

Articles Section

THE RELATIONSHIP BETWEEN SPEECH-LANGUAGE PATHOLOGY AND SPEECH SCIENCES

John H.V. Gilbert, Ph.D.
University of British Columbia

As the professional field of Audiology and Speech-Language Pathology has aged, the development of its underlying scientific premises and professional practice is not, however, entirely clear. The problems posed for an adequate theory of speech and language posed by those experiments in nature - the pathologies, are very apparent in disorders exemplified by aphasia, dysarthria, stuttering etc. There are many problems associated with the use of basic information derived from experiments in psycholinguistics, speech science and experimental phonetics, in diagnoses, prognoses and therapy associated with Speech and language pathologies. In this paper, the author presents one view of the relationship between Speech-language pathology, and speech science.

Alors que le domaine professionnel de l'audiologie et de la pathologie de l'élocution a vieilli, le développement de ses prémisses scientifiques fondamentales est devenu plus apparent. Cependant, le rapport entre ces prémisses et la pratique professionnelle n'est pas tout à fait clair. Les difficultés que cause une théorie adéquate de la parole et du langage, résultant de ces expériences pratiques, en l'occurrence les pathologies, sont particulièrement évidentes dans les troubles exemplifiés par l'aphasie, la dysarthrie, le bégaiement, etc. Il existe de nombreux problèmes associés à l'utilisation de renseignements fondamentaux dérivés d'expériences de psycholinguistique, science de la parole et phonétique expérimentale, de diagnostics, pronostics et thérapies, associées aux pathologies de la parole et du langage. Dans cette étude, l'auteur présente un point de vue sur le rapport entre la pathologie de l'élocution et la science de la parole.

It is now 19 years since Peterson and Fairbanks (1963) (PF) published an appendix in the Journal of the American Speech and Hearing Association entitled "Speech and Hearing Science". It might therefore be time to revisit some of the scenes originally set by PF, and try to determine what relationship exists between Speech and Language Pathology (S-LP) and Speech Sciences (SS).

In their article, PF make a number of points which are worth repeating, thus:

"Phonetics is the essential subject of basic speech science and vocal anatomy and speech physiology are obviously fundamental to phonetic symbolization and to descriptive phonetics. The basic principles of linguistics (1) are much more important to the field of speech and hearing science than is commonly recognized" (PF, 241).

After some discussion they continued:

(1) Author's italics.

"Linguistics is concerned with the nature of the code transmitted by phonetic data. The structural properties of this code are not simple, and they are not irrelevant to the problems of those working in any of the sub-disciplines of Speech and Hearing Science. On the contrary, the knowledge of language structure is important to almost any experiment employing speech signals: (Ibid p. 241).

Most telling it seems was PF's uncanny prediction of where the profession would be today:

"It is improbable that a student can be properly trained in the field of Speech and Hearing Science, however, if courses in basic linguistics are not available to him." (p. 242)

PF maintained that it is the study of the process of speech which is basic to the study of all types of speech disorders and that the study of speech science is greatly aided by observations on mechanisms which function abnormally.

The comments of PF had obvious reverberatory effects on the education of Speech-Language Pathologists, but the effects of S-LP on SS, are only now becoming clearer.

The Problem of Sound and Meaning

Undoubtedly the experiment-in-nature (which is what speech-language pathologies are) provides us with exceptions to general rules about how language functions; such experiments have the sobering effect of forcing us to make adjustments in theories which have evolved as a consequence of observing normal speakers. Because speech-language pathologies frequently involve problems of both sound and meaning, it is fruitful to examine how one great contemporary linguist viewed this problem. In 1942-3, the late Roman Jakobson gave a series of six lectures at the free School of Advanced Studies, founded in New York at the beginning of 1942 by French and Belgian scientists in exile. The title of these lectures was "Sound and Meaning". In the first of these lectures, Jakobson wrote: "Every word, and more generally every linguistic sign, is a combination of sound and meaning,...., a combination of signifier and signified". Whilst the fact that there is such a combination has been perfectly clear for at least 2,500 years, the structure of that combination continues to elude our understanding. This lack of clarity is unfortunate because it is to this combination - signifier/signified, that the major part of professional effort is addressed, and to which SS can perhaps most usefully contribute.

A couple of Jakobson's questions, of great importance to the practise of S-LP, are as yet still unanswered. He continued for example,

1. "A sequence of sounds can function as the vehicle for meaning, but how exactly do the sounds perform this function?"
2. "What exactly is the relation between sound and meaning within a word, or within language generally?"

Given that the sound-meaning correspondence is professionally relevant, have SS and S-LP attempted to come to grips with questions such as these? In what specific speech processing domains have models or theories been erected to test such questions? Which pathologies of speech and language have provided challenges to these models or theories?

Theories and Models in S-LP and SS

Let us first remind ourselves that a model is a representation of reality, not a description. It is a metaphor, not a statement of fact. A theory on the other hand is supposed to be descriptive and hence falsifiable. A model illustrates ways to apply the theory.

One of the many difficulties associated with discussing the relationship between SS to S-LP is that whereas in the domain of SS it is possible to construct theories and hence falsifiable hypotheses, in the domain of S-LP we must frequently work with models which are at once too broad and intuitively dissatisfying - the "punching-ones-way-out-of-a-balloon" problem. The most frustrating and infuriating remark that any S-LP can direct at a SS is to claim that the SS is really not interested in "clinical" problems. There appears to be some notion in the mind of the practising S-LP that speech scientists ignore (or simply do not understand) the enormity of the clinical problems faced by the S-LP. As a consequence of this notion, the modelling which does take place in S-LP tends to be atheoretical and thus inefficient and ultimately impractical. Ignorance of theory does not, by and large, produce effective therapeutic results.

The Relationship Between S-LP and SS

The relationship between S-LP and SS can be examined by looking at the way in which S-LP currently handles theories of speech production and theories of speech perception. In this present discussion, any reference to phonological, syntactic, semantic or pragmatic theories will be omitted although it is assumed that they are, of course, vital to an understanding of ultimate language processing. I take this approach because I consider that it is really not possible to have a theory of the abnormal; all pathologies must in some sense be accommodated by a theory of normal functioning.

Currently formulated theories of speech production can be broken down into at least three kinds: (a) laryngeal (i.e. the glottal source and its spectrum), (b) supralaryngeal (i.e. the vocal tract as a filter), and (c) stuttering. Theories of speech perception on the other hand, can be broken down into at least two kinds: (a) active: e.g. the motor theory and its derivatives, and (b) passive: e.g. feature and template theories; quantal theory.

Given this formulation, a first question which can now be asked (which emanates from a variety of sources, not just SS) is: have such theories had any influence on S-LP in the devising of (i) assessment, (ii) diagnostic, and (iii) therapeutic procedures and, should some relationship between theory and practise exist, has S-LP in turn affected the theories through its assessment, diagnostic and therapeutic findings. That is, has the relationship proved catalytic?

A second, but important question is: how have such theories, and their therapeutic utilization, been constrained by shifting theoretical

ideas in phonology, syntax, semantics and pragmatics? Any one who has observed the professional scene during the past 20 years will be aware of the invasive nature of theoretical fads; transformation rules, distinctive features, pragmatic operations, have all done the therapeutic rounds. In the absence of complete data on the normal speaker, the Catch-22 apparent in attempting to use pathologies to adjust normal theories, is to say the least, frustrating. By this I mean that to understand pathologies we need normative theories and models, but to have a comprehensive theory about the normal we need the constant adjustment provided by pathological exceptions, and so on. In addition, any theory which embraces the atypical must be in accord with normal theories of phonology, syntax, semantics and pragmatics. (See, for example, the excellent work on aphasia out of the Boston V.A. Group under Harold Goodglass.) Given that such accord exists, (even if at present incompletely understood) then the act of atypical speaking must be seen at a very close remove from but certainly coherent with, theories of normal phonological, syntactic, semantic and pragmatic functioning. The relationship between the science and its application is strong, it simply needs to be seen and appreciated.

Theories of Speech Production

S-LP has long concerned itself with the production of speech sounds. Since this is the case, it is interesting that theories associated with: (a) laryngeal mechanics (the glottal source) e.g. sub-glottal air pressure, the Bernoulli effect and muscular adjustment, etc. (b) supralaryngeal activity (the filter) e.g. coarticulation effects produced by movement of lips, tongue and palate etc., have not been effectively used to describe the perceptual consequences of voice disorder, clefts of the palate, dysarthria and apraxia. It is even more unfortunate that (c) theories of stuttering are seldom related to language processes at any level of description.

A theory of speech production at the laryngeal and supralaryngeal levels, particularly in the specific domain of vocal fold action for vowels and supralaryngeal control for consonants can be readily accommodated by Source-Filter Theory* (Fant, 1960; Stevens, 1972; Flanagan, 1972).

In the instance of laryngeal mechanics, the study of vocal pathology is only just beginning to contribute a little to model building; whereas acoustic theories of normal vocal fold function, appear so far to have contributed relatively little to the explanation and treatment of voice disorders, EXCEPT that cross-linguistic studies of various voice qualities (e.g. John Laver, Peter Ladefoged) have shown that "what is a pathological voice quality in one language may be phonologically contrastive in another" (Ladefoged, 1982 p. 28). If the latter is indeed true then something should be done to clarify and standardize the multiple terms now used by Linguists and Speech-Language Pathologists to describe the same cross-linguistic acoustic realizations.

In the case of supralaryngeal pathologies, disorders of speech sound production resulting from e.g.: (i) lesions of the central nervous system (CNS), or (ii) neoplastic lesions, have contributed more to theories speech of production. (i) Lesions of the CNS leading to

*Although certain non-linear phenomena are currently being discussed.

dysarthria have demonstrated how robust the acoustic signal can be, even under conditions of severe distortion e.g. spastic cerebral palsy. Using classical phonetic nomenclature, Lehiste (1965) has described this condition with great clarity. (ii) Neoplastic lesions, such as removal of part or all of the tongue because of cancer, also demonstrate the pervasive link between production and perception, particularly since such lesions show how important knowledge of the language is to both the speaker with the lesion, and the listener to whom the speech signal is addressed. (iii) Clefts of the palate are rarely described in terms of the acoustics of the vocal tract, and the pervasive spectral influences of nasal murmur (zeros) caused by holes in the tube (vocal tract) are seldom described as the cause of our faulty perception.

In the case of stuttering, there is still much basic work to be done. Advances in neuroscience during the past 20 years, particularly in the understanding of neurotransmitters will possibly uncover a biological basis for this disorder in the next ten years, particularly if the importance of performing autopsies on the brains of stutterers is finally recognized.

Theories of Speech Perception

It is within the general class of theories of speech perception, that the relationship between speech and language pathology and science is at once both persuasive yet tenuous. There is undoubtedly a strong desire to attach clinical importance to normative theories of perception but since the link between speech and language, or sound and meaning, is so imprecisely understood, contributions from the normal to pathologies and vice-versa are not easily elaborated.

The motor theory of speech perception and its derivatives. If one asks any clinician which or what theory drives their assessment, diagnostic and therapeutic procedures, the chances are that they will rehearse some variant of the motor theory. There is an exceptionally strong clinical claim that children with "Language"⁽¹⁾ disorders have the roots of such disorders in auditory-perceptual oral dysfunction, and that the efforts of the clinician should be bent to correcting, calibrating, or recalibrating such dysfunction to some imprecisely understood norm. Because the science of speech has succeeded admirably in describing the acoustic structure of the sounds of speech, there is a widely held assumption that the science of speech also describes the linguistic function of those sounds. The consequence of such an assumption leads, for example to a lack of awareness of the implications inherent in the fact that an aphasic deaf individual still has a disorder of language even though she/he does not have access to the auditory signals of speech, or that it is possible to transmit a phonological grammar by whistling (Busnel and Classe, 1976).

The exceptions to a strong motor theory are enough and sufficient that it is difficult to comprehend the full clinical extent of this foregoing misassumption. Speech is NOT language, it is simply a convenient code by which hearing individuals manipulate the complexities of the lexicon, syntax and semantics. There are examples in S-LP, where the assertion that speech does not equal language can be seen (Blumstein, et al. 1977); and an instance of normal perception in the total absence of a normal speech production system, has been reported by Fourcin (1974).

(1) By which is meant vocal language

These instances whilst tending to confirm the fact that the auditory portion of speech signal is sufficient for perception in the absence of access to production mechanisms, as yet add little to our understanding of phonetic processing for language purposes. It is unfortunate that it is just this important fact which is often overlooked in clinical practise.

Although one would like to make a claim for the influence of S-LP on the role of active theories of speech perception, the extent data are hardly re-assuring. Taking cognizance of the fact that most clinical populations are children and, that most modelling assumes an idealized adult speaker-learner, the lack of interaction is perhaps not surprising. Intuitively, active theories should work, and should explain the acquisition process; unfortunately explaining the grammar of language has proved more difficult than simply assuming that behaviorally modifying a misplaced phoneme to "get better" is somehow itself that explanation.

Feature and Template Theories

Passive theories of speech have also found currency in the practice of Speech-Language Pathology. (i) Feature Theories (following the work of Hubel and Weitzel, 1959) are attractive since they imply a linguistic respectively i.e. they appear to correlate with the d.f. theory of Jakobson, Fant, Halle (1963). Some recent publications in S-LP have assumed, erroneously, that the data underlying d.f. theory has both psychological and physiological reality. The problem, of course, is that we have insufficient data to support such claim. It might be the case that difficulties associated with speech sound production are ascribable to difficulty in feature assignment, but the underlying assumption of feature-theories i.e. passivity, is not consistent with acquisition data where feature movement is seen as an active phonological process. Template theories (as formulated by Blumstein and Stevens, 1979) are relatively recent and appear not to have surfaced in S-LP. The quantal theory (Stevens, 1972) falls somewhere between production-perception theories and has a number of attractions for S-LP.

The Problems in the Relationship

Despite the best intentions of PF, the present relationship between S-LP and SS is, in my estimation, still unclear. In the 19 years since PF a significant problem, which they pointed out still remains i.e. far too many of the profession seem unprepared to acknowledge and use the scientific basis of the profession. In addition, S-LP would still seem to be a profession without a clear idea of its underlying academic discipline. This lack of academic/scientific clarity means that the problems of S-LP are not easily remediable since it results in a failure to understand that the domain of clinical problems is not simply at the periphery, i.e. at the glottal source or in the supralaryngeal filter, but is deeply rooted in language processes i.e. phonology, syntax, semantics, pragmatics. To claim that S-LP is all about physics, psychology, acoustics, engineering, present a naïve view of the professional world of S-LP which has developed in the past 10 years. If we make claims to be concerned with speech and language, we should at least be clear about the academic discipline from which we are emerging.

It is unfortunate that since SS tends to be descriptive, and since its influence is pervasive, then SS tends ultimately to result in prescriptive practice; it is equally unfortunate for all of us that as yet no one knows how to prescribe doses of good language at any level of processing. A narrow descriptive view of SS also tends to impose severe limitations on a larger understanding of the constraints imposed on clinical practice by our lack of knowledge of the interactive processes of speech and language mentioned previously. (1) The simple minded speech = language equation blinkers the practitioner; a Speech Scientist who simply wants to explain what people are doing when they make audible speech sounds cannot possibly contribute much to clinical practice; contrariwise a Speech-Language Pathologist who is simply interested in what people do when they have problems making audible speech sounds cannot contribute much of their experience to Speech Science; the methods of operating in both these cases are simply mechanical, bristle counting exercises at best.

For the relationship between S-L and SS to grow and mature, it is necessary for us to understand the interactive linguistic processes behind talking: the semantic, syntactic, phonological and pragmatic systems which the speaker-hearer uses. Simple knowledge of the geography of the speaking system, (including the auditory system) whilst necessary and pertinent, has only limited interest for both the theory and use of language, in both its normal and atypical modes. Speech-Language Pathology is not only concerned with speech, and speech does not necessarily equal language. An article of faith which implies that "fixing" speech subsumes "fixing" language has had the unfortunate result of creating misunderstandings of the relationship between Speech-Language Pathology, Speech Science and Language.

It is possible that SS has led S-LP to develop better assessment techniques in a number of different domains, but such an experience is not entirely clear. If one takes, for instance, the numerous texts which are used in the training of S-LP's it may be seen that whilst the relation between speech, hearing and language is frequently admitted, any direct relationship between SS and S-LP is only cursorily ventured. Thus texts tend, by and large, to treat disorders as though they existed separate from any fundamental theoretical ideas. Any by the same token, texts in so called "basic" areas appear to assume that they need have no relationship to S-LP. It is hardly surprising therefore, that the bridge between theory and practise is seldom walked. When did you last see a text which dealt with the problems associated with clefts of the palate in terms of the source-filter theory, which is, after all, a reasonable, coherent and logical framework within which to couch such problems?

Conclusion

There is, of course, no one to blame. In a sense, neither S-LP nor SS can be faulted for their seeming lack of interaction - the results of revolutions are never immediately apparent. The effect of Chomskyeian linguistics became clinically apparent only a short while ago and our capacity to remediate or habilitate the language system is only just being realized.

(1) Intact hearing is of course presumed.

Nonetheless, the crucial issues raised 19 years ago by PF are still in some sense with us. Nineteen years on, we are constantly confronted by the paradox that whereas our theoretical formulations tend to come by way of Chomsky, our practical approaches tend to come by way of Skinner. In both our investigative and therapeutic efforts we are still left with the problems posed 40 years ago by Jakobson "... of identifying the ultimate phonic elements, of the smallest units bearing signifying value ..., of identifying the quanta of language."

Understanding and working on the relationship between S-LP and SS both in clinic and laboratory will, one would hope, bring us nearer a solution.

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