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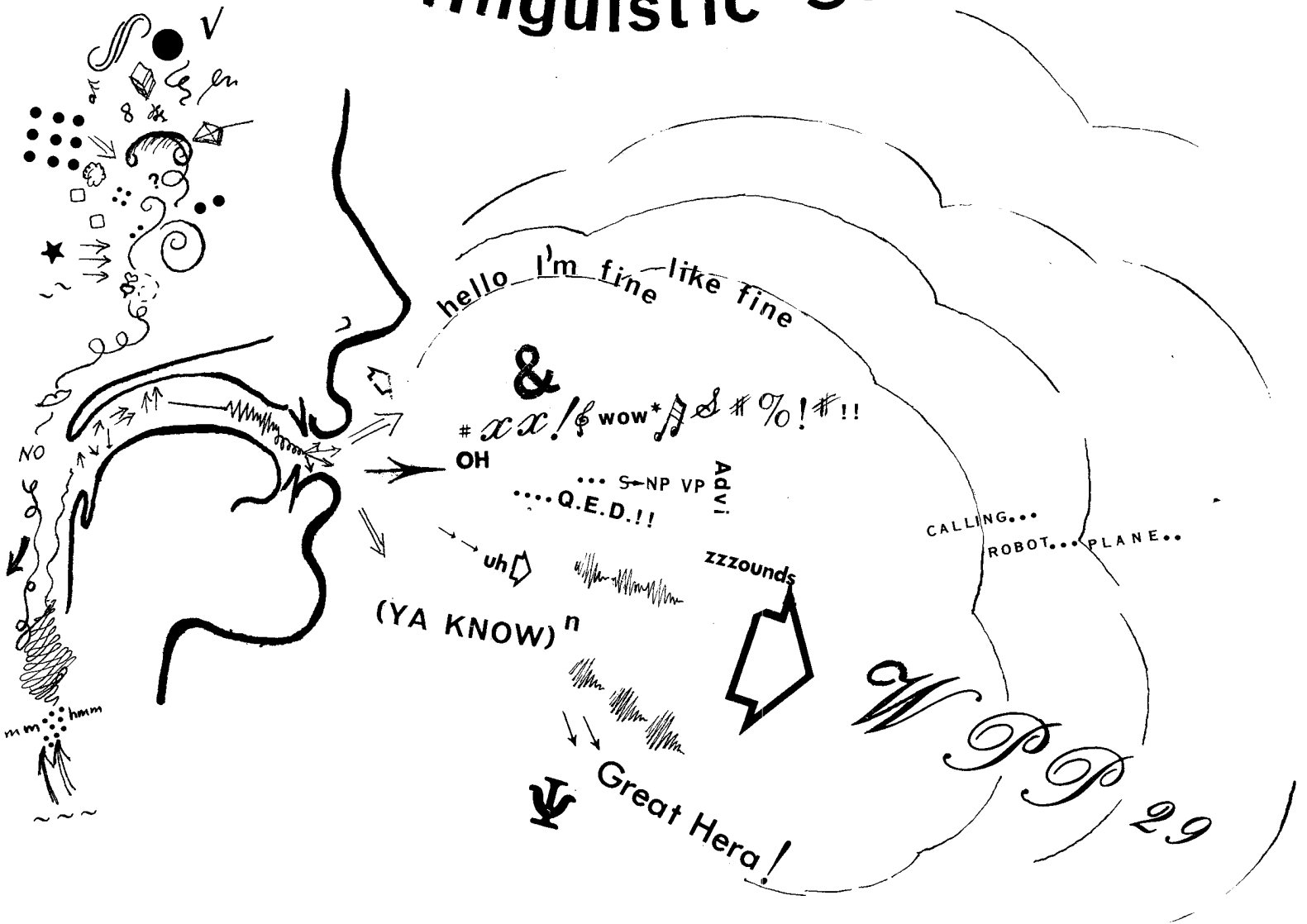
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Publication Date

1975-04-01

HETEROGENEITY in Language and Speech: Neurolinguistic Studies



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April, 1975

#29

Diana Van Lancker

Working Papers in Phonetics

Heterogeneity in Language and Speech:
Neurolinguistic Studies

Diana Van Lancker

Working Papers in Phonetics 29

April 1975

University of California, Los Angeles

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Acknowledgments

It was in a generative-transformational seminar at Brown University in 1969 that a love (what else could it be?) of neurolinguistics was sparked in my academic heart. The class presented papers on anything-and-GT grammar, and mine evolved into a huge survey of the new psycholinguistics and the old aphasia studies. Along the way I stumbled onto that landmark, Lenneberg's *Biological Foundations of Language*. The reading and writing of that period affected my semi-conscious assumptions about the domain of linguistics like a conceptual earthquake. I am grateful to Robert Meskill for encouraging those wide-ranging seminar reports, and for later performing, with Sheila Blumstein (also of Brown University) as a member of my thesis committee for the past three years across these three thousand miles.

The prospect of neurolinguistics (although I still hadn't heard the term) reared up again a few years and several tentative thesis topics later when (fade out, fade back in) I quite suddenly found myself moving about in the UCLA Phonetics Laboratory, an incipient hotbed of (among other things) dichotic listening studies. The idea for the Thai-tone study was inspired by a paper given by Ruth Day at the first Meeting of the Acoustical Society of America I attended in Denver, Colorado. Peter Ladefoged guided the drawing of the "automatic language" topic from the sack of ideas-to-pursue. He was there for the whole rest of it, through all the experiments and the presented papers and the revisions. I could always count on hearing the old hearty "How's it all going, dear?" especially when I had the least idea how it was going.

Both Peter Ladefoged and Victoria Fromkin, who was an assiduous co-worker and coauthor in the Thai-tone experiment, have read and re-read (and criticized and advocated the expunging of) this all over and over. Others who have read all or part of earlier drafts, and have taken the trouble to offer written comments, are Sheila Blumstein, Joseph Bogen, Dwight Bolinger, Harold Gordon, Thomas Scovel, William S-Y Wang, and Adam Wechsler. Richard Harshman, Stephen Krashen and John Marshall aided with statistics and with making sense out of numbers and graphs. Many others have patiently listened to me or read chapters that I sent out or just happened to have along: Among them are Arthur Abramson, Jennifer Buchwald, John Gilbert, Louis Goldstein, S. Robert Greenberg, Richard Harshman, Charles Li, Donald MacKay, Robert Meskill, Carlos Otero, George Papçun, Barbara Partee, Roger Remington, Sandra Thompson, and Julien Van Lancker. The surviving sentences herein are, of course, no one's fault but mine.

I wish also to thank Drs. Sheila Blumstein, Joseph Bogen, Chris Hagen, Adam Wechsler, and William Williams for providing me with personal or tape-recorded interviews with patients. Lloyd Rice developed computer programs for the dichotic studies, and he or Richard Harshman materialized magically at my side whenever I and the PDP-12 were in a misunderstanding. Constant technical and moral support was tendered by Willie Martin, who takes care of us in the Phonetics Lab, and Renee Wellin, who typed at least two versions of this dissertation, and takes care of us in the office. I am grateful also to all those anonymous (except in our hoary labbooks) devotees who served as subjects. May all who so naturally give of their time and energy be rewarded in life way beyond $p < .001$.

This research was supported by funds from the National Science Foundation Grant GS 37235.

Abstract

This work is based on the assumption that it is of potential value to linguistic research to correlate facts about language structure with facts about cerebral structure and function. It is in this spirit that these are subtitled "neurolinguistic studies." Human language has been described by modern linguistics as a homogeneous class, reducible to simple elements and rules for combining them. Most speech processes have been known to be lateralized to the left hemisphere in the brain. Together, these viewpoints lead to a picture of the left hemisphere as a special analytic processor.

This monograph investigates aspects of language processing that are not specialized in the left hemisphere, and claims that there are "levels" (such as some of the functions of pitch) and "subsets" (such as structuring of phrases) which are different in essential ways from each other, and from the aspects of speech and language which are typically lateralized. The conclusion is that these different properties must be represented in a grammar of human language, and that the unit-rule (or logico-deductive) model cannot incorporate many facts described here.

The evidence for nonlateralized types of language comes from clinical reports and from experiments; the claims for heterogeneous structures come also from linguistic and psycholinguistic studies. The view of language presented in this monograph suggests a compromise between Chomskian emphasis on the infinite creativity of human language and certain verbal learning approaches to language behavior. There are implications from this research for studies on the evolution of human language and on the relationship of human speech to animal communication.

Chapter 1 presents the assumptions that underlie the rest of the monograph: that varieties of evidence, including selected performance data and facts from related fields, are valuable to the formulation of models of language; and that hypotheses about language should be not only testable, but tested. The claim is made that neurolinguistics provides one such context for hypothesis-testing. Chapter 2 surveys neurophysiological foundations for studies of language and speech in the brain; Chapter 3 continues with facts about hemispheric specialization for language, especially for levels and subsets in speech performance. It is explained that some kinds of language abilities are

not specialized in the left hemisphere. After presenting linguistic arguments for separate levels in pitch processing, Chapter 4 makes the same claims for pitch in the linguistic signal: some functions of pitch in speech are not specialized in the language hemisphere. Chapter 5 presents the experimental evidence for cerebral processing of pitch, and describes a dichotic listening experiment on a tone language, Thai. The next two chapters (Chapters 6 and 7) describe types of speech performance more and less affected by brain damage. Chapter 6 is concerned with clinical observations of propositional and nonpropositional ("automatic") speech modes. The linguistic and psycholinguistic evidence that these various subsets have different properties is presented in Chapter 7. Chapter 8 describes a series of dichotic listening studies on "automatic" speech. The final chapter (Chapter 9) concludes that speech is made up of heterogeneous subclasses, and that the properties or features of these subclasses are graded (or occur in degrees). Therefore, in addition to discrete units and all-or-none categories, continua (or dimensions) are needed in descriptive models of language.

Chapter 1.

Introduction.

An hypothesis is never hurtful, so long as one bears in mind the amount of its probability, and the grounds upon which it is formed. It is not only advantageous, but necessary to science, that when a certain cycle of phenomena have been ascertained by observation, some provisional explanation should be devised as closely as possible in accordance with them; even though there be a risk of upsetting this by further investigation, for it is only in this way that one can rationally be led to new discoveries, which may either confirm or refute it.

Schwann

Chapter 1

Introduction

Diversity of evidence

I have brought together facts from various language-related studies. Many different kinds of evidence appear in these pages. There is no algorithm that guarantees the relevance of data to a theory. However, this diversification in the field of linguistics has become accepted. The theory of grammar is a theory of a human ability, and therefore the study of language is proper in many contexts. In recent years the theory of language developed by Chomsky and others has been subjected to review in research contexts other than the "purely linguistic" domain of structural analysis. Hypotheses based on the general theory of generative grammar have been developed and tested in normal speakers (Miller, 1962; Gleitman and Gleitman, 1970), in aphasics (Whitaker, 1970b; Goodglass and Blumstein, 1973) and in language acquisition (Fraser, Bellugi and Brown, 1973; Moskowitz, 1973).

Zwicky makes the same point with respect to phonology: that evidence from very diverse sources can be legitimately advanced to test hypotheses. Proposed sources of data for validating "feature systems, phonological representations, and phonological processes" are

speech errors, misperceptions, language replacement aphasia, borrowing, cross-linguistic surveys of inventories and of processes, linguistic games, productivity of processes, poetic requirements, historical change, acquisition, stylistic variations, patterns of dialect and idiolect variation, statistics of variation, orthography, articulatory and acoustic phonetics, patterns of exception, informant judgments of novel forms, psycholinguistic investigations of other types, distorted speech (1972).

A justification for this approach comes from the philosopher of science, Hempel (1966), who argues that "diversity of evidence" is a very important factor "in the confirmation of a hypothesis." He gives several examples illustrating the "power of diversified evidence" (p. 35). A corollary adds that it is "highly desirable for

a scientific hypothesis to be confirmed also by 'new' evidence -- by facts that were not known or not taken into account when the hypothesis was formulated." Extending the general theory into new contexts is desirable: "Many hypotheses and theories in natural science have indeed received support from such 'new' phenomena, with the result that their confirmation was considerably strengthened" (p. 37).

Chomsky pointed out that "investigation of performance will proceed only so far as understanding of underlying competence permits" (1965). The approach I am advocating is that examination of performance in many contexts is suggestive of factors in linguistic competence, and these refined or revised hypotheses (of competence) then can be further examined in the light of more performance data. Language can be approached as an isolated abstraction, independent of everything else in the universe. But even in Chomsky's conception of language study, the focus on internal language structure was a temporary constraint:

It seems to me that the most hopeful approach today is to describe the phenomena of language and of mental activity as accurately as possible, to try to develop an abstract theoretical apparatus that will as far as possible account for these phenomena and reveal the principles of their organization and functioning, without attempting, *for the present*, to relate the postulated mental structures and processes to any physiological mechanisms or to interpret mental function in terms of 'physical causes'. (1972, p.14). (emphasis mine)

Chomsky allocates such extensions to the future, when more is known about the structure of language, or about the nature of brain mechanisms in relation to language structures. But the orientation of generative grammar is toward analysing performance data, and relating performance data to the competence model, in a variety of contexts, from acquisition, to autism, to aphasia, to sign language. Such extensions are now underway.

With such a universe of phenomena potentially relevant to grammar, some notion of relevance of data is needed. The notion of testability of hypotheses serves as a guideline. Evidence is relevant or not only in terms of a hypothesis; hypotheses are invented in order to account for observed facts, and creative imagination is involved (Hempel, 1966, p. 15). Since no aspect of linguistic data can on principle be excluded from consideration, a guideline for assessing the relevance of

data is useful. Hempel suggests that "A finding is relevant to H (a hypothesis) if either its occurrence or its nonoccurrence can be inferred from H" (p. 12).

It is obvious that "tentative hypotheses are needed to give direction to a scientific investigation. Such hypotheses determine, among other things, what data should be collected at a given point in a scientific investigation" (Hempel, 1966). It is in this spirit that a number of tentative neurolinguistic hypotheses are proposed in this monograph.

A neurolinguistic approach: lateralization of cerebral function

The orientation of this research is toward analysis of performance data in the context of the language user. Linguistic behavior is here approached as a cerebral function. Observations in language use can be correlated with other facts in cerebral functions and with other observed behaviors and inferred abilities. The assumption of neurolinguistics is that something may be learned about the structure of language by investigating how patterns in linguistic behavior are associated with aspects of cerebral structure and function.

A stronger claim about neurolinguistics is made by Whitaker:

"a proper and adequate understanding of language depends upon correlating information from a variety of fields concerned with the structure and function of both language and brain, minimally neurology and linguistics" (1971, p. 139).

I hold, instead, that neurolinguistics is one of many valuable sources of data and theory about language structure and process.

Hemispheric specialization of cerebral functions provides background for the studies on language which are the subject of this monograph. Specific functions are lateralized to varying degrees in the brain. A neurolinguistic approach, for example, is to compare aspects of linguistic performance which are lateralized with aspects which are not lateralized to the dominant hemisphere. First, investigation must establish what features of language are uniquely

specialized in the left hemisphere. One way is to determine nonlateralized (i.e. presumably bilateral) linguistic abilities, and to "subtract" those features from a model of language processing in the left hemisphere. If it is assumed that differences in cerebral function are reflected in linguistic structure and process, then the finding that some qualities in human language are uniquely lateralized and some are not has implications for descriptions of language. This research approach has been applied to two areas of language in this monograph: pitch phenomena, and heterogeneous structure-types.

Heterogeneity in language

The work of Labov (1970) and other sociolinguists has brought about a challenge to the theoretical orientation of generative grammar and mainstreams preceding it: the "identification of structuredness with homogeneity" (Weinreich, Labov and Herzog, 1968). Sociolinguistic research has demonstrated (instead) that variation in a speech community is expected and normal. "It is perfectly true that the language of everyday life is certainly not homogeneous. Heterogeneity is the rule" (Labov, 1970). There are ranges, varying with style appropriate to social context; there are strata, varying with socioeconomic context. There is ample evidence of those kinds of linguistic variability in that speakers can be observed to switch across styles and strata. Weinreich et al (1968) argue for a "model of language which accommodates the facts of variable usage and its social and stylistic determinants" to adequately describe linguistic competence. They claim that variations are not "errorlike vagaries of performance," but constitute a kind of "orderly heterogeneity" inherent in the competence of each speaker and common to the speech community.

These variations have no place in the current transformational model of arrangement of basic units in terms of optional or obligatory rules. Labov observes that "there is no formal way of indicating that a rule applies more often in one environment than another, and quantitative data has no place in generative grammar." Yet some such formal devices may be necessary to describe the "orderly heterogeneity" -- the normal, inherent variation of everyday speech for which patterns can be consistently observed (1971, p. 463). Labov (1971) suggests that the linguistic variable must be defined in such a way that it can be handled quantitatively in a model of grammar, so that tendencies toward greater and less use of a rule by speakers can be represented.

Labov (1970) has found that speakers use different sets of linguistic variables depending on speech style. Some features are associated with casual speech, and these are distinct from a set of features used in more careful speech. The dimension which specifies this variation is "amount of attention paid to speech". Emotional and casual modes fall toward the "less attention paid" end of the dimension, and formal styles occur when more attention is paid. This kind of within-speaker variability based on an explanatory principle is analogous to a claim that is developed in this monograph.

I shall argue for another kind of heterogeneity in language. I will try to show that another dimension, like the "amount of attention paid" dimension of Labov, is needed in grammatical description to correctly account for language behavior.

There is a functionally significant dimension describing language use called a "propositional-automatic" dimension. Utterance-types at different points along this dimension have different properties. They comprise heterogeneous structure-types in language. The evidence for this type of heterogeneity, which comes from a variety of sources, presents another challenge to the homogeneous structure-and-process model of competence in generative-transformational theory.

Propositional speech is made up of newly-created, original, novel utterances. Automatic speech includes conventional and overlearned expressions, idioms, swearing, and emotional language, and other modes to be discussed in later chapters. I will argue that there are properties which distinguish automatic, or nonpropositional use of language. Utterance-types belong in subsets which fall along a dimension between the two extremes, propositional and automatic use. Evidence from aphasia indicates that these subsets are differently processed in the brain. Automatic subsets and pitch processing are consistently less impaired in aphasic deficits than other features of language. The neuro-linguistic hypothesis states that there is a neurophysiological bases to the automatic-propositional dimension.

It is well-known that language processing is primarily lateralized to the left half of the human brain. Furthermore, the two cerebral hemispheres are specialized for modes of processing. One claim in this monograph is that different subsets of language are differently processed, and therefore have different structural properties which belong in grammatical descriptions. The neurophysiological basis is that propositional language is a capacity of the left hemisphere, but that more automatic use of language is a capacity of both the dominant and the non-dominant language hemisphere. These combined points demonstrate how neurophysiological facts can interact with linguistic theory.

Summary

When facts about functional specialization and unique hemispheric modes of processing are considered in conjunction with observations in aphasia, the result is a testable neurolinguistic hypothesis. Evidence from aphasia and other clinical studies suggests that some aspects of linguistic competence in perception and production of speech are more vulnerable to disruption following left hemisphere damage than others. It follows that some features of the linguistic ability are typically (perhaps necessarily) lateralized to the left hemisphere, whereas others are not. The neurolinguistic approach assumes that facts about cerebral processing of speech and language are relevant to descriptions of human language. A neurolinguistic hypothesis considered in this monograph states that features of the language signal processed primarily in the left hemisphere are different in nature from features processed in the right hemisphere, or in both hemispheres, or subcortically; and that these differences are relevant to descriptions of language.

Specifically, in this monograph I will bring in facts about cerebral lateralization to support linguistic hypotheses about 1) "levels" of pitch function in speech, and 2) heterogeneous structure-types in language. These hypotheses can be tested in a number of ways. Evidence from various related experiments is reviewed, and two series of dichotic listening studies are presented in Chapters 4 and 8.

Chapter 2.

Language Processing in the Brain: Neurophysiological Foundations

Chapter 2

Language Processing in the Brain: Neurophysiological Foundations

Hemispheric specialization for language: neuroanatomical substrates

Language function in the brain has been a topic of investigation for well over a century.

It was clinically observed in the 19th century that lesions in the left hemisphere cause disturbances of language, or aphasia, while lesions in the right hemisphere do not. Dax was said by his son (1865) to have read a paper on this topic before a French medical society in 1836. The observation of left-hemisphere dominance for language was made generally known by Broca in 1861 by his article "Remarques sur le siège de la faculté du langage articulé, suivies d'une observation d'aphémie" ("Remarks on the seat of the faculty of articulate language, followed by an observation of aphemia," in von Bonin, 1962).

The traditional view, well-attested since Broca's time, is that the left hemisphere is dominant for language in most normal right-handed people (Figure 2.1). Recent figures suggest that about 90% to 95% of all right-handed people can be expected to be left-dominant for language. The case for dominance in left-handed individuals is unclear, and the relationship between handedness and lateralization for language remains unexplained. Intercarotid amytal studies, which inactivate one hemisphere at a time to test for language function in each, suggest that 50% to 70% of left-handers are left-dominant for language (Efron, 1963a; Milner, Branch and Rasmussen, 1964). Goodglass and Quadfasel (1954) report that 50% of left-handed cases in aphasiological literature had aphasia as a result of damage to the left hemisphere. These figures are confirmed in studies on aphasia due to brain wounds (Russell and Espir, 1961).

There are reports that language is not lateralized to the left or right hemisphere in some people, particularly left-handers, but bilaterally represented. Conrad, for example, concludes from a study of a total of 808 brain-damaged patients, of whom 47 were reportedly left-handed, that "*die Linkshändigkeit alle Zeichen der geringeren Spezialisierung zeigt*" (1949), (left-handedness has all the signs of less [hemispheric] specialization). The evidence is that in left-handed people, hemispheric injury produces milder and more transitory aphasia than in right-handed people. Similarly, Zangwill (1964b) suggests that in left-handers, lateralization may develop more slowly and less completely than in right-handers. He also points to the different clinical picture in aphasia, and adds that left-handers, like children, have less receptive defect in aphasia. In those tending toward left-handedness, "the degree of cerebral specialization appears to vary widely as between both individuals and functions and to offer greater possibilities of restitution after injury to either hemisphere." He

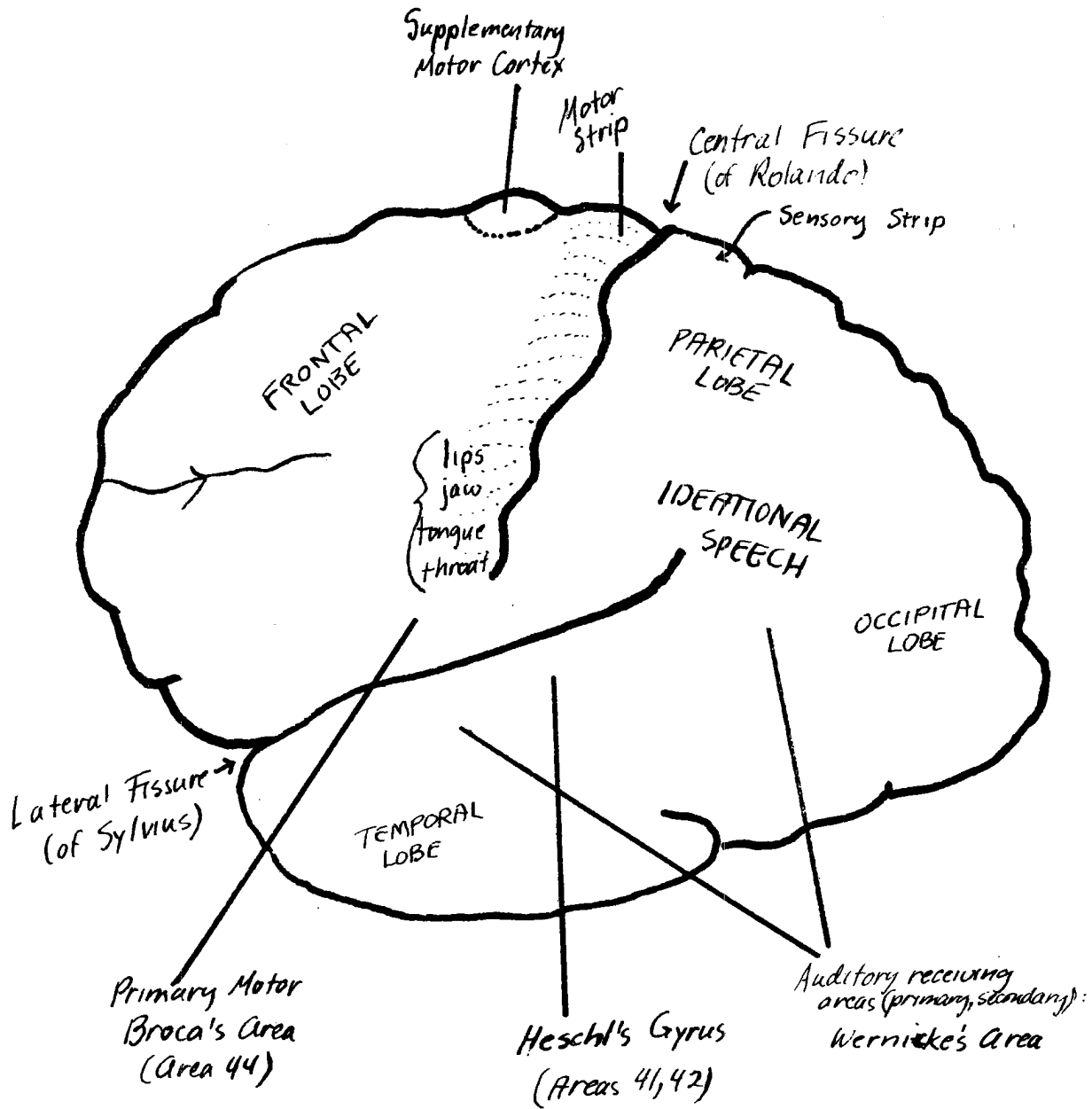


Figure 2.1. Dominant (left) hemisphere: speech areas (Broca's, Wernicke's)

uses the terms "cerebral ambilaterality" and "indeterminate cerebral dominance" to describe observations in left-handed individuals. Zangwill suggests that "cerebral dominance is in all probability itself a graded characteristic, varying in scope and completeness from individual to individual. Its precise relation to handedness and its vicissitudes still remains to be ascertained" (1960, p. 27). Penfield and Roberts (1959) state from their extensive work in mapping language functions in the brain that "a definite possibility of bilateral representation of speech exists" (p. 98), especially in left-handers.

Luria (1947, 1970) reviews facts indicating that left-sided lateralization for language is not always complete. He cites Jackson, Bastian, Goldstein, Nissl von Mayendorf, Zangwill and Subirana as having all said that the right hemisphere may take part in the organization of speech. And according to Potzl, Liepmann, Pappenheim and others, total "verbal deafness" occurs only after damage to both temporal lobes. Other clinicians, Luria observes, such as Charcot, Monakow, and Preobrazenskij report speech disturbances in right-handers after injury to the right hemisphere. And sometimes damage to speech zones in left hemispheres of right-handers does not lead to aphasic disturbances. In Luria's words,

"there is a whole series of intermediate states ranging from total and absolute dominance to the left hemisphere to partial or total transfer of the dominant role to the right hemisphere. Thus both the paradoxical appearance of aphasia following the injury of the subdominant right hemisphere in right handers and the absence of, or rapid recovery from, aphasia following injury of the speech zones of the dominant left hemisphere may be explained on the basis of variation among individuals in the degree of left hemisphere dominance which is reflected in variation in the relation of the right hemisphere to speech functions" (1970, pp. 56-57).

Lateralization of function in the human brain remains a mystery. It is unclear whether the "reasons" are neuroanatomical, functional, evolutionary, developmental or some combination of these. Lateralization of function was thought to be unique to language in man. It is now known, however, that 1) in man other functions (e.g. spatial relationships) also involve hemispheric specialization (Figure 2.2); and 2) functions are lateralized in other species (e.g. cats, birds, and crabs).*

* See reviews in *Neurosciences Res. Prog. Bulletin* Vol. 7, no. 5, *Primate Communication*, and Vol. 9, no. 1, *Central Control of Movement*.

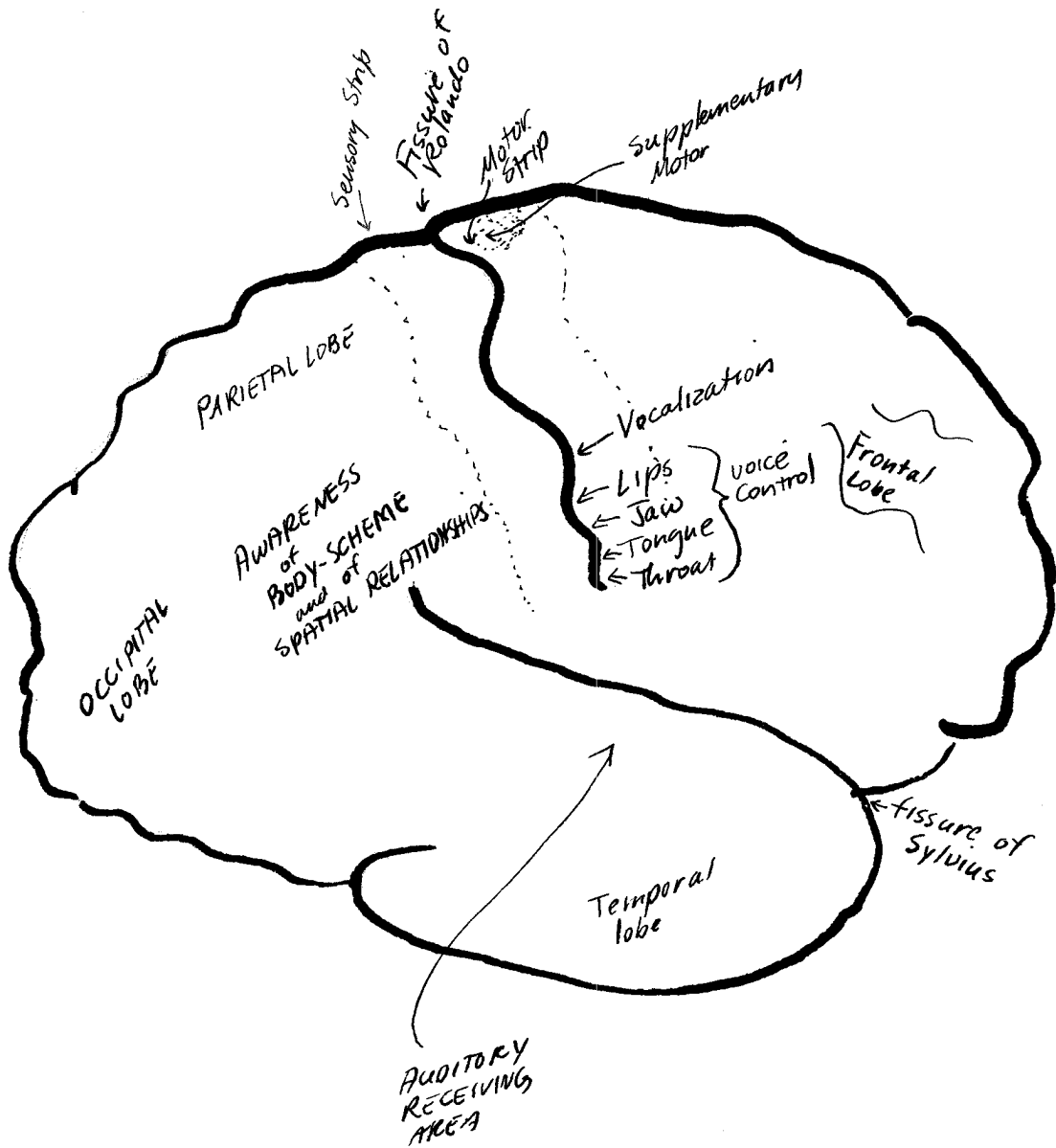


Figure 2.2. Non-dominant (right) hemisphere. Cortical areas and their function, according to electrical stimulation and surgical evidence.

For many decades the two cerebral hemispheres were considered exactly alike physiologically. It is now believed that there are differences in the hemispheres, although their gross appearance is as mirrored images. For example, the alpha rhythm is lower over the dominant hemisphere (Lindsley, 1940; Espir and Rose, 1970). Furthermore, the morphological structure is reportedly different in the left. Von Bonin (in Mountcastle, 1962) has reviewed the anatomical differences in the two hemispheres. There is a little more cortex on the left (dominant) side; the left Sylvian fissure is somewhat longer, the insula is longer and higher. Von Bonin remarks that these morphological differences are very small and do not account for the "astonishing differences in function," especially the specialization of speech (p. 6).

Geschwind and Levitsky (1968) measured 100 adult human brains, and found that in 65 % of the brains examined, the planum temporale (an extension of Wernicke's area) is larger on the left. This is the area behind Heschl's gyrus (or primary auditory cortex), containing the auditory association cortex or Wernicke's area. The left planum measures an average of 1/3 larger on the left than on the right. Similar findings were reported by Lemay and Culebras (1972) from measurements of carotid arteriograms and coronal sections of brains. The parietal operculum was "more highly developed" on the left than the right in 38 out of 44 right-handed persons (Figure 2.3). They claim that these differences can be observed in the cast of the La Chapelle-aux-Saints skull, whose Sylvian fissures allegedly resemble those of modern man. Furthermore, they are present in newborn infants, as seen in comparing the brains of a 16-week old fetus, an adult human, and a drawing of a brain that would fit into the Neanderthal skull. Wada (1969) has presented evidence that there are morphological differences between the hemispheres in the brains of infants (cited in Geschwind, 1970, 1972). Geschwind and others consider it reasonable to assume some connection between these morphological differences in the classical speech areas and hemispheric specialization for speech.

The significance of these anatomical differences for specialization of language is controversial. The relationship of brain structure and brain function is complex, and arguments between the localizationist and holistic schools have remained much the same for a century. Berlin et al. (1973b) point to these morphological differences as evidence for a hypothesis of left hemisphere perception of speech. Berlin places the specialization for perception of language at the level of acoustic processing, arguing that the structures in that part of the brain uniquely process just those sounds that can be made in the vocal tract. He proposes the following "preliminary working hypothesis":

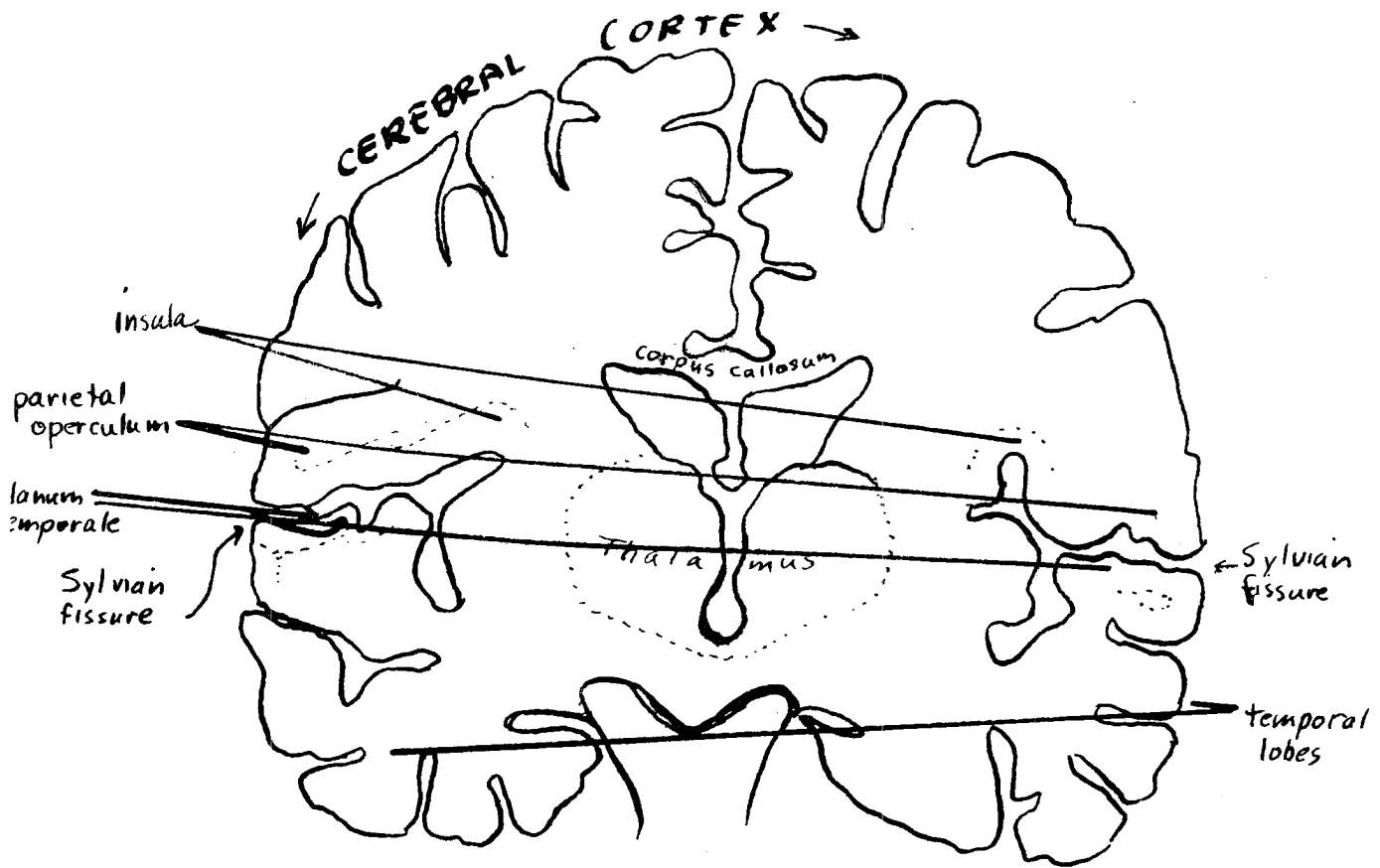


Figure 2.3. Cross-section scheme of human brain.

from Whitaker, 1969

"The proximity of tongue and larynx areas in the left hemisphere to both Broca's area and the primary and secondary auditory areas of the temporal lobe, might improve the efficiency of interaction of the right ear with any movements of the vocal tract. The asymmetry of the human brain in the left temporal lobe areas may facilitate this heightened efficiency by extending the primary auditory areas more medially and under the Rolandic strip" (1973b, p. 705).

The weakness of this argument is that structural proximity in the brain does not necessarily imply cooperation in function.

In his "Summary of the Conference" on *Interhemispheric Relations and Cerebral Dominance*, Jung comments on the problem of "explaining" dominance:

"The minute differences between the human cerebral hemispheres and their various morphological asymmetries cannot account for the astounding differences in hemisphere function. At this time morphology offers no explanation whatever for the facts of cerebral dominance. ...At present...we can only assume that there must be functional differences in the learning capacity of the two hemispheres, differences which lack, so far, an obvious basis in structure" (in Mountcastle, 1962, p. 264).

The weakness of arguing from structure to function is underlined by observations in apes' brains. According to Jung, the cortical substrate in the "language areas" is present in the ape's brain as in the human brain. The cytoarchitectural speech areas in apes are very well developed and similar to those in man, but they are apparently used for other purposes (p. 270). Similarly, Kreindler and Fradis (1968) suggest that the morphological substratum for speech preceded its functional development in evolutionary history. Their evidence is from Neissl von Mayendorff (1930), who found the same special cells as appear in man's speech areas in analogous cortical zones in apes (Kreindler and Fradis, 1968, p. 100).

Penfield and Roberts (1959) originally claimed that voicing (production of prolonged phonation) from electrical stimulation of motor speech areas of both hemispheres is unique to man. Judson and Weaver (1965) report that instead of phonation, total adduction (closure) of both vocal cords is observed experimentally in monkeys

on stimulation of the area in monkeys corresponding to the motor speech area in man on either hemisphere. Monkeys emit sounds only after deep stimulation within the mid brain or limbic areas (Kelly et al. 1946; Robinson, 1967a).

Lieberman et al. (1969) have claimed that the vocal tract shapes of apes are limited to a few configurations. Whatever their brain potential, nonhuman primates are severely restricted by their "peripheral" apparatus, and on that basis could not have developed spoken language.

Cortical control of peripheral speech mechanisms: production and perception

The nature and source of the central mechanisms in the brain, necessary for initiation of speech, are not well understood. Motor sources of speech (for phonation and articulation) are bilaterally represented in the primary and supplementary motor areas on the cortex. There are four cortical areas which, when stimulated by an electric current at surgery, cause the patient to emit a vowel-like phonation: the precentral Rolandic gyrus of both hemispheres, and the supplementary motor area of both hemispheres (Penfield and Roberts, 1959). Thus vocalization can be initiated by electrode stimulation of either hemisphere, and specifically at points anterior to the speech center.

It has been claimed that singing and music perception are capacities of the right hemisphere (Henschen, 1926; Luria, 1966). These abilities may be bilaterally represented (see review in Bogen, 1969a, p. 144). Observations in patients with left-hemispherectomies have confirmed the early belief that the right hemisphere is capable of the motor control for singing words (Smith, 1966). Two left hemispherectomy patients were able to recall and sing songs (with their lyrics) suggesting that the right hemisphere may play a significant role in "musical memory" and in the "neuromotor processes of singing," each of which involves many of the same mechanisms of vocalization and articulation used in spoken language. Studies on six patients using the Wada technique to determine hemispheric dominance were conducted by Bogen and Gordon (1971). They conclude that the "right hemisphere is more important for singing than speech," and that the right is specialized for "tonal abilities."

Thus, both phonation and articulation of speech gestures are bilaterally represented. In Goldstein's view,

"Even though there can be no doubt that, for the right-handed person, the left hemisphere is of paramount significance for language, it must be noted that for the *formation of sounds the corresponding area of the other hemisphere may play an important part, different in individual cases...* With regard to the bilateral speech movements... there is a *close relationship between the two motor speech areas*" (1948, p. 202).

Penfield and Roberts (1959) point out as further evidence that the motor sources for speech are bilaterally represented, that if the Rolandic motor strip of one hemisphere is destroyed, the other one takes over. They claim that "cortical control of the voice, including articulatory movements and vocalization" can be served by either hemisphere alone. Excision of the lower Rolandic motor cortex (face, jaws, tongue and throat) on either side only temporarily produces dysarthria or thickness of speech, which fully recovers to normal speech. "It seems likely that such a patient is able to speak [after removal of the lower portion of the Rolandic strip] by employment of the cortical motor mechanism of the other hemisphere" (p. 16). Hagen (1971) reports on three right hemispherectomy patients that two sustained only minimal dysarthria four weeks after removal of their entire right hemisphere. The third patient retained a more severe weakness of the left side of the tongue.

Penfield and Roberts' (1959) conclusions are based on electrical stimulation and surgery on brains of brain-damaged patients. The relevance of behavior induced by electrical stimulation of cortical areas to "cortical control" during normal behavior is uncertain. Furthermore, evidence from pathological populations cannot directly serve hypotheses about normal behavior. However, there is other evidence that the peripheral mechanisms for the production of speech are represented in both hemispheres.

Representation of most motor functions on the cortex is associated with movement on the opposite side of the body, or contralateral control of movement. However, the relationship between speech movements and lateralized function is more complex. Speech movements are mediated by the cranial nerves: Cranial nerve V (Trigeminal), whose sensory and motor portions serve face, mouth and jaw; Cranial nerve VII (Facial), a complex nerve with sensory and motor roots, which distribute into muscles of tongue, jaw and lips; Cranial nerve VIII (Acoustic or Auditory); Cranial nerve X (Vagus), with sensory

and motor fibers supplying pharynx, soft palate, base of the tongue and supraglottal portion of the larynx; and Cranial nerve XII, (Hypoglossal), a motor nerve serving the tongue (Figure 2.4) (Van Riper and Erwin, 1958; Zemlin, 1968).

The motor pathway for articulation and phonation descends from Brodmann's area 4 on the cortex, along the corticobulbar tract of the internal capsule, to relay stations in the medulla, (e.g. the nucleus ambiguus) where the cranial nerves principally involved in articulation (ninth, or glossopharyngeal and eleventh, or spinal accessory) and phonation (tenth, or vagus) emerge (Judson and Weaver, 1965, p. 259); (Figure 2.5). The upper motor neurons which descend via the corticobulbar tract to synapse in the cranial nerves are both crossed and uncrossed (Figure 2.6).

In the case of the cranial nerves involved in speech, some of the motor fibers leave the brain stem above the level where the "crossing" (decussation) occurs, so that the connections between hemispheric cortex and side of face and neck are in part ipsilateral (Zemlin, 1968, p. 524 and *passim*). For example, the innervation of the muscles of the upper part of the face is primarily uncrossed (ipsilateral or homolateral), while the innervation of the lower part is primarily crossed (contralateral) (p. 259).

Anatomically there are bilateral connections between the right and left cortical motor strips and the right and left cranial motor nuclei involved in speech. "Eyelids, jaw and trunk" have the "greatest degree of bilateral representation" (Buchanan, 1951). For the larynx, the neuroanatomical findings are confirmed by clinical observations which suggest that the control of laryngeal muscles is to a large extent bilateral. Pitch control (as in singing, emotional vocalizations) usually remains intact with left or right hemisphere damage or removal (except in cases of amusia).

There are several other neurophysiological bases for this bilaterality besides the presence of both ipsilateral and contralateral innervation. One such basis lies in "association and commissural neurons," which bring other areas in the cortex into relationship with the innervation of the cranial nerves of speech (Van Riper and Erwin, 1958). Still another explanation has been advanced by Penfield, who suggests the importance of subcortical mechanisms in speech processes, or the "centrencephalic center," which is "bi-encephalic" in the sense of being a coordinating center for both hemispheres. "The major portion of the [centrencephalic] mechanism is located in parts of the diencephalon, mid-brain and pons -- the higher brain-stem which includes the two thalami" (Penfield, 1954, p. 5); (Figure 2.7).

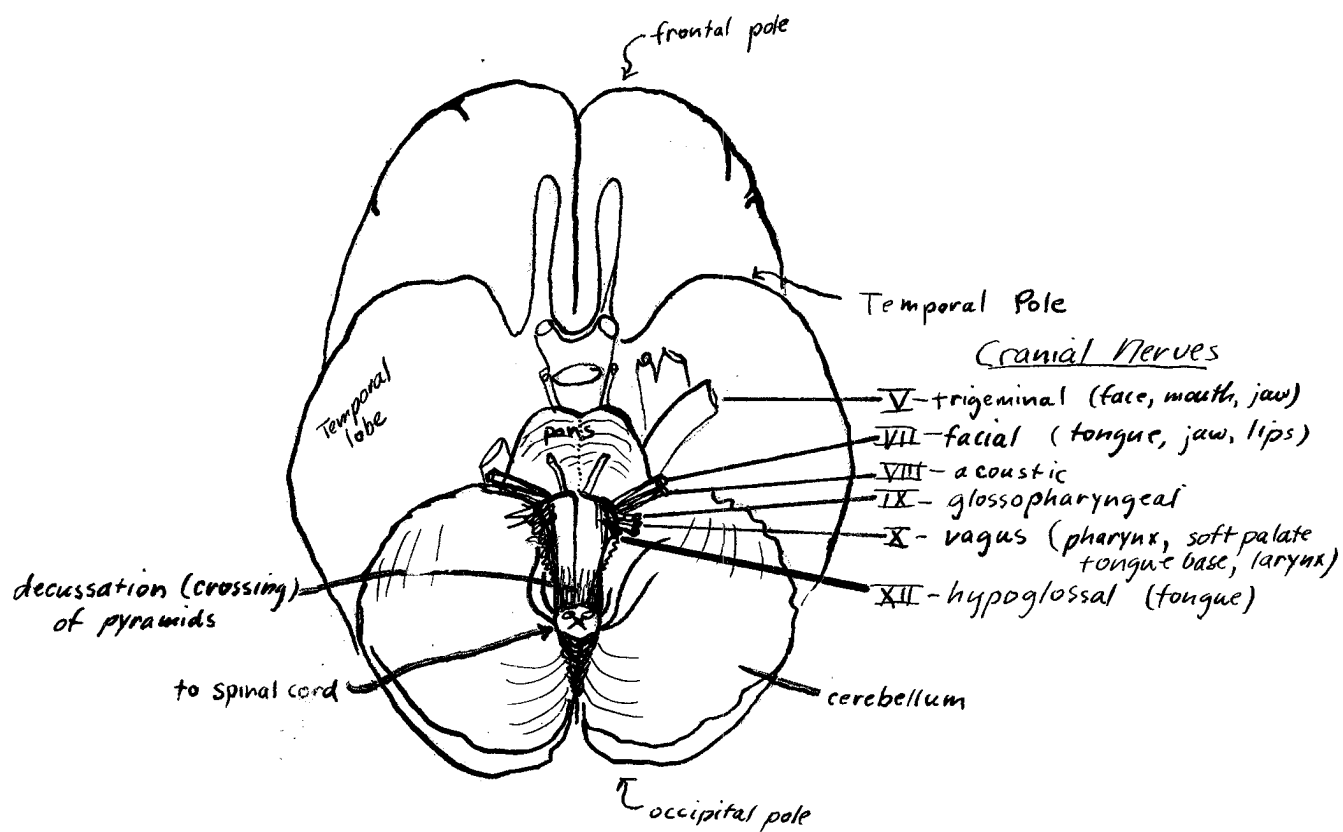
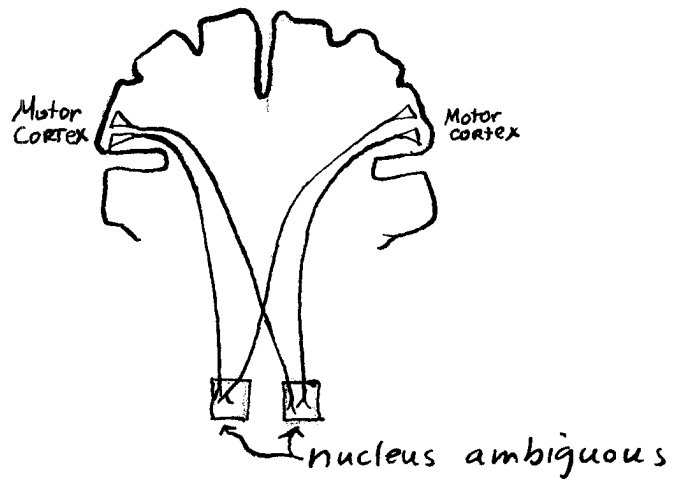
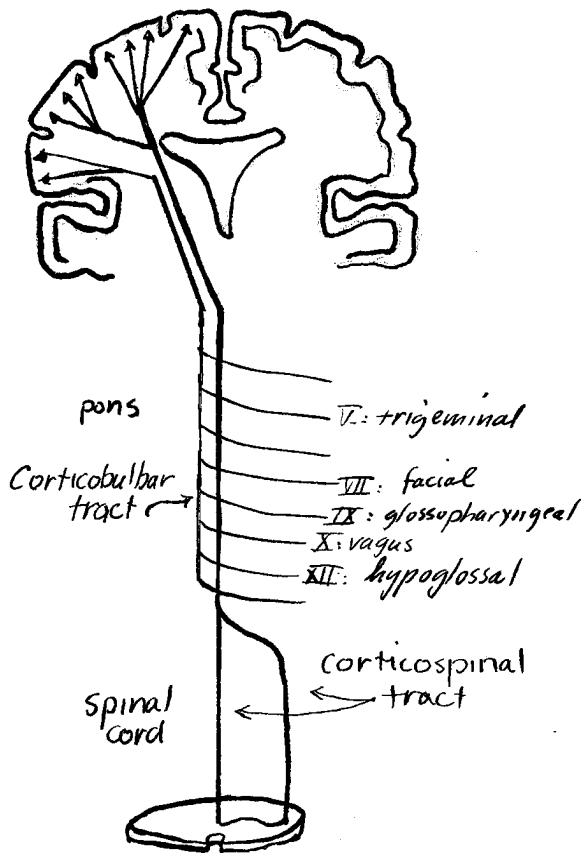


Figure 2.4. Base of brain. Cranial nerves involved in speech.



Drawing to suggest how Innervation of Nucleus Ambiguus (relay station to cranial nerves IX, X and XI) is bilateral.

Central innervation of larynx and articulators.
Corticobulbar tract via internal capsule
to cranial nerves.

Figure 2.5

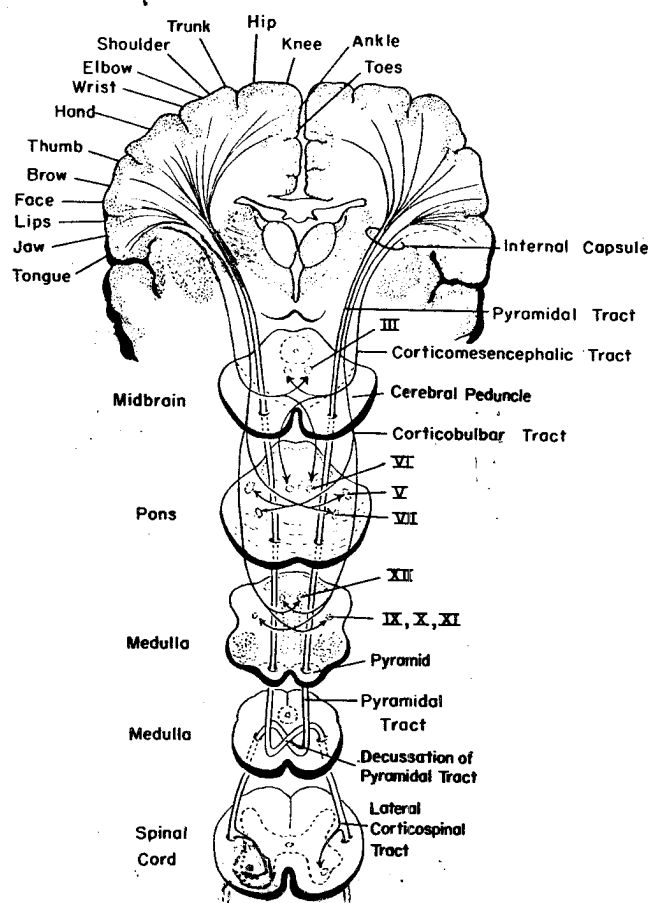


Figure 2.6. Pyramidal tract, showing Cranial Nerves.

Adapted from Matzke and Foltz, 1967

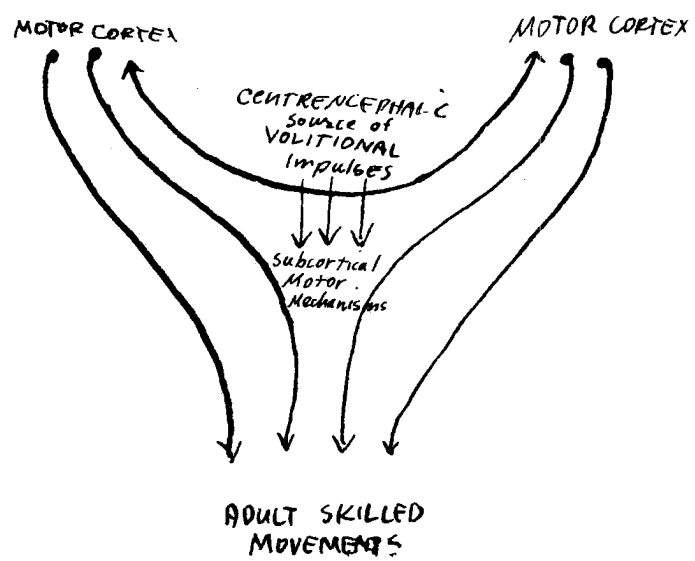
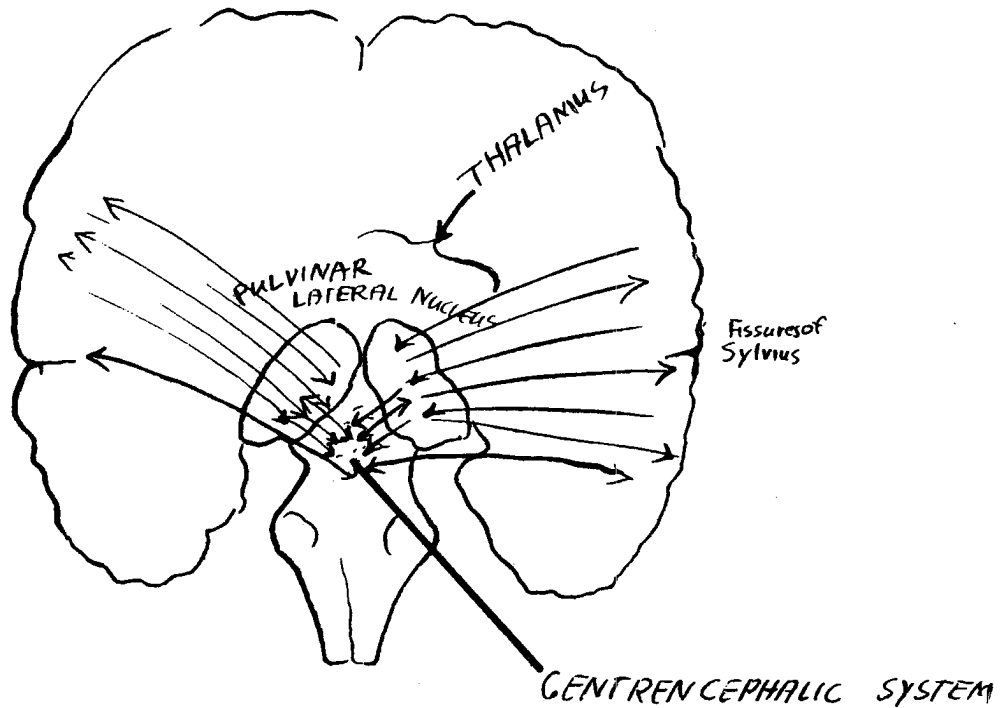


Figure 2.7. Hypothetical diagram of the stream of volitional nerve impulses from the centrencephalic area to each Rolandic motor cortex and from there to subcortical motor mechanisms and peripheral bulbo-spinal motor areas.

Adapted from Penfield, 1954
 Penfield and Roberts, 1959

Penfield (1954) observes that babies organize vocalization (which involves positioning the mouth, vocal cords, and controlling the breath) in a gesture similar to that observed during electrical stimulation of the four points on the cortex. Infants probably execute this gesture of phonation with little participation of the cortex. It is possible that initiation and execution of vocalization, as well as some aspects of articulatory control, are in part subcortically controlled.

Penfield and Roberts (1959) take the position that although the motor sources of speech are bilaterally represented, "ideational" speech is organized in the left hemisphere. Gazzaniga (1970) reaches a similar conclusion from his studies on split-brain patients: the primary motor control of speech musculature is present in each half brain, but the "neural organization required for spoken language is usually lateralized" (p. 116).

Berry and Eisenson (1956) observe that the mechanisms for speech, subserved by the "midline organs" such as jaw, lips, tongue and larynx, are bilaterally (i.e. redundantly) represented in the cortex. Therefore, for speech, only one side is "needed." There may be a teleological explanation for this specialization to one hemisphere of a potentially bilateral mechanism. Brain (1961) has written that the skilled integration necessary for speech "requires that the motor cortex of both hemispheres should be under the control of a single co-ordinating area, 'the motor speech centre.'" Speech, in other words, because of its complexity, necessitates localization. Emotional sounds in man and animals "are simple involuntary performances, and such simple reactions can utilize symmetrical and bilateral pathways. In contrast, speech calls for articulation -- the precise integration of the small muscles of the lips, tongue, palate and larynx besides the respiratory muscles, so that these contract synchronously on the two sides with such delicacy that a variety of sounds can be differentiated through a range of fine gradations" (p. 25). According to Brain (1961), Luchsinger and Arnold (1959, 1965), and others, hemispheric specialization is "required" for development of human language.

The teleological explanation does not accommodate all the relevant facts. In some individuals, dominance may be "mixed" and degrees of dominance may vary in different people. Furthermore, singing, and emotional expressions in man (for which other than left hemisphere control is possible) involve the same complex articulations and integration of many motor skills as those other utterances called human language. Curses and expletives may fall into the class of the "simple involuntary performances" which many aphasiologists have suggested can utilize bilateral pathways or the pathway from the non-

dominant hemisphere, or are subcortically mediated. These alternative modes of language processing in the brain will be examined in the chapters to follow.

The two cerebral hemispheres are equipotential for motor control of speech. Specialization is not at the level of motor organization of speech gestures. Similarly, specialization for speech perception is not to be explained at the level of peripheral processing (auditory function). According to Neff (1962), in the auditory system "one might expect to find some differences in the functions of the cortex of right and left cerebral hemispheres," but experiments on animals have not demonstrated such differences. Instead, the only kind of auditory discrimination impaired by unilateral temporal lobe ablation in cats is sound localization, a complex task requiring interaction between inputs at both ears.

The auditory pathways from the organ of Corti (in the cochlea of the ear) to the auditory cortex have been investigated in detail (Figure 2.8). Each ear projects to both auditory receiving areas in the cortex (by ipsilateral and contralateral pathways). The asymmetry in projections from each ear to the auditory cortices has been observed in records of gross evoked responses to click stimulation recorded from the auditory areas of the right and left hemispheres (R. Thompson, 1967). Tunturi (1946) and Rosenzweig (1951, 1954) demonstrated that the amplitude of the evoked response is greater at the cortical area contralateral to the ear stimulated by the click in animals. The contralateral pathways, i.e. from left ear to right cortex, and from right ear to left cortex, are "stronger" than the ipsilateral pathways, as measured by electrical activity. Anatomical and clinical studies in humans support the observations in animals. According to Rosenzweig, "the majority of nerve pathways starting in one cochlear nucleus cross to the opposite side of the brain" (1972, p. 207). However, there is considerable interaction between left and right ascending auditory pathways. Clinically, the ear contralateral to a hemispheric lesion shows greater deficits than the ear on the side of the lesion (reviewed by B. Milner, 1962).

Much work has been done on processing of components of the acoustic signal: pitch, intensity and duration (Rosenblith, 1961; Whitfield, 1967; Gulick, 1971). It is known that "tone frequency has a clear spatial representation at all levels from the basilar membrane to the cerebral cortex" (Thompson, 1967, p. 268). Butler et al. (1957) demonstrated that cats discriminate pitch even after extensive lesions of the cortex including all auditory areas. Studies on cats (Katsuki, 1961, 1962; Thompson, 1960) suggest that pitch discriminations are subcortically processed; bilateral transection

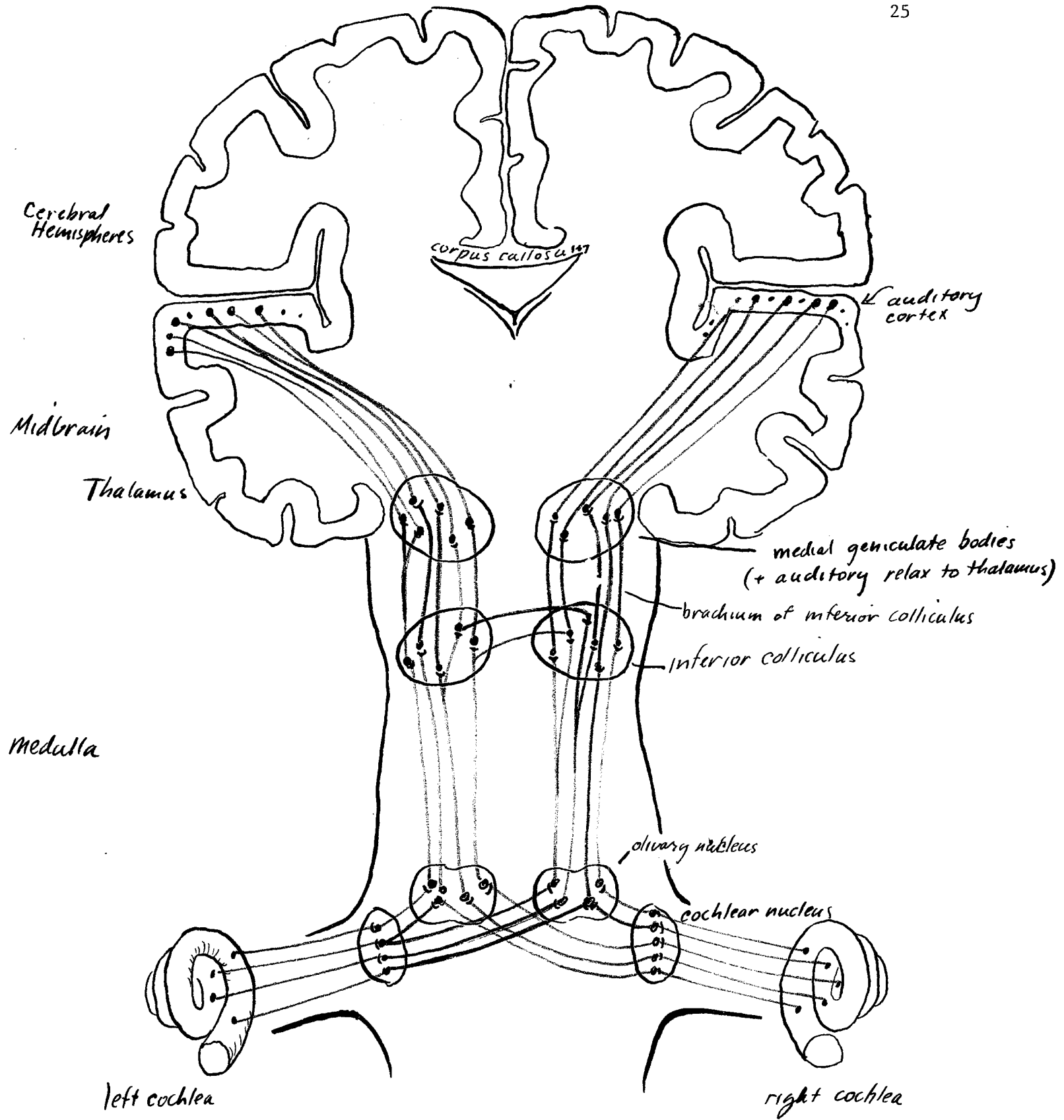


Figure 2.8. Auditory pathway

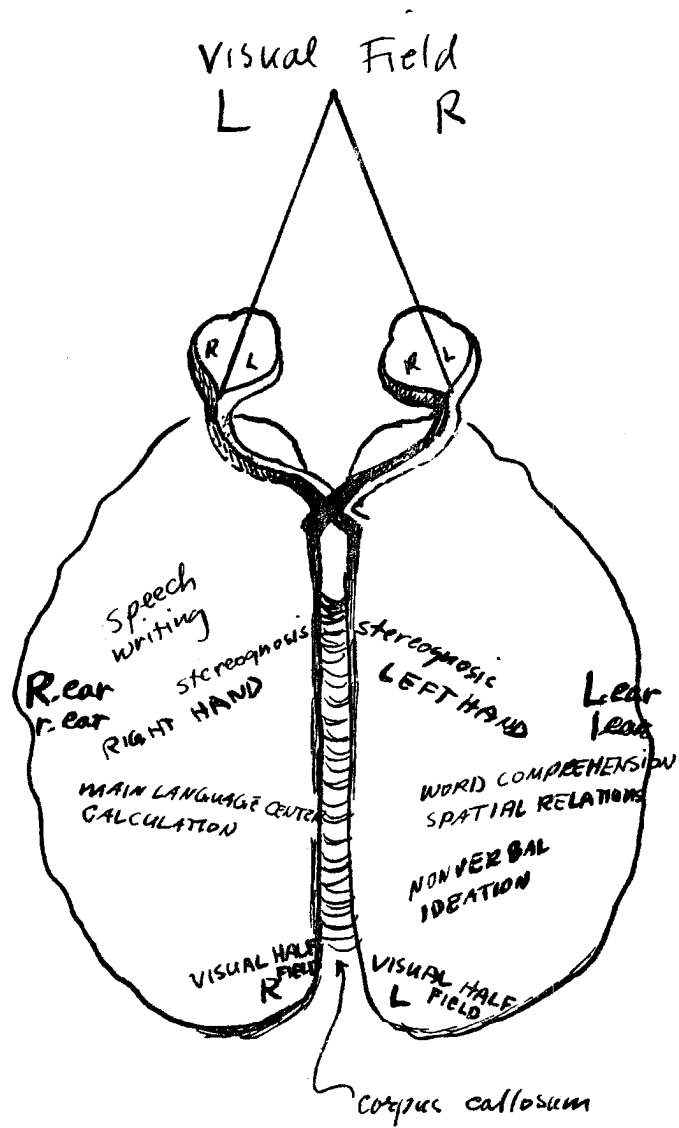


Figure 2.9. Basic cerebral functions in right and left hemispheres as indicated by behavioral tests in split-brain subjects

of the auditory pathway below the level of the inferior colliculus does not impair pitch discrimination. Simple pitch discriminations can be made by patients with unilateral brain damage on either side (P. Milner, 1970). Right temporal lobectomy patients made more errors on pitch discrimination tasks than left temporal lobe patients, but the difference was not significant (B. Milner, 1962). A right hemispherectomy patient performed better than normal subjects on both monotic and dichotic pitch discrimination tasks (Curry, 1968). In another study, three right hemispherectomy patients performed normally in bilateral pure tones test and bilateral normal speech discrimination (Hagen, 1971).

Intensity discriminations can also be made by animals that lack auditory cortex (Dewson, 1964). Animal studies suggest that "corticothalamic participation does not appear to be required for intensity discriminations" (P. Milner, 1970, p. 241). B. Milner (1962) found that right temporal lobectomy patients did slightly worse on intensity discrimination tasks than left temporal lobectomy patients. Discrimination of different durations and timbres is impaired in cats (Neff, 1961) with lesions of the auditory cortex, and in humans with right temporal lobe damage (B. Milner, 1962).

Frequency, intensity, timbre and duration are all components of the speech signal. Frequency (pitch) and intensity (loudness) are subcortically and bilaterally processed in the brain, while normal timbre and duration discriminations require intact cortex in animals and intact right auditory areas in man. Independently, these components can be processed subcortically, bilaterally or, in humans, better in the right cerebral cortex. Yet speech comprehension is a specialization of the left hemisphere. Neff concludes that the differences in function of the two cerebral hemispheres in man "cannot be accounted for readily in terms of the manner in which sense organs project to, and motor organs receive innervation from contralateral and ipsilateral hemispheres" (1962, p. 196). The hemispheric differences observed in man for processing of auditory stimuli are not based on the nature of the acoustic components.

Lateralization of other cerebral functions

There is evidence that speech is not the only lateralized function. The left hemisphere is thought to be superior for calculation (Sperry, 1964) and for temporal order processing (Efron, 1963a,b; Carmon and Nachshon, 1971), and the right hemisphere for personal geography, facial recognition, and other visuo-spatial processes (Jung, 1962). Lateralized specialization has been determined from clinical symptomology of brain

Source		
C.S. Smith	Atomistic	Gross
Price	Analytic or reductionist	Synthetic or concrete
Wilder	Numerical	Geometric
Head	Symbolic or systematic	Perceptual or non-verbal
Goldstein	Abstract	Concrete
Ruesch	Digital or discursive	Analogic or eidetic
Bateson & Jackson	Digital	Analogic
J.Z. Young	Abstract	Map-like
Pribram	Digital	Analogic
W. James	Differential	Existential
Spearman	Education of relations	Education of correlates
Hobbes	Directed	Free or unordered
Freud	Secondary process	Primary process
Pavlov	Second signalling	First signalling
Sechenov (Luria)	Successive	Simultaneous
Levi-Strauss	Positive	Mythic
Bruner	Rational	Metaphoric
Akhilnanda	Buddhi	Manas
Radhakrishnan	Rational	Integral

Table 2.1. Suggested "Dualities of the Mind" or Dichotomies of Thought-types (Bogen, 1969a, p. 158).

injury to each hemisphere (for review see Hécaen, 1962) and from studies on patients in whom the corpus callosum connecting the two hemispheres has been sectioned (Gazzaniga, 1970; Sperry, 1964); (Figure 2.9). Information about lateralized processing comes also from experimental testing of brain-damaged patients and normal subjects using special testing situations such as a tachistoscope, which projects an image to the hemispheres independently; and dichotic listening, in which two sounds are presented simultaneously (one at each ear) (see review by Dimond, 1972).

Another method involves recordings of electrical activity or evoked potentials over each hemisphere, as visual or acoustic stimuli are presented to the subject. Greater or lesser activity associated with different stimuli implies greater or lesser functional involvement. Thus there is a large body of accumulating data describing details of specialized function, or preferred processing in the cerebral hemispheres.

Hemispheric modes of function

In addition to demonstrating individual hemispheric preferences in detail, hypotheses about general differences between modes of processing have been proposed. Bogen (1969) for example, has attempted to determine features common to phenomena seen to be left hemisphere specializations, in comparison to features common to right hemisphere functions, and to distill two "modes" to abstractly characterize any of the specific abilities of each hemisphere. He has hypothesized (as have others) that the left hemisphere operates in a "propositional" mode, while the right hemisphere has its own unique mode of functioning, an "apositional" mode. Bogen does not try to reduce these to simple descriptions. He presents a table of dichotomies, gathered from beliefs on the "duality of the minds" (from Table 2B, Bogen, 1969, reproduced in Table 2.1).

These differences correlate with facts and folklore about right and left hands, and the right and left sides of the body. Notions about two minds, and two modes of consciousness are discussed by Ornstein (1972) where facts from neurophysiological studies are interwoven with philosophy, mythology and speculation (p. 67). Ornstein presents his own table of "a tentative dichotomy" of "The Two Modes of Consciousness," also reproduced here:

Who Proposed it?	The Two Modes of Consciousness: A Tentative Dichotomy	
	Day	Night
Many sources	Intellectual	Sensuous
Blackburn	Time, History	Eternity, Timelessness
Oppenheimer	Active	Receptive
Deikman	Explicit	Tacit
Polanyi	Analytic	Gestalt
Levy, Sperry	Right (side of body)	Left (side of body)
Domhoff	Left hemisphere	Right hemisphere
Many sources	Propositional	Appositional
Bogen	Lineal	Nonlinear
Lee	Sequential	Simultaneous
Luria	Focal	Diffuse
Semmes	The Creative: heaven	The Receptive: earth
I Ching	masculine, Yang	feminine, Yin
I Ching	Light	Dark
I Ching	Time	Space
Many sources	Verbal	Spatial
Many sources	Intellectual	Intuitive
Vedanta	Buddhi	Manas
Jung	Causal	Acausal
Bacon	Argument	Experience

Table 2.2: Ornstein's tentative dichotomy of the two modes of consciousness (1972, p. 67).

Lateralization of language: a functional interpretation

The bases for the specialization of language function are not primarily to be found in the physical system basic to speech. The peripheral processes of articulation and hearing are represented in both hemispheres, and there is evidence of subcortical involvement in important subparts of speech processing. The specialization must be viewed as not physical, but functional. Specialization in one hemisphere involves features of structure and organization superimposed on the physical processes. It can be inferred that there are properties of speech and language that can be correlated with left hemisphere specialization of function.

The hypothesis that specialization for language is functionally determined leads to interesting possibilities for linguistic research. The question can be asked: what is unique to the structure and processing of language, that its functioning, "above" the motor and physiological levels, is specialized in the brain? How are those language abilities, which are not specialized in the left hemisphere, structurally different from left hemisphere language? Such studies may be compared with facts about "modes" of cerebral processing associated with right and left hemispheres. This approach, in the context of cerebral functioning, generates specific hypotheses about the properties of language.

Chapter 3.

Speech Processing and the Brain: Levels and Subsets in Language

Chapter 3

Speech processing and the Brain:

Levels and Subsets in Language

Non-lateralized language abilities

The orientation of this chapter is to compare types of language which are processed primarily in the left hemisphere, with types which are not. To accomplish this closer look at language processing in the brain, it will be important to consider evidence for right hemisphere and subcortical capacity for language. These would involve language processes, which are not specialized in the left hemisphere, which is known to be the main site of language processing.

Evidence for right hemisphere capacity for speech comes from aphasia studies, hemispherectomy patients, and experiments on split-brain subjects. Some aphasiologists have claimed that the residual language observed in aphasia is retained by virtue of the language capacity of the intact right hemisphere (Jackson, 1932; Espir and Rose, 1970). These claims have been investigated in aphasia patients. They have been supported by evidence gathered from analyzing language in left hemispherectomy patients, whose speech could not have been generated by any remaining part of the left hemisphere (in contrast to aphasia). Studies have been conducted on split-brain patients, to determine the linguistic capacity of the separated right hemisphere. In these patients, the callosal fibers connecting the two hemispheres have been cut to prevent spread of electrical activity in severe epilepsy. Data accumulated from experiments on these patients lead to hypotheses about the language capacity of the right hemisphere.

Evidence for subcortical processing of speech and language is derived from clinical observations of patients with subcortical disease, from electrical stimulation studies and surgical intervention.

For hypotheses of heterogeneity in language, these neuro-linguistic investigations may be evaluated along with other sources of evidence, such as speech under delayed auditory feedback, the ictal speech of epileptic seizures, and stuttering. Psycholinguistic paradigms are adaptable to these questions. In normal speech, studies of hesitation phenomena, speech errors, and speakers' intuitions about idioms and other kinds of phrases are relevant to notions of heterogeneity in language.

In the context of these kinds of studies, a promising research approach is to compare left and right hemisphere speech capacities, and subcortical involvement in speech processing, on the assumption that different qualities or features underlie each. Left hemisphere speech can then be correlated with what is known of other left hemisphere abilities, and these facts compared and contrasted with observed right hemisphere speech, as correlated with specialized capacities of the right hemisphere. Similar contrasts are possible for subcortical language capacities. This procedure provides a context for hypotheses both about the structure of language and about cerebral function.

There are two claims advanced in this monograph. The first is that language is made up of differently processed "levels" and "subsets." The second is that some levels and subsets of language are typically or necessarily lateralized to the dominant hemisphere, and some are not. Facts about lateralized language processing can be compared with facts about cerebral function, and the conclusions may be relevant to descriptions of human language.

Right hemisphere speech

Nearly a century ago J. Hughlings Jackson (1878) proposed that the right hemisphere has a role in language function. Damage to the left hemisphere interferes with the kind of speech he called "propositional," whereas other types, or ways to use language, are typically spared. These other types have been referred to as "automatic speech." Jackson proposed that these other types are retained by the healthy right ("non-language") hemisphere. Jackson's suggestion was obscured by the more spectacular phenomenon of lateralization of most aspects of language function. Furthermore, there was no way of being sure that the retained modes (after damage to the left hemisphere) were not being processed in still healthy parts of that same dominant hemisphere. The role of the right hemisphere in speech, in normal language use and in recovery from disease, remains unsettled.

In his section on lateralization of language, Lenneberg (1967) comments on the "dramatic difference between the human brain and that of any other vertebrate," which is the "appearance of hemispheric dominance or language specialization." This fact is based on the consistent observation that only lesions in the left hemisphere (but not in the right hemisphere) "are conspicuous for their interference with verbal activity" (p. 66). But there are indications that the right hemisphere is involved in language functions, both in normal speech and in disease. The evidence is diverse and difficult to piece together. Lenneberg cautiously avoids leaving the right hemisphere out of the picture:

"Ordinarily the left hemisphere is more directly involved in speech and language functions than the right, though the lesser hemisphere is not passive with respect to verbal communication" (p. 150).

Lateralization of language: a matter of degree

The traditional view that language is processed in the left hemisphere has been modified. The notions "cerebral ambilaterality" and "cerebral dominance as a graded characteristic" (Zangwill, 1960) pertain to both left and right handed persons. Luria (1970) concludes that "latent dominance" plays a role in brain pathology. He proposes a "whole series of intermediate stages ranging from absolute dominance by the left hemisphere through equivalence of the two hemispheres, to dominance by the right hemisphere" (p. 62).

The possibility that hemispheric dominance for language is a matter of degree adds interest to the question of the role of the right hemisphere. There are rare cases of "crossed" aphasia, in which damage to the right hemisphere in a right-handed person results in a typical aphasic clinical picture (Ettlinger, 1967). These individuals may be right-dominant for language, or have degrees of bilateral representation.

Recovery from aphasia

The question of "take-over" by the right hemisphere after injury to the left remains unanswered (Needles, 1942; Goldstein, 1948). It is commonly observed that children nearly always recover from aphasia due to left hemisphere injury, and how much the phenomenon of "plasticity" invoked to account for their recovery, involves the right hemisphere, is not known. After age 18 in adults, recovery usually proceeds within a period of up to five months after injury. "However, symptoms that have not cleared up by this time are, as a rule, irreversible" (Lenneberg, 1967, p. 143). This evidence suggests that right hemisphere speech potential in most adults is limited.

Luria (1970) classifies recoveries from aphasia as resulting from 1) temporary nature of the injury; and 2) adaptive transfer of a given function from one area of the brain to another. Transfer involves either 1) transformation of the function itself, and/or 2) vicarious comprehension, by which another part of the brain takes over the function. These other parts include parts symmetrical to the speech areas (i.e. on the right hemisphere) and subcortical structures.

Recovery from aphasia in adults presents a complex picture, and the role of the right hemisphere in strongly left-hemisphere dominant individuals is not understood. Recovery of speech can be due either to "improved function of the left area" or to takeover of a closely cooperating right area; or by an "entirely new activity slowly acquired by the right area" (Goldstein, 1948).

Source of aphasic speech

The questions about how and where in the brain aphasic speech is produced are similar in complexity to the questions of recovery. In some cases a second injury to the left hemisphere produces more aphasia. Presumably in these cases at least some of the residual language ability was being processed in the left hemisphere. Other evidence suggests that the right hemisphere is the site of aphasic speech abilities.

Two studies on aphasics demonstrated that the right hemisphere was producing the residual speech. The first study used a technique for testing lateralized functions, the Wada test. The Wada test, used to establish cerebral dominance for language before surgery, has provided information on percentages of left hemispheric dominance for language in right and left-handed people. This test was performed on three adult aphasic patients, all right-handed. The patients were given left-sided injections of intracarotid amobarbital and two of the three were also given right-sided injections. There was no difference in speech after left-sided injection, but in both cases of right-sided injection, complete arrest of speech and of all vocalization was observed. The results strongly suggest that the residual aphasic speech and vocalization in these patients was "programmed by the right hemisphere" (Kinsbourne, 1971).

The second study (Pettit and Noll, 1972) used the dichotic listening test to show that the left ear (right hemisphere) was preferred for comprehending words (digits and animal names) in a group of aphasics, as compared with a group of normals, in whom the right ear was superior. These results agree with the "lesion effect" found by Sparks, Goodglass and Nickel (1970). In that study, patients with right hemisphere lesions heard fewer digits and words at the ear contralateral to the side of the lesion (the left ear), whereas patients with left hemisphere lesions showed both contralateral and ipsilateral extinction (lower scores for words presented to both right and left ears). These results are explained by a model

"which postulates that competition between [linguistic] signals received by both ears occurs in the left hemisphere" (Sparks, Goodglass and Nickel, 1970, p. 260). However, in addition, later testing by Pettit and Noll (1972) reportedly yielded a greater left ear effect in the aphasic group, suggesting that the right hemisphere participates at least in part in language rehabilitation.

Linguistic deficit following right hemisphere damage

Another source of evidence for right hemisphere language is the population of right brain-damaged individuals. There have been a few studies assessing language abilities of patients who have right hemisphere damage. Marcie et al. (1965) claim to have demonstrated that 28 right-handed patients with right hemisphere lesions were defective in written and spoken language, in both expression and reception. Repetition of nonsense words and syllables was defective. Perseveration was observed in sentence-generating. These authors conclude that in terms of linguistic symptoms and lesional topography, the right hemisphere seems to be "a weaker reflection of the dominant hemisphere and yet comporting its peculiar specificity and a qualitatively different role" (p. 245).

Critchley (1962) has submitted "a number of suggestive clinical data" on language deficits following right brain disease (pp. 211-212). These are:

1. disordered articulation, often transient
2. severe effect on creative literary work
3. problems with word-finding and resort to circumlocution
4. delayed identification of language along visual or auditory channels
5. difficulties in learning novel linguistic material
6. difficulty in discussing patients' own illness
7. problems understanding pictures (symbolic formulation)

It may be argued that certain of these observations are not linguistic deficits, especially items 2, 6 and 7 above.

Eisenson (1962) compared right-brain-damaged patients with a nondamaged control group on verbal tests. The results are admittedly "inconclusive," but suggest that the right hemisphere is "important for high level language functioning." The deficits were higher with more abstract linguistic formulations.

Hagen (1971) reported comparable results on three right hemisphere patients. Although "all subjects' language abilities were normal with respect to vocabulary and syntax in conversation speech," some subtle conceptual deficits were apparent. Several tests were administered, selected to reveal "language abilities when describing higher level conceptualizations." The Minnesota Test for Differential Diagnosis of Aphasia indicated a minimal language deficit, only in the last five items of the definitions subtest, plus a "considerable breakdown" on the other tests, which included the Wechsler Adult Intelligence Scale, a similarities and opposites tests, tests for sentence building, picture interpretation, tests using proverbs, absurd sentences and absurd pictures. The deficits were 1) difficulty in suppressing the whole concept when attempting to describe a part, and/or difficulty in getting beyond a part of the concept in order to describe the whole; and 2) difficulty in selecting the best possible response from a hierarchy of probable responses and suppressing the others. The difficulty was related to "speech, flexibility and selectivity of language formulation." Hagen concludes that the right hemisphere plays a role in language abilities. However, these results can be ascribed to nonlinguistic cognitive abilities.

Weinstein and Keller (1963) compared performances of patients with 1) left hemisphere lesions, 2) deeply seated and bilaterally diffuse lesions, and 3) right hemisphere lesions, on object-naming tasks. The items to be identified were classified into four types: Objects with compound names, such as ash tray, rubber band; parts of wholes, such as sleeve, heel of shoe; non-substantive and container objects, such as cube of sugar, pack of cigarettes; objects having to do with illness and hospitalization. The ten left-hemisphere lesioned patients made errors in all four classes of objects. The second group of patients, those with deep and bilateral lesions, made fewer errors, and the errors they made were mainly in the "illness connected group" of objects. For the right-hemisphere injured patients, most naming errors were associated with disorientation for place and/or date, and half the errors were in the illness-connected class of objects.

Weinstein (1964) suggests that there are different patterns of misnaming associated with injury to each hemisphere. In addition, the left-damaged patients did poorly in "calculation, in interpreting idioms, in spelling (particularly backward), in giving rhymes, synonyms, and antonyms." On the other hand, right-brain damaged patients, who were usually disoriented for place or date, did well on these tasks, but made errors related to their own "disability and status." Furthermore, language performance in right brain disease is similar to that observed in pathological conditions of the midbrain and diencephalon, and in bilateral lesions (p. 223).

I listened to the speech of a right hemispherectomy patient, the extreme case of the left hemisphere functioning without help from its other half. In the 30 minute taped interview, which included free speech, I noted no defect that I would call "linguistic," in any sense of phonological, syntactic, or semantic errors. The speech was fluent and grammatically correct. Oddities in the area of metonymy or other metaphoric expression may constitute linguistic defects at some sophisticated level of analysis, but these are not usually considered aspects of linguistic ability. The evidence so far suggests that the right brain does not uniquely contribute any conspicuously linguistic aspect to the language abilities of the intact left hemisphere (speech sample I, courtesy of Dr. Hagen).

Aphasic speech: the isolated right (nondominant) hemisphere

Hagen (1972, personal communication) reports a case of aphasia whom he treated in speech therapy sessions for two years. The patient, after a stroke involving the left hemisphere, could swear and utter a limited number of words. His performance did not notably improve beyond a competence of about 20 words, mostly nouns and a few verbs, which he could use singly and occasionally in strings of two. He could swear and use conventional utterances, such as "well" and "uh" (speech sample II). The case came to autopsy, and the entire left hemisphere was seen to be concave and atrophied in the region of the classical speech areas. It would appear that the left hemisphere could have had little to contribute to the residual language performance of the patient.

The extreme test of nondominant hemisphere ability for language comes from left (dominant) hemispherectomy cases. The earliest reported case (Zollinger, 1935) only lived a few weeks after the operation. During that period, the patient could only say all right, yes, no, goodbye and please. Another patient (Hillier, 1954) on the sixteenth post operative day said Mother, Father, nurse, I don't know. Another patient, who survived four months, could say yes, no, I don't want any, Put me back to bed (Crockett and Estridge, 1951). An adult patient (Smith, 1966), one year after operation, showed some comprehension of commands and questions. He could articulate swear words such as "goddammit" and "shit" (uttered as he attempted to respond to a question or command). His "pause fillers," as he searched for the correct response, such as "ah", and "well", and "oh," were all normally articulated and intoned. Repetition was laborious and impaired. The filmed session did not give evidence of sentences or productive language. The patient could sing, cued by the interviewer, correctly articulating the lyrics and controlling the pitch for melody. He reportedly did not improve beyond this point (film and discussion of case courtesy of Dr. Joseph Bogen).

Right hemispherectomy patient: Speech sample I

1. Repetition: (all items said by interviewer and repeated correctly by right hemispherectomy patient)

Baseball and bat
 Knife and fork
 My favorite vegetable
 Two times two
 Door and window
 Light the lamp
 Drive a car
 Sell the house
 Easy does it
 Thirty-three
 Father and mother
 All's shipshape
 A year yesterday
 Bake a cake
 Guess again
 Sing a song
 A kitchen chair
 Orange juice

2. Interview:

I. Would you say your voice sounds about the same now as it did before your operation?

P. No.

I. What's the difference

P. It sounds a little weak.

I. Weak to you? Okay. Do you try and speak louder?

P. Yes.

I. And what happens?

P. Nothing.

I. How does it feel? when you try to speak louder.

P. I just can't express the feeling. I just can't get enough push behind it.

Speech sample I. continued

3. On request, patient counts from one to twenty, and names days of week.

4. Sentence completion:

Interviewer:

patient

I. I want a cup of...	milk.
Do you think it looks like...	rain.
There's someone at the ...	door.
I'd like a piece of...	pie.
The grass is...	green.
The sky is...	blue.
I like bread and...	jelly.
Please pass the salt and...	pepper.

5. Interviewer:

patient

What do you use a hammer for?	drive a nail.
What do you use soap for?	wash with.
What do you use money for?	...(unintell) the things you need.
What do you use a razor for?	to shave.
What do you eat with?	a knife and fork.
What do you tell time with?	clock.
What do you write with?	a pen or a pencil.
What do you wear on your feet?	shoes or slippers.

6. patient gives name and address on request

I. Where were you born?

P. Denver, Colorado

I. When is your birthday?

P. June 5, 1911

I. And your age?

P. 57

I. And what was the last school you went to?

P. Junior High School in Denver.

(Patient continues to answer questions about school and job)

7. I. Could you tell me three things you did today?
- P. Went to...ET.
Those were the only places I went.
- I. Can you think of two other things you did?
- P. I went to breakfast.
- I. Okay. Could you tell me three things that a good citizen should do?
- P. Vote and obey the law.
- I. That's two.
- P. You wanted three.
- I. Three. Did you think of a third one? Okay.
8. I. Would you make up a sentence using the word "coat" in it?
Would you make up a sentence using the word "coat"?
- P. I gotta leave now, would you please get me my coat?
- I. Would you make up a sentence using the word "new"?
- P. I have a new car.
- I. And a sentence using the word "want."
- P. (unintell) would you want.
- I. A sentence using the word "have."
- P. I have several of those.
- I. A sentence using the word "after."
- P. After I get back, I'll come over.
- I. And the last one, a sentence using the word "belongs."
- P. These items belongs to somebody else.

Speech sample I, continued

9. I. Look at this picture, and make up a story that has a beginning, a middle, and an end.

P. The boy is with his kite, in Mr. Smith's yard. The kite flew over the house. He took his dog with him. There was a fire in the fireplace.

10. Naming task: names concrete items pictured on cards.

11. InterviewerPatient

What is a robin?	a bird.
What is an apple?	a fruit.
What does the word "return" mean?	give back.
What does the word "different" mean?	not alike.
What does the word "bridge" mean?	(unintell).
What does the word "continue" mean?	Go ahead.
What does the word "history" mean?	past things.
What does the word "material" mean?	solid substance.
What does the word "decide" mean?	make a decision.
What does the word "opinion" mean?	express yourself.

12. I. This is the comprehension section of the WISK. I'll ask you some questions and you answer them, okay?

InterviewerPatient

Why do we wash clothes?	For cleanliness.
Why does a train have an engine?	To pull the cars.
What is the thing to do if you find an envelope in the street that is sealed and addressed and has a new stamp?	Try to find out to who it belongs.
Why should we keep away from bad company?	To keep out of trouble.
Why should people pay taxes?	To help the country so you can have what you want.

Patient with severe left hemisphere damage: Speech sample II.

- I. Would you give your name?
 J. (Jack Smiths)*
 I. Jack Smith. Jack, what did you do yesterday?
 J. J. Uh, () (Unintell.)
 I. What else?
 J. Oh! uh, sh- voice practice practice practice.
 I. Anything else?
 J. uh, Well, practice ()
 I. What do you call this thing here?
 J. oh, table.
 I. It has a back on it, a seat, and four legs. A Table? Are you sure that's a table?
 J. table. yeah!
 I. What are you sitting in?
 J. um, huh?
 I. What are you sitting in, right now?
 J. uh, well, um,
 I. Yeah, that thing.
 J. sh-chairs.
 I. Yeah, a chair, you're sitting in a.. chair...
 J. uh huh. chairs.
 I. What is this?
 J. chairs.
 I. So this is a chair.
 J. yuh.
 I. What is it used for?
 J. oh. well, uh, uh, table!
 I. What is this thing here?
 J. um, um, (sigh) knife, no, uh,
 I. Well you can put a knife on it.
 J. no no no no table? and uh uh well. Think. It's um
 I. Put the food on the
 J. huh?
 I. Put the food on the
 J. table?
 I. Table!
 J. No no
 I. Yes it's a table.
 J. Table? Table?
 I. Table. What's it used for.
 J. Oh. Table! huh. Oh, well, uh, do, um, uh. damn. Table!
 (Laughs)
 I. All right, okay.

* Fictitious name given here.

The most recent hemispherectomy patient, a young girl (R.S.) was able to count, say her name, and sing Jingle Bells after removal of the left hemisphere at age 10. Other language abilities were severely impaired. Articulation and pitch control were good. Her singing ability was much better than speech (Gordon, 1973). She could sing songs complete with lyrics at a time when speech "was limited to single words and short phrases" (p. 58). On the Minnesota test (Schuell, 1965) for aphasia conducted by Zaidel (1973), R.S. was able to "produce automatized speech sequences quite well but...she cannot relate prescribed complex material or respond to linguistically abstract tasks" (p. 64). On the Boston examination for aphasia (Goodglass and Kaplan, 1972), "automatic speech and music abilities scored highest..." Examiners agreed that comprehension for language was reasonably good. She would respond to commands and questions. Asked to point or to move her hand, she would do so correctly.

More recently, Fromkin (1974, personal communication) reported that R.S. gives evidence of good use of language, with the exception of some anomia (and certain conceptual and memory losses). This recovery of speech might be ascribed to the early age at which hemispherectomy was performed, and thus to subsequent learning by the right hemisphere. In addition, R.S. has sustained some right hemisphere damage, and therefore her abilities are especially remarkable and difficult to assess.

These examples of speech ability after removal of the left (dominant) hemisphere have the common features 1) that some speech (production and comprehension) is possible without the "language" hemisphere; and 2) some modes of speech are more in evidence than others. Zangwill, after reviewing left hemispherectomy cases and observing the Smith and Burkland (1967) patient, concluded that "the right hemisphere -- possibly in association with subcortical mechanisms -- was sustaining a measure of language. In particular, comprehension and emotional utterances were clearly present" (1967, p. 1017). In addition, Smith (1966), Zangwill (1967), and Zaidel (1973) note that some propositional speech is also present, although considerably less than emotional and overlearned phrases.

Neurophysiological evidence shows that most muscles involved in speech are bilaterally represented in the brain. Clinical evidence suggests that the (non-dominant) right hemisphere can "produce" swear words, conventional phrases, and lyrics in songs. The unaided right hemisphere is capable of normal articulation and vocalization of these kinds of complex speech gestures. Other forms of linguistic expression are lacking in the adult left-hemispherectomized patient. Repetition

is impaired, especially of abstract, polysyllabic words. One partial explanation is that "ideational" speech is present in the left, but not in the right hemisphere. Free lexical items are unavailable because these are not "stored" as part of the linguistic (production) competence of the right hemisphere, but only "nonideational" or "automatic" language is available there. In addition, the fact that the left hemispherectomy patient has difficulty repeating polysyllabic words suggests that phonetic representations are not equally present at both cortices. The dexterity for some linguistic performance, but not others, in right hemisphere speech is in part a function of the "automaticity" of the speech performance.

Left and right hemisphere speech abilities may differ both in terms of 1) content (i.e. "ideational" speech is specialized in the left hemisphere) and 2) surface expression (the right hemisphere is probably restricted to overlearned speech gestures, however complex, irrespective of ideational content). This hypothesis agrees with general theories of hemispheric modes, in which the left is the analytic, digital processor, whereas the right hemisphere is the synthetic, analogue processor. For a speech hypothesis, one might predict that the left hemisphere is better at generating novel speech, whereas the right hemisphere is better at storing and processing holistic phrases.

Right hemisphere: Speech comprehension

Left hemispherectomized patients retain some language comprehension abilities. There is other evidence that the right hemisphere plays a considerable role in comprehension of language. The details of its receptive competence are difficult to demonstrate. Espir and Rose (1970) suggest that in aphasia, recovery of receptive abilities depends on the functioning of the right hemisphere, and that additional injury to the right or to the corpus callosum (fibers communicating between the two cerebral hemispheres) will hinder recovery.

Kreindler and Fradis (1968) have surveyed the clinical reports of cases of left and right hemisphere injury in aphasia. Bilateral lesions often cause irreversible receptive difficulties. These authors conclude that the "data of the literature prove that a lesion of the right hemisphere interferes with compensation of receptive disorders produced by lesions of the left hemisphere." Right injury alone does not have such deleterious effects (p. 169).

Studies by Zaidel (1973) on split-brain subjects (patients in whom the fibers connecting the two cerebral hemispheres have been cut) demonstrate considerable language comprehension ability in the disconnected right hemisphere. These results contradict earlier claims by Gazzaniga and Hillyard (1971), that the right hemisphere has "no ability to recognize either the relations between subject, verb, and object, the future versus the present tense, or singular versus the plural case" (p. 274). There was no response to printed commands, nor comprehension of auditorily presented verbs (with response choices presented visually to the right hemisphere). These authors claim that the isolated right hemisphere can recognize only simple monomorphemic nouns, and a positive-negative distinction in sentence pairs.

Zaidel (1973), in contrast to Gazzaniga (1970) and Gazzaniga and Hillyard (1971), found that commissurotomy patients can process nouns, verbs, and sentences in their right hemispheres. Four tests were used, three for children and a fourth for aphasics, all of the same paradigm:

*

"Pairs of syntactic contrasts are presented separately in aural sentences along with an array of 3-4 pictures which differ from each other in precisely one dimension involved in the contrast. The subject has to point to the one picture which best corresponds to the stimulus message — word, phrase, or sentence" (p. 190).

In tests for morphological constructions, the plural *s* and the third person *s* seemed easier than the possessive *s*. For lexical items, the right hemisphere could comprehend verbs (e.g. respond to imperatives) as well as nouns. In syntax, interrogative structures (e.g. "Has daddy finished his dinner?") were more difficult than active, passive or negative sentences. "The most important parameters in producing right hemisphere deficit would seem to be length and word order" (p. 197).

Results of the Token Test (originally designed to test receptive disorders in aphasia)(De Renzi and Vignolo, 1962) showed that the right hemisphere could respond to oral commands requiring comprehension of colors, shapes and sizes at better than chance level "but significantly inferior to left hemisphere performance" (p. 238). The results can be attributed in part to "hypothesized limitations in short term right hemisphere verbal memory," and in part to incompetence in classifying or analysing "the details of input information" (p. 264).

In conclusion, these studies suggest that the concept of left hemisphere specialization for language is meaningful for speech (i.e. production of language); however, comprehension of language (single words, sentences with redundant contexts, and even connected discourse) is present also in the right hemisphere. It is not yet known to what extent these conclusions apply to intact left and right hemisphere processing in normal language use.

Summary

Tests have failed to detect linguistic properties unique to the right hemisphere. However, some language abilities are bilaterally represented (present *also* in the right hemisphere). The concept of an "efficiency of over-wiring" in the brain could account for functions bilaterally laid down in the hemispheres (Nathan, 1969, p. 295).

The physiological bases of speech (hearing, articulation, and phonation) are not specialized in one hemisphere, although language at a higher level of organization is lateralized to the left. Yet some speech abilities are not lateralized. The nature of nondominant abilities, as contrasted with features of left hemisphere specialization of language, remains to be understood.

Subcortical processing of speech and language

Residual speech in aphasia (that which is not affected by left hemisphere damage) could be a function of right hemisphere and/or of subcortical processes, when these structures remain undamaged. Similarly, language is not affected by damage or removal of the right hemisphere. Therefore, residual (non-left hemisphere) speech is either present *also* in the left hemisphere (and therefore proceeds after dysfunction of the right) or it is present uniquely or also in subcortical structures of the brain. "Subcortical structures" in neuroanatomy usually refer to all parts of the brain between the spinal cord, and the cerebral and cerebellar cortexes (Thompson, 1967). It includes the medulla, pons, midbrain, thalamus, and basal ganglia (caudate nucleus, putamen and globus pallidus) (Figure 3.1). This section reviews evidence for subcortical involvement in language processing.

Penfield and Roberts (1959) devote a section in *Speech and Brain Mechanisms* to subcortical connections. They claim that the subcortical areas of grey matter, particularly the pulvinar and other parts of the thalamus, play a large role in speech processing. They propose a *speech hypothesis*, that "the functions of all three cortical speech areas in man are coordinated by projections of each to parts of the thalamus, and that by means of these circuits the elaboration of speech is somehow carried out" (pp. 207-208). The thalamic center plays an "organizing role," and constitutes part of the "centrencephalic system" in this functional view of the brain (p. 216; see Figure 2.7, above).

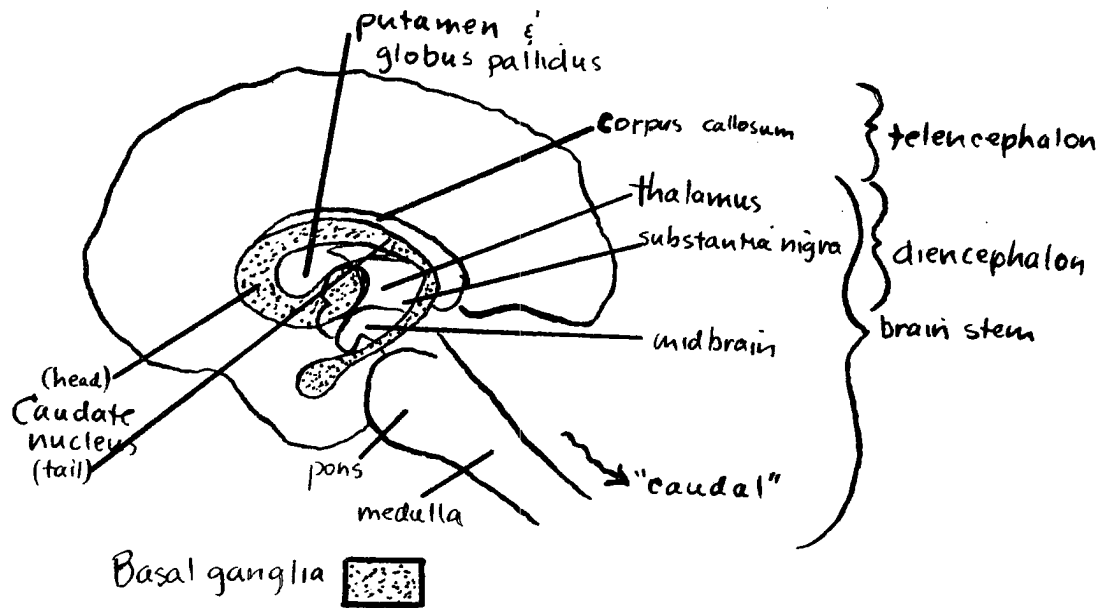
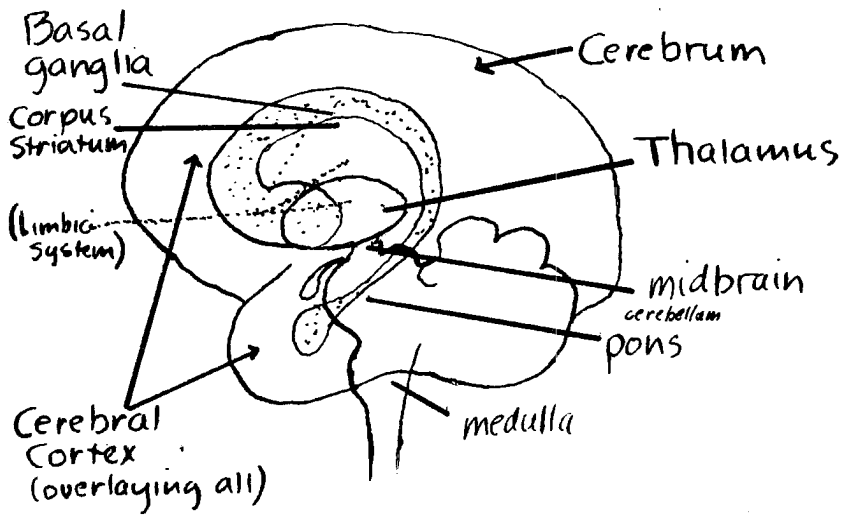


Figure 3.1. Major brain structures: cerebrum and subcortical structures

Adapted from Thompson, 1965

The "centrencephalic" hypothesis of brain function (the integrating mechanism in subcortical structures) is based mainly on anatomical evidence, namely the connecting fibers from cortex to brain stem structures. Experiments in non-human primates show that the main functional connections of the cerebral cortex are to subcortical areas, and not from parts of the cortex to other cortical structures (Pribram, 1971). However, Geschwind (1965) claims that the evolutionary development of a "new parietal association area" is related to cerebral dominance for language in man. This "secondary association area" may involve the ability to form cross-modal associations, which Geschwind claims is a prerequisite to the ability to acquire speech (1965, pp. 274-275). The "centrencephalic," or "secondary association area" hypotheses of brain function for language processing remain to be established.

The brain consists of the cerebrum, or two cerebral hemispheres, and the brain stem. Within the interior of the cerebrum are a group of structures called the limbic system, and a group of nuclei referred to as the basal ganglia (or extrapyramidal system). The limbic system is phylogenetically old, and thought to be related to emotions and instincts. The basal ganglia include primarily the caudate nucleus, the putamen, and the globus pallidus. The functions of the basal ganglia are not known (Thompson, 1967).

The cerebral hemispheres are covered by the cortex, and connected by the corpus callosum, a broad band of fibers. The cerebrum and the structures within it (limbic system and basal ganglia) are here referred to as the telencephalon (Figure 3.2).

The term "brain stem" refers to all structures between the cerebral and cerebellar cortices and the spinal cord. It consists of the diencephalon, midbrain, pons and medulla. The diencephalon is made up of the thalamus and other structures. The thalamus consists of many parts and connections (or projections) to surrounding parts. The cortical projections of the various thalamic parts have been studied extensively. The corticothalamic projections are ipsilateral; but the thalamus receives sensory information from the opposite side of the body (Eyzaguirre, 1969).

Injury to or removal of the cortex has been considered a principle cause of aphasia. Of all brain structures, the cortex is the most recent in evolutionary history, and is most developed in man (Sheer, 1961). The regions of the brain stem, including systems below the corpus callosum, are considered more "primitive." Therefore, language faculties in man have been considered properties of cortical function. However, there is evidence that language processing may not be confined to the cerebral cortex only:

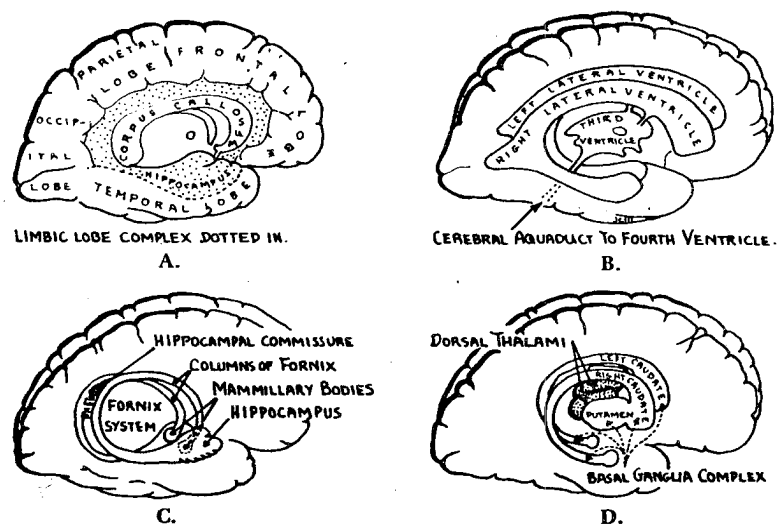


Figure 3.2. Subcortical systems.

"The evidence is strong that speech and language are not confined to the cerebral cortex (p. 64); Language and speech are not merely represented in the cortex, but there seem to be language-correlated functions that also involve subcortical and mid-brain structures" (Lenneberg, 1967, p. 71).

Burkland suggested the possibility that "some elements of language" may be in part diencephalic, i.e. [processed by the higher brain stem] rather than completely telecephalic [i.e. of the cerebral cortex]. It is not known, for example, whether language retention after damage is due to right hemisphere processing or to "more caudally [toward the tail or spinal cord] located dominant structures." The notion of "degree" of lateralization takes on a new dimension in the context of vertical organization of language processing, from subcortical to cortical structures (Smith and Burkland, 1967).

The functional role of subcortical systems, whether involved primarily in sensory and motor functions, or in more complex behavior associated with integrated perception and cognition, is not known. Parts up to the midbrain can be demonstrated (in animals) to exhibit such complex behavior as walking, vocalizing, eating and sleeping, as well as emotional expression. Limited learning is also possible for animals in psychophysiological preparations in which brain tissue is destroyed above certain levels. For example, in animal physiology, the "striatal" preparation is a decortication, which spares the basal ganglia (i.e. caudate nucleus, the putamen, and globus pallidus). "Striatal" cats feed spontaneously, localize low intensity sounds, groom, and express fear and rage. More brain is removed in the thalamic preparations: there is both decortication and removal of the striatum (everything above thalamus). Experiments show that the "decorticate brain is capable of supporting a very extensive behavioral repertoire, which can be modified to a considerable degree." These experiments lead to the conclusion that the cortex contributes to complex processing, but is not required for acquired behavior (Buchwald and Brown, 1973).

Of subcortical structures, the thalamus and the peri-aqueductal grey matter have been specifically associated with language function. The thalamus is a complex structure, made up of many nuclei projecting to other midbrain structures and to the cortex (Figure 3.3). The functions of the thalamic nuclei remain to be understood (Thompson, 1967). Lesions in the thalamus, especially the pulvinar nuclear group, and in other left-sided nuclei, have been implicated as possible sources of aphasic disturbances (Whitaker, 1971).

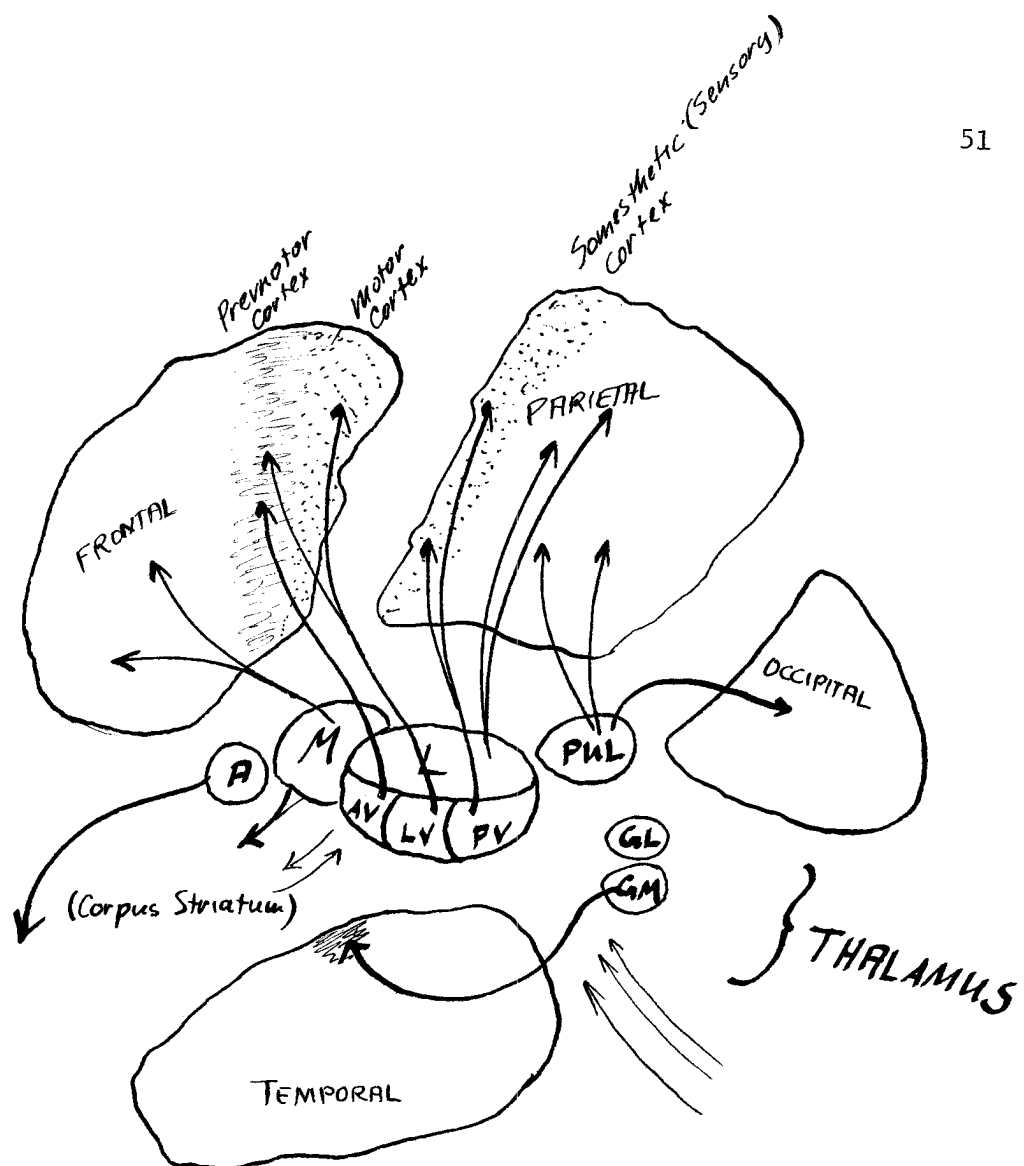


Figure 3.3. Thalamus and its cortical connections.

Left lateral view of the brain, with its lobes separated, to show the thalamus and its principle cortical connections.

A: anterior nucleus	LV: ventral lateral nucleus
M: dorsomedial nucleus	PV: ventral posterior nucleus
L: lateral nucleus	GL: lateral geniculate
AV: ventral anterior nucleus	GM: medial geniculate
PUL: pulvinar	

Adapted from Gatz, 1970

Another mid-brain region may be involved in motor integration of speech. This is the peri-aqueductal grey matter, which lies near the front of the aqueduct, between the third and fourth ventricles (Figure 3.2B). Lesions in this area cause dysarthria, (a speech-specific defect in articulatory ability) more often in children (Lenneberg, 1967). This area is also associated with animal vocalization (facio-vocal behavior in emotional expression in cats) (Kelly et al. 1946).

Whether subcortical systems are uniquely involved in language processing is controversial. Brown (1972) maintains that subcortical "dysphasias" may be due to concomitant cortical damage, or are part of generalized intellectual deficits. Other writers justify claims about subcortical involvement by invoking the "language hypothesis" of Penfield and Roberts (1959), (which is based on neuroanatomical facts of connective fibers, rather than behavioral observations). Many emphasize the potential importance of cortico-subcortical interaction, at the same time noting the lack of actual evidence for subcortical involvement in language and speech. At present, there is little that can be said definitely about subcortical systems and language, in contrast to the facts available for right hemisphere speech capacity. Furthermore, hypotheses about speech functions associated with cortical versus subcortical systems are difficult to test in normal speakers by current techniques.

There are two sources for facts about subcortical processing of speech and language: natural lesions in subcortical regions of the brain, and explorations and surgery for disease, including epilepsy and Parkinsonism.

Fisher (1959) and Ciemins (1970) report aphasic disturbances following hemorrhage in the left thalamus. In one patient in Ciemins' report, there was a "decrease in spontaneous speech, difficulty in carrying out complex commands, difficulty in writing, and a defect in reproducing material which had been read" (p. 776-777). The second patient allegedly had "mild aphasia," and "slight expressive aphasia" (p. 779). Aphasic disturbances have resulted from thalamic tumours (Smyth and Stern, 1938; Cheek and Taveras, 1966; Ojemann and Ward, 1971).

Penfield and Roberts (1959) argue that because surgical removals of cortex at regions all around the speech areas do not produce aphasia, "it seems reasonable to conclude that the functional integration must depend upon their connection with some common subcortical zone" (p. 212).

Research into thalamic involvement in language and speech has been made possible by the development of surgical procedures for the treatment of Parkinson's disease. Several groups have published clinical observations of Parkinsonian patients before and after basal ganglia or thalamic surgery.

Parkinson's disease, or *paralysis agitans*, is a syndrome of unknown cause (Kondo et al. 1973). Symptoms are tremor, difficulty with walking or balancing, failing memory and eventual dementia and disintegration of faculties. Some of the symptoms are probably due to "a disturbed functioning" of subcortical systems in the basal ganglia region, including the substantia nigra, corpus striatum, globus pallidus, and thalamus (Figure 3.4, Cotzias and McDowell, 1971). Treatment is possible by drugs and surgical intervention.

In their review on subcortical correlates of speech and language, Riklan and Levita (1969) distinguish speech defects (dysarthrias) from language defects (dysphasia). Speech defects involve vocalization and articulation, including rate, rhythm, volume, pitch and phonation. Language disturbances are defined by these authors as "losses in the use or transmission of ideas, symbols, and signs through any modality" (p. 127). The Parkinsonian syndrome includes defects of motor integration, and therefore disturbances in vocalization and articulation may be expected. Because of the known participation of subcortical systems in motor and sensory processes, speech disturbances can be also expected to follow surgical lesions to these areas. For example, Guiot et al. (1961) have reported changes in rate of speech following electrical stimulation of the thalamus. These procedures involve deep stimulation before destruction of the afflicted region for the treatment of Parkinsonism. These authors have observed the effects on speech of the sectors passed through by the needle. Arrest or acceleration of speech (i.e. counting) occurs when the needle is in the ventrolateral nucleus of the thalamus. Observations in experimentally induced rate changes may be relevant to research on timing in speech production.

There have been linguistic observations during these stereotaxic (investigatory) procedures that belong to "language," classed as "dysphasic." Ojemann et al. (1968) have observed 28 patients during electrical stimulation of thalamus and medial parietal white matter on object-naming tasks before thalamotomy. The task was to name pictures of 36 common objects in three different orders (as in Lansdell, 1965), appearing in four-second intervals on a screen. The responses were classified as (1) no error, (2) anomia, which was misnaming or failure to name object but ability to speak otherwise (3) sensory speech disruption (from subjective sensations during stimulation) (4) errors due to difficulty seeing pictures (5) motor speech disruption (6) anarthria.

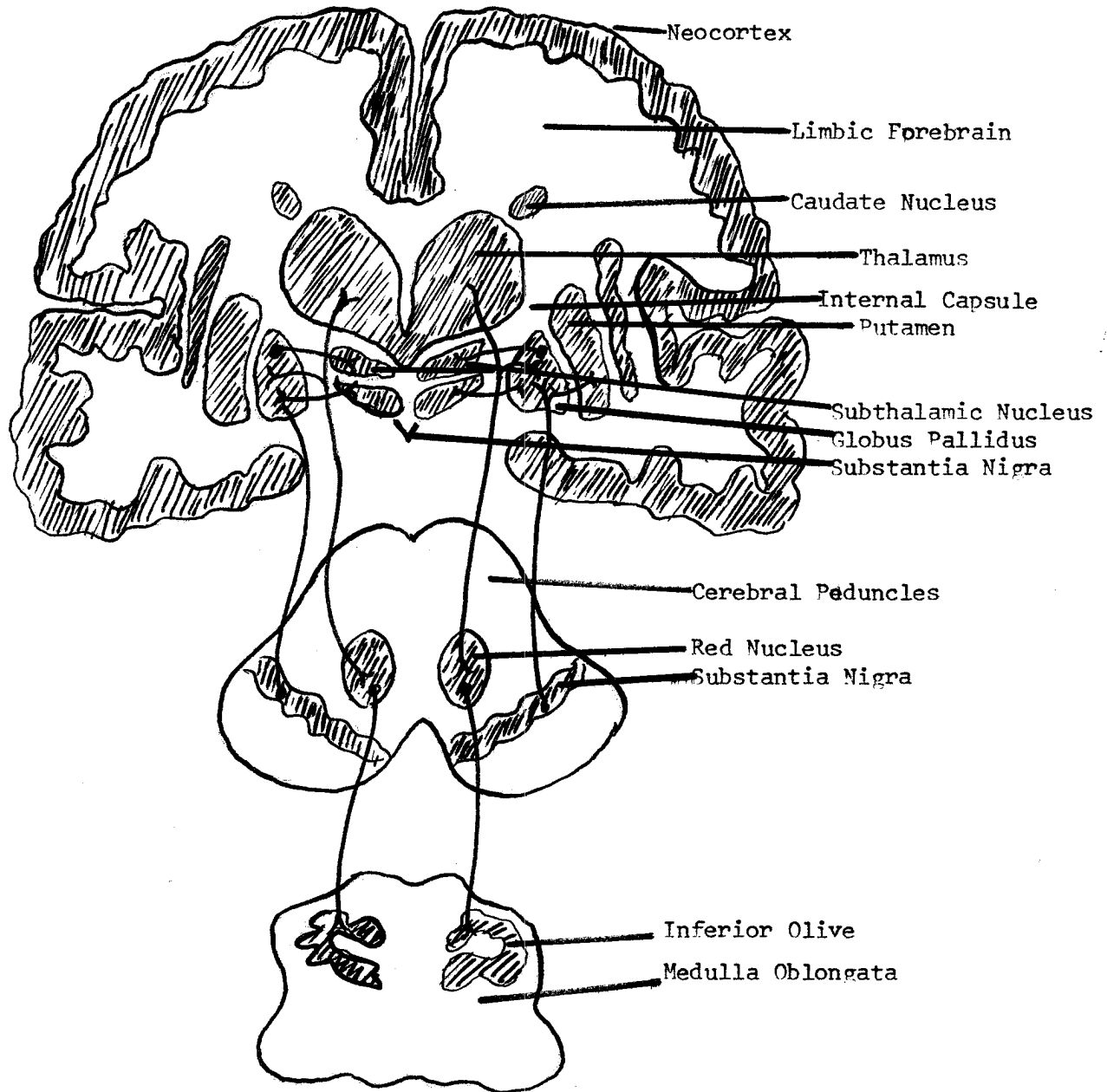


Figure 3.4. Schema of Cortex and Subcortical Structures.
Extrapyramidal system of brain, and some neural connections.

Anomia occurred after stimulation in left thalamus, specifically the pulvinar, and after stimulation in parietal white matter of both right and left sides. One anomia error was observed after stimulation of the right thalamus in a left-handed patient. Anomia was observed after stimulation of three subcortical sites in right-handed patients: the left pulvinar, and the deep parietal white substance in the paracallosal region of both hemispheres. The latter two points were surprising observations, and may be due to inactivation of left hemisphere cortical speech functions by interfering with fibers interconnecting the temporo-parietal regions. The left pulvinar, on the other hand, behaves like the cortical speech areas in these tasks, tending to confirm the Penfield-Roberts hypothesis of a cortico-thalamic system for speech (Ojemann et al. 1968, p. 114).

Schaltenbrand (1965) reported elicitation of stereotyped utterances as a result of deep stereotactic electrical stimulation of the brain, during procedures of precisely localizing needle placement. Stimulation of a specific area of the thalamus produced an arousal reaction (eyes turning, handgrasp and speech). Schaltenbrand describes these utterances as "compulsory" since patients could not repress them even when so commanded beforehand. Each patient repeated the same utterance when stimulated. Examples are: "I see something, I hear something, Now I say thou to thee." Another always said "thank you" another "now one goes home." Another patient, who produced clicks, later explained that he used that signal to call his dogs together.

Schaltenbrand (1965) suggests that this behavior resembles "a conditioned response which may have some emotional importance," different in different people, similar to "the peculiarities of speech relics in aphasic patients which have been so well described by Hughlings Jackson" (p. 839). The vocalizations were more often evoked from the dominant (left) portion of the thalamic nucleus. It is always difficult to interpret the implications of behavior produced by brain stimulation for normal behavior. However, it is interesting to note that *cortical* stimulation has never produced words (Penfield and Roberts, 1959).

Bell (1968) reviewed reports of speech disturbances associated with disease of the thalamus, and presented a study of speech side-effects following thalamotomy for Parkinson's disease. He divided descriptions of speech disturbance into three separate categories: voice volume, dysarthria, and dysphasia. Bell notes the problem in distinguishing these types of speech disturbances in the literature

descriptions. His own study on 50 cases addresses specific questions that arise from case reports found in the past literature: the nature of the speech disturbance (whether voice volume, dysarthria, or dysphasia); comparison of speech disturbances before and after the operation was performed; the time course of the speech disturbance following the operation; the question of laterality of the thalamic involvement; the possibility that other factors causing cortical damage during the stereotaxic procedures may be involved in the speech disturbances observed. Fifty-nine operations were performed on 50 patients with Parkinson's disease, producing cryogenic (by freezing) lesions in the ventrolateral nucleus of the thalamus. Diminished voice volume was observed following 17 of 59 operations. Dysarthria occurred after 34 operations, more commonly and more persistent from lesions in the dominant hemisphere. Dysphasia resulted after 10 operations, but only after thalamotomy of the left hemisphere in right-handed patients. The dysphasias were mild to severe, and included misnaming, jargon aphasia, perseveration, garbled words, rhythm disturbances without dysarthria, and expressive aphasias with relatively preserved comprehension. It is interesting to note that repetition of speech was normal. The speech defects observed after the operation had "no similarity to, nor any correlation with the features of, the Parkinsonian speech disorder" (p. 633), which include diminished voice volume and dysarthria. The time-course varied in the ten patients, with six cases showing improvement or remission within three weeks, after four months in one case, and over two years for three cases. In summary, there is evidence to suggest that a lesion of the ventrolateral thalamic nucleus can be associated with dysphasia, and that therefore "lateralization of speech functions to the cortex of the dominant hemisphere is associated with a similar lateralization of thalamic function" (Bell, 1968, p. 635).

Gilles de la Tourette's Syndrome

Gilles de la Tourette's syndrome is a rare pathological condition which often includes, among its complex of symptoms, coprolalia ("foul speaking" or compulsive swearing) and other "involuntary" utterances. The illness was first described by Gilles de la Tourette in 1885. The disease is characterized by various symptoms, changing and recurring throughout life, including facial tics, limb jerks, spitting, grimacing, blinking, shouting or barking, shaking, jumping, and fidgeting. The vocalized symptoms are hisses, stuttering, odd emphasis of words or parts of words, unintelligible sounds or words, grunts and barks, coughs and throat-clearing, echolalia and coprolalia. About half the patients with the disease develop coprolalia, or compulsive swearing (Shapiro et al., 1973b; Shapiro, Shapiro and Wayne, in press).

Thirteen of 34 patients studied in detail reported sounds, words or coprolalia (i.e. stammering, stuttering, throat-clearing and compulsive swearing) as the initial symptom. Coprolalia was a first symptom in 3 patients. A total of 18 of 34 patients developed coprolalia; fifteen of these 18 reported "fuck" as their most frequent coprolalic utterance. Three used phrases or sentences, as elaborated coprolalic utterances. The average age of onset of coprolalia was 14.5, the median age 13, and the range 4 to 36 years. The symptom disappeared spontaneously in 6 patients, after durations of from 1 to 17 years. The other 12 coprolalic patients were all successfully treated with the drug, haloperidol, after a mean years duration of 23.1, median 21.0, range 8.0 to 45.0 (Shapiro et al. 1973b).

The vocalized symptoms are essentially involuntarily, occurring throughout normal speech, punctuating and interrupting fluent expression. However, the compulsion to emit these expressions is sometimes controllable, at the expense of increasing other symptoms (tics, coughing, grimaces, etc.). The vocalization can be suppressed for minutes or hours in some cases. Such patients find refuge in private places, such as the public toilets. Patients describe the relief of being able to get off somewhere to "allow the words to come out" (Sweet et al., 1973). Unleashing coprolalic expression in the lavatory is considered diagnostic for Tourette's syndrome. The words reported in the 18 patients with coprolalia (of a total of 34 of Tourette's patients) were "fuck" (15 patients); "cunt" (3); "Prick, dick" (3); "cocksucker" (5); "motherfucker" (3); "shit" (2) "cockey" (1); "nigger" (2); "bitch" (3); "bastard" (3); "whore, blow-me, pussy, whop" (1); "pregnant," "mother" (1). In addition, 3 patients had sentences or phrases, and 3 patients reported "mental coprolalia" -- compulsive swearing in their minds, not vocalized.

The etiology of Tourette's disease is not known. Psychiatric opinion has claimed that the symptoms are caused by psychological conflicts, diagnosing schizophrenia, obsessive compulsive neurosis, underlying psychosis and inhibition of hostility (Shapiro and Shapiro, 1971). Other medical opinion has held that Tourette's syndrome is due to organic impairment. Damage to subcortical systems, the basal ganglia or corpus striatum, has been implicated in the disease. Shapiro et al. (1972) conducted studies to determine the etiology of Tourette's disease. From tests and evaluations, these authors conclude that Tourette's syndrome results from subtle organic impairment to the central nervous system. Ratings in various tests and clinical evaluations for over half the patients directly studied showed neurological impairments. About half had abnormalities in EEG ratings (Wayne et al., 1972; Sweet et al., 1973). The symptoms are alleviated by chemotherapy with haloperidol; the site of involvement is thought to be the corpus striatum. Only two post-mortem examinations have been performed on patients with Tourette's syndrome. In one the brain was normal; in the other, there was some involvement of the corpus striatum (Shapiro, Shapiro, Wayne and Clarkin, 1973a).

Bruun and Shapiro (1972) claim that Tourette's coprolalia differs from aphasic swearing, in being compulsive. The Tourette's patient "has no difficulty expressing himself but will be forced to interrupt a normal sentence with coprolalic outbursts," while aphasic swearing "is not compulsive, but occurs when the patient searches for a word he cannot find and inadvertently substitutes a coprolalic term" (p. 332).

This differentiation in terms of the patient's "willing" the utterance is problematic. Vocalized symptoms (coughs, words) in Tourette's disease are often well-integrated into a normal social setting, or held back. This suggests that "will" can operate on the symptoms with some success. On the other hand, it cannot be said that (the counterpart) aphasic swearing is voluntary. In fact, these aphasic residual utterances have been called involuntary, because they often cannot be reproduced on command, but only "spontaneously," or, as Bruun and Shapiro (1972, above) write, "inadvertantly." The obvious differences between Tourette's and aphasic language pathology lies in the intactness of other language skills.

Heterogeneous cerebral processing and heterogeneity in language

For the topic of this monograph (the investigation of different modes of language), the observations reviewed above, that deep electrical stimulation of certain subcortical points disturbs spontaneous speech, but not repetition, are relevant facts. Schaltenbrand's (1965) claim that stimulation of subcortical areas in man produces stereotyped speech utterances may be further evidence for the hypotheses that automatic subsets are differently processed in the brain. Similarly, it is interesting to note that a series of speech modes or subsets are often retained in aphasia, and that *one* among these, swearing, is uniquely symptomatic of another pathological condition, Tourette's disease. Coprolalia also occurs in a condition called Klasmomania and in von Economo's encephalitis.

Human language may be viewed as made up of different subsets, which have various relationships to evolutionarily primitive human speech and to animal communication. The first claim in this monograph is that language, which is comprised of heterogeneous subsets, is heterogeneously processed in the brain. This claim is supported by 1) the bilateral potential for motor mechanisms and perception of some kinds of speech; 2) right hemisphere capabilities for selected kinds of language processing; 3) possible subcortical processing of selected modes of speech and language. Luria (1970) described speech activity as "a dynamic system of the greatest complexity involving the simultaneous function of various brain areas" (p. 79). Chase (1965a)

suggests that the multidimensionality of speech can be detected in the effects of lesions on the central nervous system. The distinction between structures responsible for motor and ideational organization of speech is a useful one, but "insufficiently complex to comprehend... more specific sub-categories of verbal behavior, the interrelationships between these sub-categories, and the different modes of operation that can result in shifts in these interrelationships. ...The formulation of new working hypotheses in this area is badly needed" (p. 9).

The second claim in this monograph is that facts about cerebral processing are relevant to facts about the structure of language, and therefore have implications for models of language. The argument in the following two chapters takes shape in terms of "levels" and "modes" of linguistic behavior. In chapters Four and Five I will consider whether a level of pitch processing in both production and comprehension can be distinguished from other levels of a phonological grammar. Chapters Six and Seven pursue the matter of heterogeneous modes of linguistic behavior. These modes can be conceived as occurring along a continuum from "propositional" to "automatic" use of language. More "automatic" modes include idioms, familiar and overlearned expressions, emotional phrases, memorized speech, pause fillers, and other holistic and recurring phrases.

These levels and modes are related. In normal speech, expressive and overlearned speech is often associated with stereotyped intonation contours. Jespersen noted "the important distinction between formulas or formulaic units and free expressions," a distinction corresponding to the dichotomy between propositional and automatic use of language. For formulaic expressions it is not possible "to change the stress or make a pause between the words," since the phrase is for all practical purposes "one unchanged and unchangeable formula, the meaning of which is really independent of that of the separate words into which it may be analyzed" (1933/1969, p. 18). Aphasics commonly lose propositional speech but retain automatic modes. In aphasia, automatic phrases, first uttered with stereotyped intonation, often develop a widely varying repertory of contours. The aphasic regains facility of expression in control of intonation, but not of other manifestations of propositional use of language.

The question of the locus of speech and language in the brain has been debated for over a century. The "locationist" position holds that functions can be identified with structural areas in the brain. In contrast, the "holistic" view emphasizes that all parts of the brain interact, and that functions are made possible by dynamic operations of integrated structures. However, most proponents of both schools would agree that "there is 'localization' of language functions in the gross sense that one hemisphere, usually the left, is dominant" (Osgood and Miron, 1963, p. 49). It is generally accepted that there

is a "displacement of function" for language processing in the brain from right to left; and furthermore, that within the left hemisphere, there is an "antero-posterior polarization," (i.e. anterior lesions tend to disturb motor aspects of speech, while posterior lesions areas are more likely to affect sensory aspects) (Lenneberg, 1967, p. 71). In addition, there may be vertical displacement of aspects of language function, from subcortical to cortical processing of language.

Thus it would appear that some modes, levels, or aspects of language behavior are a function of the left (dominant) hemisphere, and some are not (being *also* right hemisphere or subcortical abilities). These modes or aspects of language can be referred to as "non-lateralized" (not specialized in the dominant hemisphere). For hypotheses about heterogeneous processing of language in the brain, it is not necessary to locate a primary processing center for nonlateralized or "nondominant" modes. The assumption is that the nonlateralized modes are products of different processes, or based on different aspects of cerebral function, in comparison with the language associated with left hemisphere specialization. These different language modes can be expected to be made up of distinct properties. Jackson hypothesized that "word processes are not of the same kind in each half of the brain" (1932, p. 132). The purpose of the following chapters is to examine these various modes of language and to consider how they fit into definitions or models of human language.

The aim of these studies is to sort out details of lateralized versus nonlateralized processing of language. Clinical literature and experimental studies suggest that some levels or modes of language are lateralized (specialized in the dominant hemisphere) and some are not. "Levels" can refer, for example, to pitch or intonation contours, as compared with other phonological cues; "modes" in these studies refers to "propositional" as distinguished from expressive and over-learned modes of speech ("automatic" use of language). In the following chapters, I will develop the view that facts of language lateralization in cerebral processing can be brought to bear on hypotheses about the structure of language.

Chapter 4.

Tone and Intonation: Pitch Processing and Functional Lateralization
in the Brain.

"Jeeves," I said, "don't keep saying 'Indeed, sir?' No doubt nothing is further from your mind than to convey such a suggestion, but you have a way of stressing the 'in' and then coming down with a thud on the 'deed' which makes it virtually tantamount to 'Oh, yeah?' Correct this, Jeeves."

P.G. Wodehouse, Brinkley Manor

Chapter 4

Tone and intonation: pitch processing and functional
lateralization in the brainIntroduction

Evidence from linguistic analysis, aphasia and neurophysiological studies is presented in this chapter to advance two related claims. The first claim is that features of pitch in language production and comprehension are stored and processed in the brain differently from other phonological features. That is, at least some linguistic phenomena based on pitch are separately structured and organized from other features in the phonological grammar. This chapter reviews evidence from linguistics and aphasia to suggest that the special properties of pitch in language require special description.

The second claim involves the fact that pitch cues are associated with left or right hemisphere specialization, depending on their function. The claim is that in the acoustic signal, the roles played by pitch cues depend on their linguistic function, and these roles are associated with lateralized processing in the brain. In the speech stream, pitch functions at many levels, including phonological (tonemes), lexical (words), syntactic (e.g. constituent structure and sentence-type), attitudinal (statement with major reservations contrasted with statement with minor reservations, Stockwell, 1972), and emotional levels. (Darwin, 1969, and discussion below). All the potential levels have different degrees of linguistic structure in different languages. Furthermore, the degree of linguistic structure at the various levels determines their mode of cerebral processing.

The following chapter (Chapter 5) presents a review of neurophysiological studies which suggests that the functional roles of pitch cues are associated with lateralization of function in the brain. Chapter 5 then describes an experimental study on linguistic tones and cerebral processing (Van Lancker and Fromkin, 1973). The results of that study suggest that a linguistic use of pitch at the phonological level (tones) is lateralized in the left hemisphere.

Prosody stands alone: linguistic evidence

The first claim in the chapter is that prosodic features comprise special phenomena in language, and have properties that set them apart from other phonological phenomena. The following section is a brief summary of linguists' views of the structure and function of prosodic features in language. There are controversies and unresolved contradictions in descriptive approaches to pitch phenomena in language. Therefore it seems real, as Sapir (1921) wrote, that "variations in accent, whether of stress or pitch" are "the subtlest of grammatical processes" (pp. 78-9).

Prosodic features, then, including tone and intonation phenomena, present special challenges to linguistic analysis. It is difficult to establish basic parameters. There remain controversies about the size and extent of units, the nature of minimally contrastive features, and the range of linguistic function (as distinguished from "nonlinguistic") of prosodic phenomena in language. At least some of these difficulties apply both to studies of linguistic tone and to studies of intonation. Regarding tone, Leben (1973) observes the "number of distinct kinds of underlying representations" that have been proposed for tonal phenomena in various tone languages (p. 117). Similarly, in the case of intonation, many descriptive systems have been proposed, but none is generally accepted (see Crystal, 1969; Greenberg, 1969). Chomsky and Halle (1968), although they develop a system of stress rules, "have omitted pitch from consideration [having] nothing to add to the study of the phonetics of intonation...[or the] still quite open question of the systematic role of pitch contours or levels within the general framework of syntactic and phonological theory as we so far understand it" (p. ix).

A number of linguists have attempted to show that pitch features differ from other phonological phenomena in essential ways. Bolinger (1961a) has claimed that in addition to all-or-none contrasts, pitch phenomena show "gradience." This means that when the basic contrasts are spoken in degrees (of pitch height differences), they give "quantitative differences in meaning" (p. 42). Similarly, Crystal (1969) maintains that although not lacking discreteness altogether, "intonational features are not formally as discrete as phoneme segments." Nor are they "as easy to delimit and organise into systems, syntagmatically or parametrically" (p. 197). A related point is that pitch features in accent and intonation (although not tone) can be associated directly with speakers' intentions and have an isomorphic relationship to meaning (especially contrastive and emotional meanings), whereas most other phonological phenomena are conventional or arbitrary. (Exceptions are certain expressive phonological features, discussed in Chapter 6).

It has been argued that phonemic and morphophonemic descriptive models cannot be extended to prosodic analysis (for discussion see Crystal, 1969). Bolinger (see 1965) argued persuasively in articles of the 1950's against the "level-analysts" (Trager and Smith, 1951), that prosody cannot be treated like other phonological features, because it is a separate system with unique qualities and different functions. Others disagree for at least some pitch phenomena (e.g. stress, Chomsky and Halle, 1968). Lehiste (1970) has suggested a compromise view: suprasegmentals are features on phonological units, but in order to accommodate this fact, it will be necessary to revise phonological theory, and to reanalyze the relationship of phonological to other linguistic phenomena.

It is interesting to note that syntactic evidence has been adduced in the claim that "intonation assignment is not a purely phonological process," within the generative-transformational model (Stockwell, 1972). These arguments claim that intonation contours are dependent on phenomena outside the phonological component (as are certain other so-called phonological phenomena, such as morpheme boundaries and word boundaries). One argument is that intonation assignment is dependent on deep structure configurations (Bresnan, 1971), another that rules for intonation must precede certain syntactic transformations (Pope, 1971). However, Bolinger (1972b) has taken a position against the "syntax-analysts" of intonation processes, maintaining that prosody in English and syntax are "two domains which should be kept apart" (p. 644). Prosody is a separate system, according to Bolinger, determined by "semantic and emotional highlighting," only *casually* related to syntactic structure. "Accent should be viewed as independent, directly reflecting the speaker's intent" (p. 633).

Prosody as universal

Claims for universality of intonation also differentiate prosodic phenomena from other phonological features. Hockett's (1966) Language Generalization 3.7: states that "every human language has both an intonational system and a nonintonational system" (p. 19). About universality, Bolinger (1972a) concludes that "the general characteristics of intonation seem to be shared more broadly than those of any of the other phenomena commonly gathered under the label of 'language'" (p. 315, and Bolinger, 1964b).

Some linguists have ascribed the universality of intonation features in language to physical or psychophysical facts. Lieberman (1968) claimed that a universal "unmarked breathgroup" exists for statement intonation, and that it falls in fundamental frequency as a result of falling subglottal air pressure. This claim has been challenged by Ohala and Hirano (1967), who demonstrated that laryngeal muscles are active during production of statements. However, similarities of intonation contours in unrelated languages of the world suggest that at least some prosodic phenomena in human language are based in "certain underlying physiological or psychological traits" (Bolinger, 1964b, p. 841). It is in this sense that much of prosodic phenomena are instinctive, or based in species-specific universals, whereas many other aspects of language are conventional (Bolinger, 1949).

Regarding the one plainly non-instinctive linguistic use of pitch, tone, Bolinger notes that "tone languages do use intonation, and the interesting thing is that intonation usually carries the day if any conflict arises" (1964b, p. 841). Others (e.g. Fromkin, 1974)*do not agree with this specific claim. These questions remain to be answered. However, for me there is appeal and sense in Bolinger's (1964a/1972a) picture of intonation as a "half-tamed servant of language," depicted in that way because intonation serves emotions, will, and the nervous system processes of tension and relaxation (p. 29). It is especially along that zone between the tamed and the untamed that the interactions between linguistic structure and the psychophysical factors in pitch phenomena in language are unclear.

Prosody in speech production

There is evidence in speech errors for the separation of intonational from (other) phonological organization in speech production. Fromkin (1971) concludes from a review of other speech error studies and her own data that "the sentence or phrase stress and overall intonation is generated separately" (p. 43). These data show that "when vowels or syllables of parts of syllables or whole words are substituted or transposed, there is no change in the stress pattern or contour of the sentence" (p. 42). This fixed overall contour is produced according to the syntactic structure of the utterance, and therefore in a model of speech production, syntactic-semantic features logically precede the intonation-contour generator.

* personal communication

It may be possible to further refine intonation processing in a production model. Jespersen (1965, 1969) distinguished between formulas and free expressions in speech production. He claimed that formulas are produced as whole units, -- they "spring into a speaker's mind all at once," whereas free expressions are newly created (1965, p. 26). Furthermore in producing formulas, according to Jespersen, "everything is fixed: you cannot even change the stress," in contrast to free expressions, which can be produced on various intonation contours (p. 18). The distinction between formulaic and free expressions corresponds to that between overlearned or idiomatic and newly created speech. These claims are interesting, but remain to be investigated. Whereas it is possible to pronounce stereotypical utterances such as *How are you, I'm fine, Leave me alone, Hit the nail on the head, How do you like that!*, on a variety of intonation contours, it seems likely that one contour (or a small restricted set of contours) predictably identifies the conventional use of the phrase. For example, the phrase "how do you like *that!*" is an exclamatory formula when the accent occurs at the end of the phrase. However, when pronounced on a variety of other contours, it can be a free expression, asking a question about a specific object. Pronounced with the main stress on any but the last word, the phrase is less likely to be perceived as the exclamatory formula. These claims, while plausible, require empirical data and further study.

It is possible that a model of speech production should differentiate between formulaic and free expressions (and other classes of utterances). Jespersen (1969) claimed that the difference between those two classes involves different kinds of processing: "While in handling formulas memory is everything, free expressions involve another kind of mental activity: they have to be created in each case anew by the speaker" (p. 18). Investigation of the prosodic features associated with these different types of production might be one way to test Jespersen's hypothesis in the context of a production model.

Prosody in language acquisition

Lieberman (1968) reviews evidence that intonation abilities in production and perception are observed early in the infant. Mimicry of intonation in speech was observed in 10 month and 13 month infants. Babies distinguish friendly from unfriendly voices at six months (Buhler and Hetzer, 1928). Studies in child language acquisition have shown that children respond to intonation cues chronologically before phonological features (Lewis, 1936; Leopold, 1953; Frädkina, 1955; Weir, 1966). Children imitate intonation patterns very early (Pike, 1949) even as early as the babbling period (Ervin-Tripp, 1966). Intonation, accent and stress, and rhythm "come first for the child but last for the analyst" (Bolinger, 1965, p. vii).

Prosody in aphasia

Singing and speaking may be separate processes, or they may be related in specific ways. The idea that they are separate is based on observations in stuttering and in aphasia. Severe stutterers are able to sing words normally; aphasics can often sing well when they can hardly speak. Performance abilities for singing differ in aphasia. Some expressive aphasics can sing melodies on *ah* or *la*; some can sing words when prompted; others are able to sing lyrics of old songs and of newly learned songs. I have not tested aphasics' abilities to create new melodies. The patient's pitch production ability sometimes varies according to production mode. I observed a patient who read aloud on a monotone, as though only one pitch were available to him; but who then could sing melodies on *la* with ease.

Burklund's left hemispherectomy patient, a severe expressive aphasic, sang with a prompter, with normal articulation of lyrics (Smith, 1966). Another left hemispherectomy patient sang 'Jingle Bells' fluently on her own (Bogen, 1971, 1972; Gordon, 1973).

We can hardly take seriously Jespersen's (1964) claim to have proven ("by the inductive method") that the origin of human language was primitive singing. Nor is there good reason to relate singing and speech so closely in a synchronic description of language. However, the notion of heterogeneity in language, or differentially processed levels and subsets, leads to a revised view of the possible relationship between singing and speech. Singing and speech may be separate but related abilities. They are related, because singing shares features or characteristics with some modes of speech production. Thus, singing may occupy a place along a continuum of subsets of production, including emotional speech, reciting, and others, on the basis of shared underlying neurophysiological processes. The nature of the interrelatedness of these performance modes, and the nature of the neurophysiological abilities some may have in common, remains to be investigated. One source of evidence that some of these modes are related comes from clinical observations that certain modes are typically available to the aphasic and others are not. Other evidence and discussion on this point appears in chapters Six and Seven below. The relevance of these subsets to a theory of language remains to be considered.

Aphasiologists have observed a relationship between singing and nonpropositional subsets of speech. Kreindler and Fradis (1968) for example, refer to song as "an automatized series," which can be used as a facilitatory factor in therapy for aphasics.

"By repetition, on a rhythmic musical and emotional background, of words or word-sets contained in songs, reinforced by visual perception of corresponding images and words, as well as by patients singing the texts previously heard, an easier reactivation of impaired speech function can be obtained in any form of aphasia" (p. 145).

The "melodic intonation therapy" technique has been used with some success in severe aphasia. The patient first "sings" sentences, and then learns to produce the expression with pitch contours increasingly resembling normal speech intonation (Sparks, Helm and Albert, 1973). The patient responds with an exaggerated melodic contour, which need not be exactly equivalent to the therapist's pattern. In this task the patient is attempting to imitate melodies which are chosen from a repertory of known melody-types. The therapy is based on the notion that "standard melodies" and well-learned songs are sometimes available to the aphasic, even when fluent speech is not. This approach has nothing to say about the ability to create new melodies. Creative singing remains to be investigated in relationship to the competence underlying the production of novel speech utterances in both normals and aphasics.

Goldstein (1948) discusses the unrelatedness of singing and speaking. He suggests that the difference "is due to the different physiological and psychologic structures of both performances" (p. 146). However, his distinction is actually between singing and *propositional use* of language. In contrast, he assumes a connection between singing and nonpropositional modes:

"According to the more primitive character of singing and the close relationship of singing to expressive movements and to emotional language, it can be assumed that in brain damage, singing will be preserved longer than language. [Thus the preservation of singing might be explainable] in the same way as the better preservation of emotional language. In this respect, there is significance in the frequent parallelism between preservation of singing and other emotional expressions, such as the Lord's Prayer. [Furthermore]...there is possibility that this automatized performance may be guaranteed by the function of the minor hemisphere" (p. 147).

In most aphasic patients with stereotyped utterances, the first stage of recovery involves recovering the ability to produce intonation contours. The patient typically remains limited to the stereotyped phrase, but begins to show improvement when the "manner of utterance and the intonation are first modified." The patient begins to show a "differentiated organization of the permanent verbal stereotype," producing the

same identical item, but produced with varieties of intonation and speech (Alajouanine, 1956). Critchley (1970) notes that the new words produced by a recovering aphasic occur in staccato monotone, unlike the "melodious recurring utterance" comprising the automatic repertory (stereotyped phrases). A typical "monophasic" patient used the phrase "on the booze" to reply to questions and to speak spontaneously. By use of intonation and gesture "he was able to utilize these three words with such success as to make them express his immediate desires or to signify assent, negation or dismissal" (p. 206).

The mention of "gesture" renders these kinds of clinical descriptions difficult to assess for linguistic evidence. It would be interesting to omit gesture and facial expression from speech samples derived from a population of monophasic patients, in order to establish to what extent intonation alone can contribute to communication. However, these reports of facilitation in production of intonation contours, associated with severe restriction in speech output to one utterance, are common in the literature on aphasia. More examples are presented in Chapter Six. It can be concluded that the intonation component and the phonological component are separate enough so that one (intonation) can be available but not the other in some kinds of aphasia.

There is one report that tone contrasts were retained by a speaker of a tone language who became aphasic. Lyman in Peiping observed that one Chinese aphasic correctly retained tonal inflections, despite a restricted vocabulary. According to Critchley (1970), if dysarthria is also present, then the tones are distorted (p. 219). However, there are reportedly many Chinese aphasics with tone problems (Scovel, 1974).^{*} Whether tones are better retained in aphasia than other phonological features, or than other pitch phenomena in language, remains to be studied.

The fact that intonation is separable from other phonological output is striking in phonological/jargon aphasia. In semantic/jargon aphasia, well-formed words occur but the overall utterances are nonsense. There is a dissociation between sound and meaning. In addition to the sound/meaning breakdown, jargon contains neologisms and literal paraphasias in a stream of non-words (Green, 1969). Although phonemes remain intact, the phonological output is impaired at a level of abstract representation. The dissociation in jargon aphasias between exclusively phonemic or exclusively semantic paraphasias "suggests that the functional systems corresponding the phonemic structure of linguistic elements and those underlying the semantic values are different and can be selectively damaged" (Alajouanine and Lhermitte, 1964, p. 177). Yet both types of jargon aphasia are associated with good rhythm and intonation.

* personal communication

Pick's (1973) model of speech production, based on clinical experience with aphasia, separates intonation from other phonological processes. The model consists of a nonverbal phase, which includes the melodic pattern, rhythm, and the more subjective aspects of the utterance, followed by the verbal phase, including positioning of words and use of grammatical processes. This speculative model seems not to account for the close relationship between the "melodic pattern" and the syntactic structure of the sentence produced. Pick's model is based on clinical observations. It is frequently the case that in aphasia the melodic patterns are intact, but the syntactic structures are not (because only one holistic phrase is spoken by the patient, for example). One solution might be to consider that the nonverbal and verbal phases are separate but simultaneous and interrelated in normal speech processing. Another is to conceive of the details of the verbal phase as contingent to some extent on the preselected contour and rhythm. This second explanation covers speech errors which I have made, in which the words produced did not fit the overall accent or pitch contour, which was well underway.

Defect of intonation (dysprosody) is rare in aphasic conditions (Pick, 1973; Monrad-Krohn, 1947a,b,c, 1957). Such disturbances, when they occur in aphasics, are likely due to concomitant subcortical injury. Nonaphasic monotone speech, somewhat more common, has been attributed to lesions of the brain stem, specifically of the basal ganglia (Lenneberg, 1967).

Pick attributes the rarity of intonation disturbance, defective accentuation, and monotony to the "fact that intonation is a very early acquisition, preceding articulate speech and, therefore is an especially automatized achievement. Moreover, since intonation stems from emotional life, it is *per se* a more primitive feature" (1973). Pick's remarks are based on clinical observations that aphasic patients correctly use intonation contours to express emotions, whereas other sorts of verbal expression are lacking. His view of intonation, however, is not very far from Bolinger's (1964a/1972a), for whom all of intonation is based in the "tides of emotion." The "tides" are similar across languages, and they are first learned in children. Intonation in language can get a foothold in the syntax. "But the foothold is with one foot; the other one is back there doing its primitive dance" (1964b, p. 844).

The few reports of dysprosody are difficult to interpret, because the linguistic description is lacking, or difficult to assess in terms of linguistic features. Some cases of a "foreign accent" as a result of aphasic disturbance have been reported (Ustvedt, 1937; de Rueck and

O'Conner, 1964; Cole, 1971; Whitaker, personal communication; Bogen, personal communication). There is one well-known report of a Norwegian woman who lost the phonemic distinction between two intonations (phonemic in her language) but retained the pitch contours in her speech (Monrad-Krohn, 1947a). As a consequence, she was mistaken for a German in Nazi-occupied territory. It is possible that these defects are not in the production of intonation, but of rhythmic patterning, or timing in speech performance. Recently a few unpublished studies of intonation abilities in aphasics have been reported (See MacMahon, 1972, for review).

A study by Blumstein and Goodglass (1972) demonstrated that aphasics (Broca's and fluent aphasics) could distinguish between items in pairs of words that differed primarily in stress (syllable length and vowel quality are also involved to some extent in some cases). Sample pairs were white *cá*p and whíte*cà*p; *cò*nvíct and *cón*víct. Aphasics (both groups) could discriminate stress contrasts, and although they made more overall errors than the normals, the pattern of errors was the same in both aphasics and normals. The results of the study suggest that the perception of stress is preserved in aphasia. The authors conclude that "stress recognition appears to be a remarkably robust linguistic feature" (p. 806). The results were the same for aphasics with good and with poor comprehension of speech.

The acoustic correlates of stress are fundamental frequency (pitch), duration, and intensity (amplitude). According to studies by Bolinger (1965) on normal and synthetic speech, the primary acoustic cue in stress accent is pitch prominence. Fry (1955) demonstrated that intensity differences cannot serve as cues for stress placement. A number of other studies on various languages have shown that fundamental frequency is the primary acoustic correlate of perceived stress (see Lehiste, 1970 for review). Therefore the findings of Blumstein and Goodglass (1972) suggest, more specifically, that aphasics (even those with poor overall speech comprehension) retain the ability to process pitch distinctions.

Pitch, intonation and lateralization of cerebral function

As reviewed in Chapters 2 and 3, the neurophysiological substrates for bilaterality of pitch processing (in production and comprehension of speech) are present in the normal brain. Each hemisphere is capable of controlling the larynx and articulatory musculature for production of pitch, tone and intonation; and both hemispheres are capable of discrimination of pitches for perception of tone and intonation.

Facts about lateralization of pitch processing in the normal brain can be researched, to investigate the hypothesis that prosody is a separate domain from other aspects of phonology, and from other components in a competence grammar. For example, it might be predicted that processing of prosodic features, both in production and comprehension of speech, is not specialized to the left hemisphere, while other phonological features and grammatical components are lateralized to the left hemisphere. Such a finding would provide a neurophysiological basis to the separation of prosodic from other phonological phenomena.

The strongest evidence for the first claim in this chapter (that features of pitch and intonation are stored and processed differently from other phonological features) would be that no aspect of pitch distinction in a language system is specialized in the left (language) hemisphere. However, one study designed to test lateralization of a linguistic function of pitch (Van Lancker and Fromkin, 1973) indicated left hemisphere processing of linguistic tone contrasts in a tone language. Other studies, reviewed below, suggest that other aspects of the linguistic signal are not specialized in the left hemisphere. These are discussed in Chapter 5.

Pitch changes as a functional hierarchy: linguistic descriptions

The first claim in this chapter, discussed in the section above, was that pitch phenomena are processed differently in the brain from other linguistic features. The second claim, to be presented in the remainder of this chapter, is that pitch cues constitute a functional hierarchy in a language system. I shall refer to the several roles of pitch in language as "levels." Bolinger (1964/1972a), for example, notes that

"Voice, purely as voice, plays many parts in communication. It provides the overtones that are the raw material for vowels; determines the difference between certain consonants and certain others, such as [s] and [z] or [f] and [v]; most importantly, it is what gives speech its power to ride over noise and carry long distances. Besides these roles... the fundamental pitch of the voice plays others..."

such as accent, separating discourse into its larger segments, and communicating emotions (1972a, p. 19).

The notion of functional importance within prosodic systems is commonly accepted, but the details are unclear. Even the simple division, "linguistic" versus "nonlinguistic" role of pitch, is uncertain (Crystal, 1969). In his review of prosodic feature systems, Ladefoged finds it unclear which of several proposed prosodic features "specify linguistically contrasting patterns and which ones are required only for paralinguistic phenomena" (Ladefoged, 1971, p. 89).

There is some agreement at the "outer edges" of the large domain of prosodic features in speech. The features which correspond to the level of individual physiological differences (vocal tract, size, pitch range etc.) are generally excluded from linguistic analysis. The function and importance of vocal quality in the communicative process are not understood. There are reports that jargon aphasics (whose speech is nonsensical) agree that jargon speech samples spoken by themselves are nonsense, when these samples are read to them by another person. However, they claim that the samples make good sense, when the actual sample is played back by tape recording (Zangwill, 1964a; Weinstein, 1974). These observations are intriguing but difficult to interpret. It would be interesting to investigate whether, among other possible explanations, intonation contour or voice quality differences are more responsible for these results.

The next "level" of functional use of pitch in speech (and closely related to the first, i.e. the personal vocal traits level) is often called "paralinguistic," signalling personality traits and emotional states in the intonation contour. The affective function of tone is "connected much more with individual psychology than with the language community since it is concerned with conveying the affective state of the speaker" (Fry, 1969, p. 367).

Closely related to the affective level, but often analysed as "linguistic," is the distinguishing of attitudes by intonation, including attitudes toward the speaker himself, toward the remark being spoken, or toward the listener. This is a use of intonation to express "a more personal commentary on the sentence he is producing." When prosodic features extend over the entire sentence, they express such notions as "declarative statement, interrogation, hesitancy, irony..." "This use of the prosodic parameters is probably universal in human language" (Wang, 1971, p. 274).

Thus "attitudinal" and "grammatical" or "syntactic" roles of intonation in speech are intertwined. Syntactic use of intonation refers to contrasts between types of sentence, such as question and statement, or types of clauses, such as appositive vs. restrictive. Wang's

examples illustrate one syntactic function of prosody, "to configurate speech into syntactic units of various sizes" and types:

Appositive: The student, who studies Swahili, went to Tanzania.

Restrictive: The student who studied Swahili, went to Tanzania.

(The one who didn't had to stay in Paris.)

Lea (1973), citing Bolinger, 1961b, Jones, 1932, Trager and Smith, 1951b, Gleason, 1956, and Hultzen, 1959 observes that many linguists have claimed that intonation indicates the immediate constituent structure of the English sentence (p. 10). Furthermore, experimental studies on the identification of constituent structure on the basis of prosodic cues, indicate that "prosodic cues to constituent structure may contribute substantially to any schemes for the recognition of continuous speech" (p. 34).

The grammatical or syntactic function of intonation is closely tied into attitude contrasts. Pike (1945) found it necessary to define different intonation contours in terms of attitudes of the speaker:

"It was a marked surprise to me to find that there are many different contours which can be used on questions, and that for any contour used on a question I could usually find the same one used on a statement; likewise, for all -- or nearly all -- contours used on statements, I found the same ones used on questions. In other words, there appeared to be no question pitch as such. This type of evidence is responsible for the necessity of abandoning grammatical or lexical definition of contours; definition in terms of attitudes of the speaker has been utilized, instead, in this study" (in Bolinger, 1972a, p. 59).

Crystal (1969) suggests that an intonation pattern "signals different kinds of information simultaneously," including syntactic, attitudinal, and emotional. Some information is more dominant than the rest "in a given percept," and therefore Crystal advocates a descriptive model which incorporates degrees of attitudinal *and* grammatical function for any given utterance (pp. 288-289). These views are, again, unsettled controversies in linguistic analyses of prosodic features. The point is that these several levels exist in language, although their exact structure and function is difficult to penetrate.

Finally, there is a phonological or lexical level of pitch function. For example, pitch (as a primary cue in stress) functions to distinguish some noun-verb pairs in English, *import/impórt*, and to organize nouns and noun phrases, e.g. green house, greenhouse. Use of pitch contrasts at the lexical level on a broader scale occurs in many Asian and African languages, called tone languages. Use of pitch to distinguish minimal pairs of lexical items has been called "phonological" function of tone.

Thus pitch operates functionally in different ways in different languages, and the functions interact. There are various levels of systematic pitch function, and the levels are interrelated. Fry describes the hierarchical functions of pitch: "There is considerable interaction between the effects of the three functions of tone, the phonological, the grammatical and the affective, but they form a kind of hierarchy in the sense that where phonological tones exist they are likely to be modified by the demands of grammatical intonation, and this in turn is altered by the need for emotional expression" (Fry 1969, p. 367). All languages have affective fluctuations of pitch (see Lehiste, 1970; Bolinger, 1964b); virtually all have some sort of grammatical intonation (Ladefoged, 1971); some have lexical and phonological pitch contrasts. Thus pitch functions at various levels in all languages, and the function-types form an implicational series from affective to tonal.

Quirk and Crystal (1966) used the notion of functional importance in investigating intonation in English. The results of experiments requiring subjects to repeat utterances "made it clear that some intonational categories are indeed perceptually more distinct and linguistically more replicable than others, and that this gradation seems to be correlated with degrees of linguistic importance" (Crystal, 1969, p. 203). For his analysis, Crystal concludes that "one must...expect *degrees* of grammatical function for intonation: some structures will be intonationally more restricted than others, and some intonation contrasts will be more frequently used for the purpose of making grammatical contrasts than others" (1969, p. 254-5).

Greenberg's (1969) investigations demonstrated the reality of these "degrees" in comprehension and production of intonation contrasts in listeners and speakers. Greenberg based his studies on a stratified model of intonation "in which certain functions are considered to belong to basic strata, and other functions are characterized as overlays upon these earlier (in the generative sense) more basic strata" (p. 3). The

test stimuli were made up of intonation contrasts containing syntactic, attitudinal (i.e. emphatic vs. unemphatic) and emotional cues. Subjects were tested for production and comprehension of these contrasts. Results showed that some intonation contrasts were easier to produce and/or to comprehend than others. Emotional and attitudinal cues were more effectively communicated than some syntactic cues. Intersubject differences interacted with contrast-type difficulty in production and comprehension.

In Crystal's (1969) formulation, *all* aspects of "non-segmental phonation," including prosodic systems, paralinguistic systems, and non-linguistic features, are placed along a scale from "most linguistic" to "least linguistic" (p. 131). A similar scale might be conceptualized for the levels of pitch functions in language, from "most systematically linguistic" to "least systematically linguistic" (Figure 4.1).

"most systematically linguistic" ← "least systematically linguistic"

pitch contrasts

phonological tone

lexical-type

syntactic / attitudinal/emotional
(phrase structure) (sentence-type)

personal/psychological

EXAMPLE: Chinese

English

nearly universal

universal

Swedish

Thai

Japanese

DOMAIN

segment or syllable

word/phrase

phrase/sentence

Figure 4.1

A hypothetical scale of levels of function in language.

Chapter 5.

Hemispheric Specialization for Linguistic Functions of Pitch:
Evidence from Thai.

Chapter 5

Hemispheric specialization for linguistic functions of pitch:

Evidence from Thai

Introduction

In the previous chapter (Chapter 4), two claims were made about pitch in the linguistic signal and cerebral processing. The first is that pitch features in speech are stored and processed differently from other phonological phenomena. The second claim is that pitch phenomena serve various functions in the linguistic signal, conceptualized on a hypothetical scale of "degree of systematically linguistic." On this scale, the most highly structured and systematic kind of pitch feature, phonological tone, falls at one end of the scale, while emotional and personal kinds of pitch features are at the other end of the scale. (see Figure 4.1)

These claims about the linguistic functions of pitch can be investigated in relationship to facts about the lateralization of cerebral functions. Regarding the first claim, it is possible to test whether some or all pitch phenomena are processed in the left or right hemisphere (or bilaterally or subcortically processed); and for the second claim, whether certain functions of pitch along the proposed scale are lateralized to the left hemisphere, while others are not.

Psychophysical evidence for pitch processing

As reviewed in Chapter 2 (pp.24-7)above, neuroanatomical and behavioral evidence suggests that pitch discrimination abilities are bilaterally and/or subcortically represented in the brain. However, hemispheric specialization for pitch processing within different tasks has been observed in humans. These observations suggest that specialization to one or the other hemisphere is determined not alone by the acoustic signal, but by its function, or by principles of its organization in a complex signal. According to the "functional" interpretation of hemispheric specialization for incoming stimuli, a stimulus is lateralized (or not) to either hemisphere depending on the functional context of the stimulus in any given task. Furthermore, a common denominator may underlie the class of tasks specialized in the one hemisphere, different from the common characteristics underlying tasks lateralized into the other hemisphere. That is, there may be distinct modes of processing intrinsic to each cerebral hemisphere (see Chapter 2 for discussion).

As Kimura outlined, dichotic listening provides a means "for studying further the division of labour between the left and right hemispheres of the brain. By varying the stimulus dimensions, we may be able to define more explicitly just what characteristics differentiate stimuli depending more for their perception on the left hemisphere, from those depending more on the right hemisphere. That is, we can ask which stimulus characteristics are associated with a right-or a left-ear superiority" (Kimura, 1967, p. 173).

The neurolinguistic approach focuses this kind of research plan on the processing of language. There is evidence that language is heterogeneously processed in the brain (some linguistic phenomena are lateralized in the left hemisphere, some linguistic phenomena are not). If it is also true that there are modes of processing unique to each hemisphere, then it may be useful for linguistic analysis to sort out classes of "left-lateralized" from "non-lateralized" linguistic phenomena, and establish the unique characteristics or properties which underlie them. It is in this spirit that the experiments described in this monograph were carried out. The first, the Thai-tone and pitch processing experiment, tests aspects of the claims presented in the preceding chapter: 1) that pitch is processed differently in the brain from other features in the linguistic signal; 2) that different pitch cues within the signal are differentially processed in the brain.

Dichotic listening studies and hemispheric specialization

In dichotic listening, a subject wearing stereo headphones is presented with two acoustic stimuli at the same time, one at each ear. Subjects usually make more correct identifications at one ear than the other. A variety of stimuli have been tested, with right ear and left ear superiority results. As reviewed in Chapter 2 above (pp. 24-7), both right and left ears project fibers to both right and left auditory receiving areas at the cortex. The contralateral connections from ear to cortex (right ear to left temporal lobe, left ear to right temporal lobe) are "stronger" than the ipsilateral connections. Neuroanatomical and behavioral observations lead to the conclusion that ear superiority in dichotic listening is due to specialized abilities of the contralateral hemisphere.

In dichotic listening, most linguistic stimuli produce a right ear advantage (more correct identifications at the right ear) in right-handed subjects. The right ear advantage has remained constant over various experimental conditions. It is not cancelled by attention factors

(Bryden, 1969; Myers, 1971) by changed orders of report (Bryden, 1963, 1967), by response mode, whether verbal, written, or button-pressing (Springer, 1971, 1972), by the "lag effect" (lagging one stimulus behind the other), (Kirstein, 1970), or by requiring a temporal order judgment (Day, Cutting and Copeland, 1971).

Investigators have demonstrated a right ear superiority for dichotically presented consonant-vowel syllables (Studdert-Kennedy and Shankweiler, 1970; Darwin, 1971; Berlin et al., 1972a); digits (Broadbent, 1954; Kimura, 1961); words (Haggard, 1971); nonsense words (Curry, 1967); function words (Curry and Rutherford, 1967), nouns (Borkowsky, Spreen and Stutz, 1965; Pettit and Noll, 1972); backwards speech (Kimura and Folb, 1968); Morse code signals (Papçun et al., 1974); and sentences (Zurif and Sait, 1970). In addition, a right ear advantage has been found for at least two kinds of stimuli which are not obvious instances of the linguistic signal. A production-mode adaptation of dichotic listening gave a laterality effect for lingual tracking of tones, with a right ear advantage when the feedback (cursor) tone was in the right ear, while the target tone was in the left ear (Sussman, 1971). Secondly, Morse code dot-dash sequences yielded a right ear effect not only in a linguistic task (in experienced Morse code operators), but also as a non-linguistic task (7 units or less in naive subjects) (Papçun et al., 1974).

Most of the results can be explained by the notion that the left hemisphere is specialized for linguistic processing. Extensions of this hypothesis have been proposed to accommodate the two "nonlinguistic" results. For the cursor/target tone study, the notion "articulability" serves to describe these and other findings, because the ear effect was found only when the tongue (not the hand) tracked the tone. For the Morse code findings, specialized abilities for processing of "sequential sub-parts" (within a 7 unit span) in the left hemisphere can be invoked to explain the results. These interpretations claim that language is subsumed under more general processing abilities which characterize left hemisphere specialization: a specialization for vocally articulable sounds, (Berlin, et al., 1973) and/or a specialization for sequential processing (Papçun et al. 1974, Bogen, 1969) or temporal processing, (Efron, 1963a,b.; Carmon and Nachshon, 1971; Gordon, 1973). These hypotheses remain to be established.

Other sounds have produced a left ear (right hemisphere) superiority, especially various kinds of musical stimuli such as baroque melodies (Kimura, 1964) and chords (Gordon, 1970). Darwin (1969) reported a slight left ear advantage for dichotically presented pitch contours, in four stimulus conditions: on a syllable *ti*, on a single formant; in

discrete steps and glissando. In other dichotic listening studies, left ear advantages resulted for environmental sounds (Curry, 1967), sonar signals (Chaney and Webster, 1966), non-language vocalizations such as sobs and chuckles (Carmon and Nachsohn, 1972), hummed melodies (King and Kimura, 1972), the "emotional tone" of sentences (Haggard and Parkinson, 1971), and filtered intonation contours of sentences (Blumstein and Cooper, 1973). Studies by Curry (1967) exemplify the verbal-nonverbal dichotomy for dichotic listening of different sounds. A group of normal subjects showed a right ear superiority for a dichotic word test and nonsense word test; a nonsignificant left ear superiority in a dichotic pitch discrimination test; and a left ear effect for an environmental sounds test.

The verbal-nonverbal dichotomy proposed to explain right and left ear superiorities in dichotic listening has been supported by findings in patient populations. Kimura's (1961, 1967) results from patients in whom hemispheric dominance was known (by the Wada technique for ascertaining cerebral dominance) supported the claim that the right ear effect for linguistic stimuli in dichotic listening was due to contralateral processing of speech in the contralateral hemisphere. In a dichotic listening test using three pairs of digits, a right ear effect was observed in patients with left hemisphere dominance for language, in contrast to a left ear effect found for thirteen patients with known right hemisphere lateralization for language. Kimura (1961) compared matched subgroups within her two populations (left and right-dominant for language) and found that "the ear opposite the dominant hemisphere [whether left or right] is the more efficient despite the presence of severe left-hemisphere damage in both groups" (p. 169). Therefore, the result cannot be attributed to the "lesion effect" subsequently found for temporal lobectomy patients (Berlin et al., 1972a,b, and Berlin et al., 1973a) in which the ear contralateral to the lesion makes more errors than the other ("strong") ear.

Other results from brain-damaged patients confirm Kimura's (1961) findings. A study by Alpert et al. (1971), using nonverbal and verbal sounds, required patients with right or left brain damage to listen to tape-recorded words, and respond by pointing to one of four pictures on a card. Both groups (right and left hemisphere damage) performed worse than controls on a test of nonverbal meaningful sound discrimination. However, subjects with left-hemisphere lesions, especially in posterior regions, performed significantly worse than the control group on the test of verbal sound discrimination. Similarly, a right hemisphere superiority for perceiving music has been demonstrated in lobectomized patients. Subjects of listening tasks who previously had their right temporal lobes removed did worse than left lobectomized patients on the Timbre and Tonal Memory subtest of the Seashore Test of Musical Abilities (Milner, 1962), and on recognizing orchestrated melodies (Shankweiler, 1966a).

Cerebral asymmetry for linguistic and nonlinguistic auditory processing appears to be present in infants. A study of evoked responses over left and right hemispheres of infants, children and adults resulted in greater left hemisphere activity for syllables and words (verbal stimuli), and greater right hemisphere activity for a piano chord and a noise burst ("mechanical" stimuli). The differences were found in all three groups, but the greatest asymmetries were observed in the infant group (Molfese, 1972, a,b).

For production modes, bilateral and/or subcortical abilities for functions is suggested by clinical observations. Expressive aphasics rarely lose control of pitch in normal linguistic intonation, although other aspects of language production are severely impaired. Moreover, aphasics and both right- and left-hemispherectomies can usually sing (Smith, 1966; Gordon, 1973; Bogen, 1973) and correctly intone some speech utterances. In the Wada test for cerebral dominance, Bogen and Gordon (1971) observed a strong left-brain dominance for language production, but suggest that "tonal abilities" are either a right hemisphere or a bilateral function in the brain.

Perception evidence suggests that some pitch processing is not specialized in either hemisphere. Neither ear was preferred in the processing of clicks (Schulhoff and Goodglass, 1969) or steady-state vowels (Shankweiler and Studdert-Kennedy, 1967). Darwin's studies show that although some types of pitch changes are more successfully recognized by the left ear (right hemisphere), analysis of simple pitch contours can be done in either hemisphere (1969, p. 168).

Milner (1962) found no significant change in pitch perception after unilateral lobectomy (left or right). Zurif and Mendelsohn, in their dichotic listening tests for sentences, are led to suggest the possibility that "a preliminary and partial analysis of prosodic contours can be carried out in both hemispheres" (1972, p. 331). Curry (1968) found no significant difference in performances for the dichotic pitch discrimination test in normals and a right hemispherectomized patient. On the basis of the patient's high scores on both monotic and dichotic pitch discrimination tasks, (higher than normal subjects' scores) and previous findings that cats can make pitch discriminations after bilateral ablations of the cortex (Katsuki, 1961; 1962), Curry suggests that pitch is subcortically processed.

In some studies, pitch processing shows laterality effects according to task. This set-influence effect is exemplified by Spellacy and Blumstein (1970), where vowels in a linguistic context were better recognized by the right ear, while the same stimuli in a nonlanguage context

(embedded in music and environmental sounds) were preferred by the left ear. Similarly, when pitch was used linguistically to distinguish voiceless from voiced consonants, a right ear advantage resulted (Haggard and Parkinson, 1971). Studies by Day, Cutting and Copeland (1971) have demonstrated that dichotic stimuli processed in terms of a linguistic dimension are better heard at the right ear, although the same stimuli, when processed according to a non-linguistic dimension, pitch, are preferred by the left ear. This verbal-nonverbal dichotomy for acoustic processing in the left versus the right hemisphere has been further confirmed by evoked cortical response studies (Wood, Goff and Day, 1971; Cohn, 1971). A reaction-time study using binaurally presented stimuli provided further evidence that different mechanisms underlie the processing of linguistic as compared with nonlinguistic dimensions of same stimuli (Day and Wood, 1971).

The verbal-nonverbal hypothesis for left and right hemisphere processing has been extended to visual stimuli using the tachistoscope, on normal subjects for review see Dimond (1972) and on split-brain subjects Gazzaniga (1970).

In summary, psychophysiological evidence suggests that simple pitch processing is bilaterally or subcortically represented in the brain. Experimental studies indicate that there is functional lateralization in the human brain. Dichotic listening studies have usually resulted in a right ear superiority for language-like stimuli, and for at least two nonlanguage tasks involving pitch (lingual tone-tracking (Sussman, 1971) and Morse Code for naive subjects) (Papçun et al., 1974). A left ear superiority has been found for other tasks, including those involving pitch such as music, and at least one task embedded in a linguistic signal (pitch contours in sentences) (Haggard and Parkinson, 1971, Blumstein and Cooper, 1973).

The experiment reported here was conducted to test cerebral processing of pitch features when these features are functional cues in a language. We selected a tone language, Thai, in order to determine whether native speakers of a language which utilizes pitch for systematic phonological distinctions would show the right ear advantage expected for linguistic stimuli, or the left ear or no ear advantage expected for processing of pitch distinctions.

Dichotic listening of tones and pitches in Thai and nonThai speakers*

The experiment was designed to compare dichotic listening responses for Thai words differing only in tone with Thai-words differing only in initial consonant. We included a task of pitch discrimination using pitch contours identical to the linguistic tones, but presented in a non-linguistic context, as hums. We wished to compare speakers of a tone language with those of a nontone language for these three tasks and to compare these results with speakers of other tone languages, such as Mandarin and Yoruba. These comparisons with nonspeakers of Thai are not yet completed.

Subjects and stimuli

The results reported are based on a population of 24 native Thai-speaking subjects (students and residents of Los Angeles). The English-speaking group is made up of 14 American students.

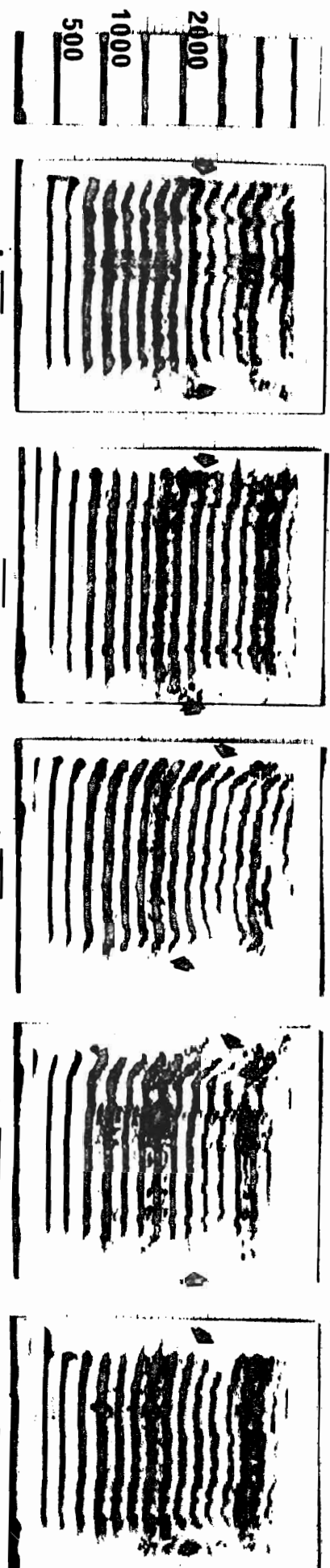
(1) Tone-words			
Stimulus	Tone	Length (ms)	English gloss
nāa	mid tone	625	"field"
nàa	low tone	650	(a nickname)
nâa	falling	575	"face"
nāa	high tone	625	"aunt"
nāa	rising	650	"thick"
(2) Consonant-words			
dāa	mid tone	700	(a nickname)
nāa	mid tone	650	"field"
sāa	mid tone	700	"diminish"
čāa	mid tone	650	"tea"
lāa	mid tone	600	"goodbye"
(3) Hums			
—	mid tone	650	
˘	low tone	550	
^	falling	550	
˙	high tone	575	
˘	rising	525	

Table 5.1. Three sets of stimuli

* This study, which was conducted in collaboration with Victoria A. Fromkin, Department of Linguistics, UCLA, Los Angeles, California 90024, has also appeared as Van Lancker and Fromkin, 1973.



Hz.



Hz.



Figure 5.1. Spectrograms of Thai stimuli. (10th harmonic contour at arrows)

Three sets of stimuli* were used: 1) five Thai words differing only in tone (pitch), the "tone-word" stimuli; 2) five Thai words contrasting only in initial consonant, and having the same tone; all five words occur on mid tone. These are the "consonant-word" stimuli. 3) For this third set of stimuli, the five Thai tones were hummed, to produce the pitches alone, without segmental information. These are referred to as "hums" (Table 5.1, Figure 5.1).

For each of the three sets, every stimulus was paired with every other stimulus, producing 20 pairs. These were presented twice, with channels reversed the second time through; then the earphones were shifted and the forty pairs (2 x 20) were presented again. Thus there were 80 stimulus pairs for each set. For all subjects, the three stimulus sets were presented in the order: 80 tone-word pairs, 80 consonant-word pairs, 80 hum pairs. The pairs were presented with a six-second inter-stimulus interval, with the exception of a block of 40 pairs in set I (tone-words), which were presented as "doubled" pairs (described below, p. 87).

The subjects were provided with eight answer sheets with five columns, ten rows per page (for a total of 80 pairs for each of the three sets), eight pages for each stimulus set (Table 5.2). Each column was headed by the appropriate 'tone-word' or 'consonant-word,' designated in both Thai and English orthography, and by iconic diacritics to represent the tones. These diacritics plus the Thai word for the tones headed the 'hum' column. The subjects were directed to respond by marking an 'L' under the appropriate column to indicate the stimulus heard in the left ear, and an 'R' under the column that specified the stimulus heard in the right ear. The order of reporting left-ear-right-ear, or right-ear-left-ear was reversed every ten pairs.

Before each of the three stimulus sets, practice sessions were conducted for all subjects using binaurally presented stimuli. The actual testing did not begin until the subjects in the recognition test showed perfect identification of each stimulus. The non-Thai speakers usually required more practice.

In preliminary sessions, Thai speakers showed few or no errors in reporting the 'tone-words.' Therefore, to induce errors, for half (40 pairs) of these stimuli, the interval between every other stimulus-pair was shortened, so that two pairs were presented in rapid succession. Thus for the first set of stimuli (only), the tone words, the subjects heard the second forty presentations as two pairs one right after the other, then a six-second pause, then two more pairs, etc. The *first* forty pairs of the tone-word set were left as originally prepared (i.e., with a 6 second interval between each stimulus pair).

* One tone-word stimulus (rising, #4) was distorted during the dichotic tape preparation. The result was a slight creaky-voice quality. Thai subjects reported that all stimuli sounded natural. Because of balanced channels, the defect could not have affected ear advantage results.

First set: tone-words

	ḡḡḡ nāa	ḡḡḡ' nāa	ḡḡḡ ² nāa	ḡḡḡ ² nāa	ḡḡḡ nāa
1.					
2.					
3.					
⋮					
10.					

Second set: consonant-words

	sāa	lāa	nāa	čāa	dāa
1.					
2.					
3.					
⋮					
10.					

Third set: hums

	—	—	∧	/	∨
1.					
2.					
3.					
⋮					
10.					

Instructions to subjects: "Listen to both ears. Mark L for what you hear in your left ear, and R for the right ear."

Table 5.2. Answer sheet format

	Left Ear Errors			Right Ear Errors			Inv.	POE
	X	I	Total	X	I	Total		
1. naa 'tone-words'	559	125	684 $\bar{X}:31$	402	107	509 $\bar{X}:23$	64	57.3
2. CVV 'consonant- words'	522	157	679 $\bar{X}:31$	428	96	524 $\bar{X}:24$	185	56.4
3. 'hums'	311	55	366 $\bar{X}:17$	314	41	355 $\bar{X}:16$	75	50.8

Table 5.3. Error scores for 22 Thai subjects. (X= non-intrusion errors, I= intrusion errors; Inv.= inversions; POE= percentage of total errors made by the left ear.

(21 subjects) excluding subjects #4 and #12

(critical value of $T = 43$)

tone words $T = 24. p < .01$

consonant words $T = 45.5 p < .05$

hums $T = 102.5 \text{ NS}$

(22 subjects) excluding subject #4

(critical value of $T = 49$)

tone words $T = 29.0 p << .01$

consonant words $T = 43.0 p < .01$

hums $T = 119.0 \text{ NS}$

Table 5.4. Wilcoxon matched-pairs signed-ranks test.

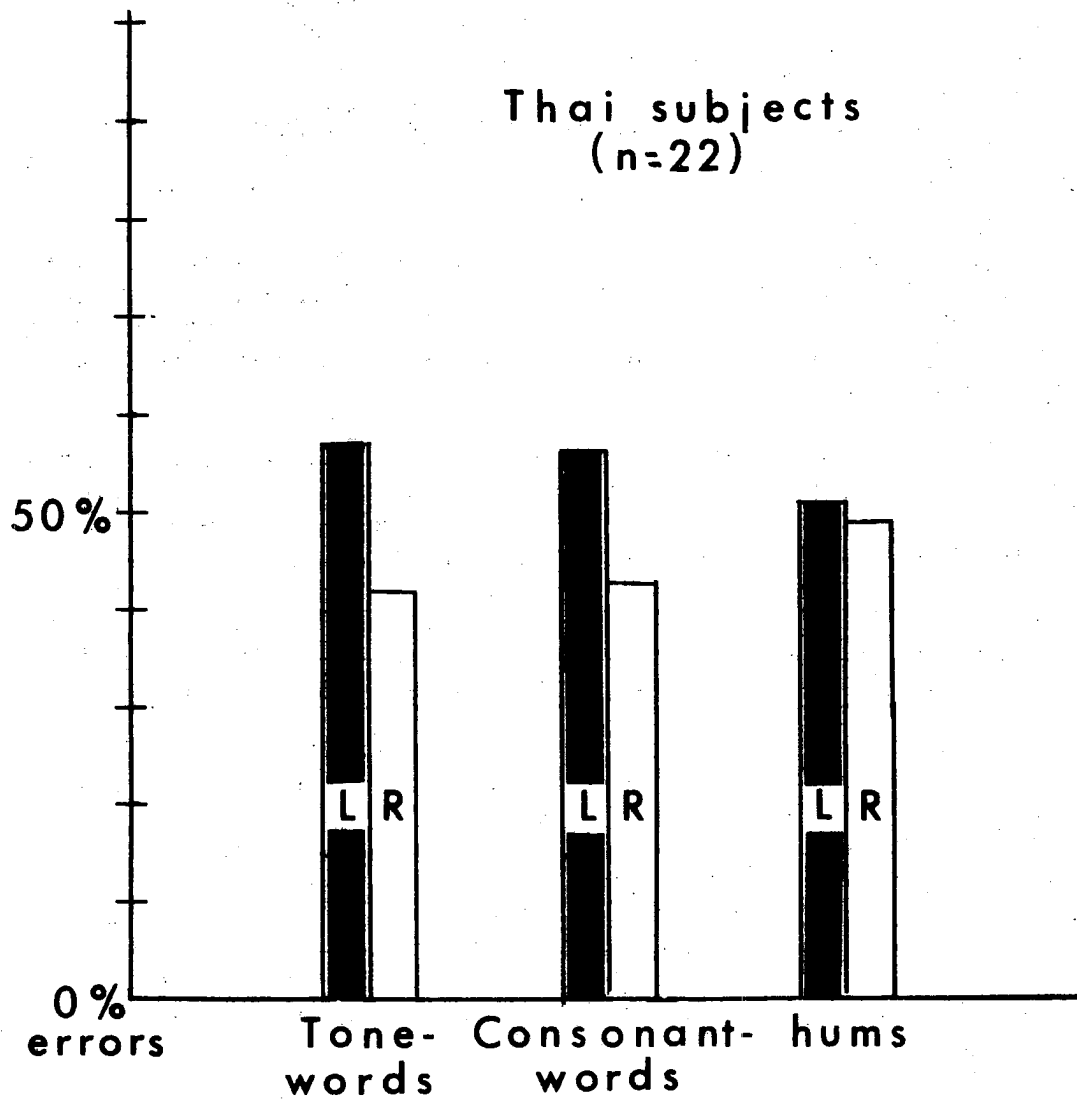


Figure 5.2. Percentage of errors (POE) by left and right ears

Results: Thai speakers

The number of errors for each ear was totaled for each set of stimuli. In addition to *errors*, (zero or incorrect response) we also noted *intrusions*, in which one stimulus was correctly identified but located at the wrong ear, and *inversions*, where both stimuli were correctly identified but ear locations exactly reversed. Inversions were excluded from the error analysis. Intrusions were counted as a single error. Table 5.3 reports the results for the Thai speakers.*

For each subject, a left ear total error score (errors and intrusions) and a right ear total error score were computed (Table 5.3). Using the Wilcoxon matched-pairs signed ranks test, the matched left ear versus right ear scores were compared. The left ear scores were found to be significantly greater for the tone-words and the consonant-words. There was no significant difference between left and right ear errors for hums (Table 5.4). Thus, Thai subjects showed a significant right ear advantage for both the Thai tone-word and consonant-word stimulus sets. For hums there was no ear advantage.

The early dichotic listening results (Broadbent, 1954; Kimura, 1961) were based on the presentation of triplet pairs of digits. Therefore, in an attempt to induce errors in the tone-words responses, we decided to present some of the Thai-tone dichotic pairs in sequence of two pairs. Half of the total set of tone-word pairs were presented as doubled pairs. This permitted a comparison of two types of presentation: subset 1, one pair presented followed by a 6-second interval, subset 2, two pairs presented in rapid succession, followed by a 6-second interval (Table 5.5).

We analyzed the data of the first forty single pairs separately. The total errors for the first forty (normally presented) pairs, (Table 5.6) showed a significant right ear advantage ($T = 35$, $p = .05$) in a Wilcoxon matched-pairs test. These figures indicate that the doubled-pairs section did induce errors by making the task more difficult, but (the ear superiority) did not significantly change across the two conditions. Therefore, the results for the tone-words cannot be ascribed to "verbal memory" effects alone. However, verbal memory may have played a role in enhancing the overall ear advantage for the tone-words.

* Two subjects from the total subject number of 24, were eliminated from these statistical analyses: one left-handed subject, and one subject with unusually high errors in the hum task (#12 in Tables 5-7 and 5-8). Tests were repeated leaving out subject #4, who was run on the original non-doubled tape (in the tone-word task) and including subject #12. The same significant ear advantage resulted.

Tone-word Condition

	<u>Channel 1</u>		<u>Channel 2</u>	
Subset 1: 40 pairs	naà _____	naá		6 seconds
		⋮		
	naā _____	naǎ		6 seconds
		⋮		
Subset 2: 40 pairs	naà _____	naá		6 seconds
	naā _____	naǎ		
		⋮		
	naâ _____	naā		6 seconds
	naá _____	naà		
		⋮		
Total:	80 pairs			

Table 5.5. Scheme of regular and doubled tone-word pairs.

	Left Ear Errors			Right Ear Errors			POE
	X	I	Total	X	I	Total	
'tone words'	127	28	155	92	15	107	58
			$\bar{X}:7$			$\bar{X}:4.8$	

Table 5.6. Total errors for 40 'tone word' pairs presented with 6 sec. intervals between them. Thai subjects.

Sub.#	Tone - word					CV-word					Hum				
	X	L	X	R	I	X	L	X	R	I	X	L	X	R	I
1.	13	1	10	4	5	19	7	19	7	8	2	1	5	2	3
2.	32	10	34	2	0	19	5	21	1	0	38	3	39	5	2
3.	37	3	31	5	0	32	12	45	9	4	21	4	23	3	3
4.*	0	0	2	0	0	25	0	6	5	4	5	0	4	1	0
5.	15	4	13	2	1	10	4	11	0	6	0	0	2	0	0
6.	29	5	25	6	1	13	7	16	3	21	1	2	4	1	11
7.	40	6	29	5	0	29	6	20	7	5	29	6	29	1	3
8.	23	7	17	4	3	17	3	18	3	9	11	3	9	1	2
9.	37	5	24	8	4	12	0	1	0	1	21	1	21	2	6
10.	15	3	5	3	2	7	3	9	1	9	1	0	0	0	1
11.	17	0	4	3	0	20	8	16	1	15	2	0	3	0	0
12.**	21	0	0	8	2	24	5	18	6	5	60	3	41	7	0
13.	20	13	30	5	4	23	12	33	8	5	11	1	13	3	3
14.	12	5	23	7	3	21	3	23	11	13	2	0	6	0	1
15.	38	10	14	3	0	51	1	8	4	0	14	0	9	3	0
16.	25	12	29	10	5	32	10	22	4	6	14	3	13	1	3
17.	19	2	3	0	0	20	6	15	4	5	4	1	2	1	0
18.	27	3	15	7	4	31	4	16	6	10	33	7	35	5	1
19.	16	10	21	9	10	23	11	34	10	15	13	4	12	2	12
20.	38	7	35	4	0	40	12	24	3	2	30	2	31	3	0
21.	35	10	14	9	9	28	18	35	5	12	11	2	10	2	5
23.	25	4	16	8	2	21	19	25	0	9	15	6	22	2	2
24.	46	5	8	3	0	29	6	11	4	9	33	9	22	3	4

Table 5.7. Individual subject scores for tone-words, consonant-words and hums.

* All undoubled pairs

** High errors

	Tones	CV's	Hums
1.	50.0	50	30.0.
2.	53.8	52.2	48.2.
3.	52.6	44.9	49.0.
4.*	0	69.4	50.0.
5.	55.9	56.0	0
6.	52.3	60.4	37.5
7.	57.5	56.5	53.8.
8.	58.8	48.8	58.3.
9.	56.8	92.3	48.9.
10.	69.2	50.0	100.9.
11.	70.8	62.2	40.0.
12**	72.4	54.7	56.7.
13.	48.5	46.1	42.9.
14.	36.2	41.4	25.0
15.	73.8	81.3	53.9.
16.	48.7	61.8	54.9.
17.	87.5	57.8	62.9.
18.	57.7	61.4	50.0.
19.	46.4	43.6	54.8.
20.	53.6	65.8	48.5.
21.	66.2	53.5	52.0.
22.	54.7	61.5	46.7.
23.	82.3	70.0	62.7.

Table 5.8. POE (percentage of errors) scores for individual subjects on tone-words, consonant-words, hums.

(*all undoubled tone-word pairs

**high percentage of errors)

The right ear superiority for tone-words and consonant-words were compared. Using the Percentage of Errors method of analysing dichotic listening results (Harshman and Krashen, 1972), error totals were converted to POE scores. For Thai subjects, the overall POE (percentage of errors made by the left ear) mean for tone words was 57.3, for consonant words 56.4, for hums 50.8. The mean for individual subject POE scores for tones was 58.7, for consonant words, the mean POE score was 58.5, for hums, 48.6. A matched-pairs T-test showed no significant difference in between Tone-word and Consonant word-sets ($T = .576$).

In contrast, individual comparisons of ear superiority results for consonant-words and hums, and tone-words and hums reveal larger numbers of subjects with nonparallel trends. For tone-words and hums, eight subjects had right ear advantages for both tasks, two subjects had left ear advantages for both tasks, ten had trends in opposite directions, and two had no ear effect on one or the other task. For consonant-words and the hums, seven had a right ear advantage for both tasks, three had left ear advantages, and twelve were opposite or inconsistent (Table 5.9).

From these figures, it seems that the tone-words and the consonant-words were processed similarly. A fact about handedness tends to support this conclusion. All subjects described themselves as right-handed, but one of the three with a left ear advantage on both consonant-words and tone-words was reportedly also "somewhat ambidextrous." Thai children are encouraged to use their right hands even if they would have preferred the left.

Data for individual subjects ($N=22$)* in the Thai dichotic listening study are included in Tables 5.7 (total errors) and 5.8 (POE scores). For the tone-word condition, 17 of 22 subjects showed a right ear advantage (a higher percentage of errors at the left ear), four showed a left ear advantage, and one showed no ear difference. These results are significantly different in a Chi Square test from a theoretical distribution of right and left ear scores at $p < .02$. For consonant-words, fifteen out of 22 Thai subjects showed a right ear advantage, five a left ear advantage, and 2 showed no ear preference. These results tend to be significant ($p < .10$). For hums, ten Thai subjects have a right ear advantage, ten Thai subjects have a left ear advantage, and one has no ear advantage.

An observation in individual subjects' performances suggests that tone-words and consonant-words were being processed similarly. Of 22 subjects eighteen subjects had ear advantages in the same direction for both stimulus sets. Fourteen had a right ear advantage for both tone-word and consonant-word stimulus sets, three had a left ear advantage for both stimulus sets, and one had no ear advantage for both stimulus sets.

* Correlation studies excluded subject #4 and the left-handed subject.

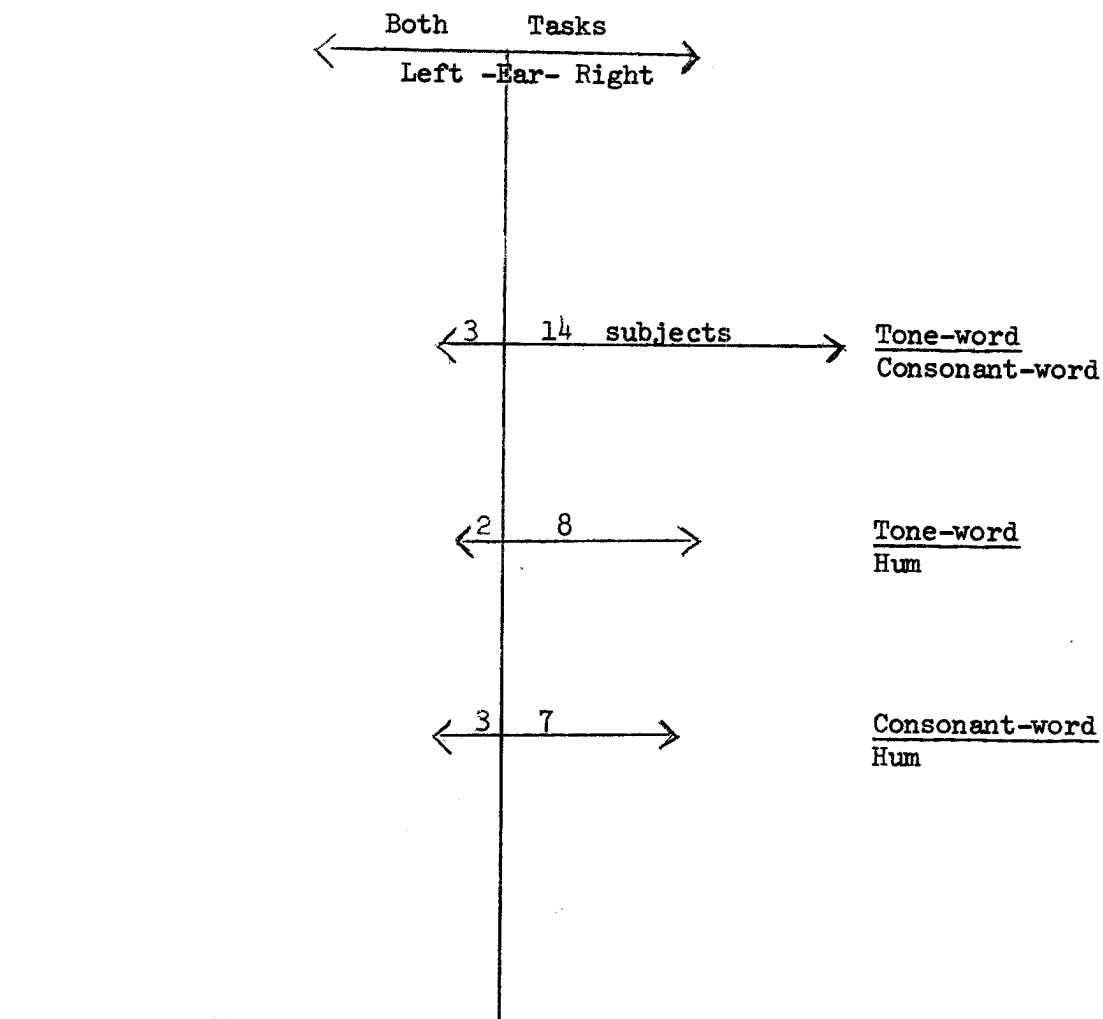


Table 5.9. Same-ear advantages across two tasks.

A recent survey on 1,200 university students conducted in Thailand (Scovel, 1974)* suggests that 1) there is enormous social pressure to write with the right hand (although this is not a Ministry of Education policy), and 2) there are at least some right-handed writers who, use the left hand for most or all other tasks, and can be said to be naturally left-handed. Therefore, for the three Thai subjects who showed a left ear advantage for both the linguistic tasks, it is possible that reported handedness does not correlate with hemispheric dominance for language. The results from one reportedly left-handed subject (who was not included in the pooled data) are mixed.

Tone-words				CV-words				Hum			
L		R		L		R		L		R	
X	I	X	I	X	I	X	I	X	I	X	I
39	8	25	9	26	13	30	11	19	4	12	3
47		34		39		41		23		15	

Table 5.10. Error scores for one left-handed Thai subject.

This subject showed a slight right ear advantage for tone-words and hums, but no discernable ear advantage for consonant-words.

Individual subjects' left and right ear scores suggest that, overall, tone-word and consonant-words were processed similarly (with respect to their ear preference, and, by inference, to their lateralization) in this dichotic listening study. A further comparison of individual subjects' scores was attempted. Correlational statistics on individual POE (percentage of errors) scores support the conclusion that tone-words and consonant-words are processed similarly. In addition, subjects' performances for tone-words and hums are also correlated. Correlation coefficients on 22 Thai subjects, presented in Table 5.11, suggest 1) that consonant-words and tone-words are similarly processed (Figure 5.3). An interpretation in the context of cerebral processing of these stimuli might be that the consonant-words and tone-words have in common lateralization of function; they share "hemispheric locus" or degree of lateralization to the left hemisphere. In contrast, the tone-words and hums may have in common a processing ability for pitch phenomena, not related to laterality. This interpretation is consistent with other findings in lateralization research, which suggest that linguistic phenomena are lateralized to the left hemisphere, but pitch processing is a subcortical or bilateral cerebral function.

* personal communication

	Tone- words	Consonant- words	Hums
Tone- words		.383	.472*
Consonant- words	.479*		.071
Hums	.568*	.085	

Pearson's r
Critical Value for
 $p < .05 = .423$

Spearman's rho Critical Value for
 $p < .05 = .450$

Table 5.11. Correlation matrix for compared performance across tasks: Thai subjects.

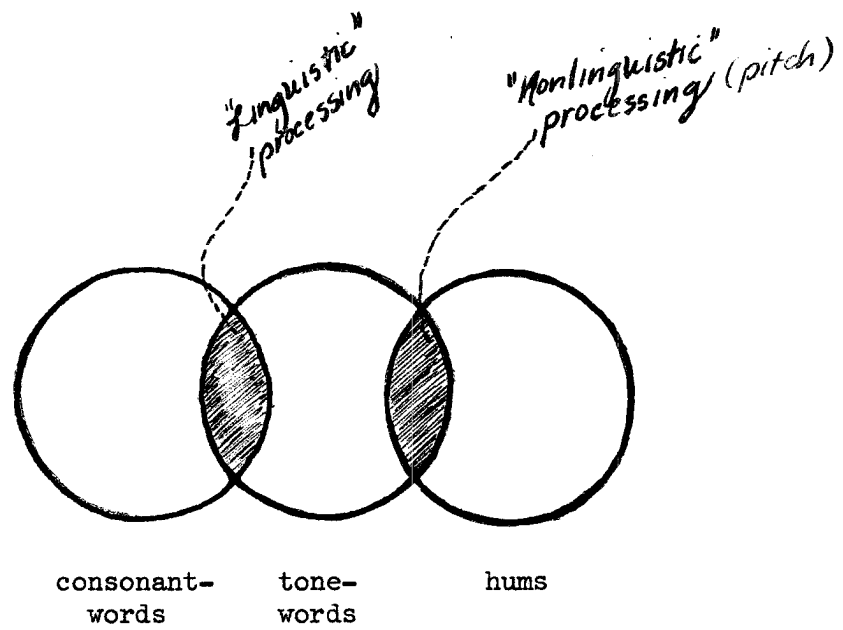


Figure 5.3. Hypothetical scheme of shared properties underlying processing of the three tasks.

Preliminary results from non-Thai speakers

The data from the American subjects are dubious because the population is mixed in handedness, musical skills and acquaintance with a tone-language. Preliminary data from 12 right-handed English-speaking subjects revealed no statistically significant ear difference for any of the three tasks (the tone-words, the consonant-words, or the hums). There is a slight *trend* toward right ear preference for the consonant-words.

The nonsignificant results for the tone-words were as expected. These stimuli were lexical items for the Thai listeners, but were nonsense syllables differing in pitch contour for the American listeners. The lack of ear superiority on the hums in American listeners was also expected. The nonsignificant result for the consonant-word task is in agreement with one other study (Zurif and Ramiers, 1972). A population of native speakers of French, listening to (American) English nonsense syllables, did not show the usual (right) ear superiority found in American subjects. It might tentatively be concluded that to be processed primarily by the left hemisphere, stimuli must satisfy phonetic criteria, and thereby qualify as language sounds to speakers of a particular language. However, contradictory findings have been reported. Myers (1971) found no difference in responses between Russian speakers and non-Russian speakers in dichotic listening of Russian syllables (Myers, 1971). Cutting (1973) has shown that speech-like sounds, including those with non-phonetic transitions (formant transitions that do not occur in speech, but are similar in quality to actual formant transitions in CV syllables in speech) also result in a right ear advantage, whereas no significant ear advantage was found for nonspeech-like transitions, constructed out of sine-waves. These discrepancies remain to be explained.

Correlation coefficients on the American subjects are of little value, because of the small size and heterogeneity of the subject population (Table 5.12). There is a statistically significant correlation between tone-words and consonant-words. These tasks did not agree in overall ear advantage, but they may have been recognized as language-like stimuli, and processed similarly to some extent.

At this time, studies suggest that the left hemisphere is specialized for both "purely auditory events" and speech. Current research is aimed at establishing the critical features that engage the left hemisphere speech mechanisms at the level of auditory analysis, and the qualities abstracted from the acoustic component which engage the left hemisphere speech-mechanisms.

	Tone-words			Consonant-words			Hums		
	L	R	POE	L	R	POE	L	R	POE
1.	56	39	58.9	46	35	56.8	20	21	48.8
2.	36	28	56.2	29	25	53.7	13	17	43.3
3.	52	36	59.1	45	29	60.8	28	25	52.8
4.	6	18	25.0	1	2	33.3	0	1	0
5.	51	54	48.6	50	33	60.2	38	36	51.3
6.	35	40	46.7	38	39	49.4	23	26	46.9
7.	45	56	44.6	33	40	45.2	29	30	49.1
8.	39	43	47.6	25	20	55.6	34	39	46.6
9.	57	51	52.8	56	65	46.3	56	59	48.7
10.	54	53	50.4	53	49	52.0	60	55	52.2
11.	62	65	45.3	43	28	60.6	66	66	50.0
12.	50	56	47.2	27	39	40.9	32	33	49.2

Individual subjects' errors

Tone-words		Consonant-words		Hums	
L-ear-	R-ear	L-ear-	R-ear	L-ear-	R-ear
543	539	446	404	399	408

Total errors

Table 5.12. Errors for 12 right-handed American subjects

	Tone- words	Consonant- words	Hums
Tone- words		.694*	.032
Consonant- words			.250
Hums			

Table 5.13. Correlation matrix for compared performances across tasks: American subjects.

* Significant $p < .01$

A tabulation of confusions pooled from the tone-word discrimination tasks (Thai subjects) is presented in Table 5.14. Rank-ordering of the confusions (Table 5.15) indicates that the most confusions occurred between $n\bar{a}a$ (mid) and $na\grave{a}$ (low), whereas the least confused pair was $na\grave{a}$ (low) and $na\acute{a}$ (high). Further statistical tests using multi-dimensional scaling will be conducted to explore the feature space that subjects use to discriminate and identify linguistically significant pitches. These findings can then be compared with confusion matrix data from nontone-language speakers.

Conclusion

The data from this study show that for a group of tone-language speakers, when pitch contrasts occurred on words in dichotic listening, a right ear effect resulted. No ear preference was observed when the same pitches occurred as hums. No significant ear advantages were observed for American subjects. If the general assumptions about dichotic listening are correct, it can be concluded that perception of phonemic pitch contrasts by tone language speakers is lateralized to the left hemisphere to at least the same degree as consonant-vowel words in that language. We conclude that when pitch is processed linguistically as part of a system for differentiating lexical items, left hemispheric specialization occurs as for other language stimuli. The results support the "functional" interpretation of dichotic listening results, in that stimuli recognized as "language" are processed in the left hemisphere, whereas similar or identical stimuli not functioning linguistically are not lateralized to the left hemisphere.

Discussion

The interpretations about pitch processing in a tone-language above await further research to be confirmed. In a similar experiment, Smith and Benson (1972) found no ear effect for speakers of Cantonese. The differences could have been due to 1) fewer subjects in the Cantonese study than the Thai study; 2) higher accuracy rate in Cantonese subjects' responses 3) differences in cerebral processing of Cantonese vs. Thai tones, due to linguistic or cultural factors. In a second Cantonese study, Smith and Shand (1974) found a right ear advantage for a larger population of subjects and consonant-words when the Cantonese tones were presented against a background of noise. Thus high accuracy and subject population would seem to account for the discrepancies found in the first study. A preliminary study of dichotic listening of Yoruba level tone-words, musical notes, and consonant-words conducted in the UCLA Phonetics Laboratory (Curtiss and Lord, 1974) on seven Yoruba speakers did not yield statistically significant results. Further testing is necessary to evaluate dichotic listening results in Yoruba speakers.

Substitution Errors

Stimulus	Total = 478	$\bar{n}aa$	$n\bar{a}a$	$na\bar{a}$	$n\hat{a}a$	$n\check{a}a$
$\bar{n}aa$ M (Mid)	88		32	17	20	19
$n\bar{a}a$ L (Low)	118	57		15	27	19
$na\bar{a}$ H (High)	85	28	16		24	17
$n\hat{a}a$ HL (Falling)	87	15	27	29		16
$n\check{a}a$ LH (Rising)	100	18	36	23	23	

Table 5.14. Matrix of confusion errors.

Stimulus → Error Error ← Stimulus	Total Number
M ~ L	89
L ~ Rising	55
L ~ Falling	54
H ~ Falling	53
M ~ H	45
H ~ Rising	40
Rising ~ Falling	39
M ~ Rising	37
M ~ Falling	35
L ~ H	31
	478

Table 5.15. Rank ordering of confusions

It is important to note that other prosodic features, in addition to fundamental frequency, are present in the linguistic signal. As Fry (1969) and others have pointed out, "Pitch variations are not solely responsible for the recognition of intonation patterns and tones; there is also a contribution from variations in loudness, length and also in sound quality" (Fry, 1969, p. 372). In the Thai experiment, in addition to pitch, the other acoustic cues available in the "tone words" were glottal stop, length, and breathy voice.

In his study of Thai tones, including acoustical analysis of real speech and perception studies of synthetic tones, Abramson (1962) found that "Pitch convincingly overrides the effects of concomitant phonetic features observed in the utterances" p. 139. However, these complex phonetic cues may contribute to the results that the Thai subjects treated the Thai tone-words as language, but not the hums. These results agree with the interpretation by Studdert-Kennedy and Shankweiler (1970) that "while the general auditory system common to both hemispheres is equipped to extract the auditory parameters of a speech signal, the dominant hemisphere may be specialized for the extraction of linguistic features from those parameters" (p. 579).

It seems that a trigger feature "switches on" left hemisphere processing. But this critical feature must be conceived at some level of abstraction as suggested in dichotic listening studies by Evans et al. (1974), left hemisphere processing is triggered by speech-code-like feature in the stimulus as an task-specific all-or-none phenomenon.

Interpretation for linguistic functions of pitch

How do the results from the dichotic listening Thai study relate to the claims about pitch features in language presented in Chapter Four and in the beginning of this chapter? The first claim was that pitch features are stored and processed differently from other linguistic (including phonological) phenomena. A finding that contrasting pitch contours in a tone language do not result in a right ear advantage in dichotic listening would be strong support for this claim. However, a right ear effect was found for pitch contours, when pitch differences occurred on words in Thai, but not when these pitches occurred without segmental information (on hums). Therefore the ear advantage results in this study do *not* strongly support the first claim, that features of pitch in the linguistic signal are stored and processed differently from other phonological features. However, the correlational values suggest that tone-word processing had some feature in common with hum processing, but that feature was not related to ear advantage. Therefore, it is possible that pitch processing in language is special in ways yet to be determined.

The second claim is that points on a functional scale of pitch function can be correlated with lateralization of pitch processing in the brain. The findings in the Thai study, when considered with other dichotic listening findings, are compatible with the notion that pitch distinctions in language comprise a functional scale of "most linguistically structured" to "least linguistically structured," and that points along this scale are associated with lateralization of processing.

The Thai results indicated that this "most linguistic" function of pitch discriminations in language, the use of pitch for phonological distinctions in a tone language, is lateralized to the left hemisphere. Other studies have found right or left ear effects for pitch in the linguistic sign with a left ear advantage more often for "less structurally linguistic" pitch cues. Haggard and Parkinson (1971) found a right ear advantage for voicing of stop consonants when the only distinguishing cues were trajectories of fundamental frequency. A right ear effect was found for the rhythm and accent structure of nonsense strings (Zurif and Sait, 1970), tentatively suggesting that "the neuropsychological systems that process the effects of intonation, rhythm, pause, and stress associated with constituent structure are lateralized" to the left hemisphere (p. 243). These apparently contradictory results may reflect the ambiguous role of pitch for syntactic/grammatical and attitudinal contrasts in English.

Another study resulted in left ear effects for the emotional tone of sentences, compatible with the notion that this function of pitch changes is the "least linguistic" in the hierarchy (and therefore processed in the right hemisphere) (Haggard and Parkinson, 1971). On the other hand, Blumstein and Cooper (1973) found a left ear advantage for intonation contours filtered from real speech, and intonation contours carried in a nonsense syllable medium. The left ear advantage resulted even when subjects were asked to identify the stimuli by sentence-type. These authors suggest that "the right hemisphere is directly involved in the perception of intonation contours, and that normal language perception may involve the active participation of both cerebral hemispheres."

On the basis of a series of studies on hemispheric processing of auditory stimuli, Darwin proposes an extension of Jackson's hypothesis about propositional (left hemisphere) and automatic speech, suggesting that "the types of pitch contour most likely to be processed in the dominant hemisphere would be those that carried grammatical distinctions rather than emotional ones" (1969, pp. 166-7). Further research is necessary to determine whether left hemisphere processing is correlated

with some linguistic functions of pitch but not others. For example, dichotic listening tests can be designed to determine ear preference for pitch contrasts cueing syntactic differences (such as white hòuse vs. white hóuse and yes? vs. yes!) and to compare such results with other functions of pitch contrasts (e.g. attitudinal and emotional signalling).

In aphasia, in general, abilities to produce and comprehend pitch contrasts (in speech and singing) are not disturbed. Such observations suggest that these abilities are not a left hemisphere specialization. In contrast, in normal subjects, a strong right ear advantage (implying left hemisphere specialization) was demonstrated for pitch contrasts in a tone language. These findings highlight the "logical difficulty in inferring the normal from the pathological" (Brain, 1961). The relationship between performances of normals and the performances of brain-damaged individuals is complex. The nature of the interaction between left and right hemispheres (e.g. the function of the corpus collosum) in normal brain processing, and therefore the nature of its disruption in disease, is not understood. One hemisphere may mirror, inhibit, or facilitate the other in any given function (Smith and Akelaitis, 1942).

Our results on Thai speakers seem to imply that aphasia would disrupt pitch processing abilities as much as other language skills in a Thai speaker. However, it is possible that such abilities are *also* represented in the right hemisphere, but that in the normal speaker, the leading hemisphere (when intact) for language processing "takes over" processing of linguistic stimuli. This question can be investigated by comparing results from this dichotic listening task on normal Thai speakers with results on aphasic Thai speakers.

Chapter 6.

Propositional and Nonpropositional Speech: Clinical Descriptions.

These ambiguous ambiguities, redundances, and deficiencies recall those attributed by Dr. Franz Kuhn to a certain Chinese encyclopedia entitled Celestial Emporium of Benevolent Knowledge. On those remote pages it is written that animals are divided into (a) those that belong to the Emperor, (b) embalmed ones, (c) those that are trained, (d) suckling pigs, (e) mermaids, (f) fabulous ones, (g) stray dogs, (h) those that are included in this classification, (i) those that tremble as if they were mad, (j) innumerable ones, (k) those drawn with a very fine camel's hair brush, (l) others, (m) those that have just broken a flower vase, (n) those that resemble flies from a distance.

Borges, The Analytical Language of
John Wilkins

Chapter 6

Propositional and nonpropositional speech:

Clinical descriptions

This chapter examines types of language which may be processed by the right or by both hemispheres in the brain. It is claimed that these "nonlateralized" components do not share those structural features present in left hemisphere language. Evidence for differently processed subsets in language is available in the clinical cases of aphasia and other speech pathologies.

Classifications of aphasias

There is no accepted classification of aphasia. Several schemes have been advanced and extensive testing procedures designed to demonstrate them. None of these is universally accepted, although many are convincing or useful for different purposes. The difficulties in establishing aphasic typology are due to individual variations, changes over time, involvement of extra-linguistic factors, and nonagreement on or misunderstanding of linguistic factors. There are also complex questions of the relation between pathology and behavioral syndromes.

Some commonly used, traditional classes of aphasic defects are: 1) Broca's aphasia, or a defect in production of language, also called motor aphasia, agrammatic, nonfluent, and telegraphic speech, often the result of injury to the third frontal convolution of the left hemisphere; 2) Wernicke's aphasia, or defect in comprehension, also called sensory or fluent aphasia, sometimes paraphasic or jargon aphasia, often a result of injury to the first temporal gyrus of the left hemisphere (see Figure 2.1); 3) Mixed aphasia, or global (when severe) in which language is defective in both production and comprehension and 4) anomia, amnesic or nominal aphasia, or word-finding difficulties, usually associated with extensive or diffuse damage to the left hemisphere ,

(although Geschwind (1967) claims that "a true anomia" is associated with a well-defined angular gyrus lesion).

The localizationist claims (which identify specific areas in the brain with a specifiable function) have been controversial for many decades. Details of the argument will not be presented here. For the work presented in this monograph, only minimal claims for correlations between structure and function are necessary, namely, that lateralization of function to left or right hemisphere is a potentially meaningful notion, and that cortical function may be differentiated from sub-cortically processed functions. This position, localization in the

"gross sense" that one hemisphere is dominant for language, is harmonious with all but the most "holistic" views of brain function (Osgood and Miron, 1963). Even Lenneberg (a nonlocationist) makes a stronger claim about structural function correlation for language processing. He accepts that language function is "displaced" from right to left (hemisphere) and that within the left hemisphere, there is antero-posterior polarization (anterior lesions are more likely to disturb motor aspects of language, whereas more posterior lesions affect sensory aspects) (1967, p.71). Furthermore, there may be a distinction between cortical and subcortical language function.

There are controversies about the traditional classification. It has been argued that all aphasias are mixed; that word finding difficulties occur in most cases; that comprehension is always impaired; even that the defects are intellectual and that the linguistic scheme is misleading. These arguments also need not be detailed in this monograph. Most observations of aphasic speech are of expressive aphasia; most details are facts about production of speech in aphasia. This is partly because speech comprehension is less "visible" than speech production, and more difficult to assess. It has therefore received less attention. The following pages are devoted to a survey of clinical reports. These cases of aphasia are considered in relationship to a propositional/non-propositional dichotomy in speech performance.

Clinical descriptions of aphasia: nonpropositional speech

In their survey of neurological aspects of speech, Espir and Rose (1970) provide a list of speech abilities typically retained in aphasics, possibly in the right hemisphere. Their term for these modes is "non-intellectual speech," and they include

1. Emotional utterances
 - a. ejaculations, expostulations
 - b. yes, no; i.e. "primitives" in the sense of first-learned
 - c. "other words used inappropriately"
 - d. jargon
 - e. recurrent utterances

2. Automatic speech (songs, poems)
3. Serial speech (alphabet, days of the week)
4. Social gestures of speech (e.g. how do you do)

This observation, that some speech performances are less impaired than others, recurs throughout the aphasiological literature. The site of brain processing is controversial; points of view in other areas may conflict, and the terminologies vary, but the fact remains that some nonintellectual, or nonpropositional kinds of speech are performed by many aphasics who are otherwise impaired in language abilities.

Jackson's (1932) ideas about automatic and propositional speech were based on the observation that patients with left hemisphere damage often could comprehend but not speak propositions, and that they could produce some kinds of speech. He assumed these abilities for non-propositional speech to be represented in the right hemisphere. The left hemisphere is for the "voluntary revival of images," and the right for their "automatic revival" (p.141). The speechless patient understands because "my words revive his words." That is, "the right half of the brain is for the automatic reproduction of movements of words, and the left the side for their voluntary reproduction." The production of certain subsets of language, in Jackson's view, came because "the sensorimotor processes for words, even in the right cerebral hemisphere, may be so strong that these words are occasionally actually uttered." Evidence for this view is that "there is loss of the most (special) voluntary form of language (speech) without loss of the more automatic (emotional manifestations). The patient smiles, laughs and varies the tone of his voice, and may be able to sing. We find that pantomime which stands half way suffers little, and gesticulation is not affected at all. ...there is loss of intellectual language with conservation of emotional language" (p. 133 and passim).

Automaticity occurs in degrees. Jackson illustrates this point by discussing the commonly observed fact that "most so-called speechless patients can utter the words 'yes' and 'no'." These are in effect propositions, but are "the two most automatic of all propositions." Furthermore, they function nonpropositionally as interjections, and as emotional utterances, in which case they are "purely automatic." The notion of degrees is illustrated by "three degrees of the use of the word 'no.' It is used most voluntarily (as speech) when the patient can say it when told. It is used more automatically when the patient can 'utter' it in reply correctly; and it is used most automatically when it only comes out like an ordinary interjection with states of feeling." These examples indicate that the notion "automatic" is a functional one. Utterances are identified as belonging to automatic processes of verbalization by properties of their use.

The ability to use language propositionally implies abilities along a dimension toward automatic use, but not the reverse. Jackson describes a patient, as an example, who could not say "no" on command, but could say it readily in reply to a question, and then used the word to make his children behave, shouting "no no no" in an angry tone. Words, then, come out "automatically" on "fit occasions," but these same words cannot be said voluntarily. The patient "can't say what he utters." It is plain that he has somewhere in him processes for words; but the facts that they are uttered only under excitement, and that they are nearly always well-organized formulae, and that the patient cannot repeat them, show that they are not speech. Observe the two things: they are well-organized formulae, and they are only uttered under strong stimulations, which is not the 'stimulus of the will.'"

In Jackson's concept of verbalising, two processes occur, each linear, involving both hemispheres: the "automatic" reproduction of words actually occurs in both hemispheres, followed by a voluntary reproduction of words (the specialization of the left hemisphere) (Figure 6.1).

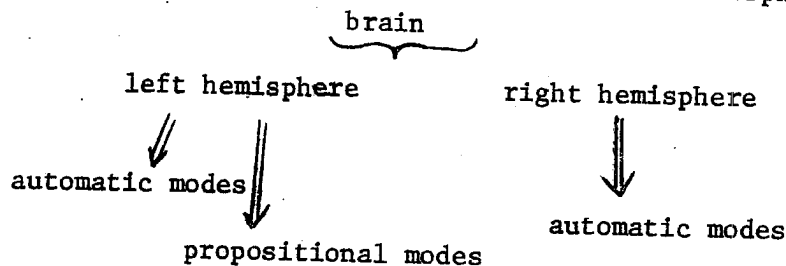


Figure 6.1. Jackson's propositional-automatic distinction, based on a partial asymmetry of language representation in the brain. Propositional language is *lateralized* to the left cerebral hemisphere, while automatic modes are bilaterally represented in the brain (1932).

Aphasiologists differ in their theories of aphasia, but agree in separating out nonpropositional speech abilities from the overall aphasic picture. Bay (1964a) follows Marie (1925) in claiming that aphasia is a unitary disorder, the varieties observed being due to defects of input and output processing, or to underlying principles, such as intentions of the speech activity. However, the propositional/non-propositional dimension appears also in this scheme. Aphasia affects

the speech performances which convey "linguistically coded information," or contain a proposition. In aphasia, according to Bay, "mere emotional reactions (swearing) are unaffected," as are "stereotyped reactions to global situations (conventional phrases such as salutations, etc.), automatisms (serials) and, ...undetermined word-finding in enumeration and association tests which mediate no sensible information." Next in line come reading and repetition; and most defective (in their testing situation) is naming and pointing to objects and story-repetition.

Bay has extended Jackson's notion (that the aphasic defect is an inability to propositionalize) to most aphasias (1964b). That is, Broca's or motor aphasia, anomia and the logorrhea (super fluency) of Wernicke's aphasia all have in common defective use of information-content bearing language. This position is expressed in another way by Gloning et al. (1963) discussing speech performances in terms of levels of complexity. The automatic greeting is a "very low-level symbol," as are the "semi-automatic sentences" of casual conversation. These processes remain faultlessly achieved by the aphasic. It is the "complex speech processes" which are defective. The aphasic picture suggests that these different types of speech require "widely different brain processes."

Critchley (1970) endorses Jackson's automatic-propositional dimension in language behavior. For Critchley, the functional roles proposed by Jackson explain observations in aphasic and normal speech, and serve to generate provocative hypotheses about human language in many other contexts. In his collection of papers on aphasiology, Critchley extends Jacksonian notions into wider ranging areas of neurolinguistics, and to speculations about the definition, function, and evolution of human language and its relationship to animal language.

Pick(1973/1931) developed a production model to accommodate his observations in clinical aphasias. He proposes four stages, two pre-verbal and two verbal: 1a) global awareness of the general import of the sentence, and 1b) schematization of the 'specific mental content'; 2a) activation of the 'specific mental content'; 2a) activation of the sentence schema, and 2b) choice of words. Pick makes an exception for sentences which are "automatic," and do not go through middle stages in production (cited in Goodglass and Mayer, 1958).

Head (1926/1963) follows Jackson's views in his two-volume work, *Aphasia And Kindred Disorders Of Speech*. He adds that in recovery from severe aphasia, nonpropositional subsets appear first: "the patient learns to utter those [words] in common use and can repeat them to order... Emotional expressions are uttered with greater ease and certainty." Similarly, in sensory aphasia (a "disorder in the perceptive

factors of speech"), most spoken words are incomprehensible noises to the patient with receptive deficit, with the exception of "some isolated words and phrases, such as [patient's] name and How are you? or similar expressions" (Vol. I.p.90). Thus, a hierarchy of disability (i.e. a propositional-nonpropositional continuum) may *also* exist in receptive aphasia, parallel to that observed in expressive aphasia. This claim, which remains to be investigated, suggests that propositional-nonpropositional factors are relevant at the level of language competence.

Luria (1970) has reanalyzed Jackson's original notions about automatic and propositional language, within his own scheme. Aphasic syndromes are classed as follows: acoustic-amnestic (usually called receptive aphasia); and expressive. Expressive aphasia takes four major forms: 1) afferent-motor (inability to make sounds, or errors in articulation) 2) efferent-motor (telegram speech); 3) semantic aphasia (alienation of meaning from word) and 4) dynamic (meaningless speech or jargon) (1964, p. 150). Generally in expressive speech, some kinds of language are conspicuously facile, while others are quite defective. In both "afferent" and "efferent" motor aphasia, habitual expressions and "well-established kinesthetic stereotypes" and other "lower levels of speech" remain intact.

According to Luria, in a typical syndrome of expressive aphasia, "...the patient is unable to formulate propositions, but he is sometimes able to name objects or repeat words; he may retain a few familiar speech expressions. He is able to utter spontaneous exclamations and to tell what his name is; he may even be able to run through certain speech sequences which have become automatic for him. Any speech pattern which might be used for the expression of a thought is impossible, but speech processes which are not a part of this system, i.e., those which involve simple verbo-motor habits or which express affective states, may be retained." Luria notes that the patient's remaining speech abilities are "based upon well-ingrained speech patterns" (1947, p. 281). The patient often cannot select individual parts of his automatic sequence or expression, but produces it as a whole. Similarly, the "dynamic aphasic" usually retains verbal stereotypes, but is defective in "propositionizing," or in the "predicative structure" of speech (Luria and Tsvetkova, 1968, p. 299).

Lenneberg (1967) is an exception among writers on aphasia, in that he does not mention the fact that conventional and overlearned and other kinds of speech are available to the aphasic. He does distinguish

another nonpropositional subset, emotional language. He divides clinical syndromes into receptive and expressive types, and further divides expressive aphasias as follows: 1) subfluency (télégraph style or agrammatism) 2) superfluency 3) semantic disturbances (a great variety) 4) difficulty in word finding 5) paraphasic disturbances including all kinds of jargon and 6) fixation on phrases (or stereotype). He comments about these aphasias that "very often the expressive disorders of language are less severe in emotional discourse than in propositional discourse. For instance, sudden, passionate exclamations may still occur at a time when the patient can no longer use language to explain something or to ask polite questions" (p. 190).

Goodglass and Mayer (1958) refer to the Jacksonian distinction, noting the commonly observed differences between propositional "as compared to exclamatory speech." They describe this as a "psychologically defined language phenomenon" which "presumably applies to aphasics of any nationality" (p. 100). It is a "fundamental psychological principle which reappears many times...that the aphasic is most apt to fail in communication which requires a volitional act of symbolic formulation, but that he performs most readily in an automatized or otherwise highly structured speech situation" (p. 101). A similar view is held by the aphasiologist Alajouanine (1956): "Situations leading to emotional, expletive, interjectional, automatic, habitual language are always more effective [in producing speech] than those requiring volitional or propositional speech" (p. 28).

Myerson and Goodglass (1972) studied three "agrammatic" aphasics, who were described as having slow, halting and telegraphic spontaneous speech, with intonations and stress contours limited to word or phrase units. "In addition, however, each patient was found to have at his command a number of stereotyped familiar expressions which were not limited by the syntactic rules of his information-carrying utterances: Example: 'I don't know' 'Yes and no' 'How are you today?' 'Oh boy!' Basically these utterances, spoken in a holophrastic usage, serve the emotive or phatic functions of language as distinct from the referential function" (p. 41-42). These authors exclude any such expressions from their analysis of the transformational grammars of the agrammatic patients.

Kurt Goldstein is an important figure in the history of aphasiology. His book, *Language and Language Disturbances* (1948) addresses questions in aphasia, lateralization, brain structure and function in language processing, recovery from aphasia, etc. and presents masses of clinical evidence to support his views. He posited a continuum in human behavior, made up of "attitudes" from abstract to concrete, and maintained that

the brain-damaged patient was defective in his abilities to perform in the mode of the "abstract attitude" (see R. Brown, 1968, pp. 288-292, for discussion). Goldstein was attempting to characterize phenomena which are the subject of this monograph: the differential performance in language behavior in aphasics, depending upon "aspect" or "mode."

Abstract and concrete attitudes in language are described by Goldstein (1948) as follows: Concrete language "consists of speech automatisms," of the "instrumentalities of speech; of sounds, words, series of words, sentences, one form of naming and of understanding of language in familiar situations for which it has been conditioned, and finally of emotional utterances." Abstract language is "volitional (sic), propositional, rational language. ...Because the various speech performances as voluntary speech, conversational speech, speaking of isolated words or of series, repetition, naming of objects, reading, etc. are in a different degree dependent on the abstract attitude, the various performances may be damaged in different degrees" (p. 25). Goldstein repeatedly observes that emotional language and "other speech automatisms" are less impaired in aphasia. Goldstein's illustrated cases, which belong in his classification of receptive, peripheral motor, central motor, and amnesic aphasia, are defective in spontaneous speech, with varying abilities in other modes.

Anomia or word-finding difficulty

These modal differences are also present in the patient's ability to name. Goldstein claims that "word-finding is different in emotional expression, in intentional speech, in speaking of motor series, of phrases in familiar connection of words, in looking for words belonging to concrete objects or abstractions (naming), in repetition, etc." For Goldstein, "the problem of finding words is a very complex phenomenon. It depends on different underlying processes: on the readiness of speech automatisms, mental attitudes, organization of the processes in thinking which precede word-finding, emotional condition." The greater difficulty comes with "various forms of voluntary speech, as in conversation, description of facts, naming objects, etc." (1948, pp. 59-60).

Brain also reports that a patient with nominal aphasia can often produce words in an automatic or well-learned series which he cannot produce as independent symbols. Thus, he may be able to count and yet be unable to tell the number of days in a week" (1961a, p. 97).

Similarly, Bay (1963) has investigated anomia, and concluded that "anomia" is not an isolated word-finding difficulty, but varies with functional significance. The disorders are both receptive and expressive, his standardized testing has demonstrated, "depending in their intensity on the intellectual level of the respective speech performance" (p. 89)

A study by Wepman et al. (1956) was designed to investigate the idea that anomia consists in a defect in naming, i.e. a loss of nouns. Their studies revealed a "more fundamental effect" of anomia, which was that only the most "general" and frequently occurring words are retained, words in all grammatical categories. The typical anomic patient's speech is made up of "the conventional formulae of language." The defect, then, is "disruption of voluntary control of those relatively infrequent words.." (with high information content), whereas the patient retains instead "more or less automatic use of the highly frequent which normally qualify more informative words" (pp. 476-77).

Palilalia

Palilalia is the involuntary repetition two or more times of terminal words or phrases. The patient is typically aware of the pathological behavior and is unable to control it. Critchley's (1970) example is, "Good morning, doctor, I'm not so well today, today, today, today..." The repeated words become more and more clipped and are spoken more softly at a faster rate. Palilalia and types of mutism occur differentially according to voluntary or automatic modes of speech. "It appears as if the habitually fused modalities of voluntary activity and automatic activity have become dissociated" (Marie, 1925). For example, a 33 year old patient, with palilalia of encephalic origin, repeated her own words 2 to 21 times in a conversation, but did not repeat any words during recitation of a story, counting from one to twenty, naming the letters of the alphabet or singing. "...a disorder such as this one which marks a borderline between purely motor manifestations (at least voluntary motor) and psychomotor manifestations will be difficult to explain in a simple anatomic pathological formula. It is a question here of a problem of different modes of activity, voluntary and automatic, and of the very substratum of these two modes of activity. Because of the difficulties, palilalia is worthy of being considered and deserves extensive research" (Marie, 1925, p. 274).

Similarly, according to Critchley, (1970), the palilalic defect occurs during "voluntary" (or "propositional" or "spontaneous") speech, *sometimes* in emotional language (varying with individual patient), and

never in read and recited speech: "The palilalia occurs not only during spontaneous speech but also in reply to questions. But palilalia does not appear during the **recital** of an automatic speech-pattern, as for instance when the patient reads aloud, or recites a well-remembered verse or prayer, or when he declaims the days of the week, months of the year, letters of the alphabet, or when he counts. Palilalia occurs not only in the course of intellectual speech or 'propositionizing,' but also -- at times -- during emotional cries, oaths, interjections and other forms of inferior speech. But this is not always the case, and in some palilalic patients, emotional speech may be free from such repetitions" (1970, p. 201).

A study of "perseveration" (the involuntary repeating of words and phrases) in aphasic patients by Halpern (1962) demonstrated that the degree of perseveration increases with words of high and medium abstraction, and with length of word. His study is consistent with observations by Marie and Critchley that perseveration (or palilalia) consistently varies with type of speech performance.

Stereotypic utterances in aphasia

The residual speech of aphasic patients often includes "recurring" and "occasional" utterances (Jackson, 1932). Recurring utterances, which nearly always appear after the initial period of speechlessness (following the injury), can be nonsense words or phrases (e.g. watty, Yabby); a single word (one, Jimmy, Battersea, yes, no); a phrase (Come on, Oh my God, Yes but you know). Occasional utterances occur in three degrees, according to Jackson: First, as nonspeech -- swearing and ejaculations such as 'Oh dear,' 'Bless my life,' and interjections which are "deeply automatic" for the individual. Secondly, there are occasional utterances which are "inferior" speech. This means the utterances are appropriately uttered, but are conventional phrases, such as 'Take care,' 'goodbye,' 'That's a lie.' There are also "higher degrees of utterance," which come by surprise from the aphasic patient. But even these utterances show, for Jackson, that "the speech possible by the right side of the brain is inferior speech. In nearly all cases it was well-organised, automatic or 'old,' and nearly every utterance required a special occasion, was, to speak properly, surprised out of the patient by a sudden accustomed stimulus" (p. 183).

In the severe case, spontaneous speech is restricted to a single recurring utterance (Alajouanine, 1956). This "hapax legomenon" is "a solitary 'word' or holophrastic word-cluster which is reiterated in

a stereotyped fashion" (Critchley, 1970). The most frequently encountered is the stereotype 'yes,' or 'no' or both. In a study of 100 aphasic cases of the retention a single word, Henschen (1922) found that 63 patients retained yes and/or no, and the rest diversity of expressions (Cited in Critchley, 1970, p. 189).

The stereotyped phrase may be nonsense: e.g. pittimy, monomentif. Stereotyped phrases are often duplicated: watty-watty, tan-tan, tara-tara, zu-zu, cousisi-cousisi; yes-yes; come-come. Interjections, sometimes deformed, commonly occur as automatism. Baudelaire retained only the phrase "cre nom," presumably from *Sacré nom de Dieu*. The stereotype can be a familiar phrase or an unusual one; it may or may not be appropriate in context. Examples are: "Bon soir, Gerechter Gott, tout de meme, the other day, As de pique, les choses d'ici bas, J'ai terriblement peur, N'ya pas de danger, That's mine, Ace of spades, Boulevard de Grenelle 131, Volontiers, dire dire, Ai bien dit, school school."

Some verbal stereotypies might have been thought or said at the time of injury. One patient, for example repeated "Farewell the things of this world." The phrase come on to me was retained by a railway signalman; "gee gee" by a woman struck ill while riding a donkey; "list complete" by a clerk struck compiling a catalogue; and "I want protection" and "on the booze" by men injured in bar fights. As previously described (Chapter 4), the aphasic usually can pronounce his automatism with different intonation patterns.

The distinction between automatic and propositional modes of speaking, (sometimes called involuntary versus voluntary) is dramatically demonstrated by patients with verbal stereotypy. Alajouanine (1956) identifies four stages in the rehabilitation of the patient with stereotypic aphasia:

1) differentiation of the repeated phrase, with modification of expression and varying speech intonation. The phrase can be used to express needs and feelings, through prosodic variation alone.

2) The patient tries to check or control the recurring expression.

3) This is a fluctuating phase, during which other fixed expressions replace or are added to the original one. For example a patient with one recurring phrase, added to his own original stereotyped expression, the phrases "After you, sir," and "pardon me. "

In the last phase (4), the fixed phrases disappear, and "volitional" speech appears, usually ungrammatical. The usual Broca's aphasia often develops. However the agrammatism occurs in the new developing speech, not in the (old) automatic language. Alajouanine observes the "very remarkable fact" that ready-made formulae of salutation, exclamations, etc. are grammatical, in contrast to the rest of the aphasic's speech. "The agrammatism does not extend to automatic language" (1956, p. 18).

Aphasia and units of processing

Verbal stereotypy holds interest for research into organization of units in speech processing. Patients are often unable to pronounce *parts* of their recurring utterance, but only the entire phrase. It is interesting to note that this also holds true for patients whose stereotype consists of nonsense, such as Da de da, do de da; Yabby, Me me comittimy pittimy, sapon, sapon. The last, for example, could not be made to say *sap* or *pon* (Critchley, 1970, p. 206).

Large units were retained in one case reported by Critchley (from Riese, 1949). A cultured scientist was speechless for three days after a brain operation (left frontal topectomy). He regained speech, but used long technical and Shakespearean expressions: e.g. "Voluntary silence terminate"; "Methinks the lady doth protest too much". "Scientific ineptitude", "Vituperative old man", "There but for the grace of God go I". Ordinarily the patient spoke very little and when he did, these verbal flamboyancies were articulated with even more monotony than before the operation. This mode of speaking lasted a few months." (from Critchley, 1970, p. 260).

Automatic speech and motor organization

Articulation ability may vary with performance mode. Critchley (1970) observes that the defective phonetic output appears in some tasks but not others, articulation being good in reading and in emotional utterances, for example, but not during "calm propositionizing." Kreindler and Fradis (1968) also claim that "to some extent, articulation disturbances depend on the general situation from which they arise and are less striking during emotional speech." However, there is no such dissociation in "pure anarthria," where the peripheral speech apparatus is defective across all modalities of motor performance (p. 94).

As mentioned in Chapter 3, the left hemispherectomy patient articulates stereotyped expressions and song lyrics correctly and with ease, but hesitates on long or low-frequency words. Thus "automatic" is relevant also at the level of motor performance.

Marie (1925/1971) challenged the traditional classification of aphasia into "motor" (production) and "sensory" (comprehension). He maintained that comprehension is always affected. He was also aware of differential speech abilities in aphasia, and described cases which demonstrated "a dissociation...between voluntary speech and automatic speech." Marie noted that the dissociation also occurs in nonaphasic speech pathologies. For example, Parkinson's patients, who are afflicted with subcortical damage, often cannot speak when they wish to; but "normal speech occurs as soon as the patient is under the influence of a sharp emotion, when speech becomes a reflex, or even...when the patient reads out loud or recites."

A sample of cerebellar speech ('hot-potato-in-mouth' speech) spoken by a chronic alcoholic (courtesy of Dr. Wechsler) suggested differing abilities at the level of motor organization. This patient read a passage from the Los Angeles Times. The reading was garbled throughout and wholly unintelligible, except for the phrase "Hollywood Bowl" which was correctly articulated. It may be that the reading task produced garble until the familiar, holistic phrase appeared "Hollywood Bowl." The analytic reading task may have been different from the production of a whole, well known phrase. A study of cerebellar speech may reveal that there are degrees of severity that correspond to features in the propositional-nonpropositional dimension.

Automatic speech and speech therapy

The notion of heterogeneous subsets in language is partly based on the observation that aphasics can perform some verbal tasks correctly, but not others. This concept figures into a scheme of types of "facilitation" i.e. situations or strategies for facilitating speech in the aphasic. In Kreindler and Fradis (1968), these situations and strategies include heightening of affective tonus, placing in a concrete situation, introduction into a verbal stereotype (automatic speech, song, etc), association of thoughts, introduction into the same notional sphere, and varying stimulus intensity or rate. This approach to therapy develops strategies for working with aphasics, based on theories of Jackson (propositional/nonpropositional dichotomy) and Goldstein (abstract/concrete attitudes). The testing situation is designed to "use" the variations in performance that correspond to speech subsets or modalities.

Kreindler and Fradis (1968) attribute the patient's abilities to use speech in some modes but not others to a possible contribution of the right hemisphere: "it is...in the nondominant hemisphere that especially stereotype language, stereotype formulas, of the most common and frequent use, polite expressions, typical and typified responses, slogan speech, etc. would be stored" (p. 111).

More samples of aphasic speech

The usual occurrences of swearing, greetings, yes and no, serials and stereotypical speech are easily recognized in aphasic speech. There is abundant evidence for the frequency of these kinds of expression in aphasic patients in clinical descriptions in the literature, and from interviewing aphasics, and persons who have experience with aphasics. However, the retention of nonpropositional modes occurs in more than the conventional subsets (emotional, conventional, stereotyped, serial, memorized). In addition, idiosyncratic expressions are retained by the individual aphasic. These are expressions which are not frequent or conventional in the language but which satisfy other criteria for being "automatic utterances."

Speech samples in clinical reports typically include classic forms of automatic speech. For example, Chapter V of Goldstein's book (1948) contains samples of "disturbances of the expressive side of language." Case one was a cooperative, interested patient whose "only defect was the inability to speak any word or sound voluntarily. Only occasionally, some words such as 'yes,' 'no' or 'oh God' might be heard. He was not able to repeat them voluntarily." Case two was speechless except for 'yes' and 'no,' which he could not repeat on demand. After some weeks he said 'I don't know, please, good night, just so, to tell you the truth, I want something, breakfast, lunch, tea, dinner, dressing has moved, pineapple.' These are all obviously conventional phrases, with the exception of the last two. As always, it is impossible to assess the

conventionality versus the newness of such phrases for the individual aphasic. Case two could repeat a few of the items listed above. He couldn't count on command, but sometimes suddenly burst out 'one, two', etc. In case three, spontaneous (i.e. propositional or voluntary) speech was totally missing. "In emotional conditions, single words were uttered such as Hans, his first name, mother, my god, yes, no, you." Repetition and speaking of series and reading aloud were lacking. Understanding was normal. Case four could say only 'mama, papa, Anna.' Series, naming, reading and writing were absent. He could sing well including lyrics.

The cases above are typical of those found in clinical writings on aphasia. The following samples of aphasic speech exemplify subtler concepts of automatic language. The samples illustrate the notion that nonpropositionality is a mode of processing, not a repertory of expressions. Although familiar phrases occur commonly in many patients, other manifestations of automatic speech are highly idiosyncratic. Thus in addition to expected words and phrases, the individual patient often has his/her own stock of (more or less) automatic expressions. These may be mistakenly thought to be propositional use of language, because they don't fit into the usual classifications of automatic speech. However, in the context of the individual aphasic's speech ability, such production can be considered automatic speech.

One example appeared in a psychoanalytic study of aphasic speech (Laffal, 1965). This sample includes the usual phenomena of expletives (God almighty, god damn it) and pause fillers (I guess, well, huh). In addition, the repetition of "I know, I gave him something, and over there," suggests facility for a limited repertory of items, unique to this patient. The samples after three months, during which time the patient had made some recovery, contain these same original items, and include some new expressions. Most are highly frequent.

First interview:

Over there, there, over there, ... too,
I guess, I gave him something too. God Almighty, and then I gave him something over there. I gave him cheese and everything else, I guess. I gave him something over there. I gave him something over there.

Dr: What did you give him?

Pt: Yes, I know. And I gave him something.

Second interview (three months later)

"Yeah, yeah. Things are great, I suppose, huh? And well... well understood, understood perhaps. I know, God Almighty! Thinkers. But when I go there, no no. I find that thinkers good thinkers too, huh? Over there is, oh God, why? Perhaps later on I'll find that, and that, I don't know. I don't know because over there, over there okay, over here is all right..."

I interviewed a chronic aphasic patient (1972, Rancho Los Amigos Hospital) who spoke a limited set of expressions normally, but became hesitant and halting in giving information beyond this repertory. Her easy utterances were "I think, I don't know and that's about all, sure, I guess so, I was...Just...that was all...Well I'm glad." These expressions occurred as responses to questions, but informational answers did not come forth in speech. This patient could *repeat* "how are you," "I'm fine," and "good morning," but not "thanks very much." She was diagnosed as a motor apraxic; but her defects in production were not expanded to this set of utterances and a number of variations of them.

Another patient answered "oh God, godsakes, okay, I don't know, no, and I don't know what to do," to most questions directed to her. She seemed to try to produce other answers, but after some attempts, said 'wait, God, ah-shit-no, goddammit,' or (very often) 'Godsakes.' She counted, on request, up to 28. She could not say the pledge of allegiance. (Some patients claim that they have lost the ability to recite poems and passages learned at an earlier age.) This patient could not say her own name. She often said, in between the other expressions listed here, "look inside and see...look inside...what to do...and wait." She said this with great assurance and much expression. Later when I asked her if she knew any songs, she began to sing a song *with those lyrics*: ("Look inside and see, what to do, and wait"). It was obvious that she had included that phrase from the song in her repertory of retained expressions. She also sang Jingle Bells with good pronunciation of the words and control of the melody. She could sing Home on the Range only with help (interview through the courtesy of Dr. Hagen).

Defect of automatic speech in aphasia

A defect for overlearned, serial, memorized speech in aphasia is uncommon, but does occur. Luria (1970) notes that sometimes automatic speech abilities, for example the utterance of familiar sequences, are disturbed as a result of injury to anterior parts of the speech zones

(p. 282). I interviewed an aphasic patient who could speak fluently but not understand, because of auditory agnosia resulting from bilateral lesions. He was very poor at counting and claimed he could not recite any poems, nursery rhymes, or the pledge of allegiance (interview through the courtesy of Dr. Williams).

Another patient (D.D. available through the courtesy of Dr. Bogen) was more defective in overlearned and recited speech than casual "spontaneous" production. This patient's primary symptom was an intrusive sound or syllable /s/, /is/ or /sis/. A similar defect in one other patient is mentioned by Critchley (1970, p. 221). The patient D.D. also had errors of stress placement which were related by trade-off to occurrence of the intrusive syllable. This symptom occurred more often in some performance modes than in others. Specifically, D.D. seemed to expend more effort in trying to speak correctly, and yet the symptom occurred more frequently, during reading, counting from 1-10, and reciting. On the other hand, the symptom decreased during free speech. The site of brain damage was not known. The case is interesting to compare with the varying abilities seen in aphasics across performance modes. This patient was more affected in some automatic modes. One explanation might be that his problem increased with an increase in self-monitoring. If so, this effect corresponds to claims made by Labov (1970a), whose studies indicate that normal speakers vary their phonological patterns according to modes from casual to formal speech styles. The phonetic events change as a function of self-monitoring.

Split-brain studies

Jackson (1932) claimed that "the right cerebral hemisphere is the one for the *most* automatic use of words, and the left the one in which the automatic use of words merges into the voluntary use of words--into speech" (p. 130). Claims about the site of aphasic speech are based on little actual evidence (reviewed in Chapter 3, pp. 35-46).

Performance of split-brain humans (epileptic patients in whom the fibers connecting the two hemispheres, or corpus callosum have been cut for relief from seizures) is important for questions of right hemisphere capacity for linguistic processing. However, so far there is no evidence from split-brain studies that bears directly on hypotheses of brain

processing of nonpropositional speech. In dichotic listening tests of callosal-sectioned patients, the right ear information was correctly reported, while left ear stimuli were seldom reported (Sparks and Geschwind, 1968; Milner, Taylor and Sperry, 1968). Another study resulted in degrees of left ear "suppression" or "extinction" in 4 patients corresponding to extent of intact colossal fibers (Springer, 1974). Thus there was apparently very little right hemisphere processing of dichotic stimuli revealed in these testing situations.

Sperry and Gazzaniga (1967), Gazzaniga and Sperry (1965,1967) and Gazzaniga (1970) reported some comprehension of linguistic items in the right hemisphere of split-brain subjects. Although de-verbal nouns and bi-morphemic nouns were recognized by the right hemisphere, other nouns and some adjectives could be processed. (For example, teller and trooper were less likely to be processed in the right hemisphere than letter or butter.) Gazzaniga claimed that language comprehension is represented in both the major and minor hemispheres, but less in the minor.

Linguistic expression seemed exclusively organized in the left, with the exception of a few emotional, tonal, or extremely familiar words (Gazzaniga, 1970). Butler and Norrsell (1968) reported observations of expression processed by the right hemisphere. Gazzaniga and Hillyard (1971) in a later paper, suggest that this finding was a false effect of cross cueing: the right hemisphere somehow (perhaps subcortically) mediated the right answer to the left hemisphere, which then produced the response.

Gazzaniga's (1970) findings for nouns can be attributed to text-frequency differences. Furthermore, more recent work on split-brain subjects has shown that the disconnected right (nondominant) hemisphere can comprehend nouns, verbs, and sentences (Zaidel, 1973). In a paradigm especially designed to investigate right hemisphere abilities of split-brain subjects, auditory comprehension in the right hemisphere was tested. The subjects matched drawings (presented visually to the right hemisphere only) to an auditory message. The aural vocabulary of the right hemisphere is smaller than the left, but considerable comprehension was found. The aural vocabulary correlates to some extent with order of acquisition and frequency functions in children and aphasics (Zaidel, 1973). This last fact tends weakly to support the Jacksonian view (illustrated in Figure 6.1) about right hemisphere involvement with nonpropositional speech.

Left-hemispherectomy studies

The belief that automatic subsets of speech can be processed in the right hemisphere is supported by reported cases of left (dominant) hemispherectomy (Zollinger, 1935, Crockett and Estridge, 1951; Hillier, 1954; Smith, 1966; Zaidell, 1973). Swearing, 'yes' and 'no,' whole phrases 'I don't know,' 'Put me to bed,' 'I don't want any,' were observed after operation and singing with words was retained in some of the reported cases. As reviewed in Chapter 3, Dr. Burkland's patient (described by Smith, 1966) correctly articulated swear words, pause fillers, and a few phrases. Specifically, he clearly and normally enunciated: 'well, yes well, no well yes, three, that's a, no place, well yes, shit, goddammit.' He could repeat longer words slowly, with difficulty and clumsy articulation: No-~~vem~~-ber, de-~~vel~~-op, pre-~~si~~-dent. In contrast, the articulation of the above list (of automatic phrases) was normal. It is interesting to note that he could not repeat the "vowels" /i/ ee or /a/ ah at the request of the interviewer, but often uttered the pause-filler "uh" with ease and varying intonation contours. Zaidell (1973) reports that the left-hemispherectomy patient R.S. retained automatic sequences and well-articulated singing.

Epileptic "ictal" speech

Studies on speech behavior in epileptics lends support to the hypothesis that the right hemisphere is capable of types of "automatic" language (Bingley, 1958; Hecaen and Angelergues, 1960; Serafetinides and Falconer, 1963). Falconer (1967) describes a study of epileptic patients for whom EEG readings demonstrated that dysphasic utterances (for which the patient, during the seizure, is conscious but unable to normally express himself) are associated almost exclusively with left (dominant) hemisphere seizures, but that ictal speech automatisms (unremembered but linguistically correct expressions uttered while out of contact with the environment) occur in seizures originating in either hemisphere, possibly more frequently in the right (non-dominant).

Chase (1967a,b) attempted to demonstrate that epileptic ictal speech suggests processing by an "open loop" system as opposed to a "closed loop" feedback system for propositional speech. He hypothesized that ictal and emotional speech would not be affected by delayed auditory feedback (DAF). Preliminary data showed that during a seizure, ictal speech was not affected by DAF, nor was an utterance "dam" following the seizure, at a time when normal propositional speech by the subject did show the distortion usual in DAF.

This chapter has presented a survey of clinical evidence to show that propositional and nonpropositional modes of speech are differentially affected in language pathology. Descriptions of aphasia typically list the actual speech performance types (modes or subsets of speech) selectively involved. Least impaired are often expletives, social formulas, stereotyped phrases and cliches. In addition, the clinical literature mentions properties or attributes which distinguish the more impaired speech modes from less impaired in aphasia (Table 6.1).

more ←	Impairment in aphasia	→ less
high information content		low information content
complex intellectual		holophrastic emotional
		nonintellectual
abstract		concrete
voluntary		reflex
propositional		nonpropositional
spontaneous		memorized
		semiautomatic
referential		stereotyped
rational		emotive
informative		phatic
infrequent		highly frequent
symbolic formulation		highly structured speech situation
creative use		ritual use of language

Table 6.1. Properties attributed to speech in aphasiological writings to distinguish more impaired from less impaired speech performances.

The more/less impaired dichotomy is insufficient to describe the various observations. I have cited cases in which some "nonpropositional modes" are more impaired. Furthermore, in the usual aphasic picture, performance types are impaired in different degrees. Therefore, instead of two disjunctive sets, I am following Jackson in proposing a continuum, from "most propositional" to "most automatic" use of language (Figure 6.2). The word "automatic" is a cover term, to be defined by the properties inherent in the kinds of speech abilities occurring toward that end of the dimension.

propositional ← more ← ↔ → more → automatic

Figure 6.2. A "propositional-automatic" dimension, characterizing one kind of heterogeneity in language use.

The continuum depicted in Figure 6.2 is also an oversimplification. It seems likely that there are actually several dimensions (one for familiarity, one for emotionality, for frequency etc.) instead of one. For now, these are viewed as properties of automatic subsets. The next chapter is devoted to investigating the properties of a propositional-automatic dimension underlying normal speech.

Chapter 7.

Properties of Non-propositional Speech-types.

Hir othes been so grete and so dampnable
That it is grisly for to here hem swere.

Chaucer, The Pardoner's Tale

Caliban: You taught me language; and my profit on't
Is, I know how to curse.

Shakespeare, The Tempest (I, ii, 362)

Chapter 7

Properties of nonpropositional speech-types

The previous chapter presented clinical evidence that some kinds of speech are differently affected than others in pathology. The evidence was presented to advance the hypothesis that language is made up of differently organized subclasses. This chapter turns to studies of normal speech and language for evidence of nonpropositional subclasses and the properties associated with them. The sources of such evidence are diverse. They include clinicians' comments about the nature of normal language (based on their observations in aphasia), speakers' intuitions, linguistic analyses, and psycholinguistic research. The chapter is intended to be suggestive of potential approaches to the notion of heterogeneity in language, as exemplified by the propositional-nonpropositional continuum. The preceding and this chapter describe some properties of nonpropositional speech. The place of these properties in a description of language is discussed in the final chapter (Chapter 9). The notion of a "automatic-propositional" dimension underlying language use is considerably extended in this chapter from the definition proposed by Jackson (1932).

Evidence from normal speech and language

Many symptoms of pathological speech occur as features of normal speech. For example, anomia, or difficulty in retrieving certain lexical items, is experienced by most normal speakers. The reduplication seen in stereotypy occurs as a normal grammatical process in some languages, and as baby talk and diminutives in others. Lenneberg (1967) remarks that a sort of Broca's aphasia occurs during emotional stress. Other aphasic patterns appear in the normal speaker with fatigue, or under the influence of alcohol and other drugs. An experience of mental caproloia, a symptom of Tourette's disease (see Chapter 3, pp. 56-58), is described by a normal speaker in her autobiographical essays:

"I am having a hard time concentrating, so I put the book down and stop to listen to my thoughts again. What I hear is a string of the crudest obscenities: 'up your ass mother fucker cock sucker drip drip drip'...everything I've ever heard on the streets or seen scrawled on bathroom walls. They are words I would never use, have never even heard my mind use. But there they are, invading some inner territory like armies of red ants preparing for a takeover. I listen more closely, but the unconscious voice seems to have exhausted itself from the effort of rising to that

single outburst, or else perhaps it is retreating in the face of my shocked attention. All I can hear are the same words, reverberating inside my mind, more softly now, less insistently" (Bengis, 1973, p. 88-89).

Jackson (1932) extended his analysis of aphasic speech to a theory of normal language use. He claimed that "there are in health all gradations from the most automatic use of words, to their most voluntary use. Let us show the steps: (1) Receiving a proposition. (2) Simple and compound interjections, as 'Uh' and 'God bless my life!' (3) Well-organized conventional phrases, as 'good-bye,' 'Not at all,' 'Very well.' (4) Statements requiring careful, and metaphorically speaking, personal supervision of the relation each word of a proposition bears to the rest" (p. 133).

Critchley (1970), having observed emotional outbursts, such as swearing, in aphasic speech, speculates that swearing may be less vulnerable to injury because it is phylogenetically "more primitive." He further observes that analogies for stereotypical aphasia are found in "verbal mannerisms," such as "don't you know, I say, As matter of fact, Do you know what I mean, naturally, actually, of course", and in folk music -- e.g. ney nonny nonny ney and Fol-de-rol (although these differ from stereoetyp in having phonological structure and in being productive).

Intuitions about automatic modes

There is little linguistic work which taps speakers' intuitions of differences between automatic and propositional use of language. And yet it seems reasonable to suppose that people are aware of many aspects of automatic modes. Most speakers might be expected to be aware of idioms, greetings, and formulas; they undoubtedly notice such instances as curses, expletives, pause fillers and verbal tics, especially in the speech of others. Many might sense that these modes function differently. I am aware, for example, of choosing formulas in situations. I have experienced discomfort in trying to repress automatic phrases when speaking English to a foreigner.

Popular writings (especially of personal experiences) contain references to these concepts. For example, one self-help book on the art of conversing and speaking warns against pause-fillers. The author recommends first taping a speech, so that "you'll pick out speech faults you never realized you have. Even your own ear will inform you that you say 'ahum' too frequently, or 'you know'" (Walters, 1973, p. 228).

A New York secretary, telling her story, revealed intuitions about formulaic expressions:

"Most of my life had been spent completely alone, and I knew none of the code responses of young people. I didn't know what to *say*. Like when somebody comes up to you and says, 'How you doing, kid?' you're supposed to say something back, you're supposed to know a code answer. But I didn't make the proper responses because I didn't know them. I would have given anything to know them!" (Olson, 1972,p.145).

Bolinger(1961a,p.30) quoted Robert Louis Stevenson (1925,p.109)as saying "the business of life is not carried on by words, but in set phrases, each with a special and almost a slang signification." A Los Angeles Times columnist made a similar observation in his weekly column:

"I can think of no other phrase of saying which has gained such an ubiquitous place in American speech in recent years as 'Have a nice day.' Of course it isn't nearly as pervasive as the mindless interjection 'You know,' or 'Y'know,' without which what is left of conversation in America would utterly collapse" (Smith, 1973).

Warhol presented a list under the heading "On my mind" in a fashion magazine (1973). The list contains a variety of items, in paragraphs, sentences, phrases and single words. These are the final six, the last of which plays on a familiar phrase:

On my mind...

Is there anyone in the lobby?

I wonder if creme de menthe is a good mouthwash.

Pauline de Rothschild.

I think about the best look, the chic look, the low look, the trashy has-been look, the trashy has-been drag-queen look.

Pimples, pickles, Porthault street, Paris, \$, and East Street are all on my mind.

Georgia is, too.

Unless Warhol happens to have a near and dear acquaintance named Georgia, it seems safe to conclude that in constructing a list of items under the heading "on my mind," in addition to the substantive items, the (meaningless, automatic) association from a well-known song rather irresistably intrudes. It seems also expected that the audience of readers will understand what has happened.

Wang (1974)*has pointed out that English is relatively poor in its resources of ready-made phrases, such as proverbs and aphorisms. Chinese and Russian seem to make more use of this potential in natural language. Investigation of the interactions of automatic and propositional speech modes may be especially profitable in languages other than English. Comparative studies across languages would throw light on the role of nonpropositional properties in human speech. Furthermore, within a language, automatic modes vary in number and type, along geographic or sociological styles. Thus comparative studies of the role of nonpropositional use of language in association with dialects and styles would be interesting. Rural dialects, for example, have been described as more folksy, more concrete, and more colorful than urban varieties of the same language. Use of automatic speech-types may account for some of this difference. In contrast, highly educated speech in formal style is characterized by its dearth of nonpropositional speech modes. Thus the application of the notion of a propositional-nonpropositional continuum to cross-linguistic and cross-dialectal analysis may be useful in explaining a variety of phenomena.

Another area of linguistic research is involved with nonpropositional properties, as conceived in this monograph in ways as yet unsolved. This is the area of translation. As pointed out in a paper by Bolinger (1974), the problem of translation is "the real proof of how much we have to remember in order to use a language acceptably." I believe that much of what is remembered is predicated on automaticity features, which are part of the speaker's competence for language.

Automatic modes and literary arts

Ionesco makes special use of automatic formulas in his plays. In *Les Chaises*, for example, stretches of dialogue consist almost exclusively of stereotyped exclamations, cliches, pause fillers and verbal gestures. It would be interesting to critically analyse Ionesco's use of aspects of nonpropositional speech as an artistic device. Other artists caricature features of nonpropositional speech for effect. In fact, properties of automatic language function at a basic level in language arts. Noncreative modes of language are manipulated artistically, in the interplay of pattern and variation on which artistic expression is built. Joke series are built on variations of a formula-types. A classic example is the "knock knock" joke. Puns are built on a violation of an expected linguistic pattern. Punch lines exist by using the same principle (e.g. where were you when the fit hit the shan).

* Personal communication

It is likely that there are short term, in contrast to long term modes of automaticity, analogous to short- and long-term memory processes. Poetry, rhetoric, humor, and other structured linguistic arts utilize short-term processes, by programming the audience to be aware of basic units and then artistically varying those formula-types, achieving that balance between structure -- without which there is chaos, and variation, without which monotony (Perrine,1969). Folk songs with stanzas are the most obvious example. In some ways, the poetic devices of rhyme, assonance, alliteration, and meter play upon establishing formulas and then creating variations.

Many language arts are based on the vast linguistic stock of long-term familiar utterance tokens and types, which speakers of a dialect have in common. The creative play achieves surprise (and therefore interest) by taking advantage of frequency and familiarity, properties of the propositional-nonpropositional dimension. This interplay between new and old is a dynamic and pervasive feature of language ability. These facts and others reviewed in this chapter lead to the conclusion that aspects of nonpropositional speech modes ought not to be conceived as a closed list appended to the grammar, but as abstract properties inhering in underlying competence for language.

Linguistic descriptions of nonpropositional speech properties

Nonpropositional subsets in speech have been discussed in the writings of various linguists. Jespersen (1965) described the "important distinction between formulas of formula units and free expressions," a distinction which "pervades all parts of the grammar." Formulas, such as "How do you do," "good morning," and "thank you" are "felt and handled as a unit" and may often mean something quite different from the meaning of the component words taken separately (pp. 19-21). Jespersen claimed that formulas and free expressions involve different kinds of mental activity (discussed in Chapter 3, p.59) (1933/1969). Furthermore, the distinction is important in a diachronic perspective of language. It correlates with the differences between the role of regular formations as distinguished from irregular forms in morphology, therefore to productive versus unproductive affixes in word formation (1965). Free expressions are associated with regular formations and productive rules for combining them. In contrast, irregular forms, which are unproductive, are preserved in the language as formula units.

A similar distinction was described by Lounsbury:

"Of two constructions made according to the same pattern, one may be an *ad hoc* construction of the moment and the other may be a repetition or reuse of one coined long ago, often heard, and much employed as a whole unit, e.g. as an idiom, a cliché, or a high frequency phrase of some sort. It is apparent that as behavioral events they are quite different and that in some sense their psychological statuses in the structure of the actual speaking behavior may be quite different" (1963, p. 561).

Divine (1970) saw a parallel between Jackson's conception of emotional speech and linguistic claims. For example, phonological theory claims that "emotional outbursts" are outside normal sound patterns, and that different styles of speech are associated with different sound patterns. Divine recommended that these interesting facts about human language not be tossed off as aspects of "parole." Instead, "Jackson's distinction between

propositional speech and emotional speech clearly relates to problems of interest to linguists. Answers to questions regarding the span and number of units in each should be sought. One might expect emotional speech to be processed in terms of single invariant units, while propositional speech might display greater freedom in its combination of units. One might ask whether emotional speech always originates in propositional speech, and if so, whether a fusion of the various units in propositional speech occurs in a transfer to emotional speech" (p. 2).

The question of unit size and automatic speech is of interest in both aphasic and normal speech research. As reviewed in the previous chapter (Chapter 6), the aphasic can often produce the entire automatic phrase, but not its constituent parts. These utterances can be short (as a syllable) or long (as a phrase, a series, a sentence). They are apparently stored and processed as a whole. A reasonable extrapolation to normal speech is that holistic storage and processing also occurs in intact language abilities at all levels of grammar.

In normal speech, various basic unit sizes have been proposed. Studies in experimental phonetics suggest that the minimum units of storage are at least as large as the syllable (Lehiste, 1970; Kim, 1971). Perception experiments suggest that at some level of organization, phrasal units are of primary importance (Johnson, 1966; Miller, 1962; Lea, 1973). Thus, it is likely that there is a hierarchy of unit size (Greene, 1972).

Analysis of holistically processed aphasic speech, and of automatic subclasses in normal speech, may lead to information about the nature of the units stored, and how and where they are stored in the brain. Nonpropositional speech may typically be organized into unanalysed units of potentially larger size than propositional speech. Unit size may be another feature that distinguishes subclasses of speech-types along the propositional-automatic continuum.

de Saussure (1968) recognized a category of "locutions toutes faites" as part of *langue* in his langue/parole framework. There are apparently degrees of structural cohesion in his concept of *les rapports syntagmatiques*. "Locutions toutes faites" are fixed and therefore belong to *langue*; but insofar as these expressions have degrees of syntactic regularity, they interact with the productive processes of *parole*. Saussure concludes that

"il faut reconnaître que dans le domaine du syntagme il n'y a pas de limite tranchée entre le fait de langue, marque de l'usage collectif, et le fait de parole, qui dépend de la liberté individuelle. Dans une foule de cas, il est difficile de classer une combinaison d'unités, parce que l'un et l'autre facteurs ont concouru à la produire, et dans des proportions qu'il est impossible de déterminer" (pp. 172-3).

Lyons (1968) recommends separate treatment of "ready-made utterances," "expressions which are learned as unanalysable wholes and employed on particular occasions by native speakers." Lyons' examples are "How do you do," which is not normally interpreted as a question, and "rest in peace" which is not to be regarded as an instruction, "but a situationally-bound expression which is unanalyzable (and which does not require any analysis) with reference to the grammatical structure of contemporary English." Other instances of "ready-made utterances" are "the stock of proverbs passed on from one generation to the next." These are "not profitably regarded as sentences...Their internal structure... is not accounted for by means of rules which specify the permissible combinations of words." They do sometimes have sentence intonation contour. "Apart from this fact, they are to be accounted for simply by listing them in the dictionary with an indication of the situations in which they are used and their meaning" (1968, p. 177). However, in addition to ready-made expressions "which permit no extension or variation," there are also "phrase-schemata," and "sentence-schemata," "which are grammatically unstructured, or only partially structured, but which can

yet be combined in sentences according to productive rules." Examples are "what's the use of ---ing?" "Down with ---!" and "for ---'s sake."

Lists will not accommodate schemata, because schemata are made up of different "ranks" (phrases and sentences) which can be combined, and they are partly productive. Indefinitely large numbers of sentences can be generated from schemata (p. 178). Lyons does not suggest a way to deal with these semi-productive processes.

Hockett (1958) places the "idiomatic composite form" along the morpheme as a basic element in language. These two kinds of basic units form the "raw materials" from which utterances are built. Phrases of all kinds, technical terms, verbal humor, abbreviations, figures of speech, and slang all qualify as idiomatic in Hockett's view. Furthermore, idiom formation is one of the grammatical processes to be accounted for in language. The "idiomatic value" of newly coined expressions is inversely related to the productivity of the pattern it is formed on. Derivation and idiom formation are different processes with different properties (1958, p. 308).

Weinreich (1969) described idioms as "transformationally defective," requiring special treatment in a grammar. He recommended an idiom list be included in the dictionary. His proposal extends to other semi-productive processes in language. In addition to a "simplex" dictionary, the grammar must include a "complex dictionary, in which would be entered all compounds, complex words, idioms, phrases, and sentences familiar to speakers of the language." The differences between idiomatic (unproductive or semiproductive) constructions and free constructions are great, and they are arbitrary. Weinreich claims that the "relation between idiomatic and literal meanings is so unsystematic as to deserve no place in the theory." Furthermore, these classes do not form disjunctive sets. Weinreich observes that "creativity comes in different degrees" (p. 77). Differences fall along a spectrum from unanalyzable, through semiproductive, to "productivity in the strongest, Chomskyan sense" (p. 23). These facts are not accounted for in Weinreich's proposal for an idiom list.

Weinreich presents evidence for essentially different processes in grammar, and therefore develops a case for heterogeneity in language.

Like Jespersen, he is pointing to inherent differences between whole unanalyzed units and free constructions. He adds the notion of "degrees." Thus his conception is comparable to the continuum from "automatic" to "propositional" use of language hypothesized in this chapter.

In dealing with the problem of idioms within the traditional model, Fraser also proposes a continuum or hierarchy (1970). He classifies idioms by "degrees of frozenness" in terms of the transformational rules that may apply to them. Rules are governed or ungoverned; simple and complex lexical entries (i.e. idioms) are marked for permitting certain governed rule operations. Types of transformations group together, corresponding to idiom type, classed by "degrees of frozenness" from unrestricted (in applicability of transformational rules) to completely frozen.

Weinreich's treatment adds a special dictionary to the generative model; Fraser's proposal includes special kinds of rules and a marking convention. Both proposals stay within the traditional generative-syntax framework. However, for Chafe (1968) idioms cannot be treated satisfactorily in a standard generative model of language. In Kuhn's (1963) formulation of "progress" in science, anomalies accumulate until adoption of a new paradigm, a different model or conceptualization of the phenomena, is required. Chafe suggests that idioms constitute such an anomaly for the Chomskyan paradigm. This radical conclusion is controversial. I include it because to present his view, Chafe has described properties of nonpropositional speech, and advocated incorporating such facts in a grammar. Chafe observes that idioms differ from other constructions in four major ways: 1) although complex constructions, their meaning is like that of a single lexical item; 2) they show transformational deficiencies; 3) they are often not syntactically well-formed; 4) the text frequency of the literal counterpart is much lower than the idiomatic construction. These facts about idiomaticity have not all been accounted for by any general model, although partial solutions have been attempted. Chafe proposes a generative model based on semantic units, mapping onto pre-phonetic combinations and thence generating phonetic output. Details of the model remain to be determined.

For Bolinger (1961a) idioms are the extreme case along the continuum of the "bondage and freedom" of the parts of an utterance in relationship to the whole. There is a "gradient of idiomatic stereotyping" belonging to the "idiom grammar" of a language (p. 22). Whereas Jespersen and Lyons included a few examples of idiom-like but particularly productive expressions. Hockett (1958) and Bolinger (1961a) conceive of idiomatization as a pervasive process in language. Bolinger (1974) has devoted a recent paper to the phenomena of "idiom-like" connections in English. He presents linguistic data to demonstrate that many kinds of idiom-like connections occur between the extremes of bound and free occurrences. For example, the restricted occurrences of such words as "ago" and "else" occupy a middle ground between what has been traditionally viewed as the bound forms of morphology, and the free forms of syntax. Bolinger presents evidence for "a vast continuum between morphology and syntax." Along the continuum are fixed idioms, "loose" idioms, clichés, and the subtlest but most characteristic and most pervasive of all, collocations. All these, in addition to exhibiting unique properties of their own, possess varying degrees of internal cohesion. It is this phenomenon, their relative cohesiveness, that distinguishes them. Bolinger's observations have important implications for notions about the structure of language, and the nature of linguistic competence. These problems are further elaborated in the last chapter (Chapter 9).

The property "degrees of cohesion" which has not been incorporated into the standard generative model of language, is developed in Firthian linguistics (Mitchell, 1971). Features of collocation belong to a specification of language in the context of situation. Habitual collocations are defined as "the mere word accompaniment, the other word-material" most commonly accompanying a word. The statement of the collocations of a word is "part of the meaning" of the word. "Collocations of a given word are statements of the habitual or customary places of that word in collocational order..." "not to be regarded as mere juxtaposition" but "an order of mutual expectancy" (Firth, 1968, pp. 12-13). These observations have yet to be worked into a general model of language.

Thus a number of linguists hold the view more or less explicitly that "idiomaticity" is a property or process in language. This property is present in degrees: expressions vary in the degree to which they are cohesive, familiar, stereotyped, frequent, etc. This view excludes the possibility of listing "automatic" expressions in grammar. Other modes of description must be sought.

Properties of nonpropositional speech are operative not only in a synchronic grammar, but in diachronic processes as well. As mentioned above (p. 135), Jespersen claimed that the distinction between frozen and free constructions is operative in the evolution of language. It is interesting to note that these different processes in language are seen at one source of evidence for language change, data from child language acquisition. Moskowitz (1972) has given evidence in the child's phonological grammar for the coexistence of unanalyzed or formula units alongside cognate expressions that have been reanalyzed in accordance with general rules for freely combining units. Similarly, R. Clark (1972) claims that "imitated items, whether single words or longer stretches, are not fully analyzed by the child for syntactic features or syntactic structure at the time they are imitated, but syntactic understanding proceeds in the course of production, usually after a lengthy period during which the utterances have been practiced as unanalyzed wholes." Thus, across generations of speakers, irregular forms are transmitted as formula units, while regular and productive formations are acquired as the product of abstract rule processes.

Other evidence for automaticity features

Research by Goldman-Eisler (1968) on pauses in speech production supports the notion of an automatic-propositional continuum. Pauses are more likely to occur in propositional, or newly created speech, than

in automatic or formulaic constructions. Hesitation is correlated with originality of choice, novelty of language, and generative processes. In contrast, fluency is correlated with high transitional probability, verbal sequences developed into habit, predictability, and associative linkage. Goldman-Eisler claims that in planning and execution of the verbalization process, automatic and propositional modes operate differently.

Delayed auditory feedback (DAF) might be useful in demonstrating differently processed modes in speech production. Although overlearned phrases such as "Mary had a little lamb" are apparently as affected by DAF as spontaneous speech, other differences have been observed. Chase distinguishes between closed loop and open loop modes. His study on epileptic ictal speech (1967a) was described above (Chapter 6, p. 128). Chase also observed that delayed feedback effects vary across performance modes in normal speakers. Subjects are less affected during reading than during spontaneous, propositional speech. Similarly, Chase (1965a, 1967b) claims that shadowing another person's speech is a different effort from using speech to modify another person's behavior, which is again different from formulating ideas via speech. (In a shadowing task, a subject is asked to orally repeat an on-going verbal message presented to him aurally.) Chase asserts that verbal behavior is made up of "many dimensions or sub-categories of function, each of which is able to operate in a variety of modes." It is necessary to gain better understanding of the functional sub-categories and modes of operation that make up the multidimensional system of verbal behavior. Furthermore, "the underlying neurophysiological mechanisms would be expected to reflect this diversity in mode of operation" (1965a, p. 6).

Psychotherapists have measured and scaled "interruptions" of continuity in patients' speech. These include "intrusions and speech mannerisms, and hesitory formulas," e.g. "but," "sort of," "wait a minute," "may I ask you," "I don't know," "you know," "I mean," "like," "well," and the like. According to a review of extralinguistic parameters in psychological research, "the manner in which [these utterances] occur appears ritualized and repetitive, and distinguishes them from utterances which are more essential and appropriate to the main stream of communication" (Mahl and Schulze, 1964).

Lieberman (1963) investigated differences between two kinds of meaningful English sentences: 1) those containing "common maxims and stereotyped phrases," and 2) less familiar sentences, containing test words also occurring in the stereotyped sentences. The test words were given indexes of redundancy by two independent rating tests. The test words were excised out of context, and presented in several conditions to listeners. Most of the redundant excised words were identified less often (than the same words in nonredundant contexts) at +4 db signal-to noise ratio, but these same words were always identified at +4 db

signal-to-noise ratio when in the context of the complete sentence. It was concluded that speakers and listeners "are aware" of differences between redundant and nonredundant types of sentences.

Lieberman(1963) claims that speech production varies with type of sentence, redundant and nonredundant. "The degree of stress and carefulness of articulation are approximately inversely proportional to the operational 'total context' measure of the redundancy of the excised words." Speech comprehension is dependent upon whether the acoustic cues are occurring at one of "two levels." On the primary level, acoustic cues can identify a word out of context. A redundant context "reduces the acoustic cues from the primary to the secondary level," and out of context, the listener may not be able to identify them.

In Lieberman's(1963) study, redundancy and familiarity were correlated. Systematic differences between more and less redundant (associated with more and less familiar) types of sentences were found in both speaking and listening.

A finding of Bolinger's (1961) is consonant with Lieberman's experimental results. Bolinger demonstrated informally that duration of syllables in words is a function of familiarity. Condensation is associated with familiarity, length with unfamiliarity. Speakers were presented with pairs of compound words.

wine glass	-	wine press
lovesick	-	lovelorn
wall paper	-	wallflower

Most speakers "voted" the first word of the first column *shorter* than paired words in the second column. A subset of the polled speakers commented that the "longer" forms seemed "less familiar."

Grammarians have claimed that a feature "familiarity" operates in the formation of the English comparative. It is one of three or four factors determining whether the terminational method (adding -er, -est at the end of the word) or the periphrastic method (placing *more* or *most* before the word) is used. According to Pound (1901), the terminational method is preferred over the periphrastic for shorter and more familiar words. In disyllables, the choice is determined by the phonetic ending, the familiarity of the word, or by the author's preference. Similarly,

Poutsma (1914) claims that terminational comparison has increasingly come to be applied to the shorter and more familiar words, whereas periphrastic comparison is preferred for longer and more unfamiliar words (p. 474). One approach might be to set up a rule of "familiarity" to take care of exceptions to the morphological rule for forming comparatives. For example, this solution would account for such examples as:

lovely	→	lovelier	but	poorly	→*	poorlier;
fine	→	finer	but	wan	→	*wan(n)er.

(Bolinger, 1974)*

Weinreich (1969) also proposed incorporating "familiarity" as a factor in an idiom list. This feature is needed to account for phrases and sentences which are not idiomatic but are "stable and familiar;" expressions which have no grammatical defects, but have "specialized subsenses" are "distinguished by nothing but their familiarity" (p. 71). Examples are *Latin and Greek*, and *Two wrongs don't make a right*.

Experimental results demonstrated the reality of a familiarity factor in language ability.

A study of psychological scaling of linguistic properties (Danks and Glucksberg, 1970) directed subjects to rate sentences as grammatical, meaningful, or familiar. The familiarity factor in this study operated differently from 'grammaticality' and 'meaningfulness:' "Rated familiarity seems to be some function of grammaticalness, meaningfulness, and, perhaps, other variables..." (p. 137). The authors suggest that grammaticalness and meaningfulness are different kinds of linguistic properties from familiarity. All three are involved in comprehension, but familiarity, perhaps, reduces the need for linguistic processing.

Much work on speakers' performances on high frequency as compared with low frequency words has been conducted (Howes, 1957; Broadbent, 1958; and Savin, 1963). The "word frequency effect," which means that high frequency words are more intelligible in low signal-to-noise ratios than low frequency words, is consistent in aural, visual, and other verbal tasks. There is a correlation between word frequency and abilities in verbal tasks, such as verbal comparisons and the unscrambling of anagrams (Risch, 1970). Another study of listener's abilities to perceive different types of words presented dichotically demonstrated that the features frequency, meaningfulness, and emotional tone were important in the perceivability of words in word-pairs (Dodwell, 1964).

Expressive features

The automatic subset "emotional speech" has received some attention in linguistic analysis. In phonology, for example, Fudge (1970) has claimed that:

* Personal communication

"words of certain semantic types, which can be subsumed under the label 'expressive' (notably onomatopoeias, movement words, and words with pejorative, jocular, or intense connotations) have a tendency in a wide range of languages to be associated with peculiarities of phonological structure. These peculiarities include types of sounds, sound-sequences and syllable-structures which can be regarded as peripheral in the language concerned."

Expressive word-types also include affective words, hypocoristic names (nicknames), nursery words, colloquial and taboo words, and abbreviations. These have in common all being "affective;" all can be called "vivid or forceful"; they tend to have emphatic intonations; they occur in familiar instead of formal situations, and their effect is to strengthen social bonds. In addition to English (Thun, 1963), other languages, including Malgache (Bernard-Thierry, 1960), Javanese (Uhlenbeck, 1950) and Finnish (Austerlitz, 1967) manifest unique phonetic systems for effective subsets similar to those listed by Fudge (1970).

Stankiewicz (1964) surveyed expressive features in many languages. These features appear at all levels of language, including intonation, phonology (features and phonemes), morphology, words, and context. Such facts are evidence for an expressive or emotive element or function in language, in addition to the cognitive elements, which have been the "linguists's primary concern" (p. 247). Examples of expressive features, besides the prosodic features of quantity, intensity, and stress intonation, are consonant gemination, palatalization, aspiration or glottalization, a fortis/lenis distinction, single expressive phonemes and special distributional patterns of phonemes. There are "peculiarities of inflection" such as special suffixes. Interjections "often show phonetic features and consonantal clusters which are alien to the cognitive system" (p. 253). Stankiewicz makes a claim for "various degrees of integration of the interjections into the non-expressive phonology and grammar of a given language."

There is both synchronic and diachronic evidence that "emotive and cognitive sub-codes of language are set apart through different formal devices. Some emotive devices are ... nearly universal...But...the cognitive and emotive forms...are kept formally apart." For example, in language evolution, emotive and cognitive elements switch elements from one system to the other. "The systematicity of the expressive devices and their relationship to the cognitive elements of the code" remain to be elaborated (Stankiewicz, 1964, p. 267).

Affective or emotional speech is often selectively retained in aphasia, and thus comprises one of the automatic subsets. Its role in normal speech remains to be understood. Psychological research has demonstrated special responses to affective verbal cues. Experiments have shown that subjects respond selectively to their own names (1) while asleep (Oswald, Taylor, and Treisman, 1960) (2) in dichotic listening while shadowing messages in one ear, (Moray, 1959) (3) and in binaural listening of lists of names. The sleeping subjects also responded to lovers' names (Oswald, 1970). Thus both long-term (own names) and short-term (lovers' names) stimuli produced similar response.

Properties of automatic language

The notion that there are degrees of propositional use of language, and degrees of automatic use of language, is derived from observations in aphasia. Aphasics often lose abilities for propositional speech, but variously retain overlearned and for emotional utterances such as swearing, counting, stereotyped phrases, conventional social formulas, familiar phrases, highly frequent items, idioms, and stock expressions. These same phenomena are plentiful in normal speech where they are integrated with propositional use of language. They are "disguised" as part of the speaker-hearer's uniform competence. However, these "automatic subsets" have unique properties, which have not been accounted for within traditional grammatical frameworks. Evidence suggests that emotional and/or overlearned speech is processed differently from "cognitive" or propositional speech.

Further research is required to determine features and qualities of more and less automatic modes. The following discussion is suggestive of details which may be properties of nonpropositional speech.

One feature common to nonpropositional modes is low-content, or lack of referential meaning. This feature characterizes many types of automatic language. It distinguishes propositional from automatic use of language. Automatic speech, in its extreme form, is ritual use of language.

People often do not "hear" each other respond during an interchange of social formulas. Even further, some instances resemble reflexive behavior, in the sense of being stimulus-bound. Evidence for this comes from varying the expected linguistic performance in a highly-structured situation-context, such as saying anything other than *hello* upon answering the telephone.

Another property of automatic speech is cohesion, or high transitional probability across parts of a unit construction. At one extreme, there is the nondissoluble structure of whole-unit constructions. Intermediate types are loosely bound units; others are unit-parts that merely fail to combine freely (Bolinger, 1974). Thus it is argued in this chapter that all construction-types are describable in terms of degrees of cohesion.

Automaticity correlates with frequency in some cases. Some subsets, such as greetings, idioms, conventional phrases, and social formulas can be explained almost primarily in terms of frequency: that is they are constantly used, they become "overlearned" and therefore automatic, because they are experienced often. Frequent use may increase "automaticity," to eventually establish a phrase or phrase-type as a frozen unit. Some aphasic residual speech is also accounted for by the notion frequency, especially the ubiquitous "Yes and No, Well," and other common phrases "I don't know, ya know, okay".

Frequency is neither necessary nor sufficient to describe all occurrences of automatic speech in aphasia. Nor does it cover automatic types in normal speech. Some highly frequent items in a language cannot be considered candidates for automatic use of language. Furthermore, some instances of automatic modes hardly occur outside an idiosyncratic use. Use of prepositions illustrates the first point in aphasic speech. Critchley makes the observation that articles, prepositions and conjunctions have statistically high frequency counts, but these are least often retained by the "fluent" aphasic (1970, p. 189). In fact, they are the most commonly lost, except in unanalyzed, automatic phrases.

Prepositions do not stand alone in normal speech, but occur mainly in conjunction with other words. In this sense, they are not likely to be retained as isolated units in language disruption. It is therefore all the more remarkable that in Broca's aphasia, function words are selectively lost but they are retained in the residual automatic utterance.

Hörmann (1971) reports the 30 most frequently occurring words in German (from Meier, 1964): die, der, und, in, zu, den, das nicht, von, sie, ist, des, sich, mit, dem, daß, er, es, ein, ich, auf, so, eine, auch, als, am, nach, wie, im, für. It is these auxiliary words, especially prepositions and pronouns, which are absent or difficult in Broca's aphasia or agrammatism. One German patient reportedly could pronounce *Ei* (egg) but not *es* (it) (demonstrating that word length

was not a factor). Some other parameter, such as independence, or form class, or saliency, or importance of the verbal item must interact with, and in some cases override the frequency factor.

The second point, that automatic expressions may have zero-frequency, illustrated by the kind of stereotypic aphasia in which the recurring utterance is a nonsense phrase, or other improbable or unusual phrase. As reviewed in Chapter 6, these are possibly the patient's last thought or last utterance before injury. This suggests that recently processed speech can behave exactly like old and frequent speech -- as automatic phenomena. Some other factor is operating here. The same thing occurs in normal language, in slang, jargon, and fad phrases which appear and are rapidly replaced. These are short-lived automatic expressions which have "caught on."

Perhaps a clue to understanding infrequent but automatic speech lies in the affective feature. Emotional subsets may be described by being associated with an increase in intensity or vividness (analogous to the imprinting effect observed in animals). Certain emotional utterances, such as swear words, may not be frequently heard or uttered, but indeed may occur "automatically" when stimulated by high affect. In psychological research, such items have a lower threshold in perceptual tasks than other sorts of words (e.g. the sleep studies and selective attention studies mentioned above, p. 145).

The features of cohesiveness, redundancy, familiarity, frequency and affective strength are associated with occurrences of nonpropositional speech. Considerable work on these parameters has been done in language psychology and psycholinguistics. These parameters are features of subsets of speech along a propositional-automatic continuum. Further linguistic studies are needed to determine what roles these and related parameters play in human language ability.

Chapter 8.

Dichotic Listening Study: Automatic and Propositional Words

Chapter 8

Dichotic listening study:

Automatic and propositional words

A series of experiments was conducted to investigate lateralization of aspects of language in normal speakers. Two assumptions, both elaborated throughout this monograph, are interrelated for this study. The first is that language is made up of different modes or subsets. These may be described as occurring along a continuum from propositional to nonpropositional (or automatic) linguistic behavior. Secondly, not all such subsets are lateralized to the left (or language) hemisphere. Instead, they are heterogeneously processed in the brain. Propositional language is lateralized to the left, but automatic subsets of language use are bilaterally processed in the brain. As reviewed in earlier chapters, evidence supporting one or both of these assumptions comes from clinical and experimental studies.

Observations in pathology provide clues about the structure of normal behavior. Evidence for the existence in normal speech of heterogeneous speech subsets has been reviewed in Chapter 7. It was argued that these various subsets produce an illusion of a homogeneous behavioral class because they are well integrated in normal speech. Since some of the subsets are correlated with facts about lateralization, differences can theoretically be demonstrated in normals using techniques currently available. This chapter describes a series of dichotic listening experiments, designed to investigate the notion that some identifiable types of language use are lateralized to the left hemisphere, and others are not in the normal brain. The purpose was to take a step toward demonstrating that language is heterogeneously processed. The hypothesis in this study is that certain types of language, like those often retained in aphasia, are not lateralized to the left hemisphere in the normal brain.

Dichotic listening findings suggest that the hemisphere contralateral to the right ear (the left hemisphere) is better prepared than the right hemisphere for the perception of language items. Certain nonlinguistic stimuli, such as music and environmental sounds, produce a left ear advantage, suggesting superior processing capacity of the right hemisphere for those sounds (See Chapter 6 for review). (Evidence for the hemispheric specialization of function is stronger from the brain-damaged cases and aphasia literature.)

There are problems in using dichotic listening to test the Jacksonian hypothesis about lateralization differences in propositional and automatic speech. It is possible, first, that subjects could do better at the right ear because they become "set" for language and process the stimuli in the leading (language) hemisphere, including such sounds as can be processed in both hemispheres. There is evidence from other studies that the left hemisphere is generally more easily aroused than the right, (Murphy, 1969) or that it executes an inhibitory effect on the right hemisphere for some functions. These facts might obscure results for normal subjects in the dichotic listening paradigm.

Secondly, automatic speech is a concept meaningful at the level of natural language use, and the dichotic listening testing situation is artificial. And the notion "propositional" actually refers to sequences of words; dichotic tasks have usually involved single words. However, results for longer strings have been reported (Zurif and Mendelsohn, 1972; Zurif and Sait, 1970; Blumstein and Cooper, 1973).

The third problem is that the propositional-nonpropositional continuum is inferred from observations in language production, while dichotic listening deals with perception. In Jackson's original conception, comprehension constituted the most automatic of processing. However, there is evidence that features associated with the continuum are also relevant to comprehension.

Finally, it is not known whether aphasics use their right hemispheres for automatic speech. The automatic speech could be produced by the damaged left hemisphere. Furthermore, it does not follow that if aphasics use their right hemispheres for the retained automatic speech abilities, then so also do normal language users. It may be that normal language users can potentially process some kinds of speech in their right hemispheres, but normally do not. Damaged brains might be expected to behave differently from normal brains.

In the experiment about to be described, a right ear advantage in normal subjects for automatic speech could mean that the left hemisphere leads for linguistic stimuli in dichotic listening either because of dominance over the right hemisphere for linguistic processing, or because both automatic and propositional modes are processed primarily in the left hemisphere. In contrast, no ear advantage for the automatic words would suggest that these stimuli are not specialized in the left hemisphere. A left-ear advantage would suggest that the right hemisphere is specialized for the processing of these stimuli.

Experiment 1: automatic words study

Words and short phrases were selected which seemed likely to be automatically processed and stored in the comprehension mode. Many of these words were brief commands, such as *cut it out, don't, come on, get up, hurry*; others were greetings, such as *good morning, how are you, I'm fine, hi, hello, good-bye*; there were question words such as *what, why, and where?*; other stereotyped expressions, including *because, thank you and all right*, and taboo and swear words, *damn you, shit, bitch, bastard and Jesus*. These were recorded as uniformly as possible by a male voice with natural intonation appropriate to each item. The words were selected on the basis of my impressions of what comprises automatic speech. These were derived from studying the clinical data reviewed in this monograph. Some of the words selected may be more propositional than others. Revisions of the word lists may be desirable.

As in the experiments reported previously, the tapes were prepared by means of the PDP-12 computer at the UCLA Phonetics Laboratory, using programs developed by Lloyd Rice for this purpose. Each stimulus was stored in digital form on magnetic computer tape. Words and phrases were paired to agree in overall intensity levels and length. For alignment of the items onto paired channels for dichotic presentation, the wave form of each stimulus was observed, and a point of alignment chosen at the approximate first vowel onset of each item. The aligned pairs were then re-recorded from the computer tape onto audio tape for the listening task.

Thirty-four items from the originally recorded list of allegedly automatic expressions survived the selection and preparation procedures. These were matched and aligned to produce a total of 36 pairs or 72 presentations, with a seven second interstimulus interval between each pair (Table 8.1). Each set of 36 pairs was presented twice to eight subjects and four times to thirteen subjects and six times to two subjects. There were no learning effects observed to correlate with ear preference results. Subjects responded by writing the two words they heard, indicating ear location for the members of each pair, entering responses in "left ear" and "right ear" columns. Order of report (left-right, right-left) was switched every ten items, and headphones were reversed after each set of 36 pairs. The subjects were 23 right-handed students or secretaries.

1. because	1. how are you
2. thanks	2. get up
3. all right	3. come here
4. yes?	4. all right
5. let's go	5. come on
6. thank you	6. shit
7. what	7. here
8. thanks	8. how come
9. Jesus	9. please
10. don't	10. all right
11. here	11. hello
12. thanks	12. okay
13. because	13. damn you
14. bastard	14. I'm fine
15. let's go	15. why
16. because	16. please
17. hurry	17. hello
18. thank you	18. stop
19. how come	19. okay
20. Jesus	20. damn you
21. what	21. hello
22. don't	22. come here
23. how come	23. get up
24. no	24. hi
25. come on	25. why
26. stop	26. shit
27. quiet	27. shut up
28. damn you	28. please
29. okay	29. get up
30. good bye	30. cut it out
31. bitch	31. faster
32. damn you	32. how are you
33. no	33. there
34. come here	34. yes
35. there	35. hi
36. how are you	36. please

Table 8.1: Pairs of words prepared for automatic speech tape.

Results

Of a total pool of 5,760 heard items, a total of 929 were incorrect responses, either not reported, wrongly reported, or reported from the wrong ear (intrusion errors). This ratio of correct-to-incorrect is in line with standard dichotic listening results. However, the errors were not distributed asymmetrically; that is, they did not demonstrate the right ear superiority for language expected in dichotic listening of linguistic stimuli. Instead, these errors were nearly evenly distributed at the two ears: 461 errors at the left ear, and 468 at the right ear. The difference is nonsignificant, as was confirmed by the Wilcoxon matched-pairs signed ranks test, comparing left and right ear errors subject-by-subject. ($T=107.0$, where the critical value was 59 at the .05 level). The results are in keeping with the hypothesis that the kinds of language processing referred to here as "automatic" are not lateralized to the left hemisphere, but are bilaterally represented in the brain.

The results suggest that in dichotic listening, both ears, and therefore both hemispheres, can deal equally well with automatic-type words. In addition, there is evidence in the data that underlying this "surface" equality of performance, there are different modes of processing unique to each cerebral hemisphere. Substitution-errors, exclusive of intrusion errors, or wrong ear reports, were tabulated. For automatic word presentations, substitutions at the left ear seem to be different from substitutions at the right ear. For example, left ear (or right hemisphere) errors for the target word *get up* were *fast, shit, dammit, stop*, and *get out*; for the same target word, *get up*, the right ear (processed in the left or language hemisphere) heard *thank you, enough, up, duck, get out, stop, donut, camp, gap, shut up*, and *can't*. For the stimulus word *thanks*, the left ear (or nondominant hemisphere) heard *stop* and *shit*; the right ear (or left hemisphere) reported *are, back* and *stop*. Compare the responses for *shut up*; the left ear substitutions were *stop* and *shit*, whereas the right ear heard relatively more propositional words: *stop, child, shop* and *shout*.

Classification of substitution responses into "automatic" and "propositional" type false responses is sometimes uncertain. Some individual items could be either "stereotyped situation responses" or "free lexical items," depending on use. The lists of actual responses are included as illustrations of this point (Table 8.2). These pooled data show a significant tendency for the left ear to have more automatic substitution errors, and for the right ear to hear more propositional words as errors (Table 8.3).

Left ear	Right ear	Type of error
please (4) high (1) get out (3) shit (7) dammit (3) stop (5) yes (1) cheers (16) that's right (1) cut that out (3) all right (2) thanks (2) shut up (1) now (8) how (12) watch (1) bastard (24) bitch (3) I'm sorry (1) come here (3) why (5)	here (6) gotcha (1) go away (1) all ready (1) good morning (1) what (1) thank you (2) where (7) out (1) how much (1) that's good (1) come on out (4) hell (5) hello (3) yeah (3) damn (1) gee (1) jeez (3) I'm coming (1) hi (22)	bitch (1) why (6) how (10) hi (6) thanks (1) gotcha (1) cut that out (2) be quiet (1) get it out (2) come on out (2) stop (3) bastard (2) out (2) help (3) now (6) well (1) where (1) ow (1) here (3) look (1)
rear (1) fast (2) twins (2) cute (1) he can't (1) you can't (1) we can't (1) which one (1) uncle (1) hit (1) pout (1) kill (1) chair (1)	hear (1) car (1) high (6) comma (1) gift (1) stairs (2) cheese (15) sometime (1) doctor (1) can't (1)	stank (1) twice (1) high (6) child (1) shop (3) shout (1) hit (1) guitar (2) became (1) queer (1) keys (2) cheese (18) choose (1)
(172)	(114) TOTALS	(70) TOTALS
(45)	"automatic"	"propositional"

Table 8.2. Substitution Errors: types and tokens (in parenthesis). Automatic words tape, first set of subjects.

Left ear	Right ear	Substitution type
172	114	automatic
45	70	propositional

Table 8.3. Automatic words tape: Substituted errors at left and right ears of the first set of subjects.

The difference in the total number of automatic versus propositional words reported at the right ear, as compared to the left ear, is significant by a Chi-square test. Because the Chi-square test is not strictly appropriate for pooled data, a matched-pairs test (Wilcoxon) was also performed on the totaled left-minus-right ear automatic-type errors, subject-by-subject, correlated with the totaled left-minus-right ear propositional errors. The results also on the Wilcoxon were significant.

The substitution-error results seem interesting for the automatic-propositional hypothesis, because they were generated by the subjects. That is, substitution errors occur at a level of response organization, which might be said to be closer to the production mode, where the automatic-propositional distinction is most clearly in evidence.

This study was run a second time on 20 right-handed subjects. There was no significant ear difference, with 278 errors at the left ear, and 262 errors at the right ear.* The errors for the second set of subjects was consistent with the results from the first set (see Tables 8.4 and 8.5).

Experiment 2: Propositional words study

It was conceivable that some other factor in this automatic list of words was "cancelling" the usual dichotic listening ear effect. For example, about half of these words are two or more syllables. In contrast, the words from the Thai experiment, and other words in most other dichotic listening studies, are monosyllabic. To compare results for propositional words under the same conditions as those for the automatic words, another dichotic tape was prepared, with the following pairs, chosen from a Rank List of words ranking 900 or less of a total corpus of 86,741 word types (Carroll, et al. 1971) Table 8.6).

* Five subjects were eliminated from the statistical test. Four were ambidextrous subjects. A fifth subject was eliminated because his error rate was very significantly different from the others. He had a total of 117, as compared to the highest of 37 in the remaining 20 subjects, lowest 12. This subject's score was 69 errors at the left ear, 48 at the right ear. A Wilcoxon test run on all these subjects together was not significant.

Left ear		Right ear	Type of error
quiet (2)	cheers (7)	get out (5)	
how you (2)	shit (1)	here (2)	
hi (11)	cheezz (8)	all right (1)	
cut it out (2)	gee (1)	come on back (1)	
get out (4)	dammit (1)	good morning (1)	
don't (1)	please (4)	come here (4)	
bitch (2)	damm (1)	yeah (4)	
hello (12)	be quiet (1)	shit (3)	
come here (4)	stop it (1)	cheers (11)	
why (8)	cut that out (4)	stinks (3)	
how are you (19)	bastard (24)	be quiet (3)	"automatic"
how (6)		okay (1)	
thanks (2)		faster (1)	
bye-bye (1)		hi (34)	
bye (1)		wait (1)	
sure (1)		cut that out (6)	
good (2)		why (1)	
what (3)		hey (3)	
yeah (4)		cut it out (1)	
thank you (5)		stop (1)	
stinks (5)		bye (2)	
cunt (1)		now (12)	
be quiet (5)		how (6)	
wait (2)		hello (6)	
now (13)		where (4)	
where (4)		yeh (1)	
here (4)		yes (1)	
no (1)		cheesz (4)	
come here (2)		dammit (1)	
hey (1)		please (1)	
		don't (1)	
	(183)	bastard (21)	(148) TOTALS
	(56)	damm you (1)	(70) TOTALS
car (1)	til (1)	faret (1)	ner (1)
how are (2)	cheese (26)	you (1)	hair (1)
to miss (1)	can't (2)	tomorrow (2)	yet (1)
tomorrow (1)	chesse (1)	hear (1)	miss (1) "propositional"
out (1)	choose (3)	out (1)	us (1)
expect (1)	plant (3)	ex (1)	cheese (33)
speak (1)	BMU (1)	exorus (1)	forgot (1)
guitar (4)		petard (1)	choose (6)
good times (1)		you can't (1)	I sure (1)
I can't (1)		guitar (1)	can't (2)
I (1)		tired (1)	use (1)
us (2)		shut out (1)	can you (1)
hoe (1)		quite (1)	cheeses (1)
yet (1)		plant (3)	cheer (1)
		I'll stay (1)	

Table 8.4. Substitution errors: Types and token (in parentheses): Automatic words tape (second set of subjects).

Left ear	Right ear	substitutions
183	148	Automatic
56	70	Propositional

Table 8.5. Automatic words tape: Substituted errors at left and right ears of second set of subjects.

1. however-different
2. before-among
3. without-middle
4. forward-children
5. plant-field
6. sentence-example
7. floor-times
8. sound-change

Table 8.6. Pairs of words prepared for propositional speech tape.

The words were all pronounced with falling intonation by the speaker who also recorded the automatic words. They were balanced for length and intensity and aligned using the UCLA Phonetics Laboratory computer in the same manner as the automatic words tape. The tape was run on a group of 22 right handed subjects.

Results

No significant ear effect was observed. The figures were 620 errors at the Left Ear, and 600 errors at the Right ear, and the Wilcoxon matched pairs test was non-significant. This, therefore, is another list of words showing no ear effect. But this list consists of propositional words. We cannot conclude from the results of the previous experiment that it was the automatic character of the words that led to the results, with the exception of the high-frequency property, which both lists of words have in common.

The false response tabulation is presented in Tables 8.7 and 8.8. In the propositional-words condition, the left ear made more propositional type false responses than the right ear. For automatic-type responses, both ears mis-heard about the same number.

Summary of experiments 1 and 2

The results are no ear effect for automatic-type words, no ear effect for high frequency propositional words; more automatic false-responses at the left ear during the automatic condition, and more propositional false-responses at the left ear during the propositional condition.

Experiment 3

New tapes were prepared to directly compare performances for automatic versus propositional words under identical conditions, and to make the task more difficult, thus enhancing errors. Five pairs from each set (automatic and propositional) were chosen, and presented in pairs of two, followed by eight seconds time for the subject to record four responses. That is, pairs of words were "doubled up" as in the second half of the tone-words condition in the Thai study. The automatic and propositional tapes were kept separate, and the order in which they were given to each subject was alternated. This was done to balance for learning or set effects. The ten pairs, five automatic and five propositional, are presented in Table 8.9.

Left ear			Right ear		Type of Error
look out (56)	cool it (2)		look out (48)		
four (26)	come home (2)		four (29)		
no more (5)	uhup (1)		come on (12)		"automatic"
oh my (10)	buzz (2)		go home (5)		
come on (5)	alot (1)		some more (1)		
whore (1)	how (1)		no more (12)		
go home (5)	no (1)	(118)	oh my (6)	(113)	TOTALS
		(414)		(374)	TOTALS
arch (38)	toward (1)	chives (1)	mate (33)	poet (4)	
march (11)	friend (1)	watch (6)	march (26)	port (1)	
mate (19)	pimple (3)	hit (1)	for (9)	neck (1)	pimple (4)
art (25)	torrent (2)	however (1)	art (26)	hark (1)	part (1)
for (7)	hurt (4)	mix (1)	watch (7)	sounds (1)	peeled (3)
fudge (7)	admire (3)	on hand (1)	enfant (11)	hat (1)	nob (1)
sore (7)	mark (1)	out (1)	hurt (7)	plant (4)	rewind (1)
a month (7)	might (1)	farm (1)	arch (28)	times (2)	stars (1)
delinquent (10)	jewelry (6)	think (1)	stores (6)	children (3)	snore (1)
arm (7)	da (1)	form (1)	mental (6)	people (1)	slower (1)
poet (10)	circus (1)	anand (1)	domage (5)	field (1)	stop (1)
heart (6)	thinks (1)	more (1)	bake (5)	aware (1)	size (2)
dig (5)	milk (1)	marge (1)	tomorrow (5)	armand (1)	signs (1)
tomorrow (8)	porridge (4)	amar (1)	fudge (4)	ama (1)	watch (1)
bored (5)	mills (1)	aware (3)	table (4)	amount (1)	will (1)
bug (4)	cake (1)	forever (1)	horn (4)	admire (2)	wait (1)
time (4)	ilk (1)	before (1)	time (4)	amar (3)	clint (1)
torn (4)	little (5)	for (4)	fort (3)	omar (3)	now (1)
cheese (3)	tower (1)	slower (4)	meal (3)	porridge (4)	more (1)
program (3)	sounds (2)	armand (4)	digs (3)	cement (1)	
metal (7)	table (2)	take (1)	parameter (1)	dimple (1)	
bake (3)	before (2)	peeled (1)	ford (2)	date (1)	
domage (3)	plant (4)	lake (3)	exams (2)	chrysmums (1)	
door (2)		times (1)	sadness (2)	Christmas (1)	
now (2)	skill (1)	sneeze (1)	domar (2)	cars (1)	
deliver (6)		peels (1)	down (2)	cold (1)	"propositional"
right (2)	enfant (4)	current (1)	mill (2)	deliver (1)	
tires (6)	food (1)	help (1)	without (2)	examples (9)	
up (2)	a man (1)	quest (1)	up (2)	found (3)	
towers (3)	clear (1)	cold (1)	metal (5)	force (1)	
march (12)	stores (1)	cars (1)	short (2)	forest (2)	
found (4)	hark (1)	touch (4)	sport (2)	forever (4)	
thwart (2)	bold (1)	held (1)	torn (1)	forms (3)	
examples (4)	slower (1)	chairs (1)	arm (5)	fork (1)	
cement (6)	pull it (1)	hurdle (3)	man (1)	food (4)	
different (3)	house (1)	stars (1)	it (1)	horn (3)	
middle (1)	metal (1)	larch (1)	tires (1)	hurt (3)	
amount (6)	hand (1)	snake (1)	kinds (1)	however (1)	
table (4)	boat (1)	sadness (1)	heart (1)	little (3)	
minute (3)	paint (1)	horn (4)	towers (1)	jewelry (3)	
arm (3)	toys (2)		lake (4)	large (1)	
mental (4)	behind (1)		delinquent (5)	meadow (2)	
			before (5)	minute (2)	
			right (1)	mental (5)	
			toward (1)	milk (3)	
			nickle (1)	maple (1)	

Table 8.7. Substitution errors: Types and tokens(in parenthesis), propositional words tape.

Left ear	Right ear	Substitutions
113	113	automatic
414	374	propositional

Table 8.8. Propositional words tape: Substituted errors at left and right ears.

"propositional" words	"automatic" words
1. floor-times	1. thanks-okay
2. sound-change	2. hurry-hello
3. middle-without	3. no-there
4. different-however	4. damn you-how are you
5. sentence-example	5. shit-stop

Table 8.9. Word-pairs selected for doubled-pairs tapes.

Results

In this more difficult version of dichotic listening to propositional and automatic words, the results remained the same for the high frequency propositional words: no ear advantage. Counting errors of identification *and* ear location, there was a total of 337 errors at the left ear, and 330 at the right ear. Counting "ear location errors" as correct, the figures are also nearly even at the two ears: 293 at the left ear, 288 at the right ear. However, the results for automatic words did not come out as expected. There were more errors at the left ear in both scoring systems, and the difference was significant at the .05 level when intrusion (ear location) errors were counted correct (Table 8.10, Figure 8.1).

Automatic				Propositional			
left ear		right ear		left ear		right ear	
errors	intrusions (wrong ear)	errors	intrusions (wrong ear)	errors	intrusions (wrong ear)	errors	intrusions (wrong ear)
289	23	233	43	293	44	288	42

Table 8.10. Errors on "Doubled Pairs" tape

The substitution errors in this study were consistent with trends from the previous tapes for automatic and propositional words. Generally, the left ear makes more false responses of the sort in the given repertory. When the subject is listening to the automatic-words tape, he/she mis-hears more automatic-type words for words heard in the left ear; when listening to propositional words, a subject produces more propositional false responses for left-ear stimuli (Tables 8.11 and 8.12).

This priming effect may be related to specific processes in the right hemisphere. If the right ear also consistently makes more 0 (zero) responses, then perhaps an explanation might be that the left hemisphere needs more information to proceed in its mode, call it an "analytic mode," whereas the right hemisphere contributes relatively more guesses, based on an adopted strategy, (which does not include matching up of analyzed subparts). That is, the left hemisphere is more easily "primed" into guessing and producing (false) responses which correspond to general features differentiating automatic and propositional types.

Automatic Words		SOURCE TAPE		Propositional Words		Type of error		
Left ear	Right ear	Left ear	Right ear	Left ear	Right ear			
? Bill (4) ? Mel (1) ? how (2) ? honey (1) there (2) hi (25) damm (1) hell (5) ? next (6) ? now (8) where (2) hi there (4) great (2)	hi (1) ? Scott (1) no (1) hi (15) ? Bill (3) ? Mell (2) ? how (3) ? I'm here (1) great (1) ? now (7) hell (3) hi there (2)	no (1) four (20) look out (16) look up (1) cucus (1) stop (1) hell (1)	no (1) four (16) ?how (1) lookout (29)	(63)	(40)	(41)	(47)	"Automatic"
(37)	(36)	(82)	(57)	Totals		Totals		
bell (5) start (2) how are (2) facts (2) hx (1) thats (1) ex (1) x (3) milk (3) near (1) mail (1) shift (4) mirror (4) thank (2) bail (1) channi (1) mill (3)	facts (2) bell (1) ? start (2) stacks (1) hear (1) near (1) ship (2) ? Hi the (1) hair (1) mare (5) thank (1) mirror (4) shift (3) ? sex (3) ? wait (1) their (1) thank (1) bail (1) mail (2) X (1) cocaine (1)	found (1) tower (1) time (4) chess (1) sent (2) sounds (5) ? so (1) send (1) charge (1) sample (1) for (10) diff (2) and (1) forrest (4) forward (6) sand (1) little (8) torn (1) sour (1) with (6) ex (4) ripout (41) exchange (1) fast (3) thorns (5) stars (3) ? I will (1) mid (1) diff (1) flo (1)	found (1) examp (1) sample (1) force (1) sent (1) towers (1) little (2) exam (1) differ (8) ? look (1) time (2) examples (5) foor (1) said (1) ex (1) shaft (1) changes (1) rivet (2) ripout (3) thing (1) force (1) stars (2) sounds (2) for (7) ex (3) rounge (1) tower (1) cliff (1) ? so (1) exams (1) mid (1)					"propositional"

Table 8.11. Substitution errors: Types and Tokens (in parenthesis). Automatic and propositional "doubled-pairs" tapes (? indicates uncertainty of classification).

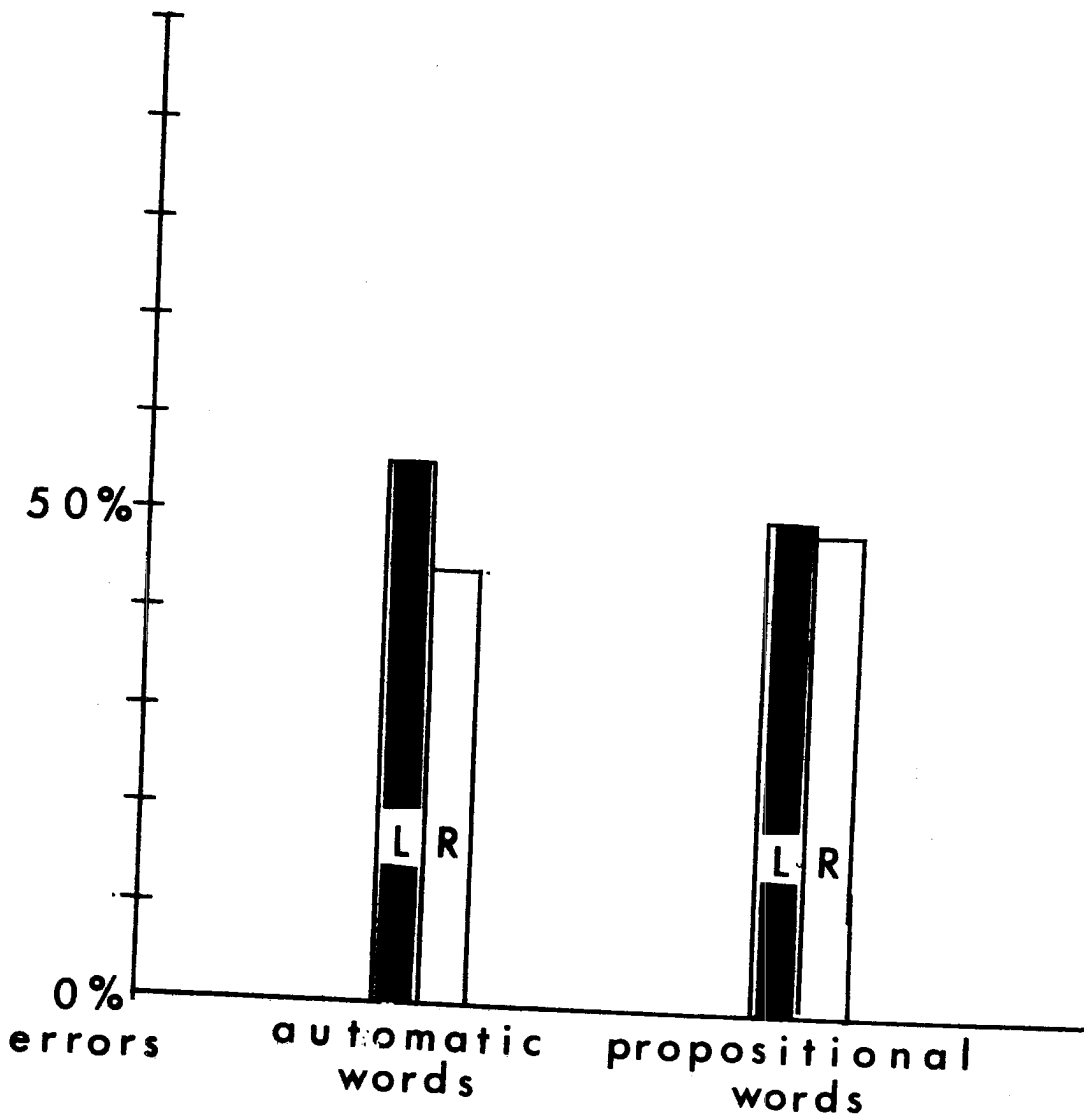


Figure 8-1. Percentage of errors (POE) by left and right ears: doubled pairs tapes.

left ear	right ear	type of SUBSTITUTION	original condition
61	40	automatic	AUTOMATIC WORDS TAPE
37	35	propositional	
41	47	automatic	PROPOSITIONAL WORDS TAPE
82	57	propositional	

Table 8.12. Automatic and propositional errors substituted:
"doubled pairs" tapes.

Discussion

These findings are compatible with the general hypothesis that different aspects or modes of language are differently processed in the brain. However, if the ear effects of these dichotic listening studies reliably imply lateralized processing of these different modes of language, then the particular form of notions about propositional as compared with automatic subsets must be revised.

The results for the high frequency propositional words agree with other results in psycholinguistic research. In studies by Marshall (1973)* a laterality effect is observed (left hemisphere superiority) when subjects are presented with low frequency words, but that effect decreases as a function of word frequency. As reviewed in Chapter 8, psycholinguistic tests have shown high frequency words to be more perceptible. Furthermore, word frequency is known to be an important factor in aphasia. Aphasics typically retain high frequency words across all grammatical form classes (excluding function words). Thus the non-laterality for high frequency automatic and propositional words presented in single pairs in these dichotic listening studies agree with other psychological tests for laterality and with observations in aphasia.

* Personal communication

It is unclear why the "doubled pairs" tape gave a significant ear superiority (right ear) for automatic words, while the pairs with constant interstimulus intervals did not. This discrepancy must be explained before these results merit serious interpretation. Recall that this difference in task did *not* affect the ear superiority for listening to Thai tones. In that case, half the pairs (10 pairs) were presented with regular interstimulus intervals, and the other half (40 pairs) as "doubled pairs." The right ear effect was significant in both conditions, indicating that "verbal memory" was not a primary factor in the right ear effect found for Thai tone-words. However, there was a difference in the response aspect of the task. The Thai subjects wrote (R) or (L) (for right and left) under the column headed by the Thai symbols corresponding to stimuli. For the doubled-pairs of propositional and automatic words, subjects wrote down all four answers on an answer sheet as depicted in Figure 8.2.

It is possible that verbal memory could have been a factor in this kind of task, which required 1) longer writing time, and 2) a conversion of the auditory pairs into linear order on the page. Further testing is required.

The automatic words were pronounced with natural intonation, as though each item were actually being said in a situational context, whereas the propositional words were recorded in list pronunciation (falling contour on all items). It can be tentatively observed that these results agree with studies by Zurif and Sait (1970) and Zurif and Mendelsohn (1972) in which the acoustic cues of rhythm and stress gave a right ear effect (on nonsense strings). The automatic words in these lists differed from the propositional words in containing more such linguistic cues. Furthermore, presenting these words in sequential pairs changed the nature of the task from automatic recognition to a sequencing task, which may underlie the specialized abilities of the left hemisphere (Carmon, 1972). As pointed out by Harold Gordon, "Thanks," "okay", "hello" singly perceived might be automatic items, but "Thanks-okay", "shit-stop" are not (1974).*

It is possible that the word selection for the automatic and propositional lists needs revision in two respects, both phonetically and conceptually. First, although the words were exactly balanced and aligned for intensity and length, they were not balanced for number of syllables and phonetic structure. Lowe et al. (1970) and Berlin et al. (1973b) have claimed that there are specific phonetic factors involved in

* Personal communication

left ear	right ear
1. _____ _____	_____
2. _____ _____	_____
3. _____ _____	_____

Figure 8.2. Answer sheet format for doubled-pairs tapes.

the ear effects in dichotic listening. It might be useful to design pairs of phonetically balanced, monosyllabic words for these tests. Secondly, perhaps the types of words chosen to represent "automatic" and "propositional" need to be reconsidered. The selection was based on intuition and clinical observations in aphasia. Further tests could compare automatic and propositional words of low frequency, predicting a right ear advantage for the propositional words only.

The results on the "doubled pairs" automatic words test lead to a revision of Jackson's hypothesis that automatic modes are bilaterally represented. They suggest that these modes are not only a capacity of the right hemisphere, but are also more strongly represented in the left hemisphere. In this view, automatic subsets are represented in the right hemisphere, and overrepresented in the left, and therefore, they are very likely to survive various types of injury. They are more diffusely represented in the brain. This would account for the robustness of these subsets in aphasia, and for the right ear effect in the more difficult dichotic listening task.

Dichotic listening in normal subjects may not be the most fruitful way to investigate the concept of automatic and propositional speech. One difficulty is the complex relationship between normal and brain-damaged processing of language. This aspect can be investigated by extending these dichotic listening studies to aphasics, and to split-brain subjects.

Sparks and Geschwind (1968) report "complete extinction" of the left ear in dichotic listening of digits and animal names in a callosal-sectioned patient. That is, this patient identified only words presented at his right ear. With practice, however, the left ear score for digits improved from 0% to 35% detection. Serial speech (producing or comprehending lists of numbers) is one of the automatic subsets said by Jackson to be represented also in the right hemisphere. The original dichotic listening studies (Broadbent, 1954; Kimura, 1961) resulted in consistent right ear advantages (when presented to normal subjects in series of three pairs). However, on the basis of the Sparks and Geschwind (1968) results, it is conceivable that other automatic words (greetings, swear words) might be better detected at the left ears of split-brain subjects than (low-frequency) propositional words.

The differences between production and comprehension of non-propositional speech remain to be investigated. Such differences might be found, and related to hypotheses about automatic and propositional language, by comparing dichotic listening results with results from experimental techniques that work in production modes, such as delayed auditory feedback, or evoked cortical responses. Clinical indications are overwhelming that there is something meaningful in differences referred to traditionally as automatic versus propositional use of language. Further research can aim toward determining the cerebral processes that underlie these differences.

Chapter 9.

Conclusion.

Chapter 9

Conclusion

Linguistic status of pitch

Some linguists have recognized that prosodic features, especially features of pitch and intonation, are fundamentally different from other phonological features (Bolinger, 1961a,b,c; Stankiewicz, 1964; Crystal, 1969). The separateness of some prosodic features from other phonological phenomena is supported by neurophysiological facts reviewed in this monograph. Intonation abilities are rarely disturbed in disease, in contrast to other aspects of the phonological component. They are first recovered. These observations have been attributed to the claim that the anatomical substratum for pitch production and perception comprises "practically the whole of the brain" (Monrad-Krohn, 1963), whereas processing of other phonological features is purportedly specialized in the left hemisphere. Intonation is closely related to nonlinguistic performance such as singing, and instinctive and emotional vocal expression, all of which are selectively retained in aphasia. The more resilient abilities for song are perhaps accounted for by the speculation that musical abilities are "phylogenetically and ontogenetically older than speech and more uniformly represented over both hemispheres" (Henschen, 1926). This notion would agree with Jespersen's (1964) suggestion that speech originated in song.

The representation of prosodic features in a grammar has been debated in linguistics. There is no question that some prosodic features must be included in an adequate model of language. The problem lies in establishing the linguistic features, determining the size, function and scope of units, and developing the appropriate formalism. Neurolinguistic research can contribute very little, if anything to such investigations. But it can help us to determine the function of certain phenomena. Linguistic function of prosodic features can be correlated with lateralization of function in the brain. For example, as reviewed in Chapter 4, studies suggest that certain pitch contrasts in a tone language (Thai) are processed in the left hemisphere, whereas pitch for emotional cues is not specialized to the left hemisphere (see review in Chapter 5, pp. 79-84).

Thus, observations in aphasia and facts about the cerebral lateralization of different kinds of pitch processing can help separate linguistic from nonlinguistic features in prosodic phenomena.

Linguistic status of automatic speech

The status of automatic subsets depends on whether one wishes to consider them typical instances of human language. Whether or not they constitute human language is dependent upon notions of definitions of human language. Traditionally, emphasis has been placed on propositional use of language (rather than on emotional and overlearned usage) in analysis of human language. According to Chomsky, the essential attributes of human language are that speakers have the ability "to speak in a way that is innovative, free from stimulus control, and also appropriate and coherent" (1972, p. 13). This is a characterization of propositional use of language. These properties do not cover automatic subsets. In fact, the first two rather exclude automatic speech. Socially conventional phrases, idioms and stereotyped formulas are not "innovative," in Chomsky's sense "of being entirely new, not a repetition of anything that we have heard before and not even similar in pattern" (1972, p. 12). These modes and others (pause fillers and greetings, etc.) are not entirely free from stimulus control, and emotional expression may be said to be highly situation-context dependent, and in that sense stimulus-bound, especially to internal states of the speaker.

Human language can be defined as the class of natural languages learned and spoken by human beings. In this approach, all properties of that class are of potential interest to linguists. Some attributes are "central" and distinguish human language from other phenomena. Other features are inherent in different ways, with different relationships to other phenomena. The properties which allow for the production and perception of newly-created strings (i.e. productivity) are central, distinguishing features (although these occur in other systems, i.e. logic). Other features operate to provide for and to maintain formulas, familiar structures, predictable strings etc. Still other properties include stereotyped but more or less "instinctive" expression, through speech, of internal states. These nonpropositional properties are present in human language and to varying extents also in other biological systems (i.e. animal language). I would hold that human vocal behavior forms a continuum, extending from involuntary cries of pain, which may be likened to items within an animal signaling system, through to the more involved uses of speech in propositional statements. Within this continuum it is impossible to say where "language" begins. Support for this view may be found in the literature. Expressive speech, for example, has been identified with the instinctive cries of animals. The neurologist Head (1926) referred to the residual automatic speech of the

aphasic as having the status of a "growl or a purr" (p. 142). Luria stated that "these forms of verbal activity do not constitute speech in the true sense of the word" (1947, p. 281). Psychoanalytic studies of speech mannerisms classed such phrases as "I don't know" with laughs, sighs and intruding incoherent sounds (cited in Mahl and Schulze, 1964).

In a reference to conventional subsets in automatic speech, another writer maintains that speech has "degenerated into tittle-tattle," when the conversation "abounds with repeatedly introduced meaningless token phrases, familiarity clauses, intimacy clauses, verbal garbage or sympathetic circulatory sequences -- 'One does, doesn't one; yes, you know; well I never; you see; Well it's like this you see'" (E. Critchley, 1967, p. 44).

Other aphasiologists have referred to automatic subsets as "inferior speech" (Jackson, 1932) or "lower levels of speech" (Luria, 1970). Stereotyped phrases, intrusive words, swearing and emotional expressions are peripheral (and undesirable) in language. Critchley has observed in normal speech "the immoderate use of certain phrases, words, expression, or even meaningless sounds with which the speaker decorates his articulate utterance, such as 'in fact, you know, actually, of course, naturally, if you know what I mean', (1970, p. 221) and the "irritating use of verbal mannerisms, whereby a person in conversation emits ad nauseam such trite little phrases as 'don't you know, I say, as a matter of fact, Do you know what I mean.' By gradual steps these verbal sillinesses graduate to sheer *verbal tics*, where a phrase is enunciated as an obsessional trait, without any pretence at meaning or congruity" (1970, p. 203). Similarly, for Sapir "interjections are the least important of speech elements," and there is no record of "a noticeable tendency toward their elaboration into the primary warp and woof of language...They are never more, at best, than a decorative edging to the ample, complex fabric" (1921, p.7).

An automatic-propositional continuum

A continuum of heterogeneous speech modes provides a context in which new hypotheses about relatedness of past and present expression systems can be formulated. Some subsets of nonpropositional speech can be posited to lie between the class of instinctive cries, which may be related to animal behaviors, and evolved human language. On the other hand, some subsets are more closely related to propositional speech than to instinctive cries. There are many kinds of automatic speech in human language. Thus instead of two disjunctive sets (e.g. automatic and propositional, expressive and cognitive, instinctive and symbolic, reflex and voluntary) corresponding to a gross distinction between animal vocalization and human language, I propose a continuum in human speech abilities between such extremes. It is probable that a number of neurophysiological systems (not just two, cortical and limbic) underlie the integration of these modes. Emotional cries and verbal tics (or intrusive phrases) constitute the "most automatic" type, and other utterance-types occur along a continuum to "most propositional" use of language. This dimension specifies a kind of heterogeneity in language use (Figure 9-1). Further research can determine whether the discontinuities at both ends of the hypothesized continuum are quantitative or qualitative; that is, whether the subsets are related all along the dimension in a continuous line, or whether there are "missing links" between, for example, reflexive and overlearned types, and/or between the overlearned and idiomatic and semi-productive types and propositional use of language (see question mark (?) on Figure 9-1). With this conception of heterogeneity in human language, questions about the relationship of animal communication and human language can be reformulated. Some modes of human speech may be seen to be more closely related to animal communication antecedents, and others not.

Properties of automatic speech and grammar

More importantly, this conception of heterogeneity accounts for features of language described by linguists. It accounts for both ready-made utterances and schemata (Lyons, 1968) or semiproductive processes. It provides for the description of a sliding scale of cohesion, of bound-to-free interrelatedness within word groups (Bolinger, 1961a, 1974) degrees of frozenness in idioms (Fraser, 1970). Within such a framework, the processes of idiomatization (Bolinger, 1974; Hockett, 1958) can be described. It accommodates observations in aphasia, that some modes or subsets are more disrupted than others. The continuum also provides for a reformulation of the use of levels of pitch phenomena in speech. Aspects of storage and processing, relevant to the construction

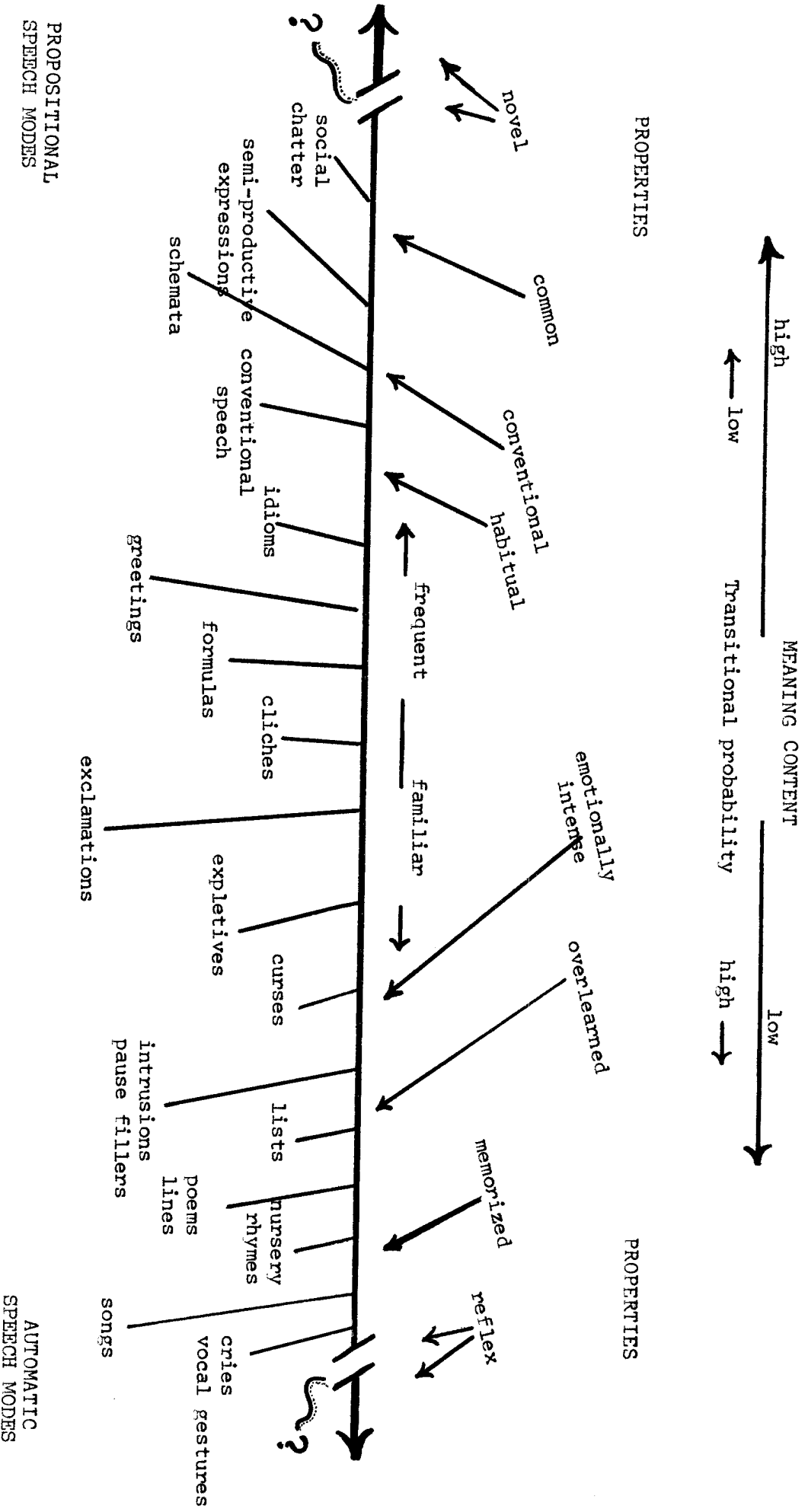


Figure 9-1. A hypothetical continuum of propositional and automatic speech modes and their properties.

PROPOSITIONAL
SPEECH MODES

AUTOMATIC
SPEECH MODES

of performance models, involve properties represented by the automatic-propositional continuum. Further research could determine what other specifications in performance modes would be needed: e.g. the elimination of a "morphophonemic rules" process for some nonpropositional speech. It is an empirical question, for example, whether speech error phenomena are different for automatic as compared with propositional speech. Other phonetic and prosodic phenomena can be investigated in the context of performance models which include automatic and propositional modes. Hypotheses about linguistic units in storage and processing can be formulated in this context. More complex performance models (Laver, 1970, 1972), which include factors of memory (long and short term storage), and different types of feedback and attention processes, etc. are especially fit to incorporate properties of automaticity.

The possible alternatives for grammars, then, are these:

- 1) Automatic speech is non-language.
- 2) Properties of the propositional-automatic dimension belong in a model of systematic performance.
- 3) Automaticity and propositionality are characteristic of human language ability and require representation in a complete model.
- 4) To adequately incorporate automaticity and propositionality features into grammatical description, it is necessary to develop a new theoretical framework within which models of language behavior can be constructed.

The pervasiveness of automaticity phenomena in language use argues against the first alternative. Their presence in speaker's intuitions argues against the second. I believe that further research will lead to the fourth conclusion, because an appreciation of heterogeneity in language, and a better understanding of nonpropositional modes, will require new descriptive frameworks.

This view of the nature of human language follows the picture drawn by Bolinger (1974). In an eloquent argument against the prevailing model language as a logico-deductive system, Bolinger has given a great deal of evidence that knowledge of collocational and idiomatic properties are vastly pervasive in the speaker's abilities to produce and recognize grammatical instances of his native language. Bolinger has claimed that memory processes play an important role at all levels of grammar. He claims that "speakers do at least as much remembering as they do putting together" and that "idiomaticity is a

vastly more pervasive phenomenon that we ever imagined, and vastly harder to separate from the pure freedom of syntax." There are "tight idioms" which "as they loosen up, ... gradually fade into that background of phrases that can be generated by rule." There are all kinds of collocations, with degrees of improbability in their interpretation (i.e. idiomaticity) and degrees of boundness or freedom of structure. Although a collocation is "stored as a unit," there are "all sorts of possibilities of degree of interplay between remembering and remaking." The simplest demonstration of these facts lies in attempts to translate from one language to another.

The facts of language indicate much indeterminacy and heterogeneity, properties which do not fit the highly structured models developed in recent grammatical traditions. Bolinger says about the "one-piece model" which the theory is supposed to be providing: "more and more evidence is turning up that this view of language can't be maintained without excluding altogether too much of what language is supposed to be about. In place of a monolithic homogeneity, we are finding homogeneity within heterogeneity." Bolinger's picture of language is not an overall testable theory. He advocates, as do Thompson (1974) and others, much further research into the "neighborhoods" of human language before an areal map is drawn. I am in sympathy with this position. I cannot propose an overall model that would accommodate the facts about heterogeneous structure-types that I have reviewed in this monograph.

Summary

This monograph presents evidence that human language is not homogeneous, but is made up of various levels and modes, differing in structural organization and function. I've taken the position that features of automatic speech are an integral part of human language. These features belong to processes in language. Nonpropositional subsets do not occur as a "closed list" in a model of language. They are modes along a continuum which underlies the range of human speech abilities.

I've presented evidence that prosodic phenomena occur in language as a functional hierarchy. Prosodic features are related to the automatic-propositional features in ways yet to be determined. The relationship of nonpropositional modes and related prosodic systems in language to animal "language," and to the emergence of human language in evolutionary history remains to be investigated. Research in neurolinguistics, such as aphasia and lateralization of cerebral function, is one approach to these questions. Psycholinguistic experimentation provides a number of paradigms suitable for this kind of investigation. I believe that these avenues of research can profitably intersect with descriptive linguistic studies and the development of grammatical models.

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