SOME OBSERVATIONS AND SPECULATIONS ON NEUROLINGUISTIC ASPECTS OF LANGUAGE ACQUISITION

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INTRODUCTION

In this paper I shall discuss in the most cursory fashion, some aspects of language acquisition which might be broadly subsumed under the title "Neurolinguistic". Although the term is most often used in reference to language dissolution, it seems not inappropriate to talk about perception and production in language ontogeny by referring, at least in part, to the child's emerging neurophysiology.

It is apparent that the sense systems used by the child to perceive and produce the sounds of speech, represent the substrate of that ultimately larger and more general ability to understand and produce a theoretically infinite number of verbal sentences.

In reviewing experiments which have been conducted both with and on neonates, infants and young children in an attempt to enlarge our understanding of the speech-language function, one is interested in the array of physical, physiological and psychological processes which interact and present difficulties to a determination of just what sorts of acoustic, visual and kinaesthetic patterns will cause the ultimate perception of a speech segment, whether it be distinctive feature, phoneme or syllable. Somehow or another the signal goes in via multiple channels, is "processed", and eventually comes out sounding usually like the adult language model.

Setting aside a number of difficult questions which numerous authors have posed for an input-output experimental paridigm, it **is** apparent that very early in the language acquisition process, the neonate-infant-child does produce noises which are meaningful outputs of **speech** processing, **even though** the child is faced, for example, with the complex task of choosing from among all the audible variations in spoken language, those sound relations which play the role of differentiating meaning, always supposing that we are able to arrive at a definition of "meaning".

PHYSIOLOGICAL PRELIMINARIES

It is now well known that by six months in utero, the cochlea is completely formed, the neonate entering the world with a mechanism which is ready to begin analyzing auditory signals, at least in terms of the fundamental physical parameters: frequency, intensity and duration. Also well documented are the facts: **first**, that the left cerebral hemisphere which is **presumed** to do the predominant language "thing" is slightly larger in the neonate (Witelson and Pallie, 1973), and **second**, that right ear advantage for speech, using dichotic listening techniques, is present by 2.5 years, chronological age (Gilbert and Climan, 1974).

The role of brain growth and development in language has been thoroughly explored by Lenneberg (1967). Brain growth and brain weight increase rapidly up to the end of the first year, that is, during that period of time when the substrates of language, using that term in its broadest sense, are being established. One should hasten to add, however, that brain size and weight can only coincidentally be related to language ontogeny, since even bird headed dwarfs are reported by Seckel (1960) to develop certain language proficiencies.

Within six or seven months of birth children perform the speech act of phoneme production and, in addition, they produce perceptual-discriminatory feats which quickly enable some children to produce single words even by eight months. Since a child usually arrives at the correct production of speech sounds in his immediate language environment, one can only observe that **differences** which originally exist between the child's perception of the auditory events of language, and an adult's perception of the same auditory events of language, must in fact converge in a remarkably short time. In many children auditory matching to pattern is apparent by six months, (Eisenberg, 1970).

Whether, in fact, the differences between child and adult auditory perception-discrimination are only of degree, rather than kind, need further elaboration, since, for example, the work of Kuhl and Miller (1975) on perception of speech by the chinchilla has forced a re-appraisal of infanct perception studies.

A strictly **auditory** analysis by synthesis view of signal processing in the infant must take cognisance of the fact that the acoustic radiation is not completely myelinated until around the fourth year of age (Yakovlev and LeCours, 1967), yet the phonetic inventory of the child, which might be assumed to rely on complete myelinization, is not only elaborated much earlier but is one of the pre-requisites of phonological discriminative processes, which Graham and House (1971) showed to be acquired by 3 years chronological age.

It would appear, that, although the perceptual process has a **relative** correlation with gross aspects of the developing auditory system, the fact that phonological inconsistencies persist past the termination of development of the auditory system, would appear to indicate that **production** is locked to the larger physiological development of the child, thus phonological inconsistencies which exist after 2½ years of age are related to changes in minimal auditory events which maximally effect auditory perception.

Let me take one example to illustrate numerous puzzles existing here. In an experiment conducted by Menyuk (1972) children between three and five years were given a categorization task involving the consonants /p,t,k/, /b,d,g/, /f, s, s/ and /w, l, r/. My interpretation of her results is that the subjects showed the greatest number of errors on the perception task involving /p, t, k/ and on the production task involving /w, l, r/. Now, since Cruttenden (1970) reported /p, t, k/ among the first and most stable sounds in **production** during the babbling of his twins, we are left with a conundrum: apparently the ability to **produce** the sound does not necessarily improve **perceptual** performance.

For the present discussion I must set aside: **first**, the interesting acoustic problems presented by the rapidly developing neonatal external auditory canal, and its likely sharpening effects on the speech signal (Shaw, 1974); and **second**, the puzzling aspects of data which indicate that complex sounds **other than** speech seem to be more effective in eliciting responses in the neonate(Bench and Metz, 1975). Any considerations of these aspects of audition must be coupled with the rather intriguing work of Morais and Bertelson (1973) in Brussels who have shown that, when listeners are given a diotic listening task the strongest perceptual advantage accrues to sounds originating in the median plane, i.e. the direction of gaze, implying that auditory perception rests, at least in part on some low-level decision as to the **spatial** origins of a signal, which will probably determine the proportion of incoming information that engages the infant's perceptual mechanism. It would seem that some of this parameter is emerging in the speech registers data.

THE LINGUISTICALITY OF SPEECH

Allowing sufficiently for these observations, the emerging linguisticality of the speech signal would appear to be buried in that confusing no-man's land between crying/cooing on the one hand and babbling on the other. Claims for "linguistic" processing at an earlier age are, as yet, debatable.

For the ongoing fluctuations in the **OUTPUT** signals of the neonate-infant must, in the child, have to be adjusted or normalized to its language environment by its own sense system. It is evident, that the successful emergence of the child's speech-language is dependent on this normalizing process across maturational change, and, that the input-output process is both caretaker initiated and child initiated. Each operates a physiologically similar mechanism to originate sound and each operates a complex, interactive device to transform each other's code. Whether this device is, in the perceptual sense, from top-down or bottom-up, deserves attention.

Let me use one example to illustrate the complexities in such a view. It is a commonplace observation that breathing must have something to do with output from the vocal mechanism. Every study on the first year of life makes appropriate mention of intonation. It should, therefore, be apparent that the breathing cycle must ultimately impose its **particular** constraints on the signal, those constraints being in the time domain. Yet only recently, in a rather interesting study by Prescott (1975) has a reasonably accurate method of interpreting breath group measures, been proposed. If any sense is to be driven into the continuity/discontinuity argument, the data will have to come from examining the acoustic signal in parallel with other physiologic-psychologic processes. For the developing patterns of durational change and variability in fundamental frequency, which are themselves associated with timing changes, would appear to be the **first** indicators of the child's attempt at mapping the signals, which most observers then record as intonation. Timing (Allen, 1973; Hawkins, 1973) in the one domain-breathing, enters information into the perceptual-physiologic system with which we have to contend in describing, or theorizing about, the onset of linguisticality.

SPECULATIONS

Based on a much broader analysis of data than I have presented here, I would like to speculate about the neurological-linguistic interaction.

Obviously the sense organs of the system set limits on the **kind** of information that can be registered. Their ways of orienting, adjusting and exploring are partly constrained by anatomy but partly free. The basic neural circuitry for making such adjustments is built into the nervous system by the time of birth, but continues to develop in man for a long time afterwards.

All the developmental data we have to the present time indicates that the child cannot be expected to perceive certain "facts" about the world until he is ready to perceive them. He is not simply an adult who doesn't have any experience, but as Piaget has clearly shown, develops by passing through various stages. The ability to select and abstract information about the world grows as he grows.

The environment at the same time provides in inexhaustible reservoir of information. The ears, for example, are not analogous to microphones, which would imply a fixed relationship to the brain. "Listening" and all this implies continues to improve with experience, so that higher order variables can still be discovered, even in old age. It therefore comes as no surprise that the speech in the infant's environment is a product of carefully adjusted, interactive processes.

In Gibson's (1966) terminology, perceptual learning associated with the act of speaking might be conceived as that of differentiation. The process is one of learning what to attend to both overtly and covertly, within the limitations of each of the sense systems. A system "hunts" to achieve clarity, the process occurring at more than one level. First, the pick up of information reinforces the exploratory adjustments of the organs that make it possible. And second, the registering of information reinforces whatever neural activity in the brain brings it about.

CONCLUSION

For the child who is beginning to acquire the speech code and is at the same time learning to perceive the world, by the ability to attend to the higher order features of objects and events in graded stages, the sounds and ultimately the words he hears are not simply auditory stimuli or vocal responses. These sounds embody stimulus information, especially invariant information about the irregularities of the environment. They consolidate the growing ability to detect and abstract invariants, while at the same time cutting across the perceptual systems. Emergence of sounds and words are, in fact, **neurolinguistic.**

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