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THE EFFECT OF VISUAL FEEDBACK ON PRONUNCIATION IN FOREIGN LANGUAGE LEARNING. TERMINATION OF RESEARCH REPORT.

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A RESEARCH PROJECT USING THE OSCILLOSCOPE TO DETERMINE VISUAL FEEDBACK IN THE TEACHING OF FOREIGN LANGUAGE PRONUNCIATION WAS TERMINATED BECAUSE OF TECHNICAL DIFFICULTIES THAT COULD NOT BE RESOLVED WITH THE EQUIPMENT AVAILABLE. FAILURE IS ATTRIBUTED TO SUCH FACTORS AS (1) THE SPEECH SOUND WAVES SOUND THE SAME THOUGH THEIR WAVE SHAPES DIFFER, (2) THE OSCILLOSCOPE DOES NOT PRESENT AN EASILY PERCEIVED PITCH AS DOES AURAL FEEDBACK, (3) THE SUBJECT MUST AWAIT THE CRYSTALLIZATION OF THE VISUAL IMAGE WHICH IS COMPARABLE TO THE PROBLEM OF STAMMERING IN AURAL FEEDBACK, AND (4) THE LOSS OF VISUAL RECOGNITION APPEARS TO BE GREATER THAN LOSS OF AUDITORY RECOGNITION. BEFORE AN ATTEMPT CAN BE MADE TO DETERMINE THE USEFULNESS OF ANY INSTRUMENTATION FOR FOREIGN LANGUAGE PRONUNCIATION INSTRUCTION, IT IS RECOMMENDED THAT FUTURE RESEARCH AIM FOR VISUAL SPEECH RECOGNITION RATHER THAN EXACT VISUAL REPRODUCTION THROUGH FURTHER ANALYSIS OF ALL THE COMPONENTS OF PHONEME STRUCTURE, VARIABILITY, AND CONSISTENCY. APPENDIXES LIST THE EQUIPMENT USED IN THE EXPERIMENT, THE EXPENDITURES, AND A BIBLIOGRAPHY. (SS)

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PA.24

ED015689

TERMINATION OF RESEARCH REPORT

Project Title: "The Effect of Visual Feedback on Pronunciation in Foreign Language Learning" Project No. 2685

Submitted by: Macalester College
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U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

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I. General

Research on Project No. 2685 has been terminated since results with an experimental group on the effect of visual feedback on pronunciation learning have been invalidated by technical difficulties beyond the resolving powers of this researcher at this time.

The design of the project was predicated on research published by Barton and Barton.[1] It involved the visual presentation of phonemes in English by means of oscilloscopic images developed through a relatively simple resistor-capacitor input network. The use of the oscilloscope itself is not novel for this purpose. The work of Barton and Barton was, however, unusual in the claim for the distinctiveness claimed for the visual image of phonemes and the simplicity of the apparatus utilized.

It was contemplated by Dr. Paul Jenson and myself that the project as proposed by us would utilize, therefore, basic equipment and instrumentation already developed by others. Our attempt would concentrate on applying this technique and equipment in the teaching of pronunciation for foreign languages.

1. Barton and Barton, 'Forms of Sounds as Shown on an Oscilloscope by Roulette Figures,' Science, Vol. 142, pp. 1455-1456.

A test of pronunciation in German was developed as part of the project, based on work published by William G. Moulton[2] in connection with research performed for the United States Office of Education and principles as proposed by Robert Lado.[3] The ultimate criterion was communication effectiveness. Test items were chosen from basic vocabularies for beginning German courses and resulted in the selection of 64 single syllable and spondee words. Phonemic contrast and phonetic balance were strong factors in choice. Inter-rater agreement reached 90% on one form of the test and of the 64 items only two items had to be discarded.

II. Instrumentation Problems

The crux of the problem from the beginning to this time has been the failure of the instrumentation technique employed by Barton and Barton to be effective as has been noted by others working in the field. Barton and Barton were well aware of the necessity for proceeding beyond mere frequency versus time plotting. In fact, their technique degraded pitch presentation as well as losing time duration of sound components in favor of showing phase relationships. A

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2. Moulton, William G., The Sounds of English and German, The University of Chicago Press, 1962

3. Lado, Robert, Language Testing, McGraw-Hill Inc., 1964

practical test of their system when applied to the phonemes of General American English failed to be reasonably comparable between different sample speakers as well as failing to produce invariance of visual image on the same phoneme.

There is little doubt that the oscilloscope is an instrument without peer in the study of any phenomena which can be converted to electrical impulses and then examined in regard to wave form; that is, frequency, amplitude, and phase relationships. However, as experimentation with instrumentation continued, it also became clearer that the problems were much more complex than either researcher had envisioned. Digital display by means of a frequency counter was attempted but proved ineffective for the same reasons as to be given in regard to oscilloscopic images.

The basic fallacy of oscilloscopic utilization lies in its presentation of wave shapes and not the speech spectrum. Denes and Pinson of the Bell Telephone Laboratories have pointed out the advantage of spectographic presentation; a method which also has strong limitations.[4]

In using the oscilloscope for visual feedback in the teaching of pronunciation, failure appears to be attributable to the following:

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4. Denes, Peter B. and Pinson, Elliot N., The Speech Chain, Bell Telephone Laboratories, 1963

1. Speech sound images of sinusoidal waves often sound the same even though their wave shapes differ because of differences in the phase relationship of their components.
2. Aural pitch perception is not proportional to frequency but the oscilloscope visual presentation is proportional and, therefore, does not present an easily perceived scale when combined with aural feedback.
3. Aural perception of amplitude changes suffers from a similar problem with the additional handicap that the large variations in amplitude between different phonemes demand scale changes in the oscilloscope amplification factor.
4. The speech feed-back effect seems to have its parallel in visual feed-back. That is, the subject awaits the crystallization of the visual image thus leading to a concomitant of the stammering effect of delayed aural feed-back.

Characteristic patterns were developed for phonemes which could be duplicated by the speaker again and again but the communicative test proved that the visual images lost their identity much sooner than the auditory image. Further the pattern changes from subject to subject caused a loss of visual image recognition when auditory recognition was still within the virtual certainty range. By limiting the audio band pass width to a range of 1000 Hertz, as suggested by Denes and Pinson, their findings were confirmed in regard to aural intelligibility but corresponding visual images were attenuated beyond consistent recognition even for a single subject.

III. Formant Theory

The difficulties encountered with the oscilloscope, as above, led to a concomitant examination of the formant theory of speech sound classification. It is commonly claimed that the first, second, and third formants are visually sufficient for recognition of vowel phonemes. Unfortunately, this does not mean that a particular combination of formant frequencies will always be recognized as one and the same vowel. Further a vowel can be aurally recognized even though its formant frequencies vary widely. As Denes and Pinson have pointed out and, as verified here, formant frequencies do not positively identify a vowel. In fact, no acoustic feature can completely identify a speech sound. William E. Castle published a study on the possible invariance of formant structure denying the absolute theory as first suggested by Helmholtz.[5] In reference to particular vowel sounds he found that formant information per se proves less useful to listeners than does information offered to their ears through third-octave bandwidths which center at 1600 or 2000 Hertz. This finding was confirmed in visual presentation by use of a Kronhite variable band-pass filter. These problems are further accentuated

5. Castle, William E., 'A Comment on the Possible Invariance of Formant Structure for Specific Vowel Phonemes,' Linguistics, Vol. 13, April 1965, pp. 16-24

when there is doubt concerning the formant spectrum itself as evidenced by the work of Delattre in revising formant definition for French phonemes and the phonetic comparison of languages.[6]

Through application of presently available band-pass filters, a number of researchers have quite accurately determined the frequency points at which communication intelligence ceases and what frequencies may be eliminated without serious loss. However, what has been deleted, or remains, is not only a component of a particular frequency or band of frequencies but an entire complex speech block of which the prosodic features are a significant component. A de-emphasis of formant components is reflected in the work of Buiten and Lane on a self-instructional device for conditioning accurate prosody.[7] Intonation, stress and rythmn values are compared by the subject to a model by means of simple digital presentation developed by a highly complex system of instrumentation. Research referenced by A. P. van Teslaar in a previous issue of IRAL deals with manipulating the frequency curve of the feedback signal to give prominence to certain acoustic features.[8] It will be interesting to note if such research will also

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6. Delattre, Pierre, 'Research Techniques for Phonetic Comparison of Languages,' IRAL, Vol. 1/2, 1963, pp. 85-97

7. Buiten, Roger and Lane, Harlan, 'A self-Instructional Device for Conditioning Accurate Prosody,' IRAL, Vol. III/3 (1965), pp. 205-219

8. Van Teslaar, A. P., 'Learning New Sound Systems: Problems and Prospects,' IRAL, Vol. III/2, 1965, pp. 79-93

produce information on the significant parameters of phoneme identity. Reliance on "Formant" content alone is fallacious with present formant definition since:

1. A wide range of formant frequencies is recognized as the same phoneme.
2. Formant ranges for phonemes overlap.
3. Formants for any one speech sound vary from speaker to speaker.
4. Formants are significantly influenced by preceding and following sounds.
5. A particular phoneme is not invariably associated with a particular combination of formant frequencies.

IV. Practical Application

It was hoped that this research would produce a relatively inexpensive and simple practical aid for foreign language instruction; instrumentation that would be included in the language laboratory alongside the tape recorder or the auto-record machinery of Chester Electronic Laboratories. If a solution is found in the instrumentation area, it is doubtful whether it will be either simple or inexpensive. Spectographic instruments available at this time are neither. Oscilloscopic presentation or digital read-out still appear as possible avenues of attack if the intermediate instrumentation can be resolved.

For the purpose of practical application any future research should not have as its aim exact visual reproduction but visual speech recognition. In the meantime, I believe, that further expenditure of funds on applied research is premature and that funds should be directed into basic research leading to practical instrumentation. Such basic research should probably be first directed at instrumental isolation of all the components of phoneme structure, their clear definition and consequently at a test of variability and consistency. In any case, the engineer-technician must be given a clear presentation of what his instrument will define visually.

V. Future Activities

Since the contract did not permit capital purchases, instruments were acquired both by Macalester College and myself in order to carry on this research. I hope to continue the use of procured equipment and space allotted to me in continuation of research in this area. Two instrumentation techniques are planned for investigation.

First, the utilization of high-speed recording; that is, tape speeds of 60 to 120 inches. This will permit easier physical manipulation of recorded samples. Secondly, analog to digital conversion. Up to the present time, research has been accomplished almost entirely with analog read-out, with the exception, as already noted, of the work of Dr. Harlan Lane. Through the use of pulse code modulation, as proposed by Reeves of ITT, the continuously variable speech signals may be transformed into a series of digitally coded pulses. This transformation implies increased band width in the transmission of speech and may allow improved isolation and definition techniques.

It is further hoped, as the research of Professor Lane with "SAID" continues into use in foreign language instruction, that the place of the suprasegmental features of speech be more clearly defined. The parameters of segmentals may thus be limited by subtraction and more easily attacked.

Appendix A

Experimentation was carried out with the use of the following major equipment:

Oscilloscopes

"Tektronix," Type 564 Storage Oscilloscope, including type 3A72 dual trace amplifier and type 2B67 time base.

"Dumont" Type 401

Pulse Generator

"Electro-Pulse Inc." Model 2125B

Signal Generator (Audio)

"Continental Electronics" Type SG-15A/PCM

"Hewlett Packard"

Decibel Meter

"Byron Jackson" Type ME-22A/PCM

Voltage Frequency Converter

"Dymec Inc." Model Dy-2210

Variable Band-Pass Filters

"Kronhite"

"United Transformer Corporation"

Stereo Tape Recorder

"Chester Electronic Laboratories"

Vacuum Tube Voltmeter

"Ballantine Laboratories" Model 643

Electronic Switch

"Heath Company" Model S-2

APPENDIX B

MACALESTER COLLEGE
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St. Paul, Minnesota 55101

Financial Report - Final
Contract Number OE 5-10-176
Project Number 2685
Director: Professor Franz X. Westermeier

Received:					
From HEW				$11,014.00	
From HEW				14,278.00	
Total Funds Received for Contract					$25,292.00
Disbursements:					
Co-Director Salary	1965	Westermeier	$4,025.00		
	1966	Westermeier	5,160.00		
	1966	Rossman	85.00		
	1967	Westermeier	920.00	$10,190.00	
Research Assistant - Bohn				72.00	
Supplies and Materials				294.83	
Statistical and Clerical Service				331.65	
Total				$10,888.48	
Overhead - Budgeted 20% of Direct Cost				2,173.25	
Total					$13,061.73
BALANCE - RETURNED HEREWITH:					$12,230.27

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