AUDITORY IMPERCEPTION IN CHILDREN: A STUDY OF SPELLING ERRORS

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1. INTRODUCTION

There are many children with normal intelligence, free from sensory defects or emotional disturbance, who have great difficulty learning to read and spell. Estimates of the incidence of 'learning disability' in the school age population range from 5 to 15 per cent (Orton, Monroe, Hallgren, Rabinovitch, Critchley). Psychologists, audiologists and other clinicians who investigate these children often refer to an 'auditory perceptual problem' underlying the late language acquisition, articulation errors, and bizarre or erratic spelling many of these children show (Wepman, Myklebust, de Hersch, Messing, Berry, Eisenson, Monroe, Chaltint). The notion of 'auditory inperception' is poorly defined and poorly understood.

In an effort to begin to clarify the nature of some of these perceptual problems a small pilot study was undertaken. The consonant spelling errors of children with learning disabilities were examined and an analysis was made of the acoustic characteristics of the consonants most frequently misperceived.

2. METHOD

Spectrograms were made of the fifteen words in a standardized diagnostic spelling test — the Phonic Spelling Test from the Durrell Analysis of Reading Difficulty (Durrell). The words had been recorded by a female speaker (the author). The words were all polysyllabic. The number of phonemes in each word ranged from six to nine.

All are words ordinarily unfamiliar to school age children who are told to spell them 'just the way they sound'.

The acoustic characteristics of the sounds in these words were related to the spelling errors made on the test by eighteen children, between the ages of nine and thirteen years, referred to the McGill-Montreal Children's Hospital Learning Centre for evaluation of their learning difficulties.

All had at least average intelligence but had spelling scores at least one year below the level that would be expected on the basis of chronological age. Judging by their ability to spell familiar monosyllabic words all had learned our orthographic conventions for representing consonant sounds.

3. RESULTS

When frequency of errors, error types, and spectral character of misperceived sounds were calculated certain general findings emerged; there was no apparent relationship between overall difficulty of a word and either its total duration, or the number of phonemes it contained.

There was no class of phonemes that was inherently more difficult to perceive than any other. Perception depended on the acoustic characteristics of the particular segment. Thus a /t/ correctly decoded when it was the first segment in a word might be misperceived when it followed a consonant.

Speech perception and speech synthesis studies (Black, Fant) have indicated that cues to consonant perception are to be found in the frequency of the burst of a plosive consonant, the frequency of the fricative noise, formant transitions and duration of noise or silence. But not all cues are equally available in natural speech. Depending on its environment a voiced consonant may be devoiced, formant transition cues may be unavailable, the intensity of a fricative noise or consonant burst might be too low to be perceived, or a final consonant might be unreleased. Normal adults are able to make use of only a single cue if need be. These children seem to need a combination of cues. Where several were available the children were able to make use of them. Thus, raw children misspelled intervocalic, initial or final consonants unless the intensity was very low or the duration very brief when compared with other instances of the same phoneme.

The most important acoustic determinant of misperceptions was duration of a segment. Consonants of less than 8 cs duration were most apt to be omitted. These very brief consonants were usually members of a consonant cluster and frequently in unstressed syllables.

Errors of sequencing, too, seemed to be provoked by brief duration of one of the adjacent segments. In ninety per cent of the instances where segments were reordered one of the segments was less than 8 cs in duration. There appeared to be temporal factors in substitution errors too. In 85 per cent of all errors of substitution, the consonant substituted differed from the consonant presented by only one feature. (Miller and Nicely; Jakobson, Fant, Halle 1967). The three most common types of substitutions — in order of frequency — were those based on errors in judging voicing, errors in judging place, and errors in judging manner. There seems to be good evidence that where other cues are reduced, the discrimination of voicing and the discrimination of manner both depend on the ability to judge relative duration. Discrimination of place is based on formant transitions — which demands the ability to judge a change of frequency that takes place over an exceedingly brief period of time — usually shorter than the shortest segment.
Several additional observations seem relevant in trying to understand the abilities and disabilities of these children:

1. Additional consonants that were not in the original words were inserted by some children in their written versions. These epenthetic errors seemed to occur (a) in the records of children who may have failed to discriminate the individual sounds or their order, but accurately perceived the number of segments (blastment → pastement), and (b) who perceived an infrequent sound sequence as a more common one (epithet → entepithet);

2. Even in these linguistically inefficient children there were no violations of phonotactic rules: there seems to be some evidence that decoding was facilitated by the knowledge of permissible sound sequences in English (e.g., the first segment of stimulus was never misspelled); and

3. Although consonant clusters seemed inherently difficult, the obstructed /ks/ cluster in 'explicate' was never misspelled; this suggests that frequency in the language has made this common initial prefix particularly easy to decode.

4. DISCUSSION

In most studies of auditory perception input signals are degraded in order to provoke errors that might reveal more about the perceptual process. In studying these children we have a natural source of errors. There seems to be merit in studying disordered perception for the light it can throw on normal perceptual processes.

A much more rigorous study will be undertaken to follow up the suggestive leads of this pilot project. A more discriminating spelling test should be developed with enough different environments for each sound to determine more precisely the perceptual cues that are unusable by a given child. More attention will be paid to individual differences among children. If as preliminary study seems to suggest, there are differences among children in the kinds of errors they make, this may throw light on the specificity and efficiency of perceptual abilities. The role of temporal factors is to be explored further by the use of stretched speech. Will speech reduced to half its normal rate by means of a Varivox be easier for those children to process? Will doubling the time per phoneme enable them to make use of perceptual cues that normally seem to go by them too quickly?

It has been suggested (Abbs and Sussman) that normal speech perception depends on "feature detectors" — organizational configurations of the sensory nervous system that are highly sensitive to certain parameters of complex stimuli. These children seemed unable to judge the number and order of phonemes in an unfamiliar word, particularly when one or more of the phonemes was less than 8 cs in duration; they seemed to have difficulty discriminating among consonants where judgments of relative duration must be made. The feature detector model of speech perception might account for these kinds of very specific perceptual deficits. Because of defective physiological systems from birth, or systems that mature at an uneven rate, a child's feature detector system could be inefficient — and in processing speech he might show some of the same difficulties normal adults show in processing very rapid non-speech sounds (Warren and Warren).

REFERENCES


Monroe, M. 1972 "Children Who Cannot Read" (Chicago, University of Chicago Press).


DISCUSSION

GOLICK
You are right of course. This was one of the reasons for excluding in the final tabulation errors in the spelling of vowels. The examples in the handout [presented to those present at the section meeting] were all taken from records of misspellings of children with learning disabilities in order to demonstrate to this group, some of the kinds of errors they make. In this particular study tonometer would not have been considered an error.

TRUTENAU (Legon, Ghana)
One should have liked the examples given in the illustrative handout [presented to those present at the section meeting] much more rigorously classified. In some cases spellings were offered which may be quite perceptive attempts at an untutored phonetic transcription of some American pronunciations of the items involved.

Again there were cases involving the substitution of a wrong final morpheme (like 'dissonant' for 'dissonant', 'blasthood' for 'blastment'). These belong to quite a different order of 'mistake' than other examples given.

One last point: though we were assured that no phonotactic rules had been broken, examples like ebptt, tnbr, assrlb, xpeake made this assertion a little hard to believe.

GOLICK
In every case where a spelling could be construed as a possible spelling for the sound in question it was credited as correct. Thus for polarize, correct spellings could include 'polarise', 'polarizer', 'polarises', 'polarsite', etc. It was only when there was no conceivable correct representation of one of the consonants that an error was counted, e.g., bolelig.

Even when an entire final morpheme was substituted we had to go on the assumption that one or more of the sounds had been misperceived.
think, however, of doing this kind of experiments in a more rigorous manner in using nonsense words. Then, one could e.g., also more easily circumvent the difficulties George Allen mentioned.

GOLICK
Nonsense words might be a good idea. At any rate, we need a set of words that allow us to see each sound in a number of different environments.

NOOTEBOOM
We know that speech is largely interpreted in terms of the language system the hearer possesses. Do you know whether the phonemic system of the children was the same as that of grown-up? I ask this because a similar technique is used by my colleague Eggermont to investigate the phonemic system of very young children.

GOLICK
No phonemic analysis was made of the language of these children. They were not very young — between nine and thirteen years — and when judged superficially their English seemed adequate. However, children with 'auditory perceptual problems' tend to be linguistically inefficient. Perhaps this difficulty lies in an incomplete phonemic system.

SCHNORRENBERG
Es ist erstaunlich für mich, dass — auch bei Kontextlosen, ungewöhnlichen Wortstimuli — Kinder mit sinnlosen Antworten in diesem Ausmass reagieren, da vielmehr zu erwarten ist, dass sie mit lautlich assoziierbaren sinnvollen Wörtern antworten, was nach Altersphasen zu differenzieren wäre, was einige Beispiele ja auch zeigen.

GOLICK
In the examples given, there do seem to be occasional responses that suggest the child was attempting to spell a more familiar word. But on the whole, I think the children respond to the instructions: 'Here are some words you have probably never heard before. Just spell them the way they sound', and simply try to decode the sequence of sounds, without expecting them to be a familiar word.

VON RAFFLER ENGEL (Nashville, Tenn.)
In support of the last two speakers, I would like to mention an example which comes to mind of several I have collected in that particular area: One very good speller wrote instead of an only child, a lonely child.

GOLICK
The problem of misspellings and misperceptions of words in context must be different at least in part from the problem of misspelling and misperceiving unfamiliar words given in isolation. Context cues, redundancy, and perhaps even emotional factors (an only child may be a lonely child) will affect auditory perception differently in the former case than in the latter.