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ABSTRACT

This paper considers the process by which humans are able to select from the complex string of sounds impinging on the ear and understand certain frequency combinations to be linguistic signals while other combinations are not. A brief review of the complex subcortical region, particularly the known but seldom studied reticular system, indicates the probability that prior to its assessment in the cerebral cortex, the signal is filtered and integrated into matrices or patterns. From this hypothesis, a model is presented suggesting the process by which a speech signal is integrated subcortically into a series of increasingly complex matrices before being transmitted to the cortex. The matrix form of the transmitted electric signal causes cortical neurons to fire simultaneously in bursts rather than resonate sequentially. The pattern of each burst will reflect the distinctive features carried in the matrix stimulus. With memory considered held in holistic patterns, or matrices, rather than as strings of energy frequencies, identification of the distinctive features of the fired pattern with the matrices of language elements held in cognitive memory forms the basic element in oral language cognition, identified here as a cogneme. Certain pedagogical implications are considered; for example, cross cultural programs and cross cultural exposure should be extended into all areas of education to include the variety of cultural differences in America. (Contains 20 references.) (Author/CR)

SUBCORTICAL PREPROCESSING OF ORAL LANGUAGE: A HOLISTIC MODEL FOR LANGUAGE COGNITION

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Running head: SUBCORTICAL

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This paper considers the process by which humans are able to select from the complex string of sounds impinging on the ear and understand certain frequency combinations to be linguistic signals while others are not. A brief review of the complex subcortical region, particularly the known but seldom studied reticular system, indicates the probability that prior to its assessment in the cerebral cortex the signal is filtered and integrated into matrices, or patterns. From this hypothesis a model is presented suggesting the process by which a speech signal is integrated subcortically into a series of increasingly complex matrices before being transmitted to the cortex. The matrix form of the transmitted electric signal causes cortical neurons to fire simultaneously in bursts rather than resonate sequentially. The pattern of each burst will reflect the distinctive features carried in the matrix stimulus. With memory considered held in holistic patterns, or matrices, rather than as strings of energy frequencies, identification of the distinctive features of the fired pattern with the matrices of language elements held in cognitive memory forms the basic element in oral language cognition, identified here as a <u>cogneme</u>. Certain pedagogical implications are considered.

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When I first proposed this topic I was not sure it would be accepted for a program. The study of speech as a phenomenon has been largely relegated to other organizations while we have shifted to the social, political, cultural, and psychological problems of communication. An examination of the programs presented at this convention seem to indicate that for many it is assumed that we need not concern ourselves with the production and comprehension of speech because "Speech happens."

The thesis of this presentation is that a change in the paradigm by which we describe the way the brain works in producing and in understanding speech is relevant to communication since most of the problems we are beginning to deal with involve people talking with people.

In the tradition of those earlier linguists Eduard Sapir and Benjamin Whorf we can say that the way we think is determined by the language we use, while paradoxically the language any culture develops is, to a large extent, generated by they way its members think. As cognition is a multisensory phenomenon, every language is a reflection of the totality of the sensory and emotional experiences relating to the culture. At times we may forget that all written forms of any language derive from an oral language base.

Various theories and models of learning, including language learning, have been extensively covered in the relevant literature and need not be cited here. We do need to remind ourselves that oral language is the vehicle through which much of our subsequent learning is carried. Linguistic memory, then, is the associations that have been made between a particular sequence of sounds and the objects, experiences, and emotional responses related to them. This memory is not stored as a recollection of particular sound freqnencies but holistically as an image matrix.

When a speech sound is produced and received it occurs as a discrete sequential series of frequencies which can be recorded, measured and reproduced mechanically or electronically. Memory of language sounds is stored as an image pattern which appears to have two aspects: identification memory which accepts the sound as a part of the language structure, and cognitive memory which assesses what the sound signifies relative to the total linguistic inventory.

While the human body is a fascinatingly complex organism which we are only beginning to understand, the human brain is even more baffling. Brain research in the last half century has brought greater understanding of its structure and possible functions than was known in the past, research is limited to the response, or lack of response, elicited. When we inquire about how the multi-billion neural cells generate thought and acquire understanding we can only theorize. Empirical research into the way these billions of cortical and subcortical neurons individually interact with one another in the process of cognition, thought, and understanding is frustrated by the Heisenberg principle of uncertainty and the limits of our current technology. Present brain research is analogous to attempting an archeological dig with a bulldozer.

Faced with the fact that we are precluded by both our culture and our laws from detailed physical examination of living normal human brains engaged in the process of thinking we can only generalize from PET and MRI scanning about gross cerebral activity under different conditions. Because of its relative inaccessibility the subcortical region has not been explored as extensively as has the cortex. Most researchers are cautious and conservative, couching their conclusions with expressions such as "it appears that," and similar cautions. With this caveat, let us turn our attention to the subcortical area and examine its probable function in organizing the barrage of incoming sensory stimuli into meaningful segments.

Ever since early investigators discovered that different areas of the cortex appear to be associated with specific areas of the body and expressed different functions relevant to various activities, the focus of research has been on the cerebral cortex. The cortex has been assumed to be the place where everything comes together in the phenomenon known as cognition. In oral language, microelectric currents are generated in the cochlea of the inner ear which correspond to the frequencies and strengths of the sound complex that has vibrated the eardrum.These microcurrents are then assumed to be transmitted to the cortex sequentially by way of the auditory nerve where in some vaguely identified "language association area" cortical neurons resonate the stimulus and identify it as a language item. This is the telephone paradigm by which psychologists express metaphorically the process of language cognition. There is considerable evidence this paradigm may not derive from correct inferences.

The subcortical reticular core in the upper brain stem is the oldest part of the brain. George Bishop (1958) found that it appears in every vertebrate species and suggests that evolutionarily it stood in an internuncial relation between the sensory system and the motor system as a survival mechanism directing the behavior of the motor system in response to the sensory input. It may have evolved from an even more primitive system by which the/organism responded to its environment.

In 1957, a number of investigators convened at the Henry Ford Hospital in Detroit, Michigan to share a number of research papers on the structure and possible function of the Reticular formation. One of the more significant observations by Arnold and Madge Scheibel was that the reticular core is the site of the first synapse from every sensory neuron. In other words, every sensory stimulus comes through the reticular core before going to the cortex. Its structure has neural fibers running three dimensionally in all directions with axonal branchings reaching columnar fashion to the cortes. Carl Pribram describes the structure as felted,.with connections extending to every other area of the brain with "axons streaming into each other's field of interaction indiscriminately."In 1966 neurosurgeon Wilder Penfield, after studying and mapping hundreds of cases of brain injury in battle casualties, observed, "Transcortical association tracts are of importance, no doubt, but certainly of less essential importance than subcortical integration." In 1975 he confirmed his conclusion with, "Valid evidence has been presented that the integrative neuronal action that makes consciousness possible is localized in the higher brain stem rather than in the cerebral cortex."

From these examples and other related research we infer that the reticular core serves as a neural filter, or gate, by which the cortex is relieved of stimulus overload. It has long been identified with the sleep-wake condition or the attentive-inattentive state, and until recently many considered this to be its only function. While the reticular core receives all sensory information it does not always relay it all to the cortex. Apparently it does not act as an on-off switch but more like a variable capacity filter maintaining a proper ratio between inhibiting and arousing. I am sure we are all familiar with the experience of concentrating attention on one sensory mode while other sensory stimuli fade so that we are not conscious of them even though we know the other sensory stimuli are present.

When one considers the volume and variety of information being transmitted from all sensory receptors at any given waking moment, the need for a filtering mechanism is obvious. Neuropsychologist John Wilke noted after studying the research on the reticular core that it apparently serves "to allocate limited capacity mechanisms to only that input having the momentarily highest priority."

Assume, for example, y0u are holding a conversation in a room with many other people and a variety of activities going on. Your conversation has the highest priority so that even though other stimuli impinge on your senses they fade out of your consciousness. In the case of the multitude of sounds they all strike the eardrum and excite the cilla in the cochlea to generate an exceedingly complex string of microelectric currents. If this entire microcurrent were to be relayed to the cortex unfiltered only confusion would occur.

Choices among the variety of phenomena in establishing priorities for attention appears to be a function of memory involving the entire range of experiences and learned behavior which began in infancy. We will not elaborate on the variety of theories of memory at this time, although present biomolecular research and subatomic investigation may indicate memory to be a phenomenon below the cellular level.

In this model for explaining the way humans understand the string of oral language sounds we postulate that not only does the subcortical reticular system separate stimuli on the basis of attention priority it organizes the speech signal into matrices before relaying it to the cerebral cortex as meaningful language units. We must, therefore, adjust our thinking to the speed of an electric current and view time intervals in microseconds or shorter, not in intervals of the speed of sound.

The first matrix takes the cacophony of sounds impinging on the ear and separates it into significant and irrelevant frequencies. This, as in the case of separating multiple sensory stimuli because of the focus of attention, also depends on which aspect of the sound complex you are giving attention. For example, if you are intensely focusing on a musical concert you may not hear someone speak to you until you change your focus of attention, and vice versa. This first stage of the model will be designated an F-Matrix, or frequency matrix to be held in micromemory for the accumulation of sufficient additional F-Matrices to identify a series of frequencies to be a part of the known language.

While linguists segment language into phonemes and allophones, morphemes of various types, phrases, sentences, and grammatical units, cognition occurs in chunks, or cognitive units. Every language has its inventory of habituated permissible elements. After identifying a string of F-matrices,the matrix enlarges to accept the sound as permissible within the phoneme structure, This we will designate a P-Matrix, which expands into morphologically permitted units we will designate as M-Matrices. If the M-Matrix is a free morpheme it will then be relayed to the cortex as a unit. If not, it will be held until other M-Matrices form and expand into a syntactically permitted unit which we will designate as an S-Matrix.

The matrix expansion is a function of the interaction of the passive stimulus of the generated electric microcurrent and the accumulated memory matrices of the language known. Regardless of the theory by which we explain memory, we do not remember language in terms of specific frequencies but in matrices holding frequencies as cognitive units. These matrices reflect the totality of experiences and semantic values of the language. Obviously, the wider the linguistic experience the larger the cognitive memory.

Analogous to the Prague School of Linguistics' concept of distinctive features promoted by Roman Jacobson, each memory matrix in the cognitive memory reportory and each cumulation matrix for the incoming sound contains distinctive features separating it from all other matrices even though there may be a wide range of tolerance for both individual and dialectal variations. When a match between the incoming matrix and the memory matrix occurs the composite of all the accumulated electric impulses is relayed to the cortex holistically. If no match occurs, as with an unfamiliar word or phrase or from an unfamiliar language, it becomes reduced to the category of other extraneous non-linguistic sounds which are received as meaningless.

When the holistic impulse reaches the cortex with its columnar layers of neurons it excites a pattern of simultaneous neuron firing which will have distinctive configuration corresponding to the disdinctive features of the exciting matrix. This configurational pattern of neuron firing links with the configurational pattern held in linguistic memory to form what we will designate as a cogneme, or a basic unit of cognition.

Difficulty arises when the semantic and emotional value of the cogneme differs from the semantic emotional value held by the speaker. In our multiracial and multicultural society we have developed a multifaceted form of what we tend to assume is the same language. The current tendency toward increasing social fragmentation only exacerbates the problem. Every cogneme formed reflects the semantic, cultural and emotional values retained in the cognitive memory matrices of each individual. When the matrices formed at the subcortical level from the sound frequencies of the input stimulus are thought to be equal to the matrices held in cognitive memory, the cogneme so formed will reflect the individual's own cultural and emotional background. The language signal, then, only appears to be mutually understood.

Communicators, particularly mediators, face the same difficulty experienced by the inter-language translator. Without experience in both language cultures translation can only translate lexical and grammatical elements but not the cognemic equivalents. In my experience teaching English in several foreign cultures I found that advanced students and native English teachers can usually handle the vocabulary and syntax of English very well without fully comprehending the meaning. I have had students from New York City experience culture shock in trying to understand "Southernese." And if you are a native of the deep south, try trying to communicate in Brooklyn or the Bronx.

The written form of the language may standardize the visual form of the language, but the cognemes formed still reflect the semantic and emotional velues of the spoken culture. While increased communication technology, study of the psychology of human behavior, and refining organizational communication networks are worthy areas of research, the basic aspect of communication is the level of congruence in the linguistic cognemes generated.

At least two areas of significance are indicated. Cross cultural programs and cross cultural exposure should be extended into all areas of education not only to include non-American cultures but the variety of cultural differences in our own country. This will be difficult in some areas of the country because of long standing historical biases. Some progress is being made, but the fascination with computerized instruction may be an impediment to further growth. This is the second area of concern: the tendency of some teachers to substitute computerized learning for spoken communication. I am not implying that computer literacy is not important, for it is. I would, however, suggest that the visual mode should not become a substitute for talking together. No matter how much we may know, we will continue to face the need for better oral communication. By being aware of the cogneme differences we can reduce problems which are inherent in our efforts to talk together with what we assume is our common language.

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