

CHAPTER 1

INTRODUCTION

- 1.1 Importance of speech
- 1.2 Role of speech in human communication
- 1.3 Uses of speech in different walks of life
 - 1.3.1 Linguistics
 - 1.3.2 Sociolinguistics
 - 1.3.3 Psychology and Psycholinguistics
 - 1.3.4 Phonetics
 - 1.3.5 Acoustics
 - 1.3.6 Medical field
- 1.4 Biological foundation of language/speech
 - 1.4.1 Speech production
 - 1.4.2 Speech rhythmicity
- 1.5 References

CHAPTER 1

INTRODUCTION

1.1 IMPORTANCE OF SPEECH :

Speech is social tool designed for communication of ideas from one person to another; we must be careful to distinguish it from mere self-expression. We must think of it in its functional setting as means of transmitting thoughts, attitudes, emotions and many more informative things yet to be known. In dealing with the voice of a man, we must not fall into the habit of separating it from the whole bodily behaviour of man and regarding it merely a sort of outward symbol of inward private thoughts. The air we breathe, the air we talk and hereby; is not to be regarded as merely out-side air, it is inside air aswell.

The voice of man is one component in a whole body postural scheme in some sort of situation. And in this sense a man speaks with his breathing apparatus, his body muscles and head. The physical efforts has its accompaniment in vocal efforts. Thus all with their own vocal and muscular obligates in harmony with characteristic posture and movements of their lives, in a speech. According to Hindu mythology as well, speech sound has different body centres of generation and has the roots of characteristics of their body behaviour as phonetic information.

1.2 ROLE OF SPEECH IN HUMAN COMMUNICATION :

Speech plays very important role on human communication. Physically what we transmit is the signals or signs—audible, visual, tactual. But the mere transmission and reception of a physical signal does not constitute communication. A sign, if it is perceived by the receipient, has the

potentials for selecting responses in him. Physically, when we communicate, we make noises with our mouth or gesticulate, or exhibit some token or icon, and these physical signals set up a response behaviour [1].

The theory of communication is partly concerned with the measurement of information content of signals, as their essential property in the establishment of communication links. But the information content of signals is not to be regarded as commodity; it is more a property or potential of the signals, and as a concept it is closely related to the idea of selection or discrimination.

Since no two individuals speak exactly alike, there are great difficulties of defining, standardizing and specifying utterances—the whole difficult field of phonetics and of signal analysis. Language and other social activity are mutually related; the interests and needs of the day force changes upon the language and, in turn, the language is dominant over our thoughts. We think and we see the world as our language conditions us to do. Communication essentially involves a language, a symbolism, whether this be a spoken dialect, a stone inscription, a morse code signal, or chain of binary number pulses in a modern computing machine [1].

The process of communication deals with the way people communicate with each other. It is concerned with the scope and purpose of communication, the factors involved in the process and the role of language in human behaviour. There is a research evidence to indicate that the average American spends about 70 percent of his active hours communicating verbally—listening, speaking, reading and writing, in that order. In other words, each of us spends about 10 or 11 hours every day, performing verbal communication behaviours [2].

Birdwhistell [3] and others have studied communication involving nonverbal gestures; facial expressions, movements of the hands and arms. Though use of infrared cameras and other devices such as the “wiggle meter”, researchers have observed the gross bodily movements of people attending movies or television and have found that audiences communicate

their interest by these bodily movements. The field of professional communicator can be defined even more broadly than we have. Many social commentators call this the age of symbol-manipulation. In our grandfather's days; most people earned their living by manipulating things, not by manipulating symbols [4].

1.3 USES OF SPEECH IN DIFFERENT WALKS OF LIFE :

Speech is useful in different fields of life, such as linguistics, sociolinguistics, psychology and psycholinguistics, phonetics, acoustics and medical field.

1.3.1 LINGUISTICS :

Language has always held central place in the affairs of man—in his education, his art, and his science. Language is among the very first forms of behaviour that we learn as children. When we later learn other skills and acquire other knowledge, much of our learning can reach us only through the medium of language. Other animal learn while only men can receive explanations. Whether in oratory, in singing or in written form, language has been an important medium of artistic expression for all people [5].

The major subdivisions of linguistics illustrates the tendency towards autonomy. In syntax, for instance, an attempt is made to formulate rules which can account for the arrangements of words and their major parts such as prefixes, bases, suffixes (the units that linguists refer to as morphems) and to distinguish the permissible sequences of words and morphems from the many conceivable sequences that cannot be used. Clearly father, daddy and pop are not identical even though they all refer to the male parent. The choice among these forms is governed not by the referent to which they all refer, but by such factors as the speaker's personality, his father's presence, or absence, his feelings towards his father,

and the formality of the situation. Perhaps all languages make some distinction between formal and in-formal styles [6,7].

1.3.2 SOCIOLINGUISTICS :

The social function of speech is studied in more detail in a branch of sociology, called sociolinguistic. One of the best way to illustrate the nature of speech and its function in society is to consider various theories concerning the origin and development of language. There are many such theories. Some scholars believe that automatic cries of alarm, screams of pain, snarls of rage, and other emotional expressions form the basis of language. As human beings recognized these sounds and made finer distinctions among them, a means of communication evolved which became more and more specific. Gradually language systems developed, employing vocal sounds and written symbols as words to represent thousands of meanings [8].

Language began with man's attempt to imitate the sounds of nature in order to tell about his experiences; and still another holds that meaningful articulation resulted from the movements of the tongue, jaw and lips which accompanied changes in facial expression. While the beginnings of human speech are lost in antiquity, the development of speech in children is well understood. Beginning with simple emotional cries of hunger, pain and pleasure, the child soon reaches the "babble" stage — that is, he plays with sounds, making all sorts of noises apparently just for the fun of it. He gradually finds that certain of these noises produce reactions; his mother responds to some of his sounds but not to others. Later, words are put together into simple sentences and gradually this process is extended to more complex phraseology as it keeps pace with the growing complexity of his own thoughts and actions [9].

Speech, therefore, develops in the child for the same reason that language developed in the race—in order to meet a social need. Because

speech is a means of human adjustment, it is a distinctively social tool. In order to communicate, the speaker must translate the idea into language symbols of some kind : words, phrases, sentences in English or some other language. As yet, however, these language symbols are mental concepts only; they have not emerged from the speaker's mind. To make these symbols audible, nerve impulses from the central nervous system must actuate and control the complex systems of muscles used in speech—the breathing muscles, the muscles of the larynx and jaw, the tongue, the lips etc and these muscles must react in coordinated movement to produce the proper sounds. But these sounds are no longer words and sentences; they are merely disturbances in the molecules of air surrounding the speaker, a wave pattern of compressed and rarefied particles of gas [10].

After long experience in public life, Benjamin Disraeli, the British statesman, declared, "There is no index of character so sure as the voice". It is true that often we tend to judge a person by his voice. A woman whose tones are habitually sharp and nasal may be thought of as a shrew. A man whose voice is harsh may be judged crude and rough. A thin, breathy voice, dominated by the frequent use of upward inflections, may suggest a lack of conviction or decisiveness. Sometimes a speaker's voice may be the most important single factor determining the impression his hearers form of him as a person, frequently it is among the major factors. In addition to the impression the speaker's voice gives of him as a person, there is second reason why a good voice is important; the speaker can make what he says more interesting and meaningful [11,12].

1.3.3 PSYCHOLOGY AND PSYCHOLINGUISTICS :

Psycholinguistic is branch of Psychology in which concepts of linguistic is employed for personality development of man or woman. Pauses in speech, hesitation pause in speech are studied in detail for determination of human behaviour, status of excitation and its control is analysed by

speech breathing apparatus [13,14,15]. The division of time into periods of activity (speech) and inactivity (silence) proved particularly fruitful from personality development point of view. The period of silence where ever shown is to be the main determinants of the rate of speech [16,17,18] and this inturn emerged as a personality characteristic of remarkable constancy. *Pauses interrupting the smooth flow of speech thus becomes the main subject of all further investigations.* The units which compose the dynamic and semantic structure of speech belong to different classes of phenomena and to different systems of organization.

- (a) There are the linguistic systems,
- (b) The physical, physiological and neuro physiological systems, *i.e.*, operating through respiratory muscular and electrical activity, and
- (c) The temporal phenomena, which includes duration of activity by any of these systems and of the gaps of inactivity which interrupt and alternate with activity [19, 20].

1.3.4 PHONETICS :

Phonetics as a science, is an integral part of linguistics; phonetics as an art proceeds from the basic data of scientific phonetics. Linguistics is the scientific study of a language, or of languages. Linguistics therefore has to study one kind of human behaviour; namely, the systematic use of sound signals for the purpose of evoking appropriate or desired reponses from the bearers thereof.

Such speech sound signals can be shown to consist of individual sounds, or of sounds recongnizable as recurrent, produced singly or in configurations. Phonetics, then, is the study of the sounds of speech [21].

The stimulus–response behaviour, which we call speech, consists typically of a series of physical movements initiated by patterned nervous impulses and performed in sequence by the vocal organs so-called, in such a way that these movements result in audible agitations of the surrounding

air. That is speech movements produce sound waves. These sound waves in turn displace, in intricate and minute movement patterns, the tympani of the ears and the displacement ultimately produce nervous impulses which act as sound-signal stimuli and when uninhibited, lead to response. In a nut-shell, the general phonetics deals with how speech sounds are produced, what they are when they are produced, the manner of their production and their nature when they are combined in speech forms [22, 23].

At purely physical levels, there are two approaches towards the problem of specification of speech, the analytic and synthetic. Briefly, the former proceeds through direct measurements upon speakers, with the aid of X-ray photography, the laryngoscope and all the techniques and methods of the physiological laboratory, together with measurement and analysis of the sounds themselves with the aid of oscilloscopes, spectrometers, and all the apparatus of the acoustics laboratories. The later approach, the synthetic, is through the construction of mechanical or electrical synthetic speakers, which can imitate human speech; devices such as the vocoder, artificial vocal tracts, the hand painting of speech energy spectra, and other experimental means. The specification of speech sounds, by such synthetic methods, would be made in terms of those physical parameters which determine the construction and adjustments of these devices. Speech analysis and specification is a major study in itself [24].

1.3.5 ACOUSTICS :

The speech wave is the response of vocal tract filter systems to one or more sound sources. This simple rule, expressed in the terminology of Acoustic and Electrical Engineering, implies that the speech wave may be uniquely specified in terms of source and filter characteristics. Acoustics generally correlates the physiological data concerning speech production and physical data from the description of the speech wave [25,26,27]. An important application of acoustic theory of speech is in the field of X-ray

studies of Russian articulations. The main object of this study is to attempt a reconstruction of the spectra of speech sounds from physiological data of their production. High speed X-ray films and advanced technologies are being used now a days for measurements of whole vocal tract [28,29].

What has been said above about linguistics as a science, it would be clear from it that the forms of language and the working of language may be applied to practical problems of automatic or machine recognition of speech. The communication engineer is helped by knowledge of the basic composition of language signals whose transmission and reception are his responsibility.

In another sphere of activity linguistic–acoustic knowledge will be a powerful tool in the remedial treatment known as speech therapy including biomedical assessment etc. It is also related to a number of fields such as speech pathology, anthropology, engineering and education [30, 31].

From auditory analysis and perception of speech, it is found that temporal regularities can be observed which can be interpreted as an advancement of the initial articulatory gestures of those speech sounds or syllables that are articulated with more effort [32, 33]. Data presented by scientists might indicate that higher muscles innervation can be found in all muscles involved in the production of speech sounds with more efforts. Temporal data seem to indicate that the advancement correlated with effort is anticipated by preceding speech gestures, viz an advancement of opening or closing gestures in the preceding syllable. Data can be obtained showing that the temporal effects that are correlated with effort have perceptual consequences at least in the voice-less voiced opposition and in the perception of stress [34, 35].

1.3.6 MEDICAL FIELD :

In the field of medical science, speech plays important role. The analysis of speech evoked activity in the auditory nerve is based on the

study of speech encoding in the central auditory pathway [36,37,38].

The use of phonetics in the field of medical study was reported in 1897 by H. Gulgman for the first time. In the speech utterances of healthy as well as epinosic patient, the vowels and voiced consonants may be distinguished easily [39, 40, 41].

Specific contributions of clinical linguistics to speech pathology as (a) classification of terminology, (b) systematic description, (c) analysis of linguistic behaviour, (d) interaction, (e) assessment of patients linguistic behaviour in nermative terms, (f) the formulation, (g) evaluation of remedi-al hypothesis [42, 43, 44].

Broad band frequency speech spectrum are being used in speak-er's race and sex identification [45,46,47].

Speech recognition [48, 49, 50, 51], the burning issue now a days, also plays an important role in defence. Enemies activities, there idintification and presence, can be judged by the speech recognition. At the present time human recognize speech much better than any hardware processor. Studies have been done on speaker's height and weight identifi-cation from voiced and whispered speech [52,53,54,55].

Thus it can be inferred that speech has an important role right from the development of individual personality to the extent of health condi-tion assessment in the field of medicine, including the phonetic, acoustical, behavioural pattern recognition. Therefore it seems that we must expose ourselves to the biological foundation of language/speech development.

1.4 BIOLOGICAL FOUNDATION OF LANGUAGE/SPEECH :

1.4.1 SPEECH PRODUCTION :

Speech production poses a number of very important physiologi-cal problems which are best appreciated if we consider this activity under the following headings : (a) the problem of discrete articulatory events; (b) the problem of rate of articulation; and (c) the problem of ordering ar-

ticulatory events.

(a) Discrete articulatory events—It is not immediately obvious that there are discrete events in the flow of speech. In fact, there has been considerable controversy in this connection, especially among phonologists. In recent times, however, linguists, seeing speech signals projected on cathode-ray screens, were unable to find dividing marks between speech sounds in the waveform; this suggested that segmentation might be an artifact of our perception. From psychological point of view, phonetic discreteness must have a perceptual reality, for otherwise linguists would not be able to make phonetic transcriptions of languages of illiterate societies, particularly in cases where the linguist does not speak the language himself. There is at least one form of display, namely sound spectrography, in which there are clear discontinuities indicating that there are certain events with definable beginnings and ends, for instance, signals bounded by silences, or vowel phonemes preceded and followed by stop phonemes. In the context of physiology, the perceptual and acoustic events are of less concern to us than the motor events, that is, the contraction and relaxation of muscles. Even here the beginning and end of activity are not self-evident phenomena. When a muscle contracts there is very dramatic increase in electrical potentials. When we think of the entire musculature of the speech apparatus in activity, we realize that there is a continuous waxing and waning in states of contraction throughout these muscles. Operational definitions for states of contraction are very easy : a critical voltage is chosen, and if the recorded potentials exceed it, the muscle is said to be contracted. The digital approach is a necessity in many motor physiological investigations.

(b) Rate of articulatory events—How fast does one speak ? It has shown that for utterances above a certain length, those who speak English, talk at a fairly constant rate, about 210 to 220 syllables per minute

(these figures include hesitation pauses) [56,57]. If the utterances are shorter, much higher rates are regularly observed because few or no hesitation pauses are included. Most adults are capable of producing syllables at rates up to 500 syllables per minute. These higher rates occur particularly if the speaker uses common phrases. Apparently, the most important factor limiting the rate of speech involves the co-gnitive aspects of language and not the physical ability to perform the articulatory movements [58,59].

We cannot state exactly the number of muscles that are necessary for speech and that are active during speech. But if we consider that ordinarily the muscles of the thoracic and abdominal walls, the neck and face, the larynx, pharynx, and the oral cavity are all properly coordinated during the act of speaking, it becomes obvious that over 100 muscles must be controlled centrally. Since the passage from any one speech sound to another depends ultimately on difference in muscular adjustments, fourteen times per second an "order must be issued to every muscle", whether to contract, relax or maintain its tonus.

The physiology of speech production would be very simple if every phoneme were associated with one and only one pattern of muscular interaction. However, this is not what we find. The muscular activity associated with one phoneme is influenced by the phonemes that precede and follow it.

Thus the motor patterns that we must investigate here are complex motor configurations that extend over relatively long periods, as in the duration of a syllable or word.

(c) Ordering of articulatory events—There are many articulatory events or more generally, motor events, that leave no trace on spectrograms. Before the onset of phonation, muscles in the abdominal and thoracic wall and in the larynx have to assume certain positions, with some of these events preceding the onset of sound by 100 milliseconds (msec) and more. Also during those silent periods which appear as short blanks on spectrograms a great many move-

ments are performed, particularly by the tongue, which must get into position for alveolar or palatal stops (d,t,g,k) or which gets ready for the production of the next vowel.

Krmpotic, who has been, specifically interested in the problem of differential innervation time, has computed so called neuromuscular indexes for all major muscles involved in speech. These indexes are simply the ratio of the average length of the nerve to the mean size of fiber diameter. Since there is still some uncertainty about the physiological interpretation of these determinations, we need not be concerned here with the details. Suffice it to say that the anatomy of the nerves suggests that innervation time for intrinsic laryngeal muscles may easily be up to 30 msec longer than innervation time for muscles in and around the oral cavity.

The synergisms involved in mastication and swallowing, in respiratory adjustments, in whistling, or sucking, or blowing, and in speaking do not make use of identical set of muscles. Mastication involves only the oral cavity; swallowing, the back of the tongue and pharyngeal structures, but not the lips; it is only speech that requires precise temporal integration of laryngeal musculature with those of the face and mouth. Phylogenetically mastication is undoubtedly an older synergism than speaking, and if there were any built-in "delay-circuits", they would regulate the timing of the motor activity for eating and respiration rather than speech. It is very doubtful that the entire bronchial physiology is adjusted to the timing requirements of speaking; but even if it were, we would have to postulate as high a degree of neurophysiological specialization due to speech as is necessary for the other postulation (that is, that the brain is capable of programming speech-specific temporal order formations).

1.4.2 SPEECH RHYTHMICITY :

We have proposed that a rhythm exists in speech which serves as an organizing principle and perhaps a timing device for articulation. The

basic time unit has a duration of one-sixth of a second. If this rhythm is due to physiological factors rather than cultural ones, it should be then present in all languages of the world. But what about the rhythm of Swedish, Chinese or Navaho which sound so different to our English-trained ears ? What about American Southern dialects which seem more deliberate than the dialect of Brooklyn, New York; and the British dialects which seem faster than American ones ? These judgements are based on criteria such as intonation patterns and content of communications, which have little in common with the physiological considerations here.

On the neuromuscular level the interdigitation phenomenon poses a problem of timing owing to the fast rate of sound production. Throughout the duration of individual speech sounds, muscles must be activated (or deactivated) at such rapid succession that a neuronal firing order must be assumed that functions with an accuracy of milliseconds. This can be accomplished only by automatisms consisting of intricate time-patterns. Patterning in time (in contrast to temporal disorder) is based on an underlying rhythmic metric. The hypothesis is advanced that the temporal patterns on which the neuromuscular automatisms are based have at their roots a physiological rhythm consisting of periodic changes of 'states' at the rate of 6 ± 1 cps. Indirect evidence is cited that articulation itself reflects such a basic rhythm. There are also psychological and neurological rhythms or basic temporal units and their possible relationship to the speech rhythm is discussed [60].

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