THE DEVELOPMENT OF PERFORMANCE-BASED AUDITORY AVIATION CLASSIFICATION STANDARDS IN THE U.S. NAVY

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The Development of Performance-based Auditory Aviation Classification Standards in the U.S. Navy (Unclassified)

Gerald B. Thomas, Carl E. Williams, and Jill F. Raney

Abstract
A series of studies was undertaken to develop a performance-based test battery to ascertain the auditory fitness of naval aviators. On the basis of literature reviews, interviews with experienced pilots, and published job analyses, several auditory abilities were identified. These included perception of degraded speech, response time to auditory signals, auditory short-term memory, and auditory selective attention. Tests to measure these abilities were developed and evaluated in terms of sensitivity and test-retest reliability (Experiments I and II; total N = 105). Sensitivity was sufficient to readily discriminate between pilots of disparate age groups, and test-retest reliabilities ranged from .71 to .88 for individual test battery elements. Experiment III sought to increase the validity of the test battery by incorporating major elements into a tape-recorded flight scenario.
SUMMARY PAGE

THE PROBLEM

Decisions regarding pilot auditory fitness and classification traditionally have been based on chronological age and pure-tone hearing thresholds. The Sensory Division of the Naval Aerospace Medical Research Laboratory (NAMRL) was tasked to develop a battery of tests to measure and evaluate the more complex auditory skills required by a pilot. These performance-based data should allow more precise statements about pilot auditory fitness.

FINDINGS

On the basis of literature reviews, interviews with experienced pilots, and published job analyses, several auditory abilities important in the operation of aircraft were identified. These included perception of degraded speech, response time to auditory signals, auditory short-term memory, and auditory selective attention. A battery of tests was developed to measure and evaluate these abilities. The criteria for including specific tests in the test battery were availability, existing baseline data, ease of administration, face validity, and published estimates of reliability and validity. The evaluation and refinement of selected elements of the test battery resulted in test-retest reliabilities ranging from .71 to .88, acceptable levels of face validity and administration ease, and degrees of sensitivity sufficient for the desired goals. A shortened version of the test battery (on audio cassette and in the form of a simulated flight scenario) was also developed for evaluation.

ACKNOWLEDGMENTS

The authors express their gratitude to Donald Maxwell for his assistance with equipment and materials; Lt. Robert W. Clipper for his initial design of the automated reaction time device; and Ray Griffin for his expertise with the dichotic listening test. Gratitude is also extended to Al Thomas and Ensign Thomas Browne for their tireless recruiting and testing of subjects during the project. Thanks also are due to Nell Davis, Jalaine Bowen, and Elaine Cotton for secretarial support and to Dr. Jefferson Koonce for his instructive input regarding aviator performance. We acknowledge the hundreds of volunteers who gave freely of their time to participate in this study. Finally, a special thanks must go to those members of the local Association of Naval Aviators who so willingly agreed to take part in this research.
The skills required of a naval aviator to successfully carry out his flying duties are varied and complex. Sensory, perceptual, cognitive, and motor capabilities are among the principal general factors cited in various taxonomies as being critical in the successful operation of an aircraft. Current U.S. Navy hearing standards for incoming aviation candidates are based on the traditional pure-tone, air-conduction threshold. In addition, chronological age was recently a principal determining factor in service group assignment. That is, when a Service Group I or Service Group II aviator reached age 45, that aviator was automatically assigned to Service Group III regardless of performance capabilities (1). Because the ability to detect pure tones in quiet bears debatable relevance to the hearing requirements of the operational environment, and because humans age physiologically at different rates, it would be desirable to make classification decisions on the basis of aviation-pertinent performance data. To date, these data have not been routinely available.

The Naval Aerospace Medical Research Laboratory (NAMRL) was tasked by the Chief of Naval Operations to develop a battery of performance-based tests to supplement or supplant the current system of classification. To accomplish this task, several broad, sequential phases of research were required:

1. Determine the auditory abilities necessary for aircraft operation. This determination was made by a literature search of job analyses and through formal and informal interviews with experienced pilots and instructors (see Appendix A for an example of a radiocommunications questionnaire administered to pilots and instructors at the Naval Air Station Oceana).

2. Select, assemble, test, and refine the test battery elements. In this phase, each element's sensitivity and reliability was evaluated, as well as its ease of administration and face validity.

3. Validate the test battery by comparing it with performance in real or simulated operational environments. This was the most difficult phase of the project in that objective quantification of real-world performance is problematic.

The first two phases of development have been completed and will be described in this report.

AVIATION-RELEVANT AUDITORY ABILITIES

Because naval aviators range in age from 20 to 50+ years, critical auditory abilities that tend to change with age were of particular interest in the design and development of a NAMRL performance-based test battery. As the literature searches revealed, virtually all of the auditory abilities of interest tend to deteriorate with increasing age, although at differing rates and times of onset. The following is a brief overview of selected aviation-relevant auditory performance variables that are reported to vary as a function of age.
Speech Perception

Principal among the auditory functions necessary for successful aircraft operation is the ability to accurately receive voice communications in operational environments. Therefore, initial efforts in the past to establish minimal hearing criteria centered around the so-called "speech frequencies" (i.e., 500, 1000, and 2000 Hz), which have been used as standards to the present day. Subsequent research has shown, however, that the relationship between an individual's ability to detect pure tones in quiet (pure-tone audiometry) and his/her ability to accurately perceive speech, especially speech that has been degraded in some way, is not perfect (2-7).

The relatively poor correlation between pure-tone detection in quiet and the perception of degraded speech is not too surprising in light of the fact that pure-tone audiometry is primarily a measure of peripheral sensory function whereas the perception of speech involves higher order, central, processes. Studies devised to measure the integrity of the central auditory function reveal a decline in this area with age. For example, speech discrimination comparisons between groups that differed in age but were similar in pure-tone thresholds for the speech frequencies show distinct, age-related declines (4,5). This age effect for speech perception becomes magnified when the speech materials are degraded. That is, as a general rule, speech that is filtered (8-10), time-altered (11,12), embedded in noise (4,13), or temporally interrupted (14,15) is perceived more poorly by older persons than by younger listeners.

At what age do decrements in auditory function begin? Pure-tone thresholds begin worsening in males "beyond about 30 years" (16) but specific magnitudes depend on the subject population, measurement techniques, et cetera. The perception of typically redundant, undistorted speech can continue without significant change into the eighth decade (14) although noticeable declines generally occur around age 60. The perception of less than optimal speech signals also depends on the type of signal degradation, subject population, etc., but declines generally are noted in the fifth decade of life (14,17,18) with a steepening of the decline by the seventh decade. Interestingly, longitudinal studies of auditory function suggest that the age-related changes in speech perception are greater than the age-related changes that occur with pure-tone thresholds (19).

At last report, several member nations and service branches of the North Atlantic Treaty Organization, including the Federal Republic of Germany, the United Kingdom, France, Norway, and the U.S. Air Force, specify in their medical fitness standards for flyers the use of speech audiometry as an adjunct to pure-tone audiometry (20). Those that do not provide for some test of central auditory function are the U.S. Navy, the U.S. Army, Canada, and Belgium (20). The U.S. Navy developed a speech discrimination test in 1964 (the Naval Aviator's Speech Discrimination Test) for use in the flight physical examination (2,21). While mention is made of this test in the U.S. Navy flight standards (22), it is no longer routinely in use (J.W. Greene, Navy Environmental Health Center, Norfolk, VA, April 1980, personal communication).
Auditory Short-Term Memory

Memory has also been mentioned as an age sensitive function that is related to pilot performance (23, 24). While debate continues regarding whether age-related memory decline results from deficient storage, search, retrieval, etc., (25, 26), performance scores on laboratory measures indicate a slow decline after maturity with a sharper decline occurring in the seventh decade of life. These memory deficits can have such functional effects as making sentence length a determinant in correct sentence perception (16) and reducing the number of sequentially presented digits that can be learned (23).

Auditory Reaction Time

In general, the speed with which a person responds to a stimulus slows with increasing age. As with short-term memory, differences of opinion exist regarding whether decision making or psychomotor processes are primarily responsible (23). Regardless of which process is of principal importance, the speed with which an aviator responds to an auditory warning signal, for example, can be critical.

Selective Attention/Dichotic Listening

The amount of information available to a pilot during flight is potentially overwhelming. Successfully managing the attentional processes is instrumental in the operation of an aircraft (26). In situations where there is information competing for attention, age effects have been noted (16, 23).

The dichotic listening test is a task that involves selective attention (as well as auditory short-term memory and speech perception). Studies employing this measurement device report changes in performance with age (16, 18, 27, 28) as well as correlations with student pilot flight training success (J. Mosko and R. Griffin, Naval Aerospace Medical Research Laboratory, Pensacola, FL, personal communication) and the proficiency of pilots in high performance aircraft (31).

In addition to the preceding aviation-related auditory abilities, changes with age have been noted in auditory vigilance (18), listening strategies (30), brainstem evoked responses (31), loudness and pitch discrimination (18), masking level differences (32) and several anatomical and physiological features (18, 33-35). These factors, however, have not usually appeared in aviator task analyses (though they may underlie or reflect some of the aforementioned abilities) and were not, therefore, seriously pursued in this project.

TEST BATTERY

On the basis of the preceding information, numerous tests were evaluated along the dimensions of availability, existing baseline data, ease of administration, face validity, and published estimates of reliability and validity. These criteria provided the following tests for further evaluation:
1. **Pure-tone, Air-conduction Audiogram** - a peripheral sensory system assessment technique; currently, the routine screening device for pilot auditory fitness.

2. **W-22 (Clear version)** - a widely used test of speech perception; administered under ideal (i.e., quiet) listening conditions at levels 50 dB above an individual's auditory thresholds for 500, 1000, and 2000 Hz.

3. **W-22 (Background version)** - similar to the preceding measure, but the speech signal is presented 5 dB above a background of intelligible verbal interference (four talkers).

4. **Tri-word Modified Rhyme Test (TMRT)** presented at 0 dB and +4 dB signal-to-noise ratios - an adaptation of the Modified Rhyme Test (36), this instrument is designed to simulate radio communications in that the signal is degraded by a noise masker, and multiple target signals are presented in a single communication (37). Routinely presented at 80 dB (SPL), presentation at approximately 90 dB (SPL) can detect the existence of unusual cochlear or other distortion under short-duration, high-signal, or noise level conditions.

5. **Digit Span (Forward and Backward)** - a measure of short-term memory of signals presented through the auditory modality; taken directly from the Wechsler Adult Intelligence Scale.

6. **Dichotic Listening Test (DLT)** - a test of auditory selective attention that involves both intra- and inter-channel information selection.

7. **Auditory Reaction Time (ART)** - a test devised to not only assess response latencies to auditory signals but also to determine the effects of loading the perceptual system (through perceptual expectancy) on those latencies. Because most of the information with which a pilot deals is visual, a reaction time paradigm was developed such that 80% of the signals which occurred were visual (either a red (6%) or green (20%) light), while the remaining 20% were auditory (a 2000-Hz tone presented at 50 dB above threshold). A session consisted of 10 trials of simple reaction time (each stimulus presented singly) and 2 blocks of 50 trials of choice reaction time.

**EXPERIMENT I**

Experiment I sought to determine the gross sensitivity of the various tests by comparing the results provided by two aviator populations expected to differ in auditory abilities.

**METHOD**

Subjects

Two groups of aviators served as subjects in Experiment I. One group had an average age of 24.3 years (n = 24) and was referred to as the "Younger" group; the other group of subjects had a mean age of 56.7 years (n = 24) and was termed the "Older" group. The Younger group was made up
primarily of student naval aviators whereas the Older group was principally composed of retired naval aviators.

**Equipment**

Audiometric measures were derived using a manual Tracor RA115A clinical audiometer and TDH-39 headphones. Later administrations of the test battery employed an automated Maico MA26 audiometer. The two forms of the W-22 speech test were created by Auditec of St. Louis and were played on a two-channel cassette deck with the channels being amplified and controlled by the Tracor RA115A audiometer. The same TDH-39 headphones were also used for the W-22 tests. The TMRT was recorded and calibrated in the Sensory Division at NAMML and was presented to the subjects via a reel-to-reel Ampex tape deck over TDH-39 headphones. The Digit Span test was orally presented by the experimenter according to the Wechsler Adult Intelligence Scale protocol, and the DLT was presented using a Uhren 4200 two-channel, reel-to-reel recorder and Sennheiser TD-400 headphones. The ART test was manually administered using a Gerbrands GL360 reaction time controller and GL271 digital clock. A Maico MA40 audiometer was interfaced with the controller to present the auditory stimuli over TDH-39 headphones at a sound pressure level of 78 dB. Later administrations of the reaction time paradigms were totally automated using a Hewlett-Packard HP-85 portable microcomputer (the numerals "8" and "T" replaced the red and green visual stimuli). All tests were presented to individual subjects in Industrial Acoustics Corporation sound attenuating booths.

**Procedure**

The order of presentation of the elements of the battery remained the same for all subjects: Audiogram, W-22 (Clear), W-22 (Background), TMRT (+4 dB), TMRT (0 dB), DLT, Digit Span, and ART. Subjects were given 5 to 10-min breaks after the W-22 (Background) and the DLT.

**Results**

Student’s t-test was used to compare the two populations of aviators. The results are presented in Table 1.

**Discussion**

Despite the fact that critical peripheral sensory inequalities were corrected through the setting of amplitudes on the basis of individual thresholds (except on the TMRT and DLT, which were both presented at levels well above the thresholds for all subjects), statistically significant differences in complex, higher level auditory function between the two groups are evident (see Table 1). These differences suggest that, on the whole, the chosen instruments are sufficiently sensitive to detect at least gross differences in auditory performance. An exception is the finding that the W-22 (Clear) failed to differentiate between the two groups; for this reason, it was dropped from the battery. Also, the Digit Span (Backward condition) provided inconclusive results given the performance data on the Digit Span (Forward condition); both versions were retained for further testing.
TABLE 1. Results of Experiment 1.

<table>
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<tr>
<th>TEST</th>
<th>Younger Group (n = 24)</th>
<th>Older Group (n = 24)</th>
<th>M</th>
<th>SD</th>
<th>M</th>
<th>SD</th>
<th>t</th>
<th>p</th>
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<td>Pure-tone threshold (dB)</td>
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<td>Right ear</td>
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<td></td>
<td>125 Hz</td>
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<td>16.0</td>
<td>5.3</td>
<td>6.6</td>
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<td>250 Hz</td>
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<td>12.9</td>
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<td>6.6</td>
<td>2.9</td>
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<td>5.0</td>
<td>6.4</td>
<td>2.7</td>
<td>.005</td>
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<td>35.4</td>
<td>10.3</td>
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<td>44.4</td>
<td>16.2</td>
<td>25.3</td>
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<td>.001</td>
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<td></td>
<td>Left ear</td>
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<td>3.7</td>
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<td></td>
<td>250 Hz</td>
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<td>14.6</td>
<td>7.4</td>
<td>8.3</td>
<td>2.9</td>
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<td>500 Hz</td>
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<td>12.7</td>
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<td>9.3</td>
<td>3.0</td>
<td>.005</td>
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</tr>
<tr>
<td></td>
<td>1000 Hz</td>
<td>3.5</td>
<td>12.7</td>
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<td>12.1</td>
<td>3.3</td>
<td>.001</td>
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<tr>
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<td>2000 Hz</td>
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<td>13.1</td>
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<td>4000 Hz</td>
<td>10.0</td>
<td>42.1</td>
<td>19.3</td>
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<tr>
<td></td>
<td>6000 Hz</td>
<td>17.6</td>
<td>44.4</td>
<td>21.9</td>
<td>22.0</td>
<td>4.2</td>
<td>.001</td>
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<tr>
<td></td>
<td>8000 Hz</td>
<td>9.6</td>
<td>36.3</td>
<td>16.2</td>
<td>24.3</td>
<td>4.4</td>
<td>.001</td>
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<tr>
<td></td>
<td>W-22 (Clear)*</td>
<td>99.3</td>
<td>99.0</td>
<td>9.9</td>
<td>2.2</td>
<td>6.0</td>
<td>.28</td>
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<tr>
<td></td>
<td>W-22 (Background)*</td>
<td>83.3</td>
<td>79.2</td>
<td>6.5</td>
<td>14.1</td>
<td>1.1</td>
<td>.13</td>
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<tr>
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<td>TMRT (+4 dB)*</td>
<td>87.1</td>
<td>77.3</td>
<td>4.8</td>
<td>2.9</td>
<td>3.0</td>
<td>.01</td>
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<td></td>
<td>TMRT (0 dB)*</td>
<td>78.3</td>
<td>67.0</td>
<td>6.6</td>
<td>4.2</td>
<td>4.2</td>
<td>.001</td>
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<tr>
<td></td>
<td>Digit span (F)</td>
<td>7.7</td>
<td>7.1</td>
<td>8.6</td>
<td>1.2</td>
<td>1.7</td>
<td>.05</td>
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<td>Digit span (B)</td>
<td>5.9</td>
<td>5.7</td>
<td>1.4</td>
<td>1.3</td>
<td>1.3</td>
<td>.4</td>
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<tr>
<td></td>
<td>Dichotic listening**</td>
<td>104.0</td>
<td>97.3</td>
<td>4.6</td>
<td>9.6</td>
<td>2.7</td>
<td>.005</td>
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<td>Reaction time (msec)</td>
<td>572.0</td>
<td>635.0</td>
<td>43.1</td>
<td>90.9</td>
<td>3.0</td>
<td>.001</td>
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</table>

* Percentage correct
** Number correct
EXPERIMENT II

Experiment II consisted of a series of studies to ascertain and improve (through methodological manipulations) the test-retest reliabilities of the test battery elements.

Despite several methodological and procedural manipulations, the highest test-retest reliabilities were attained using the initial test parameters. The investigators discovered, however, that the choice reaction time portion of the ART could be shortened to 50 trials with no loss of sensitivity or reliability.

To date, 57 subjects have performed in the series (with the time between test and retest ranging from 4 h to 3 days) and have provided the reliabilities contained in Table 2. In the opinion of the investigators, these reliabilities are sufficient to continue with the test battery development and probably represent maximal values given the nature of the tests and the subject population (i.e., student naval aviators) from which they were derived.

<table>
<thead>
<tr>
<th>Test</th>
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<td>TMRT (+4 dB)</td>
<td>.88</td>
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<tr>
<td>TMRT (0 dB)</td>
<td>.71</td>
</tr>
<tr>
<td>W-22 (Background)</td>
<td>.72</td>
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<td>Digit span</td>
<td>.73</td>
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<tr>
<td>Reaction time</td>
<td>.84</td>
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<td>Dichotic listening</td>
<td>.78</td>
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<td>Audiogram</td>
<td>.84</td>
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</table>

EXPERIMENT III

The purpose of Experiment III was to investigate the possibility of increasing the face validity of the test battery as well as improve its overall ease of administration and shorten its administration time. These ends were pursued by incorporating several of the critical elements of the original test battery into a simulated flight scenario. Measures of short-term memory, speech perception in noise and with verbal interference, and attention management are represented in the scenario.

The flight scenario was written using current NATOPS procedures and was recorded using the investigators as speakers. The listeners were provided a copy of the script and were instructed to follow the scenario being played over their headphones and to fill in the blanks on the script with the target words they heard. The scenario contained simulated radio-communications mixed with a background of cockpit noise and followed a pattern that included communications with the automatic terminal information service, clearance delivery, ground control, tower, departure control, and approach. In addition, special "test comms" incorporating high and low
probability words (from the Speech Perception In Noise test (38)) and two lists of the TMRT occurred during the "flight." (See Appendix B for a copy of the script and test instructions.)

Although this form of the test battery is still under development, data provided by 48 subjects (student naval aviators) have indicated that the correlations between corresponding elements of the original test battery and the flight scenario form were equal to or greater than .70. These results are sufficiently encouraging to warrant a continuing parallel development of this shortened form of the test battery.

FUTURE RESEARCH

In addition to continuing development of the shortened form of the test battery, major emphasis will be placed on the validation of the test batteries. This is an undertaking of significant proportions given the potential difficulty of identifying objectively quantifiable operational environment performance by which the batteries can be validated. Data potentially suitable for validation are available from several sources including flight school scores of student naval aviators, performance scores on flight simulators, and measures obtained during controlled air combat maneuvering. Several data-gathering visits have been made to VFA-106 at Cecil Field, NAS Jacksonville, an activity that uses videotape recordings and instructors' scores of flights to carefully evaluate pilot performance. At this time, data have been gathered from a total of 25 F-18 pilots at VFA-106. In addition, data have also been gathered from 27 student naval aviators for the purpose of comparison with the experienced F-18 pilots. Finally, aviators referred from the operational environment have been, and will continue to be, administered the test battery to aid in the establishment of a "least acceptable score."
REFERENCES

1. OPNAV Instruction 3710.7H, NATOPS General Flight and Operating Instructions.


RADIOCOMMUNICATIONS QUESTIONNAIRE

Personal Information

Name (optional) ____________________________________________ Rank

Navy Occupational Billet Code ____________ Years in Service ______

Flight Hours (total) __________________________

Type of aircraft presently flying (and to which the answers on this questionnaire refer) ____________________________________________

1. In the course of in-flight operations, about what percentage of radio voice communications are unintelligible to the point where a "repeat" or other action (e.g., change of channel) is required? 

% 

2. Of those unintelligible communications referred to in Question 1, about how frequently are they due to the following causes?

Please place an "X" on the line representing the continuum from "Never" to "Always." For example,

<table>
<thead>
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<tr>
<td>Never</td>
<td>Infrequently</td>
<td>Sometimes</td>
<td>Frequently</td>
<td>Always</td>
</tr>
</tbody>
</table>

a. High level of cockpit noise---

I-------------X-------------I--------------I

Never | Infrequently | Sometimes | Frequently | Always

b. Degradation of signal by atmospheric noise (e.g., static)---

I-------------I--------------I-----I--------------I

Never | Infrequently | Sometimes | Frequently | Always

c. Poor equipment condition (e.g., poor modulation, intermittency of operation, etc.)---

I-------------I--------------I--------------I

Never | Infrequently | Sometimes | Frequently | Always

d. Weak signal (not caused by cockpit or atmospheric noise)---

I-------------I--------------I--------------I

Never | Infrequently | Sometimes | Frequently | Always

e. Interference to the signal by other voices on the channel---

I-------------I--------------I--------------I

Never | Infrequently | Sometimes | Frequently | Always
2. (cont.)

f. Intentional electronic jamming---
   I-------------------I-------------------I-------------------I-------------------I
   Never Infrequently Sometimes Frequently Always

   g. Signal distortion of unknown origin---
      I-------------------I-------------------I-------------------I-------------------I
      Never Infrequently Sometimes Frequently Always

   h. Unclear speech by the talker (e.g., unfamiliar dialect or accent, poor enunciation, etc.)---
      I-------------------I-------------------I-------------------I-------------------I
      Never Infrequently Sometimes Frequently Always

   i. Lack of attention by listener---
      I-------------------I-------------------I-------------------I-------------------I
      Never Infrequently Sometimes Frequently Always

   j. Other (please describe)_____________________________________________________
      ____________________________________________________________
      ____________________________________________________________

3. What do you typically do when a contact is unintelligible?
   ________________________________________________________________
   ________________________________________________________________
   ________________________________________________________________

4. Are there any specific aircraft or radio equipment which you've noticed as being particularly troublesome in the communication of voice signals?
   No_______ Yes_______
   If Yes, which ones?
   ________________________________________________________________
   ________________________________________________________________
   ________________________________________________________________

5. Are there particular flight scenarios where voice communications tend to be difficult?
   No_______ Yes_______
   If Yes, which ones?
   ________________________________________________________________
   ________________________________________________________________
   ________________________________________________________________

   A-2
6. What type of hearing protection do you typically use during flight? (Indicate one or more)

- Standard issue helmet and phones
- Plugs
- Non-standard issue helmet and/or phones (please describe)

7. In your opinion, how should the technical and scientific communities use resources to improve radiocommunications?

- Improve electronic equipment
- Develop operator training/speaking programs
- Other (please explain)

8. Any other comments you might make regarding radio voice communications would be appreciated.

Thank you for your cooperation.
Auditory Performance-Based Test Scenario

This is a recording of simulated radiocommunications between an aircraft (NJ19—Navy Juliet One Niner) and the various control centers it communicates with during a flight.

The tape begins with current weather and aviation data from the Automatic Terminal Information Service (ATIS) and proceeds through the Clearance Delivery, Ground, Tower, and Departure Control centers. Before landing, contact is also made with Approach Control.

Your task in this test will be to read along with the script and fill in the blanks which appear in the script with the word(s) or number(s) which occur on the tape. Besides routine aviation communications, "boded messages" will occur throughout the tape. When you hear a transmission called a "boded message," write down the LAST WORD ONLY of the message in the appropriate blank. Also, once the aircraft is airborne, two "Test Com Series" will be given. The instructions for these appear later in this response package.

Throughout the tape, YOU will be the pilot of Navy Juliet One Niner (although another voice will appear on the tape) and you should pay particular attention to all communications directed to, and sent by, Navy Juliet One Niner.

We thank you for your participation.

If you have any questions, please ask the experimenter now.
ATIS (Automatic Terminal Information Service)

This is Navy Pensacola information ________, recorded nineteen hundred zulu. Field is VFR, ________ scattered, visibility ________. Wind is three ________ at ________, gusting to ________. Altimeter ________. Runway temperature is ________, dew point ________, pressure altitude is ________. Duty runway seven right.

Precision surveillance TACAN approaches and landings are being conducted runway ________; landing and departing runway ________.

Inform ground control tower and Pensacola approach control on initial contact that you have received information ________.

CLEARANCE DELIVERY

NJ19 Clearance Delivery, Navy Juliet One Niner, transient line, IFR, Navy Jacksonville

CLEARANCE Navy Juliet One Niner, Clearance. Will have your clearance shortly. Copy last word of coded messages one through three. Repeat, copy last word only.

Coded Message One ______________________(last word of message)
Coded Message Two ______________________(last word of message)
Coded Message Three ______________________(last word of message)

End of message group

CLEARANCE Navy Juliet One Niner, Clearance. I have your clearance. Are you ready to copy?

NJ19 Navy Juliet One Niner. Ready to copy.
CLEARANCE Navy Juliet One Niner is cleared to Navy Jacksonville as ____. Climb and maintain flight level ________; squawk mode _______; code __________. After departure, maintain _______ heading and _____ feet until _____ DME. Departure control frequency ____________. No readback.


CLEARANCE Navy Juliet One Niner, Clearance. Copy last word of coded messages four through six. Repeat, copy last word only.

Coded Message Four ____________ (last word of message)
Coded Message Five ____________ (last word of message)
Coded Message Six ____________ (last word of message)
End of message group.

GROUND CONTROL

NJ19 Ground, Navy Juliet One Niner, taxi, IFR, Navy Jacksonville, Information ______.

GROUND Navy Juliet One Niner, Ground. Roger, stand by for coded message series.


GROUND Navy Juliet One Niner, Ground. Copy last word of coded messages seven through nine. Repeat, copy last word only.

Coded Message Seven ____________ (last word of message)
Coded Message Eight ____________ (last word of message)
Coded Message Nine ____________ (last word of message)
End of message group.
GROUND
Navy Juliet One Niner, Ground. Taxi runway _______,
alimeter ________; time ____________.

NJ19
Navy Juliet One Niner, altimeter ____________, wilco.

TOWER
NJ19
Tower, Navy Juliet One Niner, take off, IFR.

TOWER
Navy Juliet One Niner, Tower, hold _____, you're number
______.

NJ19
Navy Juliet One Niner, holding ________.

TOWER
Navy Juliet One Niner, Tower. Copy last word of coded
messages ten through twelve. Repeat, copy last word only.

Coded Message Ten ________________ (last word of message)

Coded Message Eleven ________________ (last word of message)

Coded Message Twelve ________________ (last word of message)

End of message group.

TOWER
Navy Juliet One Niner, Tower. Position and hold ________.

NJ19
Navy Juliet One Niner. Position and hold ________.

TOWER
Navy Juliet One Niner, switch to departure control, monitor
______, winds ______ at ______. Cleared for take
off ________.

NJ19
Navy Juliet One Niner, cleared __________, switching.
DEPARTURE CONTROL

NJ19 Departure Control, Navy Juliet One Niner, airborne, feet for flight level __________.

DEPARTURE Navy Juliet One Niner, Radar contact. Prepare for coded message group.


DEPARTURE Navy Juliet One Niner, copy last word of coded messages thirteen through fifteen. Repeat, copy last word only.

Coded Message Thirteen ____________ (last word of message)
Coded Message Fourteen ____________ (last word of message)
Coded Message Fifteen ____________ (last word of message)

End of message group.

DEPARTURE Navy Juliet One Niner. At flight level __________, switch to ____________ for test COM series.

NJ19 Navy Juliet One Niner, approaching flight level __________, switching for test COM series.

***PLEASE TURN TO THE LAST FOUR PAGES OF THIS PACKET FOR TEST COM SERIES***
YOU WILL HAVE 60 SECONDS TO READ THE INSTRUCTIONS
You will return to this point after completing the series

APPROACH

NJ19 Jacksonville Approach, Navy Juliet One Niner, flight level __________.
JAX  Navy Juliet One Niner, Jacksonville Approach, maintain
     ________ flight level to copy coded message group.

NJ19  Navy Juliet One Niner.  Wilco, ready to copy.

JAX  Navy Juliet One Niner, copy coded messages sixteen through
     eighteen.  Copy last word only, repeat, last word only.

     Coded Message Sixteen  ____________ (last word of message)
     Coded Message Seventeen ____________ (last word of message)
     Coded Message Eighteen  ____________ (last word of message)

     End of message group.

JAX  Navy Juliet One Niner, Jacksonville Approach, now say your
     request.

NJ19  Navy Juliet One Niner, request radar vector to precision
     approach to a full stop.

JAX  Navy Juliet One Niner, Approach.  Turn ________, descend and
     maintain _________.  Altimeter _________.

NJ19  Navy Juliet One Niner, left ________, leaving flight
     level _________.  Altimeter _________.

JAX  Navy Juliet One Niner, Approach.  During descent, copy coded
     messages nineteen through twenty-one.  Copy last word only.

     Coded Message Nineteen  ____________ (last word of message)
     Coded Message Twenty    ____________ (last word of message)
     Coded Message Twenty-one ____________ (last word of message)

     End of message group.
JAX Navy Juliet One Niner. Approach. This will be precision approach to runway _______.

JAX Navy Juliet One Niner. If no transmissions received for one minute in pattern or ________ on final, execute the final portion of a TACAN Niner approach. Your missed approach instructions are to climb to ________ feet on the ________ degree radial and await further instructions.


JAX Navy Juliet One Niner, left ________, maintain ________ feet.

NJ19 Navy Juliet One Niner, left ________, Wilco.

JAX Navy Juliet One Niner, perform landing checks.

JAX Navy Juliet One Niner, turn left ________, maintain ________.

JAX Navy Juliet One Niner, this is your final GCA controller. Report gear down and locked on final. Do not acknowledge further transmissions.


JAX Navy Juliet One Niner, approaching glideslope, begin descent.

JAX Navy Juliet One Niner, drifting _______ of course, turn ______ heading ________, going slightly below glideslope.

JAX Navy Juliet One Niner, on glideslope, on course.

JAX Navy Juliet One Niner is at _______ height.

JAX Navy Juliet One Niner, over landing threshold, _______ straight ahead. Switch to ground control when clear of runway.

***THIS COMPLETES THE TEST SESSION***
Instructions for Test Corn "A"

In Test Corn "A" you will hear a speaker say a number (that's the trial number), then he'll say,

"Do you read...."

followed by three words--

(word #1)

(word #2)

(word #3)

and he'll close with,

"Over."

The first of the three words will be one of the six in the top of the trial block on your response form, the second word will be one of the six in the middle rectangle, and the third will be one of the six in the bottom rectangle.

For example,

Speaker

"One. Do you read

RENT
DUG
PUFF

Over."

You would respond by circling the correct words--

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<tr>
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<th>RENT</th>
<th>BENT</th>
<th>TENT</th>
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<tbody>
<tr>
<td>DUN</td>
<td>DUB</td>
<td>DUG</td>
<td></td>
</tr>
<tr>
<td>DUCK</td>
<td>DUD</td>
<td>DUNG</td>
<td></td>
</tr>
<tr>
<td>PUP</td>
<td>PUS</td>
<td>PUFF</td>
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</tr>
<tr>
<td>PUCK</td>
<td>PUN</td>
<td>PUB</td>
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</tbody>
</table>

Notice that the words are very similar in sound, so listen carefully. Guess if you are unsure. Also, the words are presented somewhat quickly.
CUFF CUS S CUB CUD
PAVE PALE PAY PANE PACE
DID DIN DIG DILL

BEACH BEAD BEAK BEAN
WIG PIG RIG FIG BIG DIG
SAP SAG SAD SASS SACK SAT

KEEL FEEL PEEL REEL
GALE PALE SALE BA ALE
SIN WIN FIN DIN TIN PIN

DUN DUG DUB DUNG
TICK WICK PICK LICK SICK
BILL FILL TILL WILL HILL KILL

LAME LANE LACE LAY
TEST WEST REST VEST
MAY GAY PAY DAY SAY WAY

HELL SILL SIT SIP SING SICK
HEN TEN THEN DEN MEN PEN
SOIL TOIL OIL FOIL BOIL

TANG TAM TACK TAN
TAM TAP TACK TAN
BUS DUCK BUT BUG
RENT WENT TENT BENT DENT SENT

NAME FAME TAME GAME SAME
PAD PASS PATH PACK PAN PAT
LED SHED RED FED BED

MEAT FEAT HEAT NEAT BEAT SEAT
PARK MARK HARK DARK LARK BARK
PEAS PEAL PEACH PEAT PEAK PEACE

COOK BOOK HOOK SHOOK LOOK TOOK
SAFE SAVE SAEK SALE SANE SAME
POP SHOP HOP COP TOP MOP

FIZZ FILL FID FIN FIT FIG
BAN BACK BAT BAD BASS BATH
GOLD HOLD SOLD TOLD FOLD COLD

WING FING LING DING HING MING RING
SING ING LING DING HING MING RING

DUN DUG DUB DUNG
TICK WICK PICK LICK SICK
BILL FILL TILL WILL HILL KILL

TANG TAM TACK TAN
BUS DUCK BUT BUG
RENT WENT TENT BENT DENT SENT

NAME FAME TAME GAME SAME
PAD PASS PATH PACK PAN PAT
LED SHED RED FED BED

SUN NUN GUN RAN RUN BUN FUN
BIT SIT HIT WIT FIT KIT
SUB SUD SUP SUNG SUM

HEAL HEAP HEATH HEAVE HEAR HEAT
PAW JAW SAW LAW RAW
LOT NOT HOT POT TOT

KIT KICK KIN KILL KING
CAME CAPE CASE CAVE CAKE
PILL PICK PIP PIT PIN PIG

SEEN SEED SEEK SEEM SEETHE SEEP
SIP LIP RIP TIP HEP HIP DIP
GANG HANG FANG BANG RANG SANG

TEASE TEAK TEAR TEAL TEACH TEAM
PUB PUS PUCK PUN PUFF PUP
HOT GUT NOT POT TOT LOT

REAL
HEAP HEATH HEAVE HEAR HEAT
PAW JAW SAW LAW RAW
LOT NOT HOT POT TOT
Instructions for Test Com "B"

Test Com "B" is identical to Test Com "A" with the exception that instead of just noise in the background, you will hear other voices. Do your best to ignore these voices and concentrate on the target words.
Other Related NAMRL Publications*


Thomas, G.B. and Williams, C.E., Noise Susceptibility: A Comparison of Two Naval Aviator Populations, NAMRL-1320, Naval Aerospace Medical Research Laboratory, Pensacola, FL, June 1986. (AD A172 222)

*Publications with AD numbers are available from DTIC, Cameron Station, Alexandria, VA 22314 (Phone: (C) 202/274-7633 or (AV) 284-7633). Use the AD number when requesting reports from DTIC. Publications without AD numbers may be requested from the NAMRL author or Code 00A4, NAMRL, Bldg. 1953, NAS, Pensacola, FL 32508-5700.