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

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19. ABSTRACT (Continue on reverse if necessary and identify by block number) 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 (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 RAll5A 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 RAll5A 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 Wechsler 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 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 "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 <u>n</u> = 24		Older Group <u>n</u> = 24		<u>t</u>	<u>p</u>
	<u>M</u>	<u>SD</u>	<u>M</u>	<u>SD</u>		
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	.002
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 subject population (i.e., student naval aviators) from which they were derived.

TABLE 2. Test-Retest Reliabilities of Battery Elements.

<u>Test</u>	<u>r</u>
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 TMRP 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

<u>RENT</u> SENT	BENT WENT	TENT DENT
DUN DUCK	DUB DUD	<u>DUG</u> DUNG
PUP PUCK	PUS PUN	<u>PUFF</u> 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

7

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

13

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

2

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

8

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

14

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

3

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

9

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

15

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

4

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

10

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

16

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

5

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

11

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

17

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

6

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

12

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

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

7

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

13

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

2

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

8

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

14

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

3

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

9

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

15

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

4

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

10

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

16

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

5

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

11

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

17

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

6

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

12

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

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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