<table>
<thead>
<tr>
<th>UNCLASSIFIED</th>
</tr>
</thead>
<tbody>
<tr>
<td>AD NUMBER</td>
</tr>
<tr>
<td>--------------</td>
</tr>
<tr>
<td>ADA801492</td>
</tr>
<tr>
<td>CLASSIFICATION CHANGES</td>
</tr>
<tr>
<td>TO:</td>
</tr>
<tr>
<td>FROM:</td>
</tr>
<tr>
<td>LIMITATION CHANGES</td>
</tr>
<tr>
<td>TO:</td>
</tr>
<tr>
<td>FROM:</td>
</tr>
<tr>
<td>AUTHORITY</td>
</tr>
<tr>
<td>OSRD list no. 9 dtd 18-21 Feb 1946; OTS index dtd Jun 1947</td>
</tr>
</tbody>
</table>
The U.S. Government is absolved from any litigation which may ensue from the contractors infringing on the foreign patent rights which may be involved.
RESTRICTED

Applied Psychology Panel, NDRC
Project SC-67: VOICE COMMUNICATION

Report No. 18, August 20, 1945

TRAINING STUDIES IN VOICE COMMUNICATION:
III. EFFECTS OF TRAINING IN ARTICULATION

Prepared by
Harry M. Mason

for
C. Hess Haagen
James F. Curtis
Harry M. Mason
3/Sgt. John H. Wiley

loaned to the Project by Commanding Officer
RAAF, Taco, Texas

Approved for Distribution by
the Applied Psychology Panel

Office of Scientific Research and Development
Contract OEM 8-550

OSRD Report No. 5461
Copy No. 6 of 200 Copies

THE PSYCHOLOGICAL CORPORATION
New York, New York
George K. Bennett, Contractor's Technical Representative
John C. Black, Project Director
DISTRIBUTION LIST

Applied Psychology Panel

Dr. W. S. Hunter
Dr. G. K. Bennett
Dr. Leonard Carmichael
Dr. G. H. Graham
Mr. J. L. Stalnaker
Dr. M. S. Viteles
Mr. J. L. Kennedy, 5 copies
Mr. Deel Wolfe
Dr. C. C. Bray

Consultant to the Panel

Dr. D. L. Bronk

Contractors' Technical Representatives
and Project Directors, Panel Projects

Dr. W. C. Bieil
Dr. K. J. Brogden
Dr. J. H. Gorsuch
Dr. H. C. Guiliiken
Mr. E. Kappauf
Dr. D. B. Lindsley
Dr. U. C. Leek
Mr. H. L. Nissen
Dr. K. U. Smith

Army

Adjutant General's Office
Classification and Replacement Branch
Att: Dr. H. V. Bingham**
Att: Col. Frederick S. Foltz**
Att: Lt. Col. W. H. Richardson**
Att: Dr. Edwin R. Henry*

War Department General Staff
Assistant Chief of Staff, G-1
Personnel Policy Branch
Att: Col. C. F. Collier, Jr.**
Assistant Chief of Staff, G-3
Att: Chief, Training Group

Headquarters, Army Air Forces
Assistant Chief of Staff - Training
Att: Lt. Col. J. C. Courtney, Jr.*
Att: Dr. Lon Lewis, **5 copies
DISTRIBUTION LIST (Cont'd)

Headquarters, Army Air Forces
Assistant Chief of Air Staff - M and S
Att: Col. L. H. Tetley*
Assistant Chief of Air Staff - O, C and R
Att: Maj. R. A. Trench
Air Communications Officer
Office of the Air Communications Officer
Att: Maj. L. A. McColland
Att: Col. Clay I. Hoppough
Office of the Air Surgeon
Att: Col. J. C. Flanagan**
Att: Col. L. E. Griffis
Management Control Operations
Analysis Division
Att: Lt. Col. L. B. Leach

Office of the Secretary of War
Att: Mr. W. E. Strieby

Office of the Chief Signal Officer
Att: Chief, Personnel and Training Service
Chief, Engineering and Technical Service
Att: Aircraft Radio Branch

Eastern Signal Corps School,
Fort Monmouth, N. J.
Commanding General

Headquarters, Army Ground Forces
Att: Assistant Chief of Staff, G-3
Att: Signal Section
Att: Capt. M. L. Lewis**

Headquarters, Communications Control Division
Boiling Field, D. C.
Air Communications Office
Att: Maj. Virgil Clapp

AAF Tactical Center
Orlando, Florida
Commanding General
Att: Col. O. L. Grover

President AAF Board
Orlando, Florida
Att: Communications Division
AAF Training Command, Fort Worth, Texas
Commanding General
Assistant Chief of Staff, A-3
Att: Lt. Col. C. H. Frost
Att: Maj. C. W. Peterson
Att: Maj. C. M. Peterson
Assistant Chief of Staff, A-4
Att: Col. H. L. Bennett
Att: Surgeon

AAF Central Flying Training Command
Randolph Field, Texas
Commanding General
Att: Assistant Chief of Staff, A-3
Att: Assistant Chief of Staff, A-3
Psychological Research Project (Pilot)
Att: Director

AAF Central Instructors School,
Lack, Texas
Office of the Director
Ground School
Att: Maj. C. H. Rhoades

AAF School of Aviation Medicine,
Randolph Field, Texas
Commandant
Att: Chief, Department of Psychology
Research Division
Att: Lt. Col. Paul Campbell
Att: Capt. Ben H. Senturia

AAF Training Aids Division, New York, N. Y.
Commanding Officer

AAF Instrument Flying Standardization Board,
Bryan, Texas
Commanding Officer

AAF Eastern Flying Training Command,
Maxwell Field, Alabama
Commanding General
Att: Assistant Chief of Staff, A-3

AAF Western Flying Training Command
Santa Ana Field, California
Commanding General
DISTRIBUTION LIST (Cont'd)

Laco Army Air Field, Waco, Texas
Commanding Officer
At: Col. Pearcy

1st Air Force, Mitchel Field, New York
Commanding General
At: Communications Training

2nd Air Force, Colorado Springs, Colorado
Commanding General
At: Communications Training

3rd Air Force, Tampa, Florida
Commanding General
At: Communications Training

4th Air Force, San Francisco, California
Commanding General
At: Communications Training

Laredo Army Air Field, Texas
Research Division, CSFG
At: Director

AAF Central Instructors School -- Navigator
Ellington Field, Texas
Commanding Officer
At: Director of Training
Psychological Research Project (Navigator)
At: Director

AAF Central Instructors School -- Bombardier
Midland Army Air Field, Midland, Texas
Director of Training
Psychological Research Project (Bombardier)
At: Director

AAF Central Instructors School -- B-17 Pilots
Lockbourne Army Air Field, Ohio
At: Director of Training

AAF Central Instructors School -- B-24 Pilots
Smyrna Army Air Field, Tennessee
At: Director of Training

Scott Field, Illinois
Director of Training -- Technical

San Antonio Aviation Cadet Center
San Antonio, Texas
Psychological Research Unit
At: Director
DISTRIBUTION LIST (Cont'd)

Navy

U. S. Coast Guard Headquarters
Commandant (PT)

U. S. Marine Corps Headquarters
Division of Aviation
   Att: Lt. Col. Wm. F. Hausman**
Personnel Department
   Att: Lt. Col. H. E. Hirt**

Office of the Commander-in-Chief
Readiness Division
   Att: Capt. E. C. Beard**
   Att: Lt. S. H. Britt**

Office of Research and Inventions,
Research and Development Division, 4 copies for:

    Pacific Fleet Radar Center and
    Pacific Fleet Schools
    Officer-in-Charge
    Fleet Training Command, Seventh Fleet
    Commander
    Comdr. A. L. Shepherd
    Capt. P. E. McDowell**

Bureau of Medicine and Surgery
Medical Research Division
   Att: Comdr. J. G. Jenkins**
   Att: Lt. Merle Lawrence

Bureau of Naval Personnel
Enlisted Distribution Division
   Att: Lt. Comdr. J. A. McCain
Planning and Control Division
   Att: Lt. Comdr. J. C. O'Brien**
Standards and Curriculum Division
   Att: Comdr. C. R. Loomis**
   Att: Lt. Comdr. R. N. Faulkner**

Ordnance and Gunnery Schools
Washington Navy Yard
   Att: Comdr. D. F. Eller

U. S. Submarine Base, New London
Medical Research Laboratory
   Att: Capt. C. W. Shilling**

Operational Training Command, Atlantic
  Commanding Officer
Naval Air Technical Training Command,
Chicago, Illinois
Att: Lt. Comdr. E. C. Callahan*

NavTraCen, Great Lakes, Illinois
Att: Lt. Comdr. David Braswell

NaTechTraCen, Gainesville, Georgia
Commanding Officer

NavTraSch, Fort Lauderdale, Florida
Commanding Officer

NavAirSta, Corpus Christi, Texas
Aviation Safety Board
Att: Lt. F. H. Sanford

NavAirSta, New Orleans, Louisiana
Att: Naval Flight Instructors School

NavAirSta, Atlanta, Georgia
Instrument Flight Instructors School
Att: Lt. E. T. Curry
Att: Lt. Walter H. Lile

NavAviationTraSta, Pensacola, Florida
Aviation Psychology
Att: Lt. Max Steer

Medical Field Research Laboratory,
Camp LeJeune, N. C.
Medical Officer-in-Charge

Combat Operation Department, Orlando, Florida
Marine Liaison Officer
Att: Capt. Paul V. Smith

Civil Aeronautics Administration
Dr. Dean R. Brinham

National Research Council
Dr. L. H. Weed

National Defense Research Committee
Executive Secretary, 7 copies
Division 6
Dr. Adelbert Ford
Dr. G. P. Hartwell
Dr. W. E. Neff
DISTRIBUTION LIST (Cont'd)

Section 7.4
Dr. S. L. Fernberger

Section 17.3
Dr. S. S. Stevens

OSRD Liaison Office, 23 copies

**General Liaison Officers
*Project Liaison Officers
Summary

Four experiments designed to investigate effects of training in pronunciation or articulation are presented.*

Results indicate that training to pronounce accurately and clearly produces increased intelligibility.

Instruction to stress final consonants resulted in increased intelligibility when the T-17 (hand held) microphone was used, but not when T-30 (throat) or ANB-M-C1 (mask) microphone were used.

No gains in intelligibility were shown as a result of instruction to stress sibilant sounds.

Training for one hour in clear pronunciation affected a subsequent intelligibility test, not only in the scores obtained by the speakers, but in the degree to which words were articulated, as determined by judges who heard phonograph recordings of tests given before and after training. Loudness of speech signal was not changed by this training.

*These experiments were performed in part at Voice Communication Laboratory, Vance AAF and in part at Goodfellow AAF in conjunction with the ground school course in voice communication, Major H. B. Krueger, Director, and Lt. R. P. Stewart, instructor in charge.
EFFECTS OF TRAINING IN ARTICULATION

I. Introduction

Since the difference between one word and another is often a difference of a single sound, it is obvious that slovenly pronunciation of words may result in lowered intelligibility. The crucial question for Army Air Forces voice communication training, however, is whether a relatively small amount of training directed at improving articulatory practices is effective in improving intelligibility in noise.

The effects of three types of training, each of which was directed toward clear pronunciation, are shown in four experiments presented in the following sections. The types of instruction given were:

1. Instruction to stress final consonants.
2. Instruction to stress sibilant sounds (s, z, sh, zh, ch, j).
3. Instruction in precise articulation of words.
   (Lecture and practice in quiet.)
4. Instruction in precise articulation of words.
   (Lecture, practice in noise, demonstration record.)

In the first two experiments reported emphasis was put upon the manner in which individual sounds were to be made, in one case sounds were singled out for attention; in the other, attention was paid to the last sound in each word. The last two experiments deal with attempts to get the student to pay attention to pronunciation generally, no attempt being made to stress any particular sound.

II. Instruction to Emphasize Final Consonants

Twelve lists, each made up of 20 one-syllable words, were assembled. Words were chosen so that each list contained at least once in the final position each consonant sound that commonly is so used in the English language. Twelve groups of 16-20 AAF student pilots spoke and listened to the words. Six-eight from each group served as readers, the remaining 16-14 as listeners. Readers and listeners were surrounded by 100-110 db aircraft-type noise.

Each speaker read the lists of words over an inter-hone network, one in his normal manner, and one with added stress on final consonants.
A schedule of reading was followed in which, among 4 repetitions of the procedure, each list was read twice normally and twice with stressed final consonants. In one instance the stressed reading of a list occurred first, in the other, the normal. Speakers watched a VU meter connected across the interphone headset circuit, and produced each word at a loudness level of -4 VU, where 0 VU = 0.7 volt.

This procedure, with four readings of each list, was repeated with three groups of subjects, one each with readers using AMH-4-Cl microphones in 7-10 K oxygen masks, T-17 (hand held) microphones, and T-30 (throat) microphones.

Intelligibility values were computed so that the value obtained by speakers pronouncing normally could be compared with that when lists were read with special stress on final consonants. Due to absences, the counterbalancing for order of stressed and non-stressed readings was not complete. Analysis showed, however, that this was not a serious defect, since there was negligible variance due to order of stressed-normal readings.

Table I

Intelligibility of One-Syllable Words Read Normally and With Special Stress on Final Consonants

<table>
<thead>
<tr>
<th>Microphone</th>
<th>N</th>
<th>Normal Mean</th>
<th>Stressed Mean</th>
<th>Difference</th>
<th>S.D.</th>
<th>&quot;t&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-17</td>
<td>20</td>
<td>50.5</td>
<td>56.5</td>
<td>6.0</td>
<td>10.2</td>
<td>4.76</td>
</tr>
<tr>
<td>T-30</td>
<td>32</td>
<td>39.2</td>
<td>40.9</td>
<td>0.7</td>
<td>9.9</td>
<td>0.50</td>
</tr>
<tr>
<td>AMH-4-Cl</td>
<td>37</td>
<td>56.2</td>
<td>55.9</td>
<td>-3.3</td>
<td>11.2</td>
<td>1.61</td>
</tr>
</tbody>
</table>

"t's" from distributions of differences.
"t" (15) for 30 d.f. = 2.76.
"t" (35) for 30 d.f. = 2.04.

A significant improvement was made by stressing final consonants in the case of the T-17 microphone (Table I). The mean gain and loss for the other two microphones were within the amount expected by chance.

III. Training to Stress Sibilant Sounds

Some sounds have been shown to be factors in the low intelligibility values of words containing them. For example sibilant sounds are among the most difficult to understand in nonsense-syllable articulation tests. To find whether the detrimental effects of these sounds could be overcome in voice communication through training,

*Phonetic Characteristics of Words as Related to Their Intelligibility in Aircraft-Generated Noise. ONR Report 4631. Restricted.
Speakers were tested, trained and re-tested for intelligibility. Fifty-eight AAF student pilots, who had previously served as subjects in an experiment in voice communication, were given an intelligibility test, using the T-17 microphone. Twenty-nine were then given 3 half-hour periods of lecture and practice in quiet on stressing sibilant sounds. At the end of the second training session, both groups were given a final intelligibility test.

Table II
Initial and Final Intelligibility Scores of Control Subjects and Subjects Trained in Stressing Sibilant Sounds

<table>
<thead>
<tr>
<th>Group</th>
<th>Initial Mean</th>
<th>Final Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental (N=29)</td>
<td>54.2</td>
<td>53.9</td>
</tr>
<tr>
<td>Control (N=29)</td>
<td>51.7</td>
<td>54.0</td>
</tr>
</tbody>
</table>

Weighted Ave. S. D. within groups = 10.9.

Since the trained subjects (Table II) lost in performance, it is evident that the training to stress sibilant sounds was not effective. It is probable that the strong sibilant articulation resulted in distortion of word patterns, making words less, instead of more, intelligible.

IV. Instruction in Precise Articulation (in quiet)

To study the effect of instruction in precise articulation of words upon intelligibility, 50 AAF student pilots were given 24-word write-down intelligibility test in 80-100 db aircraft-type noise. Thirty of the men then received two 2-hour periods of training (lecture and practice in quiet) in precise articulation of words. The training periods were on successive days. At the end of the second training period, both trained and untrained (control) subjects were re-tested. All subjects used the T-17 microphone in tests.

Table III
Initial and Final Intelligibility Scores of Control Subjects and Subjects Trained in Precise Articulation

<table>
<thead>
<tr>
<th>Group</th>
<th>Initial Mean</th>
<th>Final Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental (N=26)</td>
<td>56.0</td>
<td>60.34</td>
</tr>
<tr>
<td>Control (N=30)</td>
<td>57.0</td>
<td>57.2</td>
</tr>
</tbody>
</table>

"t" from distribution of differences.
"t" (1%) for 17 d.f. = 2.77.
Weighted Ave. S. D. within groups = 10.3.

The experimental groups (Table III) gained by a significant amount; the control group made no significant gain in performance. It is evident that the training given the experimental group was effective.

In most experiments involving an intelligibility test and re-test, a slight gain is registered by a control group, even though no intervening training has taken place. The failure of the control group to gain in score is probably due to the fact that neither it nor the experimental group was completely naive at the beginning of the experiment. Both had served for several days as listeners in another experiment, and had taken an intelligibility test before the initial test given at the outset of the present experiment. These circumstances probably stabilized the scores of both groups to some extent, making it more difficult to produce a significant gain in either.

V. Instruction in Precise Articulation (in noise)

Thirty-seven AAF cadets in pre-pilot training were tested for intelligibility, trained for one class hour in clear pronunciation of words, and re-tested. Thirty-eight cadets were tested and re-tested without intervening training, as a control group.

The multiple-choice intelligibility test was used, Form A in initial tests, and Form B in final tests. In addition, each cadet read a list of 24 one-syllable words in both initial and final testing sessions. The 24-word lists were of selected "difficult" words, and were written down by the listeners as they were spoken. All of them contained one or more of the sounds sir, fox or thin, and all were of low intelligibility. Tests were administered in 100-105 db aircraft-type noise. Instead of the usual situation in which each man serves both as speaker and listener, listening was done by special panels of AAF cadets.

To provide a measure of the incidental effect of training in pronunciation upon loudness of speech signal, monitors read VU meters connected across the microphone circuits, noting the peak loudness for each word. Phonograph recordings were made of initial and final tests for as many speakers as equipment would allow.

Training given in articulation covered one 55-minute class period on the day between initial and final tests. The outline of the training hour follows:

1. An instruction period on the need for clear articulation when speaking in noise (5 minutes).

2. Examples of words containing sounds of low intelligibility value (5 minutes).
3. Drill with word lists. Words had been selected for low intelligibility. In 100-102 db airplane-type noise, each reader read a word over the interphone system. Another subject called the word back. If the word was incorrectly received, the speaker pronounced the word again. If the monitor perceived inadequate articulation, he gave a corrected pattern for the faulty words spoken. Each speaker read 12 different words (57 minutes).

4. Speakers listened to a demonstration recording, "Articulation," through their headsets (6 minutes).

5. Drill with interphone messages. Each speaker read an interphone message in noise, and a listener answered a question of fact about the content. The monitor criticized unclear speech (5 minutes).

Throughout the teaching session, all criticisms were directed toward clarity of speech and articulation of sounds. No mention was made of rate of speaking, loudness, or rhythm.

Data available from initial and final testing periods were:

1. Initial and final scores on equivalent forms of the multiple-choice intelligibility test.

2. Initial and final intelligibility scores on 12-word lists of low intelligibility, where each man read the same words in initial and final tests.

3. VU meter readings for each word in all tests (1 VU = 4.2 volts).

4. Phonograph recordings of intelligibility tests for approximately 1/4 of the speakers' initial and final tests.

The trained group made significant gains in performance on both the multiple-choice test and the lists of difficult words (Table IV). The control group showed no improvement on the multiple-choice test. However, it did improve significantly on the difficult words. The gain of the control group on the difficult words was almost equal to that of the trained group. Since the same tests were used in initial and final difficult word tests, the gain in both groups was probably due to increased speaker-listener familiarity with the items. The fact that the trained group made a gain on the multiple-choice test, while the control group did not, indicates that the training did produce better intelligibility on words in general.

All single-word VU readings for a speaker were averaged, and the average treated as his initial or final VU level. Comparison
Table IV

Intelligibility of Trained and Control Speakers

a. Multiple-Choice Test

<table>
<thead>
<tr>
<th></th>
<th>Initial</th>
<th>Final</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>S. D.</td>
<td>Mean</td>
</tr>
<tr>
<td>Trained Group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$N=37$</td>
<td>58.8</td>
<td>6.6</td>
<td>66.2</td>
</tr>
<tr>
<td>Control Group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$N=38$</td>
<td>63.4</td>
<td>8.7</td>
<td>64.1</td>
</tr>
</tbody>
</table>

b. Difficult-Words Test

<table>
<thead>
<tr>
<th></th>
<th>Initial</th>
<th>Final</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>S. D.</td>
<td>Mean</td>
</tr>
<tr>
<td>Trained Group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$N=37$</td>
<td>32.6</td>
<td>11.3</td>
<td>45.2</td>
</tr>
<tr>
<td>Control Group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$N=33$</td>
<td>32.8</td>
<td>11.8</td>
<td>45.0</td>
</tr>
</tbody>
</table>

"t's" from distributions of differences.
"t" (1%) for 36 d.f. = 2.75.

Correlations, initial vs. final scores were as follows:
trained, multiple choice, $r = -.01$;
control, multiple choice, $r = .36$;
trained, difficult words, $r = .49$;
control, difficult words, $r = .60$.

...
Effect of Training in Articulation on Strength of Signal

Table V

<table>
<thead>
<tr>
<th>Group</th>
<th>VU Initial Mean</th>
<th>S.D.</th>
<th>VU Final Mean</th>
<th>S.D.</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trained (n=37)</td>
<td>-2.4</td>
<td>2.9</td>
<td>-2.0</td>
<td>2.7</td>
<td>.4</td>
</tr>
<tr>
<td>Control (n=38)</td>
<td>-2.2</td>
<td>3.2</td>
<td>-2.3</td>
<td>3.1</td>
<td>-1</td>
</tr>
</tbody>
</table>

"t" = 1.118 from distributions of differences.

From CCG recordings of 12 of the trained group, re-recordings of the lists of difficult words were made in such a manner that initial and final speaking of each word by the same speaker were paired. Position in the pair (initial - final) was determined from a table of random numbers. Volume levels of recording was equalised for each pair by monitoring its peak-level on a cathode-ray oscilloscope connected across the output of the recording amplifier. The re-recording was done from 2 turntables, each system used alternately for reproducing an initial test. These pairs of records of the same word, spoken before and after training, were played to a panel of 9 persons, 4 of whom were specialists in speech. All were given the instruction to designate the 1 or 2 member of a pair of words as articulated with most precision. Judgment was not to be on correctness of pronunciation or probable intelligibility, but on degree of formation of sounds. Judges were provided with lists of the words heard, so that intelligibility would not necessarily be a factor in their judgments. A judgment was required for each pair. Table VI presents the number and proportion of correct judgments for each of 9 judges, with X² (chi-square) to show the probability of such a departure from chance expectancy. It may be seen that all judges were able to detect the effect of training upon articulation to a significant degree.

Table VI

<table>
<thead>
<tr>
<th>Judge</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>N Correct</td>
<td>62</td>
<td>68</td>
<td>67</td>
<td>64</td>
<td>68</td>
<td>65</td>
<td>62</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>N Incorrect</td>
<td>26</td>
<td>27</td>
<td>30</td>
<td>26</td>
<td>29</td>
<td>32</td>
<td>34</td>
<td>34</td>
<td>34</td>
</tr>
<tr>
<td>% Correct</td>
<td>73.4</td>
<td>79.2</td>
<td>75.4</td>
<td>80.0</td>
<td>80.0</td>
<td>80.0</td>
<td>74.1</td>
<td>70.0</td>
<td>70.0</td>
</tr>
<tr>
<td>X²</td>
<td>13.6</td>
<td>13.6</td>
<td>13.6</td>
<td>13.6</td>
<td>13.6</td>
<td>13.6</td>
<td>13.6</td>
<td>13.6</td>
<td></td>
</tr>
<tr>
<td>X² (1%) for 1 d.f. is 6.64</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*This judge missed 16 judgments, being called out during the judging session.*
although the 12 speakers taken as a group were judged to be changed by articulation training, some speakers did not change in a discernible degree. To show this, the proportion of "after training" words judged more articulated by the whole judging panel for each speaker was computed (Table VII). Some men made great changes due to training. For others, no discernible effect on articulation appears.

Table VII
Proportion of Words Spoken with Greater Articulation* after Training, for 12 Speakers

<table>
<thead>
<tr>
<th>Speaker</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent of words more articulated after training</td>
<td>94</td>
<td>88</td>
<td>88</td>
<td>85</td>
<td>83</td>
<td>81</td>
<td>79</td>
<td>79</td>
<td>64</td>
<td>49</td>
<td>46</td>
<td>39</td>
</tr>
</tbody>
</table>

*Degree of articulation is determined by composite score of a panel of 9 judges listening to 7-C pairs of words per speaker.

VI. Summary and Interpretation

Three of the four experiments reported in this study showed significant effects of training in precise articulation upon intelligibility. The effects were shown with word intelligibility tests involving a wide variety of speech sounds. All involved the T-17 (hand held) microphone. The only experiment in which other microphones were used failed to show any effect of training in pronunciation with the T-30 (throat) or ANB-M-C1 (mask) microphone. Training in this experiment, however, only involved stressing final consonants, so that no general conclusion is possible regarding the effect of training in clear speech with respect to the T-30 or ANB-M-C1 microphone.

Gains in intelligibility were not due to increased loudness of speech signal which might have accompanied more careful articulation. In one experiment, (stressing final consonants) loudness was controlled by the reader, who watched a VU meter as he spoke; in another, loudness readings were compared before and after training in clear pronunciation. No appreciable change in loudness occurred.

Where phonograph records of speech before and after training were available, judges were able to pick out the speech of trained speakers by the degree to which they articulated test words.

Two experiments afforded an opportunity to measure the effect of training upon sounds associated with low intelligibility. In one, training in stressing sibilant sounds was given. In another, general training in clear pronunciation was given, and a special test of
one-syllable words containing the s (sit), f (fox), and th (thin) was given before and after training. Trained subjects gained no more than untrained subjects in either experiment. These results indicate that training for good articulatory patterns is likely to improve intelligibility, and is superior to training which attempts to improve the pronunciation of difficult sounds.

In two cases where general patterns of clear speech were taught, the one involving instruction in noise was the more effective. Too many conditions were different in the experiments to attribute the greater gain to the presence of noise, but the presumption is that noise used during training was helpful.
ABSTRACT:

Since the difference between one word and another is often the difference of a single sound, it is obvious that slovenly pronunciation of words may result in lowered intelligibility. Four experiments designed to investigate effects of training in pronunciation and articulation are discussed. Results indicate that training to pronounce accurately and clearly produces increased intelligibility. Instructions to stress final consonants resulted in increased intelligibility when the T-17 hand held microphone was used, but not when the T-30 (throat) or ANB-M-C1 (mask) microphones were used. No gains in intelligibility were shown as a result of instruction to stress sibilant sounds. Loudness of speech signal was not changed by this training.
UNCLASSIFIED FOR AUTHORITY OSRD LIST #9,
DATED 18-21 FEBRUARY 1946
BY John E. Moore, USCO