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SUMMARY PAGE

THE PROBLEM

How well do ataxia test scores that fall at the lowest 5 per cent of the normative distributions predict threshold caloric responses also falling in the same range, and, conversely, how well do the caloric responses predict the ataxia test scores in various groups of individuals?

FINDINGS

Most of the individuals with labyrinthine defects severe enough to produce ataxia test performances scores within the lowest 5 per cent of the normal distributions also showed threshold caloric test responses which fell within the same range. Similarly, almost as many individuals with decreased threshold caloric test responses also showed poor ataxia test performance scores. In those individuals with total or near total bilateral loss of labyrinthine function each test was the maximum, or nearly maximum, predictor of the other.

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INTRODUCTION

As part of our study of the problems of man's gravitoinertial force environment in space flight, particular attention has been given to testing the vestibular organs to determine their role in man's ability to withstand such an environment. A threshold caloric test (8) and an ataxia test battery (1,5) were introduced recently as part of the testing procedure at this laboratory. They serve as rapid, reliable screening tests for selecting individuals without known labyrinthine defects from those who have such defects, and provide a means for comprehensively studying their vestibular apparatus.

Slight, even moderate, degrees of vestibular ataxia may go unrecognized in persons who either do not challenge their capabilities in this regard or misinterpret their handicap as poor "athletic ability." Moreover, ataxia as well as a loss of semicircular canal function may go undetected during routine medical evaluations because of insufficiently precise measurements. Our findings with the threshold caloric test and the quantitative ataxia test battery have led us to suspect abnormal scores on both if either one is abnormal. The purpose of this report is to demonstrate their diagnostic value independently and jointly, based on an analysis of the scores obtained on 365 individuals classified either as normal subjects or as persons with various diseases and disorders of the inner ear.

PROCEDURE

SUBJECTS

The "vestibular normal" group consisted of 240 men, in the age range of 17 to 63 years, who had been tested by the threshold caloric and by the ataxia test battery. The group included student military aviators, volunteer Navy enlisted research subjects, medical students, Navy deep sea divers, individuals with varied experience on centrifuges, and military and civilian technical and scientific personnel. All were in good health and free of any known vestibular disturbance, and had had benefit of recent medical and audiometric evaluations.

The group of patients with vertigo included men and women (N=76), with an age range of 18 to 71 years, who were referred from military and civilian physicians because of vertigo as a major symptom or complaint. The great majority of these referrals presented a diagnostic problem; some had received a tentative diagnosis, while the symptoms of others could not be diagnosed. Diagnoses of the remaining few individuals represented the following classifications: vestibular neuronitis, typical and atypical Ménière's syndrome, postural vertigo, positional nystagmus, labyrinthine artery occlusion, post-traumatic pseudobulbar palsy, acoustic trauma, longstanding deafness, orthostatic lightheadedness, cerebral vascular insufficiency, and psychogenic disorder. The health and physical status of these patients were adequate for undergoing testing.

The group of bilateral labyrinthine-defective (BL-D) subjects consisted of 26 men, 18 to 48 years of age, in whom meningitis or mastoiditis had developed early in life.

Ten of these subjects have participated frequently in the vestibular research program at this laboratory (2,4); the other 16 subjects with highly similar afflictions had been screened recently from a larger population of deaf students and faculty at Gallaudet College for the purpose of their participating in vestibular research. The health and physical status of these individuals ranged from good to excellent.

Eleven individuals constituted the group of unilateral labyrinthine-defectives (UL-Ds) and included men and women, in the age range of 33 to 58 years, who were treated surgically for acoustic neuroma (7) one-half year to three years prior to threshold caloric and ataxia testing. Their health and physical status were adequate for undergoing testing.

The group with Ménière's syndrome, treated with streptomycin sulfate ten years previously (6), was composed of three men, 42, 50, and 56 years of age, and one woman, 49 years of age. Their health and physical status were adequate for testing.

Another group consisted of five men, 21 to 34 years of age, in whom total or near total deafness had occurred as a result of head injury and who were screened from a larger population of deaf students and faculty at Gallaudet College. All were in excellent health and good to excellent physical condition.

The group of congenitally deaf subjects consisted of two men, 19 and 20 years of age, and one woman, 19 years of age. As established from available health records, questionnaires, and interviews, all of this group had been totally deaf since birth or before their first birthday. The etiology was not known. Their health and physical condition were good to excellent.

APPARATUS AND METHOD

Threshold Caloric Test

The apparatus and procedures were nearly identical to those described previously by McLeod and Meek (8). In the majority of cases a single Bronwill constant temperature regulator was used, and in the remaining cases the apparatus consisted of a pair of these regulators, a Yellow Springs thermistor, and Yellow Springs telethermometer that maintained constant water temperature. The thermistor was located at the tip of the irrigating nozzle and detected the temperature of the water as it left the end of the irrigating tube; the telethermometer indicated this temperature to the nearest 0.1° C. The nozzle tip was 1 mm in diameter and permitted delivery of 100 to 120 cc of water against the ear drum during the 40 seconds of irrigation.

Subjects were positioned either in a chaise lounge (lawn type) or on a couch so that a line drawn from the outer canthus of the eye to the tragus of the ear was vertical. This placed the horizontal semicircular canals in an approximately vertical plane. Prior to irrigation the room was darkened. After 30 seconds of irrigation the subjects were given a mental arithmetic problem to maintain alertness. While the subject looked straight ahead (towards the ceiling), his eyes were observed under illuminated Frenzel lens for nystagmus for a period of 30 to 60 seconds after irrigation stopped. The threshold caloric response was defined as the temperature of the irrigating water which elicited a minimum of three successive nystagmic beats in the appropriate direction within any five-second period following cessation of irrigation. Electronystagmographic records, which indicated quantitatively that this criterion was met, were obtained simultaneously on the more recently tested symptom-free normals, on some patients with vertigo (approximately 15%), and on all of the labyrinthine-defective subjects.

Because few responses above the 36.4° C to 36.6° C range could be elicited (8), the initial irrigating water temperature used with those subjects (the majority) tested earliest was 36.4° C. Increased experience with the test method, however, indicated that, in some individuals, the most accurate threshold could be obtained with an initial irrigating temperature as high as 36.8° C.

In those instances in which nystagmus was unusually strong or weak, threshold levels were redefined upwards by repeat irrigation with water warmed in 0.2° C increments when the responses were strong, and with water cooled in 0.2° C decrements when they were weak, until changes, if any, could be noted. In this manner accuracy of the threshold response was maximized.

Five minutes elapsed between irrigations. First the right ear then the left ear was irrigated, followed by continued alternate irrigation with upward or downward adjustment of water temperature until a threshold response for each ear was firmly established or, in subjects having severe vestibular defects, could be established within the lowest limit (2.6° C) of the irrigating water temperature. In the interest of saving time and preserving subject motivation and alertness, initial decreases in the stimulus applied to labyrinthine-defective individuals were often in 5.0° C and 10.0° C rather than in 0.2° steps.

Rail and Floor Ataxia Test Batteries

The seven performance test items are described here only briefly since detailed descriptions have been previously published (1,5). The tests were administered in the following sequence: 1) Sharpened Romberg (SR), consisting of standing on the floor with eyes closed for 60 seconds; 2) rail walking and rail standing; 3) standing on one (each) leg on the floor with eyes closed for 30 seconds (SOLEC-R and SOLEC-L); 4) walking a 12-foot line on the floor with eyes closed (WALEC), scored as inches of deviation from the line. Rail walking and rail standing consisted of (a) walking with eyes open (Walk E/O) on a 3/4-inch by 8-foot rail, scored as number of steps (maximum of five steps per trial); (b) standing with eyes open (Stand E/O) on the 3/4-inch rail, scored to the nearest second (maximum of 60 seconds per trial); and (c) standing with eyes closed (Stand E/C) on a 2-1/4 by 30-inch rail, also scored to the nearest second with a maximum of 60 seconds per trial.

The body position required of all subjects was: (a) body erect or nearly erect, (b) arms folded against chest, and (c) feet, shoes on, tandemly aligned heel-to-toe (SOLEC tests excepted).

RESULTS

The distribution of the threshold caloric responses of the "normative" group and of the group of patients referred because of vertigo are shown in Tables I and II, respectively, and the individual threshold caloric test responses in the five other groups of subjects are shown in Table III. The individual rail and floor ataxia test battery performance scores obtained in all except the normal and vertigo patient groups are shown in Tables IV and V.*

"Abnormal" threshold caloric responses are defined arbitrarily as responses having a 5th percentile or lower equivalent ($\leq 34.5^{\circ}$ C) in relation to the distribution of responses in the less sensitive ear of the normative group (Table I). Similarly, "abnormal" ataxia test performance skills are defined arbitrarily as scores having a 5th percentile or lower equivalent in relation to normative standards of performance in various age classifications, as reported elsewhere (1,5). For example, scores having 5th percentile rankings in a control (standardization) group of 17-42-year-old normal men were 171 (SR), 6 (Walk E/O), 11 (Stand E/O), 15 (Stand E/C), 56 (SOLEC-R), 59 (SOLEC-L), and 24 (WALEC), and in a control (standardization) group of 18-29-year-old women the corresponding scores were 35, 5, 11, 16, 27, 36, and 24 on these tests.

GROUP DIFFERENCES IN ABNORMAL RESPONSES TO TESTS

As shown in Table VI, the threshold caloric response of all of the BL-Ds, Ménière's patients, and UL-Ds were abnormal as defined by the arbitrary cut-off criterion; 60 per cent and 67 per cent of the head injury deaf and congenitally deaf individuals, respectively, and 14 per cent of the patients with vertigo also had abnormal threshold caloric responses. The group differences in the frequency of abnormal ataxia test scores very nearly paralleled those in caloric responses. Generally, the greater the vestibular loss, as shown by decreased response to caloric stimulation in the less sensitive ear, the greater was the likelihood that such loss would be reflected also by impaired ataxia test performance. Of particular interest was the finding that individuals with various loss of labyrinthine function were more often identified as being abnormal by their floor ataxia test battery scores than by their rail ataxia test battery scores.

BETWEEN-TEST PREDICTABILITY

The percentage of subjects in each group with abnormal ataxia test scores who also had abnormal threshold caloric test responses, and, conversely, the percentage of subjects in each group with abnormal threshold caloric test responses who also had abnormal ataxia test scores are indicated in Table VII.

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*All tables appear at end of text.

Abnormal ataxia test scores were found to be highly predictive of abnormal threshold caloric test responses not only of individuals with bilateral or unilateral labyrinthine defects but also of the congenitally deaf and head injury deaf. Moreover, more than twice the percentage of patients with vertigo who had abnormal ataxia test scores than of normal individuals who had such scores were identified also as having abnormal threshold caloric test responses. In the groups of UL-Ds, Ménière's patients, and BL-Ds predictability was perfect; i.e., abnormal scores on each of the seven items comprising the rail and floor ataxia test batteries showed maximum (100%) prediction of abnormal threshold caloric test responses. In all five groups of subjects in which VIIIth nerve involvement was certain (patients with vertigo and the normals excluded), the WALEC test was the best single predictor of abnormally reduced sensitivity to caloric stimulation of the vestibular organ.

Similarly, abnormal threshold caloric test responses were highly predictive of abnormal ataxia test scores (B columns, Table VII). In the group of Ménière's patients and in the group of BL-Ds, the prediction was perfect in the four items making up the floor ataxia test battery, and was substantial (25% to 96% agreement) on the rail ataxia test battery. In the remaining three groups in which VIIIth nerve involvement was certain (UL-D, HID, and CD) 18 per cent to 100 per cent of subjects with abnormal threshold caloric responses also had impaired postural equilibrium. An impressive 14 per cent to 55 per cent of patients with vertigo who were identified as having abnormal caloric thresholds also were identified as being ataxic, whereas only 0 to 17 per cent of the normals were so identified.

Generally, scores on the WALEC and SR tests were the best predictors and those of the Stand E/O and Walk E/O tests the poorest predictors of abnormal caloric responses. It is apparent also from results in Table VII that abnormal ataxia test scores predicted abnormal caloric responses better than abnormal caloric responses predicted abnormal ataxia test scores.

It is of further interest to note that, in the group of patients with vertigo, those who had a $\leq$ 5th percentile level caloric response unilaterally did not differ in the extent of their ataxia (frequency of abnormal scores on items of the test batteries) from those who had $\leq$ 5th percentile level caloric responses bilaterally. Thus from the standpoint of an ataxia test, bilateral loss was equivalent to unilateral loss of horizontal canal sensitivity to threshold caloric stimulation. Similarly, in this same group, comparison of the most ataxic individuals on the basis of the percentage of ataxia tests on which scores fell $\leq$ 5th percentile level revealed no systematic differences in caloric thresholds in the: 1) less sensitive ear, 2) more sensitive ear, 3) mean responses of both ears, 4) between-ear difference in responses, and 5) frequency of unilateral versus bilateral responses $\leq$ 5th percentile level. It is noteworthy also that the levels of threshold caloric responses in this group (Table II) were independent of age and sex influences.

DISCUSSION

The ability of the threshold caloric test and the ataxia test battery mutually to identify those individuals with severe unilateral or bilateral labyrinthine defects was of a high order. At the lowest 5 per cent of the caloric test and ataxia test score distributions, at least, ataxia test performance skills appear to have a common relationship with sensitivity of the horizontal semicircular canals to caloric stimulation. In larger samples of individuals who have various loss of labyrinthine function, it would be useful to use other cut-off criteria, ranging from the lowest 1 per cent to the lowest 15 per cent or more. In large samples, moreover, correlation, including multiple correlation, procedures would permit determination of the minimum number of ataxia tests and the best combination of those tests that could reliably predict, and be predicted by, threshold caloric test responses. From present indications, it appears that results on the tests performed with eyes closed, particularly walking, would be expected to yield the highest relationship to results of threshold caloric testing.

The threshold caloric response standards set forth in Table I show that 95 per cent of "normal" individuals had threshold values between $\geq 34.6^{\circ}$ C in the less sensitive ear and $\geq 35.4^{\circ}$ C in the more sensitive ear. The latter is identical to the average response found earlier in both ears in a different, although probably equivalent, sample of individuals (8). The 0.9° C difference in thresholds between the more sensitive and the less sensitive ear at the lowest 5 per cent of the distributions and the lesser difference in thresholds between ears at other points on the distributions (0.5° C - 0.6° C), if shown to be reliable upon testing of larger samples of individuals, may have both practical and theoretical implications. In addition to a need for statistical crossvalidation, clinical validity of caloric test findings at the lowest ends of the distribution is desirable.

Among the twelve normal individuals having the lowest responses in the less sensitive ear, four were Navy deep sea divers who have descended to 200 feet using only scuba gear; one suffered a ruptured ear drum due to blocking of the eustachian tube during a low pressure chamber descent, and one had sustained a broken neck in a racing car mishap many years previously. The remaining six individuals had either slight unilateral hearing loss, as established by audiometric testing, or complete freedom from any clinically detectable otoneurological defect.

The identification of far fewer patients with vertigo than individuals with pronounced labyrinthine defects as abnormal on the ataxia test or caloric test reflects the fact that such patients represented heterogenous types and severity of otoneurological disturbances or were not free of other medical problems, and, therefore, could not be grouped by any single criterion other than having been referred by an otologist or neurologist. The diagnostic classifications of those having abnormal caloric thresholds included Ménière's syndrome (three), vestibular neuronitis (one), streptomycin deafness (one), severe unilateral deafness (two), paroxysmal positional vertigo (one), and "vertiginous epilepsy" (one).

CONCLUSIONS

An investigation of the frequency with which abnormal scores on ataxia tests are associated with abnormal scores on a threshold caloric test in limited samples of individuals who had various loss of labyrinthine function revealed the following:

1. Most individuals with labyrinthine defects severe enough so that their ataxia test performance scores fell within the lowest 5 per cent of the normal distribution of scores also had threshold caloric responses which fell within the same range.

2. Similarly, almost as many individuals with impaired threshold caloric test test responses also showed impairments in their ataxia test performance scores.

3. One third to one fifth of a heterogenous group of patients with vertigo were differentiated from a group of symptom-free normals by the frequency with which ataxia test scores and threshold caloric test responses alike fell $\leq$ 5th percentile levels.

4. Generally, the severity of loss or disturbance of labyrinthine function paralleled the severity of impairment of caloric responses and ataxia test performances.

5. Among the ataxia tests, walking a line on the floor with eyes closed (WALEC) was the most sensitive and walking a 3/4-inch-wide rail with eyes open (Walk E/O) was the least sensitive to loss or disturbance of labyrinthine function.

6. Ataxia tests performed with eyes closed were more sensitive to various loss or disturbance of labyrinthine function than were those ataxia tests performed with eyes open.

7. While influences governing threshold caloric test responses are far more specific than those affecting results on the ataxia tests, the high degree of agreement shown between results of each in groups of individuals with various loss or disturbance of labyrinthine function implies a common vestibular effect to a considerable degree.

REFERENCES

1. Fregly, A. R., and Graybiel, A., An ataxia test battery not requiring rails. Aerospace Med., 39:277-282, 1968.

2. Graybiel, A., Vestibular sickness and some of its implications for space flight. In: Fields, W. S., and Alford, B. R. (Eds.), Neurological Aspects of Auditory and Vestibular Disorders. Springfield, Ill.: Charles C Thomas, 1964. Pp. 248-270.

3. Graybiel, A., Functional disturbances of vestibular origin of significance in space flight. Presented at the Second International Symposium on Basic Environmental Problems of Man in Space, Paris, France, June 14-18, 1965.

4. Graybiel, A., Orientation in aerospace flight. Special Report No. 66-6. NASA Order No. R-93. Pensacola, Fla.: Naval Aerospace Medical Institute, 1966.

5. Graybiel, A., and Fregly, A. R., A new quantitative ataxia test battery. Acta otolaryng., Stockh., 61:292-312, 1966.

6. Graybiel, A., Schuknecht, H. F., Fregly, A. R., Miller, E. F. II, and McLeod, M. E., Streptomycin in Ménière's disease: Long-term follow-up. Arch. Otolaryng., 85:156-170, 1967.

7. House, W. F. (Ed.), Transtemporal bone microsurgical removal of acoustic neuromas. Monograph. Arch. Otolaryng., 80:597-756, 1964.

8. McLeod, M. E., and Meek, J. C., A threshold caloric test: Results in normal subjects. NSAM-834. NASA Order No. R-37. Pensacola, Fla.: Naval School of Aviation Medicine, 1962.

Table I

Frequency Distribution of Threshold Caloric Response Levels and Their Percentile Equivalents in the Control (Normative) Group of "Vestibular Normal" Men (N=240)

Less Sensitive Ear			More Sensitive Ear		
N	Response Interval °C	Percentile Equivalent	N	Response Interval °C	Percentile Equivalent
162	≥36.0	34th - 99th	201	≥3.60	17th - 99th
20	35.8 - 35.9	33rd	15	35.8 - 35.9	16th
14	35.6 - 35.7	24th	10	35.6 - 35.7	10th
10	35.4 - 35.5	18th	7	35.4 - 35.5	6th
10	35.2 - 35.3	14th	4	35.2 - 35.3	3rd
7	35.0 - 35.1	10th	2	35.0 - 35.1	1st - 2nd
4	34.8 - 34.9	7th	0	34.8 - 34.9	
1	34.6 - 34.7	5th - 6th	0	34.6 - 34.7	
5	33.6 - 34.5	5th	1	34.4 - 34.5	1st
2	32.6 - 33.5	3rd			
1	30.6 - 32.5	2nd			
4	20.6 - 30.5	1st - 2nd			

Dotted line = arbitrary cut-off criterion of "abnormality"

Table II

Frequency Distribution of Threshold Caloric Responses in Patients with Vertigo (N=76)

N	Age Range Years	Mean Age Years	Threshold Caloric Response Levels in Less Sensitive Ear °C	Threshold Caloric Response Levels in More Sensitive Ear °C
34	21-69	38.4	≥36.0	36.0 - 36.8
8	27-61	42.3	35.8 - 35.9	35.8 - 36.6
6	38-50	44.8	35.6 - 35.7	35.8 - 36.6
11	20-68	39.0	35.4 - 35.5	35.4 - 36.4
2	68-72	70.0	35.2 - 35.3	35.6 - 35.8
4	41-69	53.5	35.0 - 35.1	35.8 - 36.4
0			34.8 - 34.9	
0			34.6 - 34.7	
- - -	- - -	- - -	- - -	- - -
3	22-50	32.7	33.6 - 34.5	34.0 - 36.3
2	20-53	41.5	32.6 - 33.5	34.2 - 36.0
1	22	22.0	30.6 - 32.5	32.4
2	40-42	41.0	20.6 - 30.5	32.6 - 36.2
2	41-58	49.5	11.6 - 20.5	18.4 - 36.2
1	47	47.0	10.6 - 11.5	35.8

Dotted line = arbitrary cut-off criterion of "abnormality"

Table III

Threshold Caloric Test Responses of Various Groups

Group	Subject	Threshold Caloric Responses in Degrees Centigrade: Right Ear	Threshold Caloric Responses in Degrees Centigrade: Left Ear	Group	Subject	Threshold Caloric Responses in Degrees Centigrade: Right Ear	Threshold Caloric Responses in Degrees Centigrade: Left Ear
BL-D	DO	Neg. at 10.0	Neg. at 10.0	BL-D	ZE	Neg. at 10.8	Neg. at 9.8
"	GR	No Response	No Response	UL-D	MN*	35.2	Neg. at 9.6+
"	GU	10.0	10.0	"	MY	36.6	Neg. at 9.8+
"	HA	Neg. at 2.8	Neg. at 2.8	"	LY	34.0	Neg. at 9.6+
"	JO	Neg. at 3.0	Neg. at 3.8	"	UE	35.8	Neg. at 10.0+
"	LA	10.0	No Response	"	CO	Neg. at 9.6+	36.0
"	MY	Neg. at 2.8	7.9	"	RA	36.0	Neg. at 9.6+
"	PE	Neg. at 2.6	Neg. at 2.6	"	RI*	Neg. at 10.0+	35.4
"	PI	9.8	NIL	"	DA*	Neg. at 10.0+	36.2
"	ST	10.0	11.0	"	BI*	Neg. at 10.0+	36.0
"	ZA	2.8	2.8	"	FI*	Neg. at 10.0+	36.2
"	AD	Neg. at 10.0	Neg. at 10.2	"	MA*	35.4	Neg. at 10.4+
"	AI	24.4	14.0	MP	AN	31.5	Neg. at 12.0
"	BA	Neg. at 9.6	Neg. at 9.6	"	CA*	Neg. at 12.0	25.0
"	BE	Neg. at 9.6	Neg. at 9.8	"	KI	Neg. at 12.0	Neg. at 12.0
"	BI	10.0	Neg. at 9.6	"	OC	30.6	Neg. at 12.0
"	BU	Neg. at 9.6	Neg. at 9.8	HID	EC	32.0	32.0
"	CR	Neg. at 9.8	10.2	"	HA	34.2	33.0
"	FA	Neg. at 9.8	Neg. at 9.8	"	PE*	35.6	35.6
"	IN	Neg. at 9.8	Neg. at 10.0	"	WA	35.4	35.4
"	KA	Neg. at 10.0	Neg. at 10.0	"	PU	Neg. at 11.0	Neg. at 11.0
"	JO	Neg. at 9.8	Neg. at 10.2	CD	BA	Neg. at 9.4	Neg. at 10.4
"	MO	Neg. at 9.6	Neg. at 10.0	"	GO	30.0	35.0
"	OL	Neg. at 10.2	Neg. at 10.8	"	WA*	35.2	34.8
"	OR	Neg. at 9.6	Neg. at 10.2				

* Women
\+ Surgically treated ear
BL-D = Bilateral labyrinthine-defective
UL-D = Unilateral labyrinthine-defective (surgically treated for acoustic neuroma)
MP = Ménière's patients treated with streptomycin sulfate
HID = Head injury deaf
CD = Congenitally deaf

Table IV

Rail and Floor Ataxia Test Battery Performance Scores and Their Percentile Equivalents, as Related to Normative Standards, in the Twenty-six Men with Bilateral Loss of Labyrinthine Function

			Rail Ataxia Test Battery						Floor Ataxia Test Battery							
	Sub-		Walk E/O		Stand E/O		Stand E/C		SR		SOLEC-R		SOLEC-L		WALEC	
Group	ject	Age	Score	%-tile	Score	%-tile	Score	%-tile	Score	%-tile	Score	%-tile	Score	%-tile	Score	%-tile
	DO	43	9	< 1st	33	< 1st	29	< 1st	17	1st	9	1st	13	1st	UTP	< 1st
	GR	47	24	< 1st	71	< 1st	19	< 1st	20	1st	11	1st	10	1st	UTP	< 1st
	GU	21	17	< 1st	34	< 1st	22	< 1st	17	1st	17	1st	12	1st	UTP	< 1st
	HA	30	24	< 1st	44	< 1st	25	< 1st	6	1st	14	1st	10	1st	UTP	< 1st
A*	JO	34	27	< 1st	30	< 1st	30	< 1st	20	1st	17	1st	14	1st	UTP	< 1st
	MY	24	28	< 1st	93	< 1st	23	< 1st	13	1st	14	1st	11	1st	UTP	< 1st
	PE	33	40	< 1st	58	< 1st	19	< 1st	12	1st	17	1st	18	1st	UTP	< 1st
	PI	24	29	< 1st	111	< 1st	21	< 1st	14	1st	10	1st	10	1st	UTP	< 1st
	ST	20	38	< 1st	122	< 1st	24	< 1st	20	1st	12	1st	12	1st	UTP	< 1st
	ZA	21	52	30th	222	< 1st	35	< 1st	28	1st	34	2nd	18	1st	UTP	< 1st
	AD	23	6	5th	8	1st	14	3rd	15	1st	18	1st	10	1st	UTP	< 1st
	AI	21	3	< 1st	6	< 1st	5	< 1st	10	1st	15	1st	14	1st	UTP	< 1st
	BA	24	5	4th	8	1st	10	< 1st	13	1st	14	1st	12	1st	UTP	< 1st
	BE	42	4	2nd	7	< 1st	6	< 1st	8	1st	6	1st	5	1st	UTP	< 1st
	BI	22	6	5th	6	< 1st	7	< 1st	17	1st	13	1st	12	1st	UTP	< 1st
	BU	35	9	15th	9	3rd	16	6th	13	1st	19	1st	18	1st	UTP	< 1st
	CR	23	8	9th	7	< 1st	8	< 1st	14	1st	12	1st	13	1st	UTP	< 1st
	FA	23	12	40th	12	7th	14	3rd	27	1st	19	1st	15	1st	UTP	< 1st
B	IN	20	10	23rd	6	< 1st	6	< 1st	14	1st	12	1st	12	1st	UTP	< 1st
	JO	22	5	4th	11	5th	7	< 1st	13	1st	14	1st	12	1st	UTP	< 1st
	KA	24	5	4th	8	1st	8	< 1st	13	1st	10	1st	11	1st	UTP	< 1st
	LA	24	6	5th	8	1st	10	< 1st	8	1st	13	1st	13	1st	UTP	< 1st
	MO	32	7	7th	7	< 1st	4	< 1st	22	1st	9	1st	7	1st	UTP	< 1st
	OL	23	7	7th	8	1st	6	< 1st	14	1st	11	1st	9	1st	UTP	< 1st
	OR	32	6	5th	3	< 1st	3	< 1st	9	1st	9	1st	13	1st	21	4th
	ZE	24	5	4th	11	5th	11	< 1st	9	1st	18	1st	19	1st	UTP	< 1st

* The Walk E/O, Stand E/O, and Stand E/C performances of these first ten individuals were tested on the Long Version of the Rail Ataxia Test Battery; subjects 11 to 26 were tested on the Short Version.

UTP = Unable to perform

Table V

Rail (Short Version) and Floor Ataxia Test Battery Performance Scores and Their Percentile Equivalents as Related to Normative Standards in Four Groups of Individuals with Various Loss of Labyrinthine Function: (A) Streptomycin-Treated Ménière's Patients; B) Unilateral Labyrinthine-Defective Indivduals (Surgically Treated Acoustic Neuroma Patients); C) Head Injury Deaf Individuals; and D) Congenitally Deaf Individuals.)

			Rail Ataxia Test Battery						Floor Ataxia Test Battery							
	Sub-		Walk E/O		Stand E/O		Stand E/C		SR		SOLEC-R		SOLEC-L		WALEC	
Group	ject	Age	Score	%-tile	Score	%-tile	Score	%-tile	Score	%-tile	Score	%-tile	Score	%-tile	Score	%-tile
A	AN	56	3	18th	6	7th	6	< 1st	9	1st	13	4th	11	1st	UTP	< 1st
	CA*	49	13	90th	8	10th	11	10th	6	1st	12	1st	N.T.	---	N.T.	---
	KI	42	4	2nd	8	1st	10	< 1st	14	1st	11	1st	12	2nd	UTP	< 1st
	OC	50	12	70th	7	5th	8	1st	11	1st	10	1st	11	1st	UTP	< 1st
B	DA	33	6	15th	8	12th	12	15th	11	2nd	12	1st	11	1st	UTP	< 1st
	LY	36	6	4th	9	3rd	20	7th	27	1st	24	1st	24	1st	UTP	< 1st
	BI*	40	7	25th	7	8th	9	2nd	14	3rd	12	1st	11	1st	UTP	< 1st
	FI*	42	2	1st	8	12th	10	4th	11	2nd	12	1st	13	5th	UTP	< 1st
	UE	43	12	70th	9	13th	14	11th	26	3rd	17	5th	18	5th	UTP	< 1st
	MA	43	5	7th	7	5th	14	11th	12	1st	22	10th	11	1st	UTP	< 1st
	CO	47	9	38th	10	19th	21	29th	63	11th	33	22nd	46	34th	UTP	< 1st
	RA	49	9	38th	12	32nd	13	9th	36	5th	29	19th	36	24th	UTP	< 1st
	MK*	52	4	15th	7	23rd	9	23rd	17	17th	14	9th	10	1st	UTP	NSL
	MR*	54	10	69th	6	9th	9	23rd	11	8th	18	27th	13	9th	UTP	NSL
	RI*	58	6	38th	7	23rd	10	23rd	13	12th	13	9th	14	9th	UTP	NSL
C	EC	23	5	4th	9	3rd	12	1st	240	99th	30	2nd	47	4th	0	99th
	HA	34	6	5th	7	< 1st	10	< 1st	18	1st	14	1st	18	1st	UTP	< 1st
	PE*	22	13	70th	12	9th	13	2nd	240	99th	23	2nd	16	1st	7	65th
	WA	22	9	15th	31	61st	33	19th	64	1st	66	8th	150	99th	18	12th
	PU	21	3	< 1st	6	< 1st	9	< 1st	9	1st	8	1st	9	1st	UTP	< 1st
D	BA	20	9	15th	20	33rd	20	10th	25	1st	37	3rd	24	1st	31	2nd
	GO	19	14	70th	12	7th	11	< 1st	56	1st	150	99th	51	4th	UTP	< 1st
	WA*	20	18	15th	25	60th	180	99th	240	99th	92	41st	111	51st	23	6th

* Women

UTP = Unable to Perform

NT = Not Tested

NSL = Normative standards lacking

Table VI

Group Differences in the Percentage of Abnormal Threshold Caloric Responses in the Less Sensitive Ear and of Abnormal Rail and Floor Ataxia Test Battery Scores

		Threshold	Rail Ataxia Test Battery			Floor Ataxia Test Battery			
Subject Groups	N	Caloric Test %	Walk E/O %	Stand E/O %	Stand E/C %	SR %	SOLEC-R %	SOLEC-L %	WALEC %
Normals	240*	5	1	5	4	7	3	4	3
Patients with vertigo	76+	14	18	26	22	37	23	35	29
Congenitally deaf	3	67	0	0	33	67	33	67	67
Head injury deaf	5	60	60	60	80	60	80	80	40
Unilat. labyr-defect.	11	100	18	18	18	64	46	64	100
Ménière's patients	4**	100	25	50	75	100	100	100	100
Bilat. labyr-defect.	26	100	72	96	96	100	100	100	100

* N = 198 on SOLEC-R and SOLEC-L; N = 147 on WALEC
+ N = 31 on SOLEC-R and SOLEC-L; N = 38 on WALEC
** N = 3 on SOLEC-L and WALEC

Table VII

Group Differences in Relationships of Ataxia Test Battery Scores to Threshold Caloric Responses

Subject Groups	Rail Ataxia Test Battery Walk E/O		Stand E/O		Stand E/C		SR		Floor Ataxia Test Battery SOLEC-R		SOLEC-L		WALEC	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Normals	0	0	17	17	10	8	11	17	13	8	10	8	0	0
Patients with vertigo	21	27	30	55	35	55	21	55	14	14	9	14	9	25
Congenitally deaf	NA	0	NA	0	100	50	100	100	100	50	100	100	100	100
Head injury deaf	100	100	100	100	75	100	67	67	75	100	75	100	100	67
Unilat. labyr-defect. (Acoustic-Neuroma)	100	18	100	18	100	18	100	64	100	46	100	64	100	100
Streptomycin-treated Ménière's patients	100	25	100	50	100	75	100	100	100	100	100	100	100	100
Bilateral labyr-defect.	100	72	100	96	100	96	100	100	100	100	100	100	100	100

NA = No applicable
Column A = Percentage of subjects with abnormal ataxia test scores who also had abnormal threshold caloric test responses
Column B = Percentage of subjects with abnormal threshold caloric test responses who also had abnormal ataxia test scores

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13. ABSTRACT

Groups of individuals with various loss or disturbance of labyrinthine function (N=49) and patients who had vertigo as a major symptom or complaint (N=76) were very different from a control group of normals (N=240) in the frequency with which their ataxia test battery performance scores and threshold caloric test responses fell within the lowest 5 per cent of the normative distributions. Generally, caloric test results could be predicted from ataxia test results better than results of ataxia tests from those of caloric tests in the various groups. In those individuals with total or near total loss of labyrinthine function all test findings were in perfect or near perfect agreement in relation to the 5th percentile cut-off criterion employed.

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14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
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Postural equilibrium						
Psychomotor skills						
Vertigo						
Vestibular functions						

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