize it fully are retained in full.

Production processes apply sequentially, and frequently later, more specific processes contradict the effects of earlier, more general ones. There is, for example, a general process that converts the velar nasal [ŋ] into an alveolar nasal [n]. This process survives in part in most speakers of English; it accounts for their tendency to pronounce Vietnamese names with syllable-initial [ŋ] as starting with [n]. However, there is a restricted process that converts [n] into [ŋ] before a velar obstruent [k,g]. Finally, there is an even more restricted process that deletes [g] that follows [ŋ] in the same syllable. Thus, velar nasals are created that are immune to the general process that converts them to alveolar nasals. (English speakers, even many young ones, do not pronounce *sing* as *sin.*)

The processes that govern speech perception seem to be a subset of those that govern production, namely the ones that apply earliest. Thus the general process that converts [ŋ] to [n] is part of perception, but not the restricted process that converts [n] to [ŋ] before [k,g], nor the one that drops [g] following [ŋ]. This accounts for our hearing (and spelling) [linŋk] as *link* and [sinŋ] as *sing*. Similarly, there is a general process that specifies that vowels are inherently non-nasalized; this accounts for the impression, which most English speakers have, that the vowels of English are characteristically non-nasal, even though in words like *pant* they always are. Children who acquire French learn to suppress this process, for reasons that have to do with the nature of the French language (for discussion, see Stampe, 1972).

If a process is applicable both early and late in production, then only its early application is relevant to perception. An example is the process that specifies that an obstruent in the same syllable with a preceding [s] is voiceless. This process accounts for our hearing the stop in *spy* as [p] rather than as [b], even though that segment is

phonetically halfway between the pronounciations of [p] and [b] when no [s] precedes them. The same process applies again in sloppy speech to devoice voiced stops that come to be adjacent to [s] as a result of resyllabication. For example, the phrase "Let's go eat" may be pronounced [skwi:t], where the [k] results from the underlying [g] of *go*. But if the phrase is understood at all, it is understood in its full form.

Langendoen's presentation ended with a reiteration that rules of grammar ought not to be confused with the rules that govern the processes of comprehension and production. With respect to the latter, he emphasized the great importance of regarding the syllable as the proper unit in phonology, not the phoneme. Stampe (1972), for example, discovered that, when normal subjects are asked to pronounce a given utterance at higher speeds than normal, they tend to cut down the number of syllables, preserving the rate and duration of syllables that is normal for them. In other words, they restructure the utterance in terms of the syllable structure that is superimposed, so to speak, on a given sequence of phonemes. This observation may have important implications for the study of speech derangements due to central nervous system disease and could easily be verified by means of sound spectography.