THE PRODUCTION OF PHONEMES

A KINESIOLOGICAL DESCRIPTION

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ABSTRACT

Although much attention has been devoted to details of phonological and acoustic aspects of speech articulation, so far no comprehensive account of the kinesiology of phoneme production has been formulated. The present work attempts to do this as it describes the kinesiological mechanism underlying articulation.
In phoneme generation certain elements of physical science are kinesthetically recognizable, such as the interactions of concurrent forces across shared nodes of their intersections (centers of mass), frameworks centered on such nodes, distortions and equalizations of frameworks, and symmetrical agent-antagonist relations. The material is built up in terms of these elements through a series of steps in a sequence of development from simple to complex structures. Each point established can undergo observation and verification before moving to the next point. Looking at such a mechanism in oro-lingual activity introduces a novel perspective in phonetics and phonology.

INTRODUCTION

The present work is a description of the kinesiology of phoneme production. It presents in **geometrical** terms an organic system underlying the behavior of muscular forces in generating phonemes. The system is shown to consist of hierarchical structures of frameworks governed by their central nodes across which concurrent forces interact.
The basic components of the system are simple, yet through various mechanical transformations they are able to create complex behaviors evident in the intricately composed behaviors of articulation.

The geometric aspect of speech

Physical actions consist of interactions of forces, which in physics and engineering they can be represented in terms of geometry.
Speech articulation is a physical action. It forms and modulates the dimensioning, the shaping and the distribution of regional constrictions of the oral tract. And since it is a physical mechanism speech production can best be understood when analyzed not as an articulatory or phonological system, but as a **kinesiological** one.

Beginning with the three anatomical divisions of the tongue (the tip-blade, body and base) and identifying the inherent centers of mass (or nodes) of these regions, three distinct frameworks controlled by the nodes can be located. These structures generate, respectively, the general frame presettings of the articulation of vowels, consonants and semivowels. The frameworks also possess phonemic substructures that, at increased levels of force become the nodes of the **simple vowels** /i/, /a/, /u/, **simple consonants** /p/, /t/, /k/ and **semivowels**. The resulting structures of these simple phonemes through variously branching permutations of nodal structures are able to generate all the remaining phonemes.

Methodology of approach

The methodology includes three components:
(a) starting analysis by minimizing variables to find the most fundamental element, (b) isolation of any element that is to be observed, and (c) kinesthetic, that is, proprioceptive analysis.

(A) Minimizing of the number of variables

The tongue as sole subject of examination

Speech production is complex to such an extent that so far no methods have been found to describe the interaction of its components. Confronted with such intricate system the "Cartesian method" of finding and building from the minimal reducible element is applicable.

The **tongue** has been recognized as the primary agent of articulation **due** especially to its relative size and central placement. This implies that a cogent investigation of articulation can be limited to analysis of the tongue, since the **tongue** will generate uniquely corresponding behaviors of **other** components of the external mechanism.
The reason for this phenomenon is that a physically active physiological system possesses a **resting** state where it stands in equilibrium, but such a state is immediately distorted when any member of the system goes into motion and therefore the other parts of the system must also **move** in response to **regain** equilibrium. As in a clockwork, all parts affect the other parts.

It is also obvious that within the tongue itself any one of its elements will reflect this rule. Such a minimal element is the **center of mass** of the tongue, and further up in the development in complexity, those of the anatomical and neural divisions of the tongue.

(B) Isolation of elements

In attempting to reduce complexity it is important to focus not on speech in its entirety but on the discrete **single** faculties of oro-lingual speech action.

Motion by **one part** in a physiological system, as in any system, can be defined only in relation to the **framework** within which the part is moving, and this motion becomes most evident when the framework is itself immobile, held neutral and stable and at a low energy level. Thus, study of a single lingual component in articulation necessitates its isolation from the encompassing framework and also that such framework be neutral.

Isolation of different faculties of the oro-lingual system is also important. Feeding and respiration are more **fundamental** than speech, therefore it is useful to identify and isolate faculties of speech that it either shares or does not share with the other two functions. This helps to distinguish what phenomena belong to speech over and above those of respiration or phonation, thus isolating those proper to articulation. Since various modulations of tract diameter, notably those in **phonation** are respiratory components of full articulation, eliminating any degree of phonation allows identifying the faculty of articulation free of external components.
Isolation is also necessary in the case of interaction of **intrinsic** and **extrinsic** lingual muscular forces. These two generally work together in an agent-antagonist opposition, which interact in actions of distortion and equalization. It is important to identify which forces are primary agents and which are antagonists. For instance, since articulation and phonation are two interacting structures exercising mutually distortive and equalizing influence on each other, exclusion of components of phonation permits clearer observation of the isolated articulative mode.

(C) Kinesthestic analysis

It is important to consider the potentials of **proprioception** (or kinesthesia) as a rigorous tool of research. Lingual proprioception is a most **natural** and intuitive process. We can all feel the finest differences in tongue postures. Not necessarily ever yone, but certainly experienced observers of articulation are able to develop relatively sufficient sense of intrinsic and extrinsic muscular actions of the tongue. The widely held objection to the value of kinesthesia has been its lack of **rigor**, and proponents of proprioceptive analysis of speech, who have not been absent in linguistics, have not offered a pragmatic methodology.
However, I believe that as the information gathered in the present work demonstrates, **precision** in kinesthesia is possible if **appropriate** experimental methods are in place. Use of an appropriate methodology and training of kinesthetically capable workers can undoubtedly further this work. It is a demonstrable fact that precisely isolating elements while keeping the system at the lowest energy level enables remarkably clear observations. Employed in a less exacting mode proprioception (or the proprio-kinesthetic method) has long been an essential tool of speech pathology.

Integration of two fields

When accurately combined physical and physiological elements of phoneme generation offer a field open to kinesthetic observation. This makes possible the mapping of interacting forces and their governing nodes of intersection (i.e., their centers of mass) that are active in the creation of phonemes. In examining tongue behaviors this presentation first considers the anatomical divisions of the tongue and continues with an analysis of their particular muscular frames and their central nodular controllers. Continuing to build from this base the entire process of phoneme generation can be described.

Efficiency proper to kinesthesia

Immediacy of experimental control and manipulation is available in proprioception. Experiments can be instantly repeated and checked, or be evaluated in relation to other factors. Opportunity exists to examine in quick succession several variables and alternate possibilities, and to retest older data in view of newly learned factors. Focusing on possible new avenues is immediately available. Instrumental research is far more limited in this respect and requires greater resources. If rigor in proprioception can be established it has many qualities to recommend its acceptance. The contrast between kinesthetic and instrumental research, in a sense, is one between internally and externally derived data. The high complexity of the inner physiological workings of speech is not easily available to external study, and this limitation would also recommend attention on the proprioceptive approach.

Validation of proprioceptive data

Forms of validation of proprioceptive data include replicability, agreement with both instrumentally obtained data and with other relevant literature, the ability to explain unsolved questions, and to offer a concise and economical description of the system.
Available at this time, then, is a geometrically interpreted description of phoneme production, which, in any case, can be **judged** on its **own merits without** any reference to

Notes:

1. During the more than twenty years that this work has so far taken, on re-examining it inconsistencies and errors always tended to be discovered, so the present first edition will certainly contain more of these. However, at this time, most likely discrepancies will be in the details; the system as a whole, I am sure, is accurate. It is hoped those interested will comment and thus help in improving the

2. Whereas verifying Parts 1-6 of this study dealing with the more basic components of speech articulation may require an amount kinesthetic application, the material in Parts 7-8 can be followed at the normal level of articulation. These sections dealing with *complex consonants* and *complex vowels* can be examined on their own phonetic and phonological terms, yielding interesting information.

3. As stated, the best analog of the notion of *nodes* in the present treatment is the one related to celestial bodies. Other uses of the term, such as in computers, where it designates a device connected to a network, or in physics, where it stands for points in standing waves at which vibration is at zero, are more indirectly connected.

Sections of the paper remaining to go online:

1. Complex vowels
2. Phase relations of intrinsic and extrinsic lingual musculatures

Works in speech mechanics that are not online:

1. Vowel harmony- so far not explained
2. Phonation
3. Metaperistalsis - analysis of those faculties of the oro-lingual system that have evolved from the primitive peristaltic pharyngeal function.
4. Ontogeny of speech in infants
5. Integration of feeding and speech mechanism as a single organ
6. The basis of articulation in languages
7. The central governor-regulator of the oro-lingual system. (This is the function of the highest hierarchical rank that unites and controls the interconnected actions of all parts of the system.)