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

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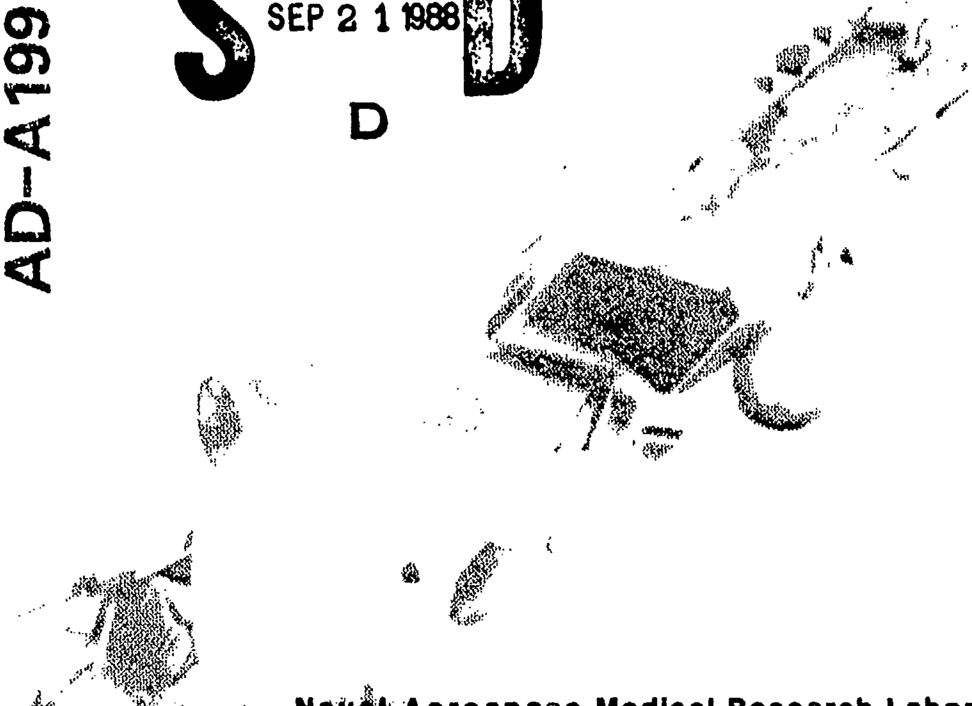

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A series of studies was undertaken to develop a performance-based test battery to ascertain the auditory fitness of naval aviators. On the basis of literature reviews, interviews with experienced pilots, and published job analyses, several auditory 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.

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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.

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INTRODUCTION

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 radiocommunications 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 (60%) 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 NAMRL 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 Wechscler Adult Intelligence Scale protocol, and the DLT was presented using a Uher Model 4200 two-channel, reel-to-reel recorder and Sennheiser TD-400 headphones. The ART test was manually administered using a Gerbrands G1360 reaction time controller and G1271 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 "3" 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.

TEST	Younger Group n = 24 M	Younger Group n = 24 SD	Older Group n = 24 M	Older Group n = 24 SD	t	p
Pure-tone threshold (dB)						
Right ear						
125 Hz	9.1	7.2	16.0	6.6	3.4	.001
250 Hz	7.6	5.6	12.9	6.6	2.9	.002
500 Hz	5.0	5.0	9.5	6.4	2.7	.005
1000 Hz	2.8	6.7	10.4	12.8	2.5	.007
2000 Hz	0.0	7.2	16.0	18.1	3.9	.001
3000 Hz	5.2	10.3	35.4	21.4	6.1	.001
4000 Hz	7.0	19.5	41.5	22.4	5.6	.001
6000 Hz	15.4	18.8	44.8	21.2	5.0	.001
8000 Hz	8.5	16.2	44.4	25.3	5.8	.001
Left ear						
125 Hz	10.8	5.3	18.1	8.2	3.7	.001
250 Hz	7.8	7.4	14.6	8.3	2.9	.003
500 Hz	5.7	6.5	12.7	9.3	3.0	.003
1000 Hz	3.5	6.3	12.7	12.1	3.3	.001
2000 Hz	3.3	6.0	13.1	17.2	2.6	.006
3000 Hz	5.9	8.6	35.2	22.6	5.8	.001
4000 Hz	10.0	19.3	42.1	22.2	5.3	.001
6000 Hz	17.6	21.9	44.4	22.0	4.2	.001
8000 Hz	9.6	16.2	36.3	24.3	4.4	.001
W-22 (Clear)*	99.3	.9	99.0	2.2	.6	.28
W-22 (Background)*	83.3	6.5	79.2	14.1	1.1	.13
TMRT (+4 dB)*	87.1	4.8	77.3	2.9	3.0	.01
TMRT (0 dB)*	78.3	6.6	67.0	4.2	4.2	.001
Digit span (F)	7.7	.8	7.1	1.2	1.7	.05
Digit span (B)	5.9	1.4	5.7	1.3	.3	.4
Dichotic listening**	104.0	4.6	97.3	9.6	2.7	.005
Reaction time (msec)						
tone	572.0	43.1	635.0	90.9	3.0	.001

* 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 ject population (i.e., student naval aviators) from which they were der

TABL .. Test-Retest Reliabilities of Battery Elements.

Test	r
TMRT (+4 dB)	.88
TMRT (0 dB)	.71
W-22 (Background)	.72
Digit span	.73
Reaction time	.84
Dichotic listening	.78
Audiogram	.84

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."

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APPENDIX A

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,

```
I----------------I----X---------I--------------I--------------I
0%              25%            50%            75%           100%
Never      Infrequently    Sometimes     Frequently       Always
```

   a. High level of cockpit noise---

```
I----------------I--------------I--------------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--------------I
Never      Infrequently    Sometimes     Frequently       Always
```

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

```
I----------------I--------------I--------------I--------------I
Never      Infrequently    Sometimes     Frequently       Always
```

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

```
I----------------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?______________________________

____

____

____

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.

APPENDIX B

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, "coded messages" will occur throughout the tape. When you hear a transmission called a "coded 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.

NJ19 Navy Juliet One Niner. Roger, 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.

NJ19 Navy Juliet One Niner, Roger. Standing by.

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 ________, altimeter ___________; 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.

NJ19 Navy Juliet One Niner. Ready 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 _______________ for _____________. 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.
NJ19	Navy Juliet One Niner. Wilco.
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 you final GCA controller. Report gear down and locked on final. Do not acknowledge further transmissions.
NJ19	Navy Juliet One Niner. Gear down and locked.
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 Com "A"

In Test Com "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--

1

(RENT) SENT	BENT WENT	TENT DENT
DUN DUCK	DUB DUD	(DUG) DUNG
PUP PUCK	PUS PUN	(PUFF) PUB

Notice that the words are very similar in sound, so listen carefully. Guess if you are unsure. Also, the words are presented somewhat quickly.

1

CUFF	CUSS	CUB
CUP	CUT	CUD
PAVE	PALE	PAY
PAGE	PANE	PACE
DID	DIN	DIP
DIM	DIG	DILL

2

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

3

TANG	TAB	TACK
TAM	TAP	TAN
BUS	BUFF	BUG
BUCK	BUT	BUN
RENT	WENT	TENT
BENT	DENT	SENT

4

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

5

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

6

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

7

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

8

LAME	LANE	LACE
LATE	LAKE	LAY
TEST	NEST	BEST
WEST	REST	VEST
MAY	GAY	PAY
DAY	SAY	WAY

9

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

10

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

11

BUST	JUST	RUST
DUST	GUST	MUST
RACE	RAY	RAKE
RATE	RAVE	RAZE
MAP	MAT	MATH
MAD	MASS	MAN

12

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

13

KEEL	FEEL	PEEL
REEL	HEEL	EEL
GALE	MALE	TALE
PALE	SALE	BALE
SIN	WIN	FIN
DIN	TIN	PIN

14

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

15

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

16

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

17

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

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.

1

REST	NEST	VEST
BEST	TEST	WEST
RAY	RAVE	RAKE
RAZE	RATE	RACE
TIN	WIN	PIN
FIN	SIN	DIN

2

OIL	BOIL	SOIL
FOIL	TOIL	COIL
KEEL	REEL	HEEL
FEEL	PEEL	EEL
BASS	BAD	BACK
BAT	BATH	BAN

3

GUST	JUST	MUST
RUST	BUST	DUST
PEACE	PEACH	PEAT
PEAS	PEAK	PEAL
HANG	RANG	FANG
SANG	BANG	GANG

4

HEN	DEN	MEN
TEN	THEN	PEN
FIT	SIT	KIT
HIT	BIT	WIT
HOP	MOP	POP
COP	SHOP	TOP

5

HARK	BARK	PARK
DARK	MARK	LARK
SUNG	SUD	SUM
SUP	SUN	SUB
BEAN	BEAK	BEAD
BEACH	BEAT	BEAM

6

SAY	GAY	WAY
PAY	MAY	DAY
TEAR	TEAM	TEASE
TEAL	TEAK	TEACH
CUB	CUFF	CUD
CUP	CUSS	CUT

7

HEATH	HEAL	HEAVE
HEAR	HEAP	HEAT
KILL	TILL	WILL
FILL	HILL	BILL
SEETHE	SEED	SEEP
SEEK	SEEN	SEEM

8

FED	SHED	BED
RED	LED	WED
CAVE	CAPE	CAKE
CANE	CAME	CASE
GOLD	COLD	SOLD
HOLD	TOLD	FOLD

9

PICK	SICK	TICK
KICK	WICK	LICK
DIP	DILL	DID
DIM	DIN	DIG
FEAT	BEAT	HEAT
SEAT	NEAT	MEAT

10

SIT	SICK	SIN
SIP	SILL	SING
POT	GOT	NOT
LOT	TOT	HOT
FIG	FIN	FIZZ
FILL	FIT	FIB

11

SAP	SASS	SACK
SAG	SAD	SAT
RENT	BENT	TENT
SENT	WENT	DENT
RIP	HIP	TIP
DIP	LIP	SIP

12

MATH	MAN	MAP
MAD	MAT	MASS
JAW	THAW	LAW
SAW	PAW	RAW
GAME	FAME	SAME
TAME	NAME	CAME

13

COOK	SHOOK	LOOK
BOOK	HOOK	TOOK
SAFE	SALE	SANE
SAVE	SAKE	SAME
KIT	KID	KILL
KICK	KIN	KING

14

PUP	PUS	PUFF
PUCK	PUN	PUB
MALE	SALE	TALE
BALE	PALE	GALE
PAN	PASS	PAT
PATH	PAD	PACK

15

TAP	TAB	TAN
TACK	TANG	TAM
DUN	DUB	DUG
DUCK	DUD	DUNG
BUN	NUN	FUN
GUN	SUN	RUN

16

PAY	PACE	PAVE
PAGE	PALE	PANE
PIN	PICK	PIG
PIP	PILL	PIT
LACE	LAY	LAME
LATE	LANE	LAKE

17

BIG	RIG	DIG
FIG	WIG	PIG
BUT	BUFF	BUN
BUG	BUS	BUCK
BIT	WIT	HIT
KIT	SIT	FIT

Other Related NAMRL Publications*

Thomas, G.B., Williams, C.E., and Hoger, N.W., "Some Non-auditory Correlates of the Hearing Threshold Levels of an Aviation Noise-exposed Population." Aviation, Space, and Environmental Medicine, Vol. 52, pp. 531-536, 1981.

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)

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