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15. Supplementary Notes This research was conducted under Tasks AM-A-73-PSY-33, AM-D-74-PSY-33, and AM-D-75-PSY-33.					
16. Abstract A brief, voluntary questionnaire was administered to 1,115 Aviation Medical Examiners (AME) to assess the frequency with which vestibular tests (broadly defined) were given during physical examinations of pilots, which tests were used, why they were used, whether AMEs believed that specific tests should be routine, and why they believed so. Responses were obtained from 55 percent of the AMEs (many not responding were new AMEs with no experience). Of the respondents, 58 percent routinely gave tests of balance, equilibrium, or vestibular functioning, 24 percent gave the tests under certain conditions, and 18 percent gave no tests. The Romberg and finger-pointing tests were the most frequently used and were employed most often for screening purposes or to identify a problem area. Seventy-five percent of the AMEs indicated that specific tests should be routine; the test most frequently recommended was the Romberg. The authors expressed the views that (a) any introduction of specific tests of vestibular function or equilibrium should be based in the overall medical value of the tests (not in an effort to significantly reduce disorientation-related general aviation fatalities by seeking to identify the disorientation prone, since most such accidents appear to be related to normal functioning of the vestibular system), (b) the tests should be simple, and (c) relatively brief modifications of the FAA Office of Aviation Medicine's "Guide for Aviation Medical Examiners" could be the vehicle for describing specific procedures and for generally improving standardization of the physical examination. Some possible modifications were proposed.					
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**THE USE OF VESTIBULAR TESTS IN CIVIL AVIATION MEDICAL
EXAMINATIONS: SURVEY OF PRACTICES AND PROPOSALS
BY AVIATION MEDICAL EXAMINERS**

I. Introduction.

The most recent annual review of aircraft accident data (1972) attributes over 15 percent of 681 fatal general aviation accidents to spatial disorientation.¹ Aviation Medical Examiners (AME) are aware of the importance of the vestibular system in the genesis of disorientation problems in flight, and, although there is no medical requirement for a specified test of vestibular function or spatial orientation in the certification of either general aviation or commercial pilots, many AMEs conduct such tests during flight physicals in completing the neurologic portion of the medical examination. Since vestibular involvement is traditionally associated with disorientation problems in aviation^{2,3} and since a substantial number of fatal accidents are attributed to this cause, the question of whether a specific vestibular test requirement is needed in pilot physicals has been posed intermittently in aviation medical circles. Thus, it seemed reasonable to assess in a uniform way the perceived needs for medical testing of vestibular function, the perceived value of existing tests, and the climate for possible introduction of a specific test requirement. The present survey, then, was undertaken to determine the extent to which vestibular testing (broadly defined) is done by AMEs, which tests are used, which tests are most highly recommended, what significance is attached to the tests, what actions are taken if tests are failed, and whether the AMEs believe specific tests should be given routinely.

II. Method.

A brief questionnaire was devised requesting one or more responses to four major items:

(1) In giving physical exams to pilots, do you *routinely* give any test of balance, equilibrium, or vestibular function?

(NOTE: None is specified on the FAA examination form.)

___Yes ___No

(2) If the answer to the above is "No":

(a) In giving physical exams to pilots, do you *ever* give any tests of balance, equilibrium, or vestibular function?

___Yes ___No

(b) If "Yes," under what conditions?

(3) If the answer to either of the above questions is "Yes":

(a) What tests do you give?

(b) What significance do you attach to these tests?

(c) What action do you take if a pilot performs poorly on these tests?

(4) Do you think tests of balance, equilibrium, or vestibular function should be given routinely in evaluating suitability for flying status? ___Yes ___No

If "Yes," which ones and why? If "No," why not?

The subject pool comprised a total of 1,115 AMEs who attended FAA-sponsored AME seminars during 1972-1974 in Chicago, New Orleans, Oklahoma City, San Francisco, and Washington, D.C. Responses to the voluntary questionnaire were elicited from 618 of the attendees, or approximately 55 percent (see Table 1). (Many not responding were new AMEs with no experience.) Respondee were divided by specialty

TABLE 1. The Number of Physicians, by Specialty, Who Responded to the AME Questionnaire at Each of Six AME Seminars

Medical Specialties	AME Seminars						Total (1,115)
	Chicago I (221 attendees)	Chicago II (132 attendees)	New Orleans (197 attendees)	Oklahoma City (89 attendees)	San Francisco (301 attendees)	Washington, D.C. (175 attendees)	
General Practice	75	52	61	44	71	46	349
Internal Medicine	12	9	14	7	29	16	87
Surgery	12	7	8	11	15	9	62
Miscellaneous	9	5	6	7	9	16	52
Otology	5	0	2	5	3	6	21
Ophthalmology	2	4	4	3	2	3	18
Aerospace Medicine	0	4	2	3	3	2	14
Industrial Medicine	4	2	0	0	1	2	9
Neurology-Psychiatry	0	1	0	0	3	2	6
Number Responding	119	84	97	80	136	102	618
% Responding	53.9%	63.6%	49.2%	89.9%	45.2%	58.3%	55.4%

into nine categories (Table 1), with the following number of responding physicians in each category: general practice, 349; internal medicine, 87; general surgery, 62; otolaryngology, 21; ophthalmology, 18; aviation medicine, 14; industrial medicine, 9; psychiatry, 6; and miscellaneous, 52.

The straightforward "Yes-No" answers to the questionnaire were tallied by specialties. The responses to open-ended questions were examined by two raters; empirical categories were established and each response was assigned to the most suitable category.

III. Results.

A. *Who Gives Tests?* Of the 618 AMEs responding, approximately 58 percent reported that they gave tests of balance, equilibrium, or vestibular functioning routinely during physical examinations of pilots, 24 percent reported that they administered the tests under certain conditions (yielding a total of 82 percent who gave tests on some if not all occasions), while 18 percent reported that they never gave such tests (see Table 2). Statistical analyses, by physicians' specialties, yielded a significant overall X^2 (16.604, $p < .05$) between the proportions of physicians who never gave tests and the proportions of those who gave tests routinely or under certain conditions, thereby demonstrating a significant relationship between responses and

specialties. Individual chi square tests were performed between all possible pairings of these proportions by physician categories. It was found that the responses of the physicians specializing in internal medicine differed significantly from those of general practitioners and surgeons ($p < .05$) and from those of ophthalmologists and otolaryngologists ($p < .01$). In addition, the responses of physicians specializing in aviation medicine differed significantly from those of surgeons, ophthalmologists, and otolaryngologists ($p < .05$). These differences can be interpreted to show that, in general, specialists in internal medicine and aviation medicine tend to give vestibular tests more often than most physicians in other specialties.

Those physicians who reported they did not give tests routinely but did give them under certain conditions were asked to define those conditions. An overwhelming majority of the 146 physicians responding to this question reported they performed some sort of specific vestibular test or tests if their suspicions were aroused in observing the patient (e.g., unusual gait) or if the patient's past history (e.g., dizzy spells) indicated a need for further testing. A few others responded that their use of the tests depended on the patient's age at the time of exam, if the patient had any specific complaints, or if he was applying for a certificate for the first time.

TABLE 2. Summary, by Medical Specialty, of AMEs Who Give Vestibular Tests Routinely,
Under Special Conditions, or Not At All

Item		Medical Specialties									TOTAL
		GP	IM	SURG	MISC	OTO	OPHTH	AM	IND	NEURO/ PSY	
Give tests routinely	N	209	55	29	31	10	5	13	4	4	360
	%	59.9	63.2	46.8	59.6	47.6	27.8	92.9	50.0	66.7	58.3
Give tests under certain conditions	N	73	24	19	12	4	7	1	4	2	146
	%	<u>20.9</u>	<u>27.6</u>	<u>30.6</u>	<u>23.1</u>	<u>19.0</u>	<u>38.9</u>	<u>7.1</u>	<u>44.4</u>	<u>33.3</u>	<u>23.6</u>
Total who give tests routinely or under certain conditions	N	282	79	48	43	14	12	14	8	6	506
	%	80.8	90.8	77.4	82.7	66.7	66.7	100.0	88.9	100.0	81.9
Never give tests	N	67	8	14	9	7	6	---	1	---	112
	%	19.2	9.2	22.6	17.3	33.3	33.3	---	11.1	---	18.1

B. *Which Tests Are Used?* In identifying the tests that they used, 70 percent of the 506 AMEs who gave tests some or all of the time responded with more than one answer. The test cited most often (by 81 percent of those who gave tests) was the Romberg (standing upright with feet together and eyes closed), which was identified by either name or description. Tests involving finger-pointing were named by 36 percent of the respondents, and two-thirds of them specifically listed the finger-to-nose test. General tests, such as observation of gait and equilibrium, and agility of movements, were listed by 16 percent of the physicians. Tests for spontaneous nystagmus were mentioned by 16 percent of the physicians, and an additional 5 percent of the responses cited some other sort of observation of eye movements, such as the corneal reflex. Other tests listed were standing on one leg with eyes closed (12 percent), heel-to-toe walking (8 percent), and caloric irrigation (8 percent). Named less frequently were neurologic and central nervous system exams, tests involving quick changes of position and turning, and tests assessing arm and leg coordination.

C. *Perceived Significance of Tests.* The individual answers given by the AMEs concerning the significance they attached to the tests they gave were examined and divided into broad categories. Approximately 25 percent responded that the tests were used basically for screening purposes to identify a need for more extensive testing or consultation. About 19 percent believed that the tests' significance was to identify neurologic and/or vestibular problems. Fourteen percent of the AMEs simply stated that the tests were very important and they placed much significance on the results; 7 percent said the tests were of little or no significance. Eight percent of the responses were noncommittal answers, such as "depends on results," "suggestive," etc. Other diverse responses were noted.

Since specific vestibular or equilibrium tests and procedures are not specified in examining pilots, it was of interest to note that if a pilot applicant performed poorly on the tests, 26 percent of the AMEs indicated they referred the pilot to an otologist or neurologist for further evaluation, 14 percent forwarded the results to the FAA, and 13 percent conducted further tests

themselves (particularly neurologic). Ten percent specifically noted that it had never happened that an applicant performed poorly (not once in 9,000 exams, according to one general practitioner with 15 years of AME experience). Only 2 percent admitted that they had failed a pilot who had performed poorly, and only 1 percent said that they had passed a pilot in spite of his poor performance. Other response statistics can be summarized as follows: 18 percent did not respond to the question since they reported they did not administer any tests, 9 percent gave various combinations of the responses noted above, 4 percent left the question blank, and 3 percent responded that they repeated the test, advised the applicant, or made some sort of judgment on the applicant's abilities.

D. *Should Tests Be Routine?* The final question asked if the physicians thought tests of balance, equilibrium, or vestibular function should be given routinely in evaluating suitability for flying status. Of the respondents, 75 percent thought that tests should be given routinely and 25 percent said they did not believe in routine tests. While statistical analyses, by medical specialties, yielded a nonsignificant overall X^2 value between the proportions of physicians who believed in giving tests and those who did not, a few of the individual paired comparisons showed some interesting relationships. The responses of the general practitioners were significantly different from those of the surgeons ($p < .05$), ophthalmologists ($p < .05$), and otolaryngologists ($p < .01$). While about 77 percent of the general practitioners believed that tests should be given routinely, it is of interest to note that only 52 percent of the otolaryngologists recommended routine tests, the lowest percentage of all the specialties.

In comparing answers to question 1 and question 4, some discrepancies appeared to exist between what is actually done by the physicians and what they recommended. Fifteen percent of all the respondents who do not routinely give vestibular tests stated that tests should be given routinely. A small percentage (less than 4 percent) did not believe that tests should be routine but did administer tests routinely.

Of those who believed that tests should be routine, almost half (49 percent) recommended the Romberg test (by name or description). Nineteen percent listed tests involving finger-pointing, 12 percent mentioned tests involving eye movements, and 11 percent cited tests of balancing on one leg. Many listed more than one test to be given routinely. Other tests mentioned, but not so frequently, were observation of gait, heel-to-toe walking, caloric irrigation, quick position changes, leg and hand coordination, turning, and several others including tests using tuning forks.

The AMEs who recommended specific routine vestibular tests were also asked why they recommended the tests, and the AMEs who indicated that they did not believe in routine tests were asked to explain why they did not recommend them. Of those who recommended that specific vestibular tests be given routinely, 58 percent gave no further explanation (possibly feeling that their response to a previous question provided adequate reason), 18 percent recommended using tests routinely in order to identify abnormalities, 10 percent stated that if tests were given routinely they should be kept simple and short (such as the Romberg), 5 percent indicated that passing the tests was necessary for safety in flight, and 9 percent gave a variety of other responses.

Of the AMEs who did not think tests should be given routinely, 28 percent did not give any reasons, 23 percent responded that none of the tests with which they were familiar seemed adequate, 15 percent believed that tests should be given only if a specific problem was noted that would require further investigation, 16 percent believed the tests were unnecessary because abnormalities would probably be discovered either during other parts of the physical exam (e.g., history-taking) or by the flight examiner, and 7 percent responded that although the tests might be worthwhile, they would take up too much time and, therefore, were not practical; the remaining 11 percent of responses were classified as miscellaneous.

About 10 percent of the AMEs had ambivalent feelings about giving vestibular tests routinely. Although these physicians did not give a "Yes" or "No" response to the item suggesting routine tests, they commented that they were unsure of the practical application of available tests to flying and did not believe that vestibular tests would lead to any significant information.

IV. Discussion.

These results indicate that a majority of AMEs routinely perform some type of vestibular test (broadly defined) primarily to assess the possibility of a need for further medical evaluation. Other AMEs conduct specific tests in special circumstances; i.e., if the examinee's history or his performance on another part of the physical exam suggests some vestibular involvement. Most often the Romberg test is used.

A clear majority of the AMEs (75 percent) would be receptive to a requirement for specific vestibular tests. Based both on the tests most frequently used in the absence of such a requirement and on some of the physicians' comments, it is apparent that any required tests must be kept simple. However, only a bare majority of the AMEs with specialties in otolaryngology were in favor of routine testing. Many of those who did not favor formal test requirements emphasized the usefulness of a carefully obtained history and felt that tests not already routine should be given only if warranted by the history.

It is perhaps surprising at first that specific tests (such as the Romberg) are not routinely performed by all AMEs in completing the neurologic part of the medical examination (item 46 on FAA Form 8500-8). The reason for this omission may well relate to the procedures and material presented in the FAA Office of Aviation Medicine's "Guide for Aviation Medical Examiners." For example, the listed neurologic conditions for which medical certificates will be denied or deferred are all of a type that is ascertained in history-taking (e.g., epilepsy, brain surgery, unexplained disturbance of consciousness, etc.); most other conditions for denial or deferral serve to specify some observation (or test) by the medical examiner (e.g., perforation of eardrum, pulse rate, cardiac arrhythmia,

anemia, emphysema, nonreactive pupils, sinus tumors, etc.) Moreover, the guide does not specify examination procedures for neurologic (or vestibular) testing, although it gives detailed procedures for other examinations (such as eye and ear). Thus, many AMEs may feel that they have complied with item 46 on the examination form by a careful history-taking covering those specified conditions which would result in denial or deferral, or perhaps by a general observational impression of the applicant.

V. Conclusions.

Although disorientation is a significant cause of fatal accidents in general aviation, it is clear that most of its manifestations are due (a) to the normal, rather than abnormal, functioning of the vestibular system in motion environments and (b) to a lack of visual information about objects fixed relative to Earth.²⁴ While clearly unhealthy vestibular or equilibrium systems could conceivably increase the likelihood or severity of disruptive (and dangerous) orientation experiences in flight, the majority of orientation-related incidents and fatal accidents in general aviation are probably attributable to normal vestibular functioning coupled with inadequate instrument flying skills and questionable judgment about safe flying conditions.

Thus, in periodic reevaluations of FAA medical standards for pilots, any hypothesized need for a vestibular (or spatial orientation) test requirement should probably reflect the particular usefulness of that test as an indicator of medical disorders of significance to the health, well-being, and performance capabilities of the examinee rather than as an indicator of, say, "disorientation proneness." In this regard, it would be entirely feasible to introduce orientation test requirements and improve the uniformity and completeness of aviation medical examinations by simply modifying the "Guide for Aviation Medical Examiners." Modifications could be added to both the "Eyes, General" and the "Neurologic" portions of the examination (items 31 and 46 on FAA Form 8500-8). Since the tests specified should be simple and should not result in many "false positives," the Romberg (standing with feet together, eyes closed, and arms folded) or perhaps the sharpened Romberg

(standing heel-to-toe with eyes closed and arms folded: sometimes referred to as Mann's test⁵) would seem to be an adequate, if minimal, choice (both are uniformly noted in clinical texts^{5 6}) and would be readily accepted by AMEs; either test could be specified as a recommended part of the neurologic portion of the examination. In combination with an expanded description of existing visual requirements on the airman's medical exam (i.e., examinations for the presence of spontaneous nystagmus, to include fixation to the right, to the left, upward, and downward as well as in the primary position^{6 7}), the Romberg or sharpened Romberg could formally provide general information regarding orientation function and improve the uniformity of required examination procedures. If a more definitive test is desired (and is in keeping with practical needs for a test that is simple and brief and

can be readily performed in the AME's office), an examination for nystagmus following head movements would probably represent an appropriate selection; this test has been cited as one of the best single indicators of a disturbance in the vestibular system,⁸ but some expertise probably would be required for proper administration and interpretation. Positive findings on any of these tests should be used only to suggest more in-depth testing. Moreover, if the above suggestions (or other alternatives) are ever implemented, they should be recommended in a context that would neither deemphasize the importance of obtaining a good history in regard to spatial orientation nor discourage practitioners from using supplementary (but not required) tests of orientation that they feel provide useful information to them in the practice of the medical arts.

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