PHONETIC EVENTS AND THEIR RETINAL REPRESENTATIONS

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There is no doubt that the following description of speech communication will be generally accepted: speech communication is a cognitive process based on the perceivable events which are produced by a competent speaker and which are semantically interpretable by the speaker and his listeners. As far as phonetics is concerned, the crucial term in this quite trivial statement is the expression 'perceivable events produced by a speaker', and there is no question that any theory of speech communication must have a basic component providing a scientific explication of what has been called 'perceivable events produced by a competent speaker'. The categories by which traditional phonetics, including phonology, successfully specifies these events as phonetic events may not be accepted as a possible basis for a phonetic theory of speech communication because these categories remain explicanda rather than explicata in the framework of such a theory.

In this paper I am limited to sketching some of the basic ideas concerning a new theoretical foundation of phonetics. "A Set of Postulates for the Science of Phonetic Speech Communication" will be presented in an extensive article which will appear in *Phonetica*.

1. CATEGORICAL IDENTIFICATION OF PHONETIC EVENTS PE_k

Our first task is to characterize the pretheoretically given empirical domain of phonetics. And the first way of doing this is to say that the human subject is the natural system capable of deciding whether a perceived event is a phonetic event or not (i.e., produced by a speaker or not). More particularly, we must introduce this natural system as the only one competent to identify phonetic events categorically. The natural system identifies a given phonetic event or it does not. A competent listener, for instance, will identify all regular phonetic events of his own language. There are two different ways in which categorical identifying of phonetic events is made explicit by the natural system.

(a) The informant produces new, but categorically identical reproductions $R_j(PE_k)$.

We say that the category k of a phonetic event is DEMONSTRATED by individual reproductions $R_j(PE_k)$. In fact, phonetic events are empirically given always only in form of concrete reproductions. Complex $R_j(PE_k)$ can be analysed into equivalently reproducible segments. Bloomfield's MINIMUM SAMES can be demonstrated by minimum reproductions $R_j(PE_{kMIN})$. In this first case categorical identification is a relation that holds between individual reproductions $R_j(PE_k)$ and between parts of reproduced identical or different PE_k.

(b) The informant can also explicitly name the phonetic events categorically identified. In this case he produces a symbolic representation $SR(PE_k)$ that refers to the set of all regular reproductions. Symbolic representations are introduced by ostensive definitions, i.e., by demonstrating equivalent reproductions. In this second case categorical identification is a somewhat more abstract relation that holds between the names of phonetic events and the whole sets of equivalent reproductions. Nevertheless, $SR(PE_k)$ are used to refer to individual $R_j(PE_k)$ as well as a given $SR(PE_k)$ can be demonstrated again by any number of competent speakers producing equivalent $R_j(PE_k)$. Symbolic representations which under certain conditions may be developed into certain types of alphabetical representations, provide all data that are required by practical phonetics as well as phonology (cf. my forthcoming article in *Phonetica*).

2. SPEECH SIGNALS AS REPRESENTATIONS $ss_j(PE_k)$ WITHIN THE SIGNAL PHONETIC BAND

Whereas the symbolic data are supplied by the natural system itself, the data of the physical processes of speech communication must be explored by another means, the external scientific observer. The physical continuum from the speaker's to the listener's brain is called SIGNAL PHONETIC BAND. The measured data in the band which coincide with a process of categorical identification are speech signals $ss_j(PE_k)$. There are as many different signal representations as there are different successive stages in the band. The relation between the symbolic data $SR(PE_k)$ and the signal data is EMPIRICAL COORDINATION established owing to the categorical interpretation through a natural system (cf. Feigl's principle of empirical identification). At this empirical level phonetic theory deals with representing the speech signals of specified PE and with the mapping relations between the data of successive stages of the band concerning the physical transmission of information.

3. RETINAL REPRESENTATIONS $OR/RT(PE_k)$

The empirically coordinated $ss_j(PE_k)$ must be given a functional significance within a model of speech perception. This model imposes some higher structure on the signal phonetic band.

Cognitive models of perception generally emphasize three stages within the given physical continuum: (a) the external object or event, (b) the stimulation of a retina, (c) the final result of neural data processing. We take (c) as an internal 'image' of the recognized object or event assuming an isomorphism Ø between these cerebral correlates and the perceived phenomena (the referents of symbolic description). (a) causes some regular representation of itself in (b); according to proximal and distal perception, (a) is called either stimulus source or signal source: in the first case an 'image' of the stimulus source is mapped directly onto the retina of the nervous system (as in tactile perception), in the second case this is achieved by means of transmitted signals (as in visual or auditive perception). The information available to the nervous system consists of all possible retina representations of the external object or event in (a). On a retina (b) the surface activity OR is transformed by a mechanism RT into neural data.

In order to apply the three-stage model of perception to the signal phonetic band, we have to postulate that the surface behavior OV of the speaker is to be taken as the external event in (a), which, during speech communication, is projected onto three different retinas, namely onto the articulatory retina of the speaker and onto the auditory retinas both of the speaker and the listener. In dyadic speech the two individual cognitive systems, the current speaker and the current listener, are interindividually connected in (a), one system recognizing the phonetic behavior of itself, the other recognizing the same surface behavior as extraneous. Current interindividual speech communication results if both systems are equally competent to recognize the same phonetic surface events synchronously. The necessary condition for this is that the same OV-events produced by the speaker cause simultaneously the proper retinal representations which provide the only information available to the nervous systems of speakers and listeners.

FINAL REMARK: nothing has been said in this paper about how the nervous system succeeds in processing the retinal data into results isomorphic to the perceived and categorically identified $R_j(PE_k)$.

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DISCUSSION

BACKHAUSEN (Bonn)
Ich habe den Eindruck, dass die Isomorphie-Forderung für die Funktion Ø zu stark ist, da sie die Klassifikation der phonetischen Ereignisse PE_k, d.h. die Kategorienbildung, schon voraussetzt. Mit einer schwächeren Homomorphie-Forderung wäre m.E. nicht nur diese Schwierigkeit zu umgehen, sondern darüberhinaus vermutlich die Klassenbildung selbst ableitbar.

TILLMANN
Der Eindsuck täuscht. Tatsächlich fällt die Relation Ø gar nicht in den Gegenstandsbereich der Theorie. Sie gehört vielmehr in den Kontext der metatheoretischen Kennzeichnung einer die Kategorien namhaft machenden Heuristik.

RICHTER (Bonn)
Welches ist der Zielbezug des Exposés? Gibt es praktische Anwendungen?

TILLMANN
Die Überlegungen zur theoretischen Basis unserer Wissenschaft verfolgen insbesondere drei Ziele: erstens die Relativierung des signalphonetischen und symbolphonetischen Empirien durch deren Integration in eine unfassendere Theorie; zweitens die Projektierung eines solchen Theorie als Theorie der phonetischen Zeichenkommunikation; drittens, speziell die retinalen Repräsentationen betreffend, die Hervorhebung der zentralen Rolle des kompetenten Systems als eines datenmessenden und datenverarbeitenden Systems. Für die Praxis darf man sich tatsächlich erhoffen, dass die Ergebnisse des phonetischen Forschung anwendbarer werden. Beispielsweise möchte ich hinweisen auf das Problem der Konstruktion eines künstlichen zweiten Retina, etwa in Form eines Hörhemdes (vgl. H.G. Tillmann: Technische Kommunikationshilfen für Gehörlose, Berlin 1970).