A BIBLIOGRAPHY OF THE ROLE OF THE VESTIBULAR APPARATUS UNDER WATER AND PRESSURE: CONTENT-ORIENTED AND ANNOTATED

Robert S. Kennedy
Naval Medical Research Institute
Bethesda, Maryland
10 August 1972
Best Available Copy
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Research Report

Report No. 1

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ROBERT S KENNEDY, LCDR, USN

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Report No. 1

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Category I. Vestibular Symptomatology as a Sign of Decompression Sickness (Compression Effects: Isobaric?)
Category II. Clinical Investigation of Vestibular Symptomatology
Category III. Tests of Positive Function of Vestibular Apparatus
Category IV. Perceptual Illusions Occasioned by the Environment Some of Which May be of Vestibular Origin
Category V. The Use of the Vestibular System as an Inertial Guidance System
Category VI. Auditory Studies which Have Relevance for Understanding Vestibular Function Underwater

The major category is Category I (293 references). Most of the citations are annotated and many are cross-referenced between and within categories. It is felt that the role of the vestibular system in compressed air work is presently underestimated. This bibliography calls attention to the incident of vestibular involvement in compressed air work and provides reference to the background material essential for understanding and future study of vestibular problems.
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A BIBLIOGRAPHY OF THE ROLE OF THE VESTIBULAR APPARATUS UNDER WATER AND PRESSURE: CONTENT-ORIENTED AND ANNOTATED

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10 August 1972

¹From Bureau of Medicine and Surgery, Navy Department, Research Subtask "4306. 1.5000BEAK9. The opinions and statements contained herein are the private ones of the writer and are not to be construed as official or reflecting the views of the Navy Department or the Naval Service at large.

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ABSTRACT

This report contains about 965 references dealing with the role of the vestibular apparatus in compressed air work. The sources for this bibliography include the diving medicine reference works as well as the literature dealing with vestibular functions. In addition, there are many items in the bibliography which would not typically be seen when consulting the standard reference works in diving medicine or vestibular physiology. These include obscure references and/or translations of articles not previously translated. The references are sorted by subject matter into six categories:

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Category VI. Auditory Studies Which Have Relevance for Understanding Vestibular Function Underwater

The major category is Category I (293 references). Most of the citations are annotated and many are cross-referenced between and within categories. It is felt that the role of the vestibular system in compressed air work is presently underestimated. This bibliography calls attention to the incidence of vestibular involvement in compressed air work and provides reference to the background material essential for understanding and future study of vestibular problems.
KEY WORDS

Diving
Compressed Air Work
Bibliography: Content-Oriented-annotated
Vestibular Function
Vestibular Symptoms
Diving Medicine
Compressed Air Sickness
Decompression Sickness
Diver Navigation
Navigation
Orientation
Disorientation
Diver Disorientation
Diver Selection
Neurological Deficits-Diver
Vestibular Hits
Diver Auditory Problems
Perceptual Disorientation
Diving History
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Vestibular Pathology
Caisson Disease
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ACKNOWLEDGMENTS

By its nature, a bibliography depends heavily on the technical assistances available to produce it. The author is indebted to the following: to Nancy Loudin, who typed the manuscript; to Jackie Holiman and Wendy Cummings, who typed drafts and performed other chores; and to Ernie Gendelman, Wendy Cummings, and Eleanor Capps, who provided general library help.

A special debt of gratitude is owed to Peggy Matzen, who performed the Herculean task of editing, categorizing, ordering and indexing the text as well as ram-rod ding the reproduction.

In addition, the author wishes to dedicate this bibliography to Mrs. T. Robinson, who as Head Librarian at the Naval Medical Research Institute, contributed to this bibliography in many important tangible ways and also by the way she conveyed her commitment to scholarship with others.
In reading the literature on compressed air work as related to Navy diving, I was prepared to see vestibular implications if they were present since my previous work in aviation medicine dealt mainly with vestibular functions. However, I became impressed with the frequency with which aspects of that sensory system were mentioned throughout the research literature: as a symptom of decompression sickness, ancillary to auditory problems, or in connection with disorientation, etc. Yet general reference works (Hoff, 1948; Greenbaum and Hoff, 1954; Greenbaum and Hoff, 1966) and manuals (e.g., Navy Diving Manual, 1976*) did not appear to deal in any formal way with problems which may center around this organ complex, and general textbooks often merely indicated that additional work is needed in this area.

A file of over 1,000 general references on "vestibular functions" was consulted and it appeared that only about a dozen articles dealt specifically with vestibular functions under water and pressure. Many more articles were probably important to an understanding of the role of the vestibular apparatus under water and compressed air, and these references do not generally appear in the diving literature. Furthermore, I knew of no "vestibular scientist" actively engaged in compressed air study and there is evidence that a correspondence

*Cited in bibliography.
between the two exists and is increasing (cf. Rubenstein and Summitt, 1970*). I therefore decided to merge studies of vestibular function which I felt were applicable to work in a compressed air environment with studies of compressed air work involving the vestibular apparatus in some way.

I decided to organize the studies into subject matter categories, so I "forced" each citation into one of six bins. When an article had broader application it was placed into the most appropriate category and cross-referenced at the end of the other categories to which it applied. Occasionally such a study had been published as a government report and as a journal article as well, or similarly in two journals, or was one of a series; in these cases an entry was made in two categories.

The available literature was searched in several ways: (a) modern sources were consulted and references which were cited therein were backtracked, (b) the overall vestibular literature was surveyed, (c) the "Sourcebooks" (Hoff, 1944; Greenbaum and Hoff, 1957; Greenbaum and Hoff, 1966; Shilling and Werte, 1971) were consulted and articles were skimmed or read as needed. Occasionally, when it was not possible to "see" hard copy of an article for one reason or another, the notation "I.V." (not viewed, therefore not verified) appears. In those instances, unless the source of the reference is specified, the source was one of

*Cited in bibliography.
the "Sourcebooks" previously listed, (d) experienced workers were consulted for leads. These people were either "vestibular scientists" or "hyperbaric scientists", (e) since studies of vestibular functions have historically enjoyed more popularity outside the United States than in it, particular attention was paid to articles which were not published in English. When titles, abstracts, or entire articles were translated by others this information is included in the text.

The implication of a particular article is carried sometimes in the title; when it isn't, the results are also listed in the text. For the most part, however, it was felt that an interpretation of the meaningfulness of the findings would be more useful for the reader and so most articles are annotated. Generally, I introduced my own opinions and interpretations regarding the application or implication of a reference. When this was done, I usually indicated I had taken this liberty by the notation "(RK)." Sometimes it was felt that a reference would be more meaningful in connection with another. When this was the case, the other article(s) were cross-referenced in the annotation.

In the course of assembling this bibliography, it was apparent that many of the vestibular findings reported in the earlier literature were not always known to later writers. To point this out, the literature throughout this bibliography is listed chronologically within each category. An author index also appears at the end of the bibliography. Each article has a unique identification number. Journal title abbreviations used were taken from the List of Journals Indexed in Index Medicus.
1972, or from ACCESS, Key to the Source Literature of the Chemical Sciences, 1969 edition.

As mentioned above, each article was placed into what was considered the most appropriate category. Six categories were employed:

1. Vestibular symptomatology reported in connection with compressed air work.

2. Clinical diagnosis of vestibular symptoms with relevance to hyperbaria.

3. Provocative tests of the positive function of the vestibular apparatus to be used as pre-post measurements of normal functioning.

4. Illusory phenomena occasioned by water and similar environments which may involve or interact with vestibular functions.

5. The potential use of the vestibular system as a navigation aid under water.

6. Relevant auditory studies.

Category I generally contains articles which report vestibular symptoms in connection with decompression sickness. Occasionally a methodology paper which would be useful in studying this problem is included. If an article appeared more diagnostic than descriptive it would be included in Category II. For example, some reports of aerotitis media report vestibular symptoms, are diagnostic, but also report auditory problems. These therefore may appear in Categories I, II or VI.

Compression also produces problems and while articles reporting decompression sickness symptoms make up the largest part of this section, compression and isobaric studies are also included.
When pathology is discussed the article may appear in Categories I or II.

Category II contains papers which it is felt would be useful in the diagnosis of involvement of the vestibular system or its central pathways, although most of the citations are to papers which do not mention hyperbaria per se. Some overlap exists between Category II and Categories I and III and, to a lesser extent, Category IV. An effort was made to include modern, representative studies in this category, and the earlier literature which may contain similar studies is not always included since it is felt that new diagnostic approaches would supersede older ones and provide reference to the earlier, if the latter were of interest.

Category III lists the many methods for measuring the integrity of the vestibular apparatus for the primary purpose of describing normal function, or what is normal for that individual. Papers contained within this category can be used to assemble a battery of tests for specific or general purposes. Thus, if pretesting is performed prior to a dive (or to a career in diving) post-testing can then be employed to show deficits if they occur. Some of these tests reported may also be used to indicate whether this organ system and its pathways is being affected by the experimental condition whilst the condition is on-going (e.g., during an extended dive).

Category IV includes papers which discuss perception in general as well as those which discuss aspects of the kinds of perceptual environments that may be encountered under water and pressure.
In this section, for example, there are reports describing submersibles and there are reports of the effects of motion on perception. Also, because water immersion was used to simulate the weightlessness of space flights, and because perceptual problems were mentioned in these reports, some articles from this literature are included.

Motion sickness as a diving problem may be of importance only indirectly (viz., a diver is often transported to his dive site and tended by a boat). However, the consequences of sea sickness to a diver who later dove could be fatal, thus a recent review of motion sickness is included (Money, 1971*).

Category V includes representative and general works regarding animal orientation, navigation, homing and migration as well as the few studies which dealt directly with human abilities to perform these operations. Several studies of importance for this category may also be found in Categories III or IV.

The list of animal navigation studies is not meant to be exhaustive but rather representative of the kind of cues that are being studied in that literature. The studies referenced generally are: a major conference with many articles, by a significant person in the field, contain a good bibliography, or are recent articles.

Category VI includes articles dealing with auditory problems. These articles were obtained during the course of obtaining the

*Cited in bibliography.
Mfaranc cited categories I to V above. These articles are included because of the similarities of vestibular and auditory systems, but the list is not meant to be complete or representative. The auditory articles are concerned mainly with barotrauma of the tympanic membrane, Eustachian tube, etc., or hearing loss or "sudden deafness."

Generally, tests of these injuries involve auditory tests and auditory symptoms (e.g., tinnitus), although vestibular involvement (e.g., vertigo) and tests (e.g., caloric) may be included.

The overall purpose of this bibliography is to call attention to the incidence of vestibular involvement in compressed air work, and to provide reference to the background material essential for understanding and future study of these problems.

References

Hoff, E. C.
A bibliographical sourcebook of compressed air, diving and submarine medicine. Vol. I. NAVED 1191.
(Available from U. S. Gov't. Printing Office)

Greenbaum, L. J., Jr. and E. C. Hoff.
A bibliographical sourcebook of compressed air, diving and submarine medicine. Vol. II.
(Available from U. S. Gov't. Printing Office)

Greenbaum, L. J., Jr., and E. C. Hoff.
A bibliographical sourcebook of compressed air, diving and submarine medicine. Vol. III.
(Available from U. S. Gov't. Printing Office)

Shilling, C. W., and M. F. Werts.
An annotated bibliography on diving and submarine medicine.
1870-1899

1. BAUER, L.
Pathological effects upon the brain and spinal cord of men exposed to the action of a largely atmospheric pressure.
The Saint Louis Medical and Surgical Journal, R. F. Studley & Co., 1870.
A report of the Mississippi Bridge works in St. Louis; historically interesting.

2. SMITH, A. H.
The effects of high atmospheric pressure, including the caisson disease.
The book describes experiences connected with building the Brooklyn Bridge. This is an excellent and little referenced study. It contains early references to animal studies (pp. 23, 24); use of pressure to treat illness (pp. 23, 24); adaptation effects (pp. 20, 34); constitutional factors (p. 37); and cardiovascular effects (p. 20). Vestibular and auditory difficulties are mentioned throughout (particularly p. 27 ff.). Smith feels a first-order problem in compressed air work is on "effect on hearing (p. 17)." He coined the term, "Caisson Disease (p. 25)."

3. TREITEL.
Die rupturen des trommelfelles mit besonderer berucksichtigung ihrer forensischen bedeutung.

4. VAN RENSSELAER, H.
The pathology of the caisson disease.
One of the earliest articles written in America. Historically, very interesting with an exhaustive bibliography, particularly of the French literature. Vestibular symptoms as prodromal signs (p. 414), obesity (p. 438), adaptation (p. 439), and cerebellar implications (p. 440), as well as case histories, are included.

5. ROBINGTON, T. H., and A. CUTHBERT.
Paralysis caused by working under compressed air in sinking the Foundation of Londonderry New Bridge.

6. CURNOW, J.
Auditory vertigo caused by working in compressed air.
One of the earliest and certainly the most descriptive report of vertigo in compressed air. An excellent paper.

7. HELLER, R., W. HAGER, and H. von SCHROTTEN.
Vorlauffige Mitteilung uber Caissonarbeiter. (Introductory report on caisson workers. Trans. by Mrs. A. Woke, NMRI, 1972.)
An early report of decompression sickness which refers to Meniere-like symptoms. Describes the early experience of the authors with the caisson at Nussdorf. The entire report later appeared as a book.
8. SILBERSTEIN.
Sur kasuistik des caissonkrankheiten.

9. ALT, F.
Über apoplectiforme Labyrinthkrankungen bei Caissonarbeitern. (Concerning apoplectic-form labyrinth diseases in caisson workers. Trans. by Mrs. A. Woke, NRRI, 1971.)

Reviews the early literature on ear (labyrinthine) problems from pressure, and although the author considered the previous literature small, he offers about 20 references. He calls attention to the large number of ear diseases that von Shrotter was discovering at the Nussdorfer Spitz floodgate, reports cases, and offers theories regarding etiology. He also reports on animal tests and performed ear sections, but shows no slides in the printed version of his talk.

10. SNELL, E. H.
Compressed air illness (or so-called caisson disease).
London: H. K. Lewis, 1890.

The author claims this article to be one of the first reviews in English (but see Smith, 1873, p2). It is excellent for its description of disorders involving the auditory and vestibular systems. In reports on vertigo (pp. 29, 30) and vomiting (p. 27) in tunnel workers Snell claims that "...cases of auditory vertigo...have not previously been met with and recognized by writers on the subject (p. 74)." He mentions thickening of the tympanic membrane due to constant "accommodation of the ear (p. 116, 117)." Case histories of vestibular involvement begin on p. 96.

Pathologie der Luftdruckerkrankungen der Gehörorgane. (Pathology of air pressure diseases of the auditory organs. Trans. by Mrs. A. Woke, NRRI, 1972.)
Monatschrift für Ohrenheilkunde 31:229-242, 1897.

Auditory problems occasioned by pressure changes in general are discussed; also labyrinthine diseases caused by gas emboli after rapid decompression, with figures which show lesions in the cochlea and semicircular canals (p. 239). The authors describe the symptoms reported by workers as including dizziness, tinnitus, vomiting, "reeling like drunkards (p. 240)," inability to stand on one foot (Romberg). They also report cases described by previous workers: Hoos, Gruber, Ekert, Pol and Watelle, Gal, Gerard, Catamas, and Snell, plus twelve of their own. Animal studies of rapid decompression from 5 ata showed hemorrhages in various places within the labyrinth particularly in the semicircular canals.

12. HOCHE, A.
Über die Luftdruckerkrankungen des Zentralnervensystems. (Air pressure diseases of the central nervous system. Trans. by Mrs. A. Woke, NRRI, 1972.)

A very good early paper. Spontaneous nystagmus (p. 465), dizziness, etc., are mentioned.

1900-1909

13. BARATOUX, J.
Des accidents survenant du cote de l'oreille dans l'air compris.
Indipend. Med. VI:114, 1900. (Cited by Lastienne; cited by A. Pagano, 1959.) N.V.
14. HELLER, R., W. MAGER, and H. von SCHROTTER. 
Luftdruck-Erkrankungen, mit besonderer Berücksichtigung der 
so genannten Caissonkrankheit. Vols. 1 and 2 
Vienna: A. Holder, 1900.

Many authors (e.g., Keays, 1909, #22; Hill, 1912, #25; Behnke, 1951, #85; 
1969, #225) have used these volumes for basic data regarding vestibular 
symptomatology and decompression sickness, but the works themselves have not 
been formally translated. Reporting similar data, articles by Alt (1896, #9; 
1897, #11), Heller, et al. (1895, #7), and von Schrotter (1904, #16) are 
found elsewhere in this bibliography.

15. ROPKE. 
Die berufskrankheiten des ohres und der oberen Luftwege. 
J. F. Bergmann. Wiesbaden, 1902. (Cited by Philip; Cited by A. Pagano, 1959.) N.V.

16. VON SCHROTTER, H. 
Zur Pathogenese der sogenannten Taucherlahmung. 
(The pathogenesis of so-called diver paralysis. Trans. by Mrs. A. Woke, 
NNR, 1972.) 

A report of post-mortem spinal cord observations (with 2 figures) in 
3 divers, one of whom had dizziness.

17. PHILIP, M. 
Des accidents auriculaires dans les travaillleurs des caissons. 

18. TORRETTA. 
Lesioni del labirinto non acustico. 
Il Policlínico, 1907. (Cited by A. Pagano, 1959.) N.V.

19. BERRUYER, G. 
Les accidents auriculaires chez les Travailleurs des caissons. 

20. BOYCOTT, A. E., G. C. C. DAMANT, and J. S. HALDANE. 
The prevention of compressed-air illness. 
J. Hyg. (Camb) 8:342–443, 1908.

They indicate that as far as "mechanical symptoms (p. 388)" are concerned, 
goats do not appear to suffer from ear problems as men do. However, 
behavioral measures of VIIIth nerve involvement are difficult to accomplish. 
They describe that a "fair number of cases have occurred when the animal 
is obviously ill (p. 387)." It may be that vertigo or other vestibular 
symptoms were present. See Brauer, et al., (1971, #266).

21. BLICK, G. 
Notes on diver's paralysis. 

An early paper.

22. KEAYS, F. L. 
Compressed air illness, with a report of 3,692 cases. 
Cornell University Medical College, Ithaca, New York, Researches 
from the Department of Medicine 2, October 1909.

One of the most quoted works on the epidemiology of decompression sickness. 
A good paper. The author claims that 5% of all cases had vertigo as 
the "most characteristic symptom (p. 38)"; he suggests labyrinthine 
bloodflow was the cause. Perhaps more cases of vertigo occurred, 
but as accessory symptoms to joint pain (See Hill, 1912, p. 78 ff., #25; 
Adler, 1964, p. 74 ff., #154.) The author appears to suggest saturation 
diving (p. 50). Good references to the earlier literature.
21. POLI, C.
   Resultati dell'esame preventivo dell'orecchio nei lavoratori in aria compressa.

1910-1919

24. BRYANT, W. S.
   Occupational diseases of the ear, nose and throat.

25. HILL, L.
   Caisson sickness, and the physiology of work in compressed air.
   London: Edward Arnold, 1912.

   A very important review of the earlier work includes slides (fig. 36, p. 83) from von Schrotter (1904, §16) of lesions in semicircular canals. Reviews work of Helier, Mager, & von Schrotter (1900, §14), (Danube caisson works), where involvement of the auditory and non-auditory labyrinth may have been as high as 28% of all cases.

26. BASSOE, P.
   The late manifestations of compressed-air disease.

   Should be read with Boot's (1913, §27) paper. Bassoe reports "ear affections," in "37 of the 161 men (p. 541); "33 complained of dizziness," "6 of vomiting" (p. 527); "6 had blind stagger, that is, labyrinthine vertigo, with nystagmus (p. 527)."

27. BOOT, G. W.
   Caisson workers' deafness.

   Boot mentions vestibular problems (p. 1131) and also indicates that the vestibular system often continues to function even though hearing losses occur. However, his index of vestibular function is probably an ice water caloric, which may not be a sensitive enough test for showing graded amounts of hypofunction (yet ice water calorics are often used in modern times). (RK)

28. BERRUYER, G.
   Les accidents auriculaires chez les travailleurs des caissons.

29. ERDMAN, S.
   The acute effects of caisson disease or aeropathy.

   Describes somewhat differently the same data reported by Keays (1909, §22). Considers vertigo to possibly "...be due to cerebellar gas embolism" or bubbles in labyrinth (p. 523). Shows 88% of cases had pain "either as the only symptom or associated with others (p. 523)." (Underlining mine (RK)) Because percent incidences sum to 100, one wonders if vertigo (for example) appeared in "more than 5% (p. 523)" as reported, or if vertigo was a prominent symptom in >5% but was an accessory symptom in some of the 88% who reported pain. (RK)

30. ANDREWS, A. H., L. W. ROTH, and A. C. IVY.
   On the use of reduced atmospheric pressure in the treatment of paranasal sinitis.
31. LEVY, E.
Compressed-air illness and its engineering importance (with a report of cases at the East River Tunnels).
A report of 680 cases of DCS. Vertigo as a major symptom occurred in 6.5%; localized pain in 91.8%. In this report, as in Kays (1909, #22), there is no record of whether vertigo appeared as an accessory symptom or as a premonitory sign of pain (although it probably did). Therefore, the true incidence of vertigo is probably undetermined.

32. GORDON, L.
Die Baumsrankhertten der Gehororgane.

33. VAIL, H. H.
Traumatic conditions of the ear in workers in an atmosphere of compressed air.
Arch. Otolaryngol. 10(2):113-126, 1929.
This paper reviews the earlier work of Alt (1896, #9), Kays (1909, #22), etc., and calls attention to the fact that the U.S. Navy had no record of "admission to the sick list for damage to the ears considered due to diving activity (p. 114)." Reasons are given and two cases histories are reported.

1930-1939

34. OTANI, N.
Beitrag Zu. Caisson Krausheit.

35. HILL, L.
Deep-sea diving.
A good paper of historical interest mentions "giddiness" (p. 165) and alludes to perceptual difficulties attendant upon the environment.

36. LESTIENNE, J.
Following a brief historical review, the author discusses case histories from compression and decompression accidents. He states compression accidents often resulted in functional damage which recovered; decompression accidents affected the nerve and were not recoverable. State-of-the-art and methods of treatment (e.g., recompression) are discussed. A good biophysical reference for decompression sickness.

37. BERTOIN, R.
Prévision des accidents labyrinthiques par decompression.

38. MAGNOTTI, T.
Alterazioni del naso, laringe ed orecchio in animali sottoposti compressione e decompressione di aria (aviatori e lavoratori dei caissoni).
Otorinolarincol. Ital. 6, 1936. N.V.

39. SHILLING, C. W., and J. A. HAWKINS.
Hazard of caisson disease in individual submarine escape.
40. SINGSTAD, O.
Industrial operations in compressed air.

Describes theories of compressed air illness and in particular, vertigo (p. 513).

41. WILLHELMY, G. E.
Ear symptoms incidental to sudden altitude changes, and the factor of over-
closure of the mandible-preliminary report.

See also Costen (1934, #302), Finto (1966, #446), and Kelly and Langheins (1946, #69).

42. ARMSTRONG, H. G.
The effect of flight on the middle ear.

Early reference to aero-otitis media with inclusion of reference to
vertigo as a symptom.

43. SHILLING, C. W.
Quantitative study of mental and neuromuscular reactions as influenced
by increased air pressure.

Mentions among other things, dizziness on compression (p. 379).

44. BERTOIN, R.
A propos des accidents labyrinthiques par decompression.
J. de med. de Lyon 19:457-460, 1938. N.V.

45. SHILLING, C. W.
Compressed air illness.

A very good earlier review of the literature, "cause, symptoms, treatment
prognosis, prophylaxis (p. 9)" of decompression sickness.

46. CHIAPPE, E.
Lesioni dell'orecchio interno da decompressione. (Rilievi, Istotopologici)
Otorinolaringol. Ital. 9:149-178, 1939. (Cited by A. Pagano, 1939.) N.V.

47. CRESPI REGUZZI, A.
Contributo clinico alle malattie professionali dei cassoni.
Arch. Ital. otor. 51:408-420, 1939. N.V.

48. MANICAN, T. P.
OtoIogic aspect of caisson disease.

Mentions labyrinthine involvement.

1940-1949

49. GANDINO, D.
La malattia dei cassoni dal punto di vista otoistrico.
Rassegna di med. industri. 11:142-148, 1940. N.V.

50. REQUARTH, W. H., and R. E. BENSON.
Compressed air illness with special reference to the middle ear.
Indust. Med. 9:115-121, 1940. N.V.
51. **Harker, H. W.**
Aerodynamic media in compressed air workers; treatment with helium-oxygen mixtures.

52. **Shilling, C. W.**
Compressed air illness. III through VI.

A continuation of a previous paper with special mention of the fact that "Meniere's symptom complex is relatively common and vertigo, either alone or associated with other symptoms, is frequently noted (p. 237)," but no reference is given. The reference list is otherwise very complete, much of it not often reviewed by modern authors.

53. **Shilling, C. W.**
Compressed air illness.

(Review of literature 1936-1940 incl.)

An update of the previous paper where "joint pathology" and "otological effect(s)" are considered the two special problems, i.e., "given more notice than before" (p. 309). Four references to the latter problem are given, and nine to the former. This paper probably dates a turning point in DCS studies toward an increased emphasis on joint pathology. (NK)

54. **Aldous, R.**
Industrial otology in caisson workers.

Mentions a Meniere-type syndrome and gives a good review. A good discussion follows.

55. **Blinke, A. R.**
Physiologic studies pertaining to deep sea diving and aviation, especially in relation to the fat content and composition of the body.

A good description of bubble formation and fat. The central nervous system and vestibular system may have a relatively high fat content compared to other structures.

56. **Campbell, P. A.**
Acute sinusitis.
*Arch. otolarvngol.* 35:107-114, 1942.

57. **Shilling, C. W., and Everley, I. A.**
Auditory acuity in submarine personnel. Part III.

This article contains a good bibliography of earlier work plus case histories of the authors. The distinction is made between barotrauma-type problems which result in vestibular and auditory problems versus Meniere-like syndromes most likely due to nitrogen bubbles causing "aural lesions (p. 669)." Vertigo as an accompanying symptom is mentioned (p. 675).

58. **Bert, P.**

In this classic, case histories of Bert's and others are reported. Vertigo, "dizziness," "vomiting" (p. 363) are mentioned frequently. For example, the author had the bends and vomited. "...reflex movements of the eyes... caused by the slightest stimulus (p. 381)" may be an example of nystagmus. "...sight was affected, and I saw my arm moving much as one perceives objects after he has whirled about several times (p. 385)," may be an example
of the osseous illusion (Graybiel & Hupp, 1946, p. 394) (RK). I was dazed and my eyes refused to serve me at all. I saw only at long intervals, and for a second at the most, then everything disappeared to reappear only after a few moments in the same way (p. 385)." It may have been nystagmus. (RK)

59. DICKSON, E. D. D., J. E. G. McGIBBON, and A. C. P. CATTLE.
Acute otitic barotrauma—clinical findings, mechanism and relationship to the pathological changes produced experimentally in the middle ears of cats by variations of pressure.
J. Laryngol. 58:456, 1943. N.Y.

60. OGDEN, F. W.
A study of altitude chamber aero-otitis media.
U.S. AAF School of Aviation Medicine, Randolph, Field, Tex., Report No. 1, Project 147, 5 May 1943. N.Y.

61. ENGEL, C. L., J. P. WEBB, E. B. FERRIS, J. ROMANO, H. RYDER, and M. BLANKENHORN.
A migraine-like syndrome complicating decompression sickness.
War Med. 5:304, 1944.

62. SHILLING, C. W.
Aero otitis media and auditory acuity loss in submarine escape training.

63. BEINKE, A. R.
Physiologic effect of pressure changes with reference to otolaryngology.
Deals mainly with barotrauma as a middle ear problem.

64. BROCH, C. A., C. H. CRONICK, H. L. IDTLEY, E. J. KOCOUR, and W. O. KLEINHAN.
Nervous system dysfunction in adaptation to high altitude and as postflight reactions.
The article provides case histories of altitude decompression sickness. The first diagnostic category employed is "Disturbances of equilibrium and coordination (p. 157)." Case No. 1 (p. 158) shows dizziness, ataxia, and nystagmus.

65. STEWART, C. B., O. N. WARWICK, and G. L. BATEMAN.
Acute otitic barotrauma resulting from low pressure chamber tests.

66. ANON.
Barotrauma.

67. GRAY, J. S., S. C. P. MAHADY, R. L. MASLAND, and H. S. WIGODSKY.
Studies on altitude decompression sickness. I. Symptomatology.
Nausea, vomiting, pallor, sweating, faintness (p. 339) are considered circulatory reactions in this report.

68. HAINES, H. L., and J. D. HARRIS.
Aerotitis media in submariners.
A good review of the problem, mentions vertigo as one of the symptoms.

69. KELLY, W. J., and H. W. LANGHEINZ.
Dental treatment for the prevention of aerotitis media.
The authors report a successful dental treatment in 46 of 50 cases of persons diagnosed with aerotitis media in submarine training. A similar
effort could perhaps be made in diver training where a careful and meticulous dental examination might be performed after tests for ability to clear the ears are conducted. This might: (a) return to training persons who fail; (b) identify persons who could develop chronic problems later in their diving careers. Behnke (1969, #225) reports that in "...5 to 25% of all compressions to 50 psi (about 30,000 compressions) applied to American submarine personnel...[the personnel] have been unable to accommodate readily to the excess pressure (p. 261)." See other articles by the senior author.

70. LENTINE, J.
A review of one hundred cases of acute aero-otitis.

71. LUND, D. W., J. H. LAWRENCE, and L. B. LAWRENCE.
Latent neurologic manifestations following decompression.
Dizziness and vomiting are reported, among other findings.

72. BEHNKE, A. R.
A review of physiologic and clinical data pertaining to decompression sickness.
Naval Medical Research Institute, Bethesda, Md., Report No. 4, Project No. X-443, 13 May 1947.
An excellent review of DCS and one of the few works to review directly (see Table 4) the studies of Helzer, Hager, and von Schrötter (1895, #7). Of those with DCS: they report 70% bends, 8% vertigo and Menière's, 6% "chokes," 4% sensory disturbances, and 12% motor paralysis; the latter two may also contain vestibular involvement. (NK) Although not widely available, this is a very good report. See also Behnke (1971a, #261) for a similar updated report.

73. DICKSON, E. D. D., J. E. G. McGIBBONS, and A. C. P. CAMPBELL.
Acute otitic barotrauma—clinical findings mechanisms and relationship to the pathological changes produced experimentally in the middle ears of cats by variations of pressure.
In E. D. D. Dickson (Ed.) Contributions to aviation otolaryngology, pp. 60-83. London: Headley Brothers, 1947. N.V.

74. SHILLING, C. W., H. L. HAINES, J. D. HARRIS, and W. J. KELLY.
In a discussion following the paper the influence of the mandible (p. 55) was mentioned and should be compared to Pinto (1966, #436).

75. ASCHAN, G. K.
Aerotitis media and aerosinusitis.
Acta Otolaryngol. (Stockh) Suppl. 69:1-93, 1948. N.V.

76. HARVEY, W.
Investigation and survey of malocclusion and ear symptoms, with particular reference to otitic barotrauma (pain in ears due to change in altitude).
This article should be considered along with Costen (1934, #302) and Pinto (1966, #436).

77. KEREKES, G.
Contributions oto-rhinologiques a la connaissance de la maladie des caissons.

78. ORTIZ, R. B.
Barotrauma otico.
79. **Uffenorde, H.**  
Oto logical experience with “Schnorchel”-equipped submarines.  
Monograph on Submarine-Medicine, Folio VII. U.S. Naval Forces,  
Germany. (Technical Section, Medical.) Date uncertain, 1948.  

Discuss es the barotraumatic effect of Snorkel submarines, particularly in heavy seas. Reports that the symptomatology in some cases included thickened ear drums, upper range hearing loss (p. D-III-5), balance disturbance and dizziness (p. D-III-6), spontaneous nystagmus (p. D-III-7).

80. **Vanden Aue, O. E.**  
Caisson disease—in the case of Ferguson, Charles P., M.D., 250-54-57.  
U.S. Navy. Naval gun factory, EDU. (aboard U.S.S. Chanticleer ASR-7),  
Report to Chief, BuNed, 6 November 1948. N.Y.

81. **Weersma.**  
Barotrauma del seno e dell'orecchio.  

82. **Boies, L. R.**  
Acute otitis media.  

83. **Flanagan, J. C.**  
Techniques for developing critical requirements from critical incidents.  

An excellent methodology for problem definition. Of potential utility in surveys of diver accidents.

1950-1959

84. **Filippi, P.**  
Sui rapporti fra pressione del liquore cerebrospinales e pressione endolabirintica nel gatto.  

85. **Behnke, A. R.**  
Decompression sickness following exposure to high pressures.  

A good review paper with a summary of 1,361,461 decompressions.

86. **Ferris, E. B., and G. L. Engel.**  
The clinical nature of high altitude decompression sickness.  

87. **Fulton, J. F. (Ed.)**  
*Decompression sickness, caisson sickness, diver's and flier's bends and related syndromes.* Philadelphia: W. B. Saunders, 1951.  

There are many good articles in this book. The ones considered most important are referenced individually.

88. **Gersh, I., and H. Catchpole.**  
Decompression sickness: physical factors and pathologic consequences.  

See especially pages 165-171.
89. PAGANO, A.
Sinusopatie da barotrauma.

90. WAITZ, C. L.
Medical problems of an underwater demolition team.

Aerotitis media and external ear infections are discussed.

91. DESPONS, M.
Labyrinthe-traumatisme chez un ouvrier de caissons. (Labyrintho-trauma in a caisson worker.)

Two other papers dealing with neurological/labyrinthine problems of caisson workers are also listed (p. 616).

92. MEDA, E.
A research on the threshold for the Coriolis and Purkinje's phenomena of excitation of the semicircular canal.

93. PASHALIAN, S., W. J. E. CRISST, A. I. SIEGEL, and E. P. BUCKLEY.
The interview: I. A selectively abstracted bibliography.
U.S. Navy Submarine Medical Center, New London, Conn., Report No. 1, Project NM 002 016.01, 2 June 1952.

If vestibular problems are increasing in incidence, techniques described in this article will be useful in studying the true base rate in diver population.

94. PORSTMANN, M., and G. PORSTMANN.
Auricular disorders due to a brutal decompression.

95. BERTOIN, R.
Evolution clinique des accidents labyrinthiques survenant chez les ouvriers travaillant en air comprime. (Clinical evolution of labyrinth accidents in the ears of compressed air workers.)
Arch. Mal. Prof. 14:221-224, 1953.

The author asks for better diagnostic categorization of these maladies. He also feels that some chronic cases of VIIIth nerve disorder (balance problems, etc.) worsen with time.

96. CHOSSEGROS, H., L. ROCHE, and L. MIGEON.
Les Attaintes vestibulaires graves dans la maladie des caissons.
(Grave vestibular hits in decompression sickness. Partial translation by F. Russo, NNRI, 1972.)

The author differentiates between vestibular hits in dem workers due to compression and those due to decompression. It is his opinion that the latter are more traumatic and are more likely to be chronic.

97. McCALLUM, R. I., and D. N. WALDER.
Compressed-air illness on Tyneside.

Vomiting is reported in 1 of 2 cases, but is most likely due to causes other than vestibular.

98. PAGANO, A.
Ricerche audiometriche nei barotraumi da cassoni.

11
99. CLARK, B., and M. A. NICOLSON.
Aviator's vertigo: A cause of pilot error in naval aviation students.

100. PAYTON, W. D. H., and D. N. WALDER.
Compressed air illness. An investigation during the construction of the
Tyne Tunnel, 1948-50.
Medical Research Council Special Report Series No. 281. London: Her
Majesty's Stationary Office, 1954.

The main symptoms recorded were: "Pain, aching, burning, gripping,
stabbing, tingling (p. 10)," and perhaps for this reason vestibular
symptomatology is being underestimated, since there is no category for recording
it.

101. ROGER.
Variations de l'EEG chez l'homme en fonction de la pression.
Rev. de Neurol. 51:6, 1954. (Cited by A. Pagano, 1959.) H.V.

102. AMBROSIO, L., V. MAZZA, and C. SERRA.
Comportamento della attività elettrica corticale e dell'equilibrio
elettrolitico in operai affetti da mal dei cassoni.
(STATUS OF THE CORTICAL ELECTRIC ACTIVITY AND OF THE ELECTROLYTE
EQUILIBRIUM [BAlANCE?/ IN WORKERS AFFECTED BY CAISSON SICKNESS.)

Electrolyte imbalances relative to EEG changes in connection with compressed
air work are reported. There is a relationship of EEG changes to the high
pressure nervous system syndrome (Bennett & Towe, 1971, #264) possible
relationships of fluid balance to decompression sickness (Warwick, 1942,
#309; 1943, #311) and Meniere's disease (Simpson, 1965, #424) elsewhere
in this bibliography. Also numerous labyrinthine symptoms in case
histories are reported (pp. 883-893).

103. BEHNKE, A. R.
Decompression sickness.

A review paper with minor mention of vestibular involvement as a symptom
of DCS, although dizziness and nausea are included in several case histories.

104. HAYMAKER, W., and A. D. JOHNSTON.
Pathology of decompression sickness. A comparison of the lesions of airman
with those in caisson workers and divers.

The authors describe their own findings in relation to a very large literature.
A good bibliography is included.

105. KOMENDANTOV, G. L.
Vestibular nystagmus in conditions of lowering barometric pressure.
In The functioning of organisms under conditions of changing gaseous
(In Russian, trans. by J. Diachenko, NHRI, 1972.)

Changes in post rotational nystagmus (induced by rotation) were noted
as a function of altitude. In general, changes begin to occur above
5,000 meters.

106. KRATOVCHIL, C. H.
The contributions of Alphonse Jaminet to an understanding of decompression
sickness.

Of historical interest, and indicates Jaminet himself suffered dizziness
after decompression.
107. ADES, H. W., A. GRAYBIEL, S. N. MURRILL, G. C. TOLHURST, and J. S. REYER.
Mystagmas elicited by high intensity sound.
U.S. Naval School of Aviation Medicine, Pensacola, Fla., Joint Project
NH 13 01 99, Subtask 2, Report No. 6, 15 February 1957.

Because vestibular responses are obtained in deaf persons by noise and
because compression chambers are noisy, vestibular testing at depth
must take this relationship into account.

108. BOZZI, E.
Il comportamento dell'Orecchio interno nel' Esercizio del nuoto
subacqueo con auto-respiratore ad aria.
Minerva Otorinolaringol. (Torino) 7:376, 1957. N.V.

109. CROSS, E. R.
Prevention of diving disease.
Water World 2:30, 44-45; May/June 1957. N.V.

110. KOOPERSTEIN, S. I., and B. J. SCHUMAN.
Acute decompression illness. A report of forty-four cases.

Presselection on the basis of: (a) ability to equalize pressure, (b) ear
drum inspection, and (c) no untoward effects with the expiration of the
first work shift (p. 493) may have contributed to the low base rate
(.0318X). (RK)

111. LANPHIER, E. H.
Diving medicine.

Calls attention to the vestibular reaction of caloric irrigation from
cold water (p. 122) and equilibrium disorder with spinal lesion (p. 128).

112. MELVILLE-JONES, G.
Review of current problems associated with disorientation in man-controlled
flight.
Flying Personnel Research Committee, Royal Air Force, Farnborough, England,
October 1957.

A good review paper with reference to pressure vertigo (p. 22 ff.). Also
describes a possible mechanism.

113. ARSLAN, M., and V. BOTNER.
Orecchio e sistema nervose vegetative.

114. BACKUS, J.
Tinnitus.
Skin Diver 7:25, Dec. 1958. N.V.

115. BRUZZI, B.
Sindrome otorinoistriche nella malattia dei cassoni.

116. BUSCAINO, V. M.
Sindrome neurologiche nella malattia dei cassoni.

117. FIELDS, J. A.
Skin Diving: Its physiological and otolaryngological aspects.

An important but short paper. Mentions how during descent underwater, the
stomach contents reorient themselves which can lead to problems, particularly
as the stomach gas bubble expands with compression, and gastric secretion can
be forced into the esophagus (p. 537). In addition, the contribution of a
"plug of carumen" (p. 539) to vertigo is mentioned.
118. DE VITA, C.
Concrlbuto al studio delle sinusiti barotraumatiche.

119. NOURRIT, P.
Barotrauma of inner ear. Experimental-clinical study. Contribution
to prevent auricular accidents in workers performing jobs in
compressed air. (65 references.)
Theesis, Marseille, 1959. N.Y.

120. PAGANO, A.
Otopatia e sinuscopatie da barotrauma nei lavoratore dei cassoni.
Napoli: Casa Editorice V. Idelson di e Macchi, 1959.

This text deals specifically with inner ear and sinus problems in
caisson workers. Early literature is reviewed and case histories are
given. A very good and complete book (more than 250 pp.).

121. PICARD, D., A. APPAIX, and P. NOURRIT.
Lesions histologiques de l'oreille interne consecutives a des
barotraumatismes experimentaux chez la Cobyse.

122. ROZSAHEGYI, I.
Late consequences of the neurological forms of decompression sickness.

This paper is a report of a follow-up of the cases first seen and reported
in a previous report (Rozsahegyi & Soos, 1956, #122a). Relative to the
vestibular system and its central connections is a "pseudo Meniere's
syndrome" which is central rather than peripheral and is probably caused
by a lesion of the medullary vestibular nuclei. It is often associated
with paresisis and signs of syncope or parasympathetic disturbances.
From the author's description one is reminded of the report by Simpson
(1965, #424) that prior to his death, Meniere was attempting to relate
the disease which bears his name to forms of migraine and was suggesting
fluid retention as a similar mechanism for both. The paper by Engal,
(1944, #61) on migraine-like symptoms in DCS is also worth noting. Further,
the comment often made (cf. van Ransselaar, 1891, #4) that diuresis occurs
in compressed air workers and high fluid exchange rates as part of a
person's habit afford some protection from DCS. The fact that sodium
excretion is reduced by compression (Radomski & Bennett, 1970b, #505)
and ADH is released during unusual vestibular stimulation (Taylor, et. al.,
1957, #363) may all be connected.

122a. ROZSAHEGYI, I., and I. SOOS.
Caissonkrankheit und Zentralnervensystem.
*Arbeitsmedizin*, Heft 30. Barth, Palsig, 1956. N.Y.

1960-1969

123. CAMPBELL, P. A.
Aero-otology.
Hagerstown, Md.: W.F. Prior, Co., Inc. 1960a.

124. DONNWELL, A. M., Jr., and C. P. MORTON.
Successful use of the recompression chamber in severe decompression
sickness with neurocirculatory collapse.

Dizziness, nausea, and vomiting (p. 1006) were reported; perhaps they were
syncopal rather than vestibular.
125. FLOTDES, L., and R. RIU.
The ear and the Navy.

126. OOLDING, F. C., F. GRIFFITHS, H. V. HEMPLEMEN, W. D. M. PATON, and D. N. WALDER.
Decompression sickness during construction of the Dartford Tunnel.

This paper points out the difficulty in adequately assessing the incidence of decompression sickness of vestibular origin. First, only cases severe enough “for the man to bring himself back for treatment” are included (p. 168). Second, it would appear that pain as a symptom (perhaps accompanied by dizziness) would still be classified as type I. Nonetheless, after pain, vertigo is the next largest symptom category. The authors also report that type II symptoms when they appear, do so with shorter latency than type I, and so, if compressed air workers were alert for their appearance, it is possible mild, type II symptoms could be used as an early sign of type I, and recompression could begin sooner.

127. HELLER, M. F.
Skin diving injury.

A hearing loss post-dive occurred, but vestibular problems are also mentioned (viz., dizziness and gaze nystagmus).

128. APPAIX, A., D. PICARD, and P. NOURRIT.
Les barotraumatismes cochléaires. Dossiers expérimentaux. (Cochlear barotraumas, experimental data.)

Histological sections are shown.

129. BOUCHE, J., J. SIARDET, and H. HANNEQUIN.
A propos de deux cas de surdité cochléaire à l'occasion de plongées sous-marines.

130. COLES, R. R. A., and J. J. KNIGHT.
Aural and audiometric survey of qualified divers and submarine escape training tank instructors.

The authors attempt to distinguish vertigo due to syncope from that due to vestibular involvement. Report hypo function from caloric stimulation in older divers. A good review and excellent bibliography of auditory and vestibular studies.

131. JARRETT, A. S.
Ear injuries in divers.

132. LAMBERTSEN, C. J.
Harmful effects of oxygen, nitrogen, carbon dioxide and carbon monoxide. Decompression sickness.

133. MALETTE, W. G., J. B. FITZGERALD, and A. T. K. COCKETT.
Dysbaria. A review of 35 cases with suggestions for therapy.
USAF, Aerospace Medical Center (ATC), School of Aviation Medicine, Brooks AFB, Texas, 1961. N.V.

134. NICOLET, L., P. MERER, and R. JAFFRES.
De l’existence des manifestations neurologiques chez les travailleurs en caisson présentant des lésions ostéo-articulaires barotraumatiques.
(On the existence of neurological manifestations in caisson workers presenting barotraumatic osteo-articular lesions).
The author emphasized the importance of diving medicine. He speaks of the mechanics of pressure upon the ear and sinuses and how it creates lesions through increased blood pressure. He also delineates the difference between compression and decompression sickness, and their different treatments. He states the prognosis of compression to be much more favorable than that of decompression.

In this article it is stated that vertigo occurs in divers and is probably due to caloric irrigation.

The article reviews well the literature of labyrinth problems in compressed air work. It shows that evidence of auditory (hearing) and vestibular (caloric) loss is greater in a group of workers who had had acute caisson disease than in a group of workers who hadn't; the latter also had larger deficits than would be expected although a normal (control) group was not studied. Etiology is discussed.
145. HIDALGO, F. C.
Syndrome de descompresión. (Decompression syndrome.)

146. LANG, J.
L'evocation du nystagmus opto-cinétique a l'aide d'un nouvel appareil et l'importance diagnostique de la méthode.

147. EDE, A.
Experience with moderate hypothermia in the treatment of nervous system symptoms of decompression sickness.

Feel greater concern should be given to CNS symptoms of DCS. Reports 7 case histories, 5 of which show sensory neurological residual deficits. Dizziness and disconjugate eye movements are reported in two case histories.

148. GRAYBIEL, A.
Significance of vestibular organs in problems of weightlessness.

The similarity of motion sickness symptomatology to symptoms from other "functional disorders resulting from a disturbance of the normal pattern of central nervous system integration (p. 26) are discussed. To the author's list might be added "decompression sickness." (RK)

149. GWOZDIEWICZ, J., and L. LABA.
Niestowy obraz neurologiczy w przypadku choroby ksenowej u nurka. (An atypical neurological picture of a case of caisson disease in a diver.)

150. HARDACRE, L. E., and R. S. KENNEDY.
Some issues in the development of a motion sickness questionnaire for flight students.

A questionnaire similar to this could be constructed in order to assess past history of vestibular involvement in compressed air work.

151. LABA, L.
Porne nastepstwa choroby ksenowej u nurków. (Late consequences of the decompression sickness in divers.)

Written in Polish, but the English summary indicates the author discusses pathology in divers.

152. MACKAY, D. E.
Comments on therapeutic recompression.

The author reports that most persons had pain only (62%). The remainder had other symptoms with or without pain. Many of these other symptoms
could have a vestibular basis. If a liberal criterion of what constitutes vestibular involvement is employed, 50% might involve the vestibular system (e.g., nausea, vertigo, disorder of sensations, etc.).

153. RIVKIN, J. C.
Decompression sickness among divers: an analysis of 935 cases.
U.S. Navy Experimental Diving Unit, Wash. D.C., Report No. 1-63,
1 February 1963.

One of the very best epidemologic studies of DCS. Table 14 (p. 12) shows the frequency of signs and symptoms. Those individual symptoms which could be due to vestibular involvement are reasonably prominent. It is felt that vestibular symptoms when reported occur often enough as initial manifestation and should be emphasized more to divers as possible premonitory signs of more painful or serious DCS.

154. ADLER, H. F.
Aeromedical reviews: Dysbarism.
USAF School of Aerospace Medicine, Brooks AFB, Texas, Report No. 1-64,
AD 601600, February 1964.

This is a very important but little referenced review of studies of compressed air. The accompanying bibliography is excellent. Of particular importance for this bibliography are the following: (1) reference to high fluid intake (p. 60) and tolerance for decompression sickness (cf. studies of Meniere's hydrops); (2) vestibular problems with reference to "bubbles in the labyrinth or cerebellum: (p. 76) as a likely locus; (3) "effects on the ear... (are considered) one of the most common manifestations of altitude dysbarism" (p. 117-125); and (4) the relationship of "barodontalgia" (p. 125) to sinus problems (p. 129), and "mal position of the jaw" (p. 119).

155. ALNOR, F. C., H. HERGET, and J. SENSING.
Drucklufterkrankungen. (Air compression sickness.)
Munich, Barth, 1964.

156. ANDERSON, B., Jr., R. E. WHALEN, and H. A. SALTZMAN.
Dysbarism among hyperbaric personnel.

157. SEEMANN, K.
Vorschlag zur Klassifizierung von Trommelfellbefunden beim Barotrauma des Mittelohrs. (Proposal for classification of tympanic membrane findings in barotrauma of the middle ear.)

158. SIIRDE, E. K., and V. A. SYARGAVA.
Ostotoryenni lorarganov vs kvalangistov i. vodolagov. (Some otorhinological observations in frogmen and divers.)

Probably the same as #159.

159. SIIRDE, E. K., and V. A. SARGAVA.
(Some otorhinological observations in frogmen and divers.) English abstract trans. from Russian article.

The similarities of syncope, migraine, Meniere's disease, decompression sickness, and motion sickness should be studied for possible common etiologies. All occur in connection with diving. Simpson (1965, #424) (p. 751) claims that Meniere was working on a paper which called attention to the similar etiologies of certain forms of migraine and Meniere's disease when he died.


A one-page review.


A good review, especially with regard to pressure vertigo (p. 1101), vestibular function, and vestibular illusions/disorientation. A very good bibliography. Main thrust of the chapter is in regard to aviation, but many problems are common in diving. (RR)


The base rate for decompression sickness in U.S. Navy diving is reported as < 1%.


A good paper on nitrogen narcosis.


An epidemiological paper and the one that focused attention on the problem. See also Terry and Denison (1966, #190), and Vorosmarty and Bradley (1970, #252) for American studies.
167. MASPETIOL, R., R. RODDIER, and J. GUTIERRES.
Barotraumas affectant les fonctions cochlée-vestibulaires chez
les travailleurs dans l'air compris. (Scaphandriers-Caissons).
(Barostruma affecting cochlear-vestibular function in workers under
compressed air. Divers-Caisson workers.)

168. MASPETIOL, R., and R. RODDIER.
Barotrauma affecting the cochlear vestibular functions occurring
in workers performing jobs in compressed air.
Arch. Mal. Prof. 26(3):164-166, 1965. N.W.

Probably the same as #167.

169. MULHOLLAND, T., and C. R. EVANS.
An unexpected artefact in the human electroencephalogram concerning
the alpha rhythm and the orientation of the eyes.

Changes in EEG are symptoms of the HPNS syndrome and this study suggests
that eye movements are related to EEG changes. The relationship of eye
movements to vestibular stimulation is well known (cf. Robinson, 1968,
#565).

170. PAULEY, P.
Decompression sickness following repeated breath-hold dives.

See "dizziness and nausea" (pp. 1028-1029).

171. POMPEIANO, O., and A. R. MORRISON.
Vestibular influences during sleep.

This paper, plus Morrison and Pompeiano (1965, #421), does not dis-
cuss vestibular symptomatology due to decompression, but may suggest
mechanisms and connections of EEG microsleep as a HPNS symptom and
vestibular function.

172. VOTH, A. C.
Autokineia and alcoholism.

Anecdotal evidence suggests Navy divers are heavy drinkers and Van
Ranserlaar (1891, #4) comments on the "fullness of habit" of com-
pressed air workers. Perhaps a correlation exists between drinking
and inhibition of apparent movement. This might suggest that the in-
cidence of subjective vertigo is less in Navy divers than in other
diving groups (e.g., SCUBA). (KK)

173. WALDER, D. N.
Some dangers of a hyperbaric environment.
In I. MCA. Ledingham, (Ed.) Hyperbaric oxygenation. pp. 5-11.
Proceedings of the Second International Congress, Glasgow, September

174. BARNARD, E. E. P.
Aspects of underwater medicine.

A short review paper. Labyrinthine problems mentioned (p. 638).
175. BARNARD, B. B. P., and D. H. ELLIOTT.  
Decompression sickness: paradoxical response to recompression therapy.  
Vomiting was reported but was more likely due to other complications than to vestibular involvement.

176. BOND, G. F.  
Effects of new and artificial environments on human physiology.  
There were no ear problems reported in this paper on SEA-LAB I.

177. CABARROU, P.  
Schema clinique et therapeutique.  
Vertigo as a serious symptom of DCS is mentioned.

178. CABARROU, P., H. HARTHAN, K. H. WEINER, P. ALINAT, and H. D. FUST.  
Introduction a la physiologie de homo aquatiqueu.  
Oto-neurologic changes in deep diving are described.

179. GWOZDZEWICZ, J.  
Mieloapatie na tle przewlekaj postaci choroby kasownik w nurkow.  
(Neupathy in correlation with a chronic form of caisson disease in divers.)  
N.V.

180. HAMILTON, R. W., J. B. MACINNIS, A. D. NOBLE, and H. B. SCHREINER.  
Saturation diving at 650 feet.  
Vestibular problems reported during compression (High Pressure Nervous System Syndrome).

181. KIDD, D. J.  
In addition to mention of dizziness, etc., as a type II symptom, the author suggests that "careful clinical (neurological) examination under pressure is the only reliable way of assessing the effect of treatment (p. 83)." [Underlining mine-NK]

182. KING, P. F.  
Otitic barotrauma.  
A good paper—describes how vertigo can result, and in the discussion the suggestion was made that this malady should be termed "barotraumatic otitis media (p. 551)."
183. LAMPHIER, E. M.
Decompression sickness.

184. LUNDGREN, C. E. G., and L. U. MALM.
Clinical aviation and aerospace medicine: Alternobaric vertigo among pilots.

Replicated their previous study (1965) in pilots and showed an even higher incidence for a problem that has gone largely ignored for divers and pilots.

185. MACINNIS, J. B.
The medical and human performance problems of living under the sea.

Vestibular problems are reported (p. 199) and a large bibliography is presented.

186. OTTOBONI, A., G. PERFUNDO, and G. SPERATI.
La patologia auricolare nei sommozzatori. (Ear pathology in skin divers.)

187. ROZSAHEGYI, I.
O neurologiickych formach dezkompresivni nemoci (kakonove a potupacski nemoci). (The neurological form of caisson disease.)

ENGLISH SUMMARY (from the journal article)
The author gives a survey of his experience with caisson disease. He distinguishes 4 types of the disease: discrete focal lesions of the CNS, a syndrome of multiple lesions of the cerebral hemispheres and the upper brain stem, a syndrome of affection of the thalamencephalon and a spinal cord syndrome. He further deals with the acute and the primary and secondary chronic form of the disease. He stresses the frequency of vegetative and mental changes as well as the variability of the clinical picture of this affection.

188. ROZSAHEGYI, I., and B. ROTH.
EEG studie dezkompresivni nemoci. (EEG study of caisson disease.)

Where labyrinthine forms of caisson disease had occurred, 50% had EEG abnormalities; where CNS forms of caisson disease had occurred, 67% had abnormal EEG's.

189. ROZSAHEGYI, I., and B. ROTH.
Participation of the central nervous system in decompression.

This and other papers by this author describe residual neurological deficits in compressed air workers and of particular interest are involvements of vestibular apparatus and its central connections. These deficits even occur in caisson workers without a history of decompression sickness episodes (although the latter difference is small). The highest "sleep activity (p. 104)" disturbances
occurred in the group "touched by labyrinthopathy (p. 104)."
Divers should be encouraged to be more candid about symptoms
of DCS, particularly when the symptom is of a vestibular or
central nature. (MK)

190. TERRY, L., and W. L. DENNISON.
Vertigo among divers.
U. S. Naval Submarine Medical Center, Groton, Conn., Special
Report No. 66-2, 8 April 1966.
A lower rate than found by Lundgren (1965, #166) but still substantial.
The authors differentiate alternobaric vertigo from other
etiologies.

191. WAGEMANN, W.
Barotrauma und Taucherkrankeiten. (Barotrauma and diseases of
divers.)
Compression problems involving the ear are discussed.

192. WALDER, D. N.
Some problems of working in an hyperbaric environment.

193. BARNARD, E. E. F.
The treatment of decompression sickness developing at extreme
pressures.
In C. J. Lambertsan (Ed.) Proceedings of the third symposium
on underwater physiology. pp. 156–164. Baltimore: The
Williams & Wilkins Co., 1967.
Case histories of decompression sickness occurring during ascent
to the surface are presented and their treatment discussed.
Unlike cases that occur at the surface, relief from symptoms
occurred at a pressure difference of only 60 feet. Very small
pressure fluctuations (one foot out of eighty) were sufficient
to cause noticeable changes in symptoms. Further, pain occurred
immediately and acutely after pressure drops.

194. BENNETT, P. B.
Performance impairment in deep diving due to nitrogen, helium,
neon and oxygen.
In C. J. Lambertsan (Ed.) Proceedings of the third symposium on
& Wilkins Co., 1967.
In connection with a study on performance, the author reported
that at 600 feet "dizziness and nausea and very occasionally
vomiting" occurred "during the latter part of the exposure or at
the initial stop during decompression (p. 334)."

195. BORASI, G., and G. SPERATI.
I. Ipocausale improvvisi nei sommassafi. (Summary in English.)
Two of three divers reported vertigo; one had "ipò-reflessia
vestibulare sempre a destra (p. 898)," that is, suppressed
response in the right ear.
196. BUNLMANN, A. A., and W. WALDVOGEL.  
The treatment of decompression accidents.  
The authors report that from their experiences approximately  
1 in 8 accidents from deep chamber exposures (11-23 ata) in-  
volved the labyrinth and nearly all (9 of 11) of these required  
treatment. Of the remaining accidents (71), 22 did not require  
treatment. The only case of permanent damage involved the  
labyrinth (hearing).

197. DOLL, R. E., and T. E. BERCHAGE.  
Interrelationships of several parameters of decompression  
sickness.  
U. S. Navy Experimental Diving Unit, Wash., D. C., Report No. 7-63,  
1 March 1967.  
The coding of DCS symptomatology is shown in an appendix to this  
paper. The codes for different symptoms which could be a reflection  
of vestibular involvement tend to have high numbers (e.g.,  
12 and 20 for "dizziness/vertigo," and "equilibrium disturbance"  
(p. 28) and tend not to be grouped together. Both of these factors  
could cause underestimation in reporting and data analysis.

198. GOULON, M.  
Résultats de l'oxygénothérapie hyperbare dans 13 cas de pneumoembolie  
gazeuse cérébrale et dans 10 cas d'accident de décompression  
chez des tubristes. (Results of hyperbaric oxygen therapy in 13  
cases of cerebral gaseous emboli and 10 cases of decompression  
accidents in pipe workers.)  
N.-V.

199. GREGG, J. B., and M. R. FERRELL.  
Cochlear and vestibular damage from middle ear pressure change.  
Although most of the references are "Personal Communication" this  
article is a good source for additional cases of vestibular in-  
volveent due to pressure.

200. MCCALLUM, R. I.  
Decompression of compressed air workers in civil engineering.  
Many good articles appear in this collection. The entire book  
should be perused. An item in the Introduction is of interest:  
if a joint pain (bends) occurs in about 1% of all decompressions  
(cf. Doll, 1965, #163; Keays, 1909, #22; Patton and Waldor, 1954,  
#100; and articles in this book), but 19% of "tunnellers in  
compressed air who were symptomless...had bone lesions (p. vi),"  
then perhaps a similar relationship exists between vestibular/  
nervous symptoms and subsequent permanent deficit. Stated  
differently, the incidence of symptoms may underestimate by a  
good deal the ultimate identifiable damage done to an organism.

201. MILES, S.  
Medical hazards of diving.  
In C. N. Davies, P. R. Davis, and F. H. Tyrer (Eds.) _The effects  
of abnormal physical conditions at work_. pp. 111-120. Edinburgh:  
Of 200 diving accidents (SCUBA) reported, 22 died of asphyxia and  
of these, two inhaled vomit. "...a situation may occur where
ill-fitting hoods block the ears so that though the middle ear equalises with
the nasopharynx the external meatus may remain at a lower pressure and the
drum is drawn outwards (p. 119)." More importantly, perhaps, if the hood
has been moved for pressure equalization, some very cold water may be let in.

202. NICHOLSON, A. N., and J. ERNSTING.
Neurological sequelae of prolonged decompression.

Concerns altitude decompression.

203. PANOV, A. G., and M. P. ELINSKY.
Stertse formy iorashenlya nervnoi sistemy dekompressionnoi etiologii u
vodoizov. (Atypical forms of nervous system disorders from decompression
in divers.)

204. ROZSAHEGYI, I.
Decompression tables in civil engineering in Hungary.
In R. I. McCallum, (Ed.) Decompression of compressed air workers in civil
engineering. pp. 41-45. Proceedings of an international working party

205. ROZSAHEGYI, I.
Decompression sickness and the Hungarian schedules.
In R. I. McCallum, (Ed.) Decompression of compressed air workers in civil

206. ROZSAHEGYI, I.
Neurological damage following decompression.
In R. I. McCallum (Ed.) Decompression of compressed air workers in civil
engineering. pp. 127-137. Proceedings of an international working party
Press, 1967c.

This article is a narrative version of Rozsahegyi and Roth (1966b, #189),
with somewhat more speculations, plus a good discussion by symposium
participants.

207. WALDER, D. N.
Adaptation to decompression sickness in caisson work.

208. WALDER, D. N.
The effectiveness of the British decompression table.
In R. I. McCallum (Ed.) Decompression of compressed air workers in civil
engineering. pp. 65-70. Proceedings of an international working party
Press, 1967b. N.Y.

209. WALDER, D. N.
Aetiological factors in decompression sickness.
In R. I. McCallum (Ed.) Decompression of compressed air workers in civil
Press, 1967c. N.Y.
210. WALDER, D. N.
Decompression sickness in tunnel workers.
In C. H. Davlu, P. R. Davit, and T. H. Tyrar (Eds.) The effects of
abnormal physical conditions at work. Edinburgh: E. & S. Livingstone,
Ltd., 1967d.

He points out that while <1% of all dives result in accidents, >20% of the
divers appear to have necrosis. Perhaps similar relationships can be
demonstrated regarding vestibular symptomatology in diving and permanent
vestibular/neurological effects. (RK) In addition, he feels that probably
everyone experiences DCS, but most don't report it because it isn't manly.
Perhaps vertigo, or a similar symptom, could be used to screen persons
who may profit by extra decompression time. (RK)

211. BAYLISS, G. J. A.
Aural barotrauma in naval divers.

This report is mainly of interest as an auditory study. However, the
author's speculation (p. 146) regarding selection procedures as a possible
influence on the low incidence of vertigo in his population vs. others
is important. Shilling and Everley (1942, #57) make a similar point in
another context. These factors could result in an underestimation of the
problem of vertigo in populations with less vigorous selection procedures.

212. DAVIS, C. D.
A review of skin diving hazards.

213. ELINSKII, M. P., and I. V. ROGOZINA.
Tserebral'nye rasstroiatva pri dekonpresslonnoi Bolesni. (Cerebral dis-
orders in decompression sickness.)
Gig. Tr. Prof. Zabol. 12:16-20, 1968. N.V.

214. FRYER, D. I.
Evolution of concepts in the etiology of benda.

A good historical treatment.

215. GILLEN, H. W.
Symptomatology of cerebral gas embolism.

The author states the symptoms of cerebral gas embolism (dizziness,
ausena, and visual disturbances reported in 20% of the cases investigated)
is similar to, and should be compared with, reports of vestibular
symptoms of DCS.

216. KELLEY, J. S., T. E. BERCHAGE, and J. K. SUMMITT.
U. S. Navy Experimental Diving Unit, Wash., D. C., Research Report 10-68,
1968.

217. LABA, L.
Przypadek choroby kesonowej z zespolem Meniera u Nurka, leczony recompressja
z zastosowaniem tlenu pod cisnieniem, 3,4 atm. (A case of decompression
sickness with Meniere's syndrome, in diver treated by recompression with
pure oxygen under 3.4 atm. pressure.)

The English summary indicates that dizziness and vomiting occurred, as well
as pain in lumbar-sacral region.
218. LAMBERTSEN, C. J.
Modern aspects of treatment of decompression sickness.
Symposium on Undersea-Aerospace Medicine, Miami, Florida, May 9, 1968.

219. MCCALLUM, R. I.
Decompression sickness: A review.
Dr. J. Ind. Med. 25:4-21, 1968.

Table I (pp. 6, 7) shows that type II ranges from 2 to 17% in a review of 13 major caisson works between 1914 and 1966. It appears that type I and type II are mutually exclusive, and the former category is used in preference to the latter. This would underestimate the incidence of type II cases.

220. PARKER, D. E., H. E. VON GIERKE, and M. RESCHKE.
Studies of acoustical stimulation of the vestibular system.

This study and references in the author’s bibliography show that noise can result in vestibular stimulation and should be considered in connection with noise levels in pressure chambers (Murry, 1970, #956).

221. RICCIO, D. C., and J. S. THACH.
Response suppression produced by vestibular stimulation in the rat.

A "behavioral approach [providing] a sensitive and quantifiable technique for assessing the effects of vestibular stimulation in animals" (p. 479) is described using FR, VR, VI, and FI schedules.

222. U. S. NAVY.

"The danger of pressure vertigo is that it occurs suddenly, may persist for 10 to 60 seconds, and is apt to occur at a critical time in flight when the plane is either gaining or losing altitude rapidly."

223. WALTREGNY, A., M. LAMEY, and J. MAWET.
Surveillance continue electroencephalographique et electrocardiographique de la plongee a l'air en caisson (4 ATA). (Continuous electroencephalographic and electrocardiographic surveillance of submergence in caisson (4 ATA).)

224. BAYLISS, G. J. A.
Civilian diving deaths in Australia.

The author reports the cause of death in 71 drownings: Decompression sickness was a factor in 9 ("neurological involvement was responsible for most deaths from decompression sickness [pp. 42, 43]"); 30 were cause unknown. Not mentioned but possibly a factor in the cause unknown category is disorientation.

225. BEHNKE, A. R.
New approaches to medical aspects of work in compressed air.

Dizziness and ataxia were reported, in some cases exposed only to 9-16 psi. The author feels that type I DCS should be called "mild (p. 263)" and
type II DCS "serious (p. 264)." He feels also that residual impairment is likely with serious DCS. Other studies are reviewed where the ratio of type I to type II is between 6:1 and 24:1. The importance of the patency of auditory tubes, and auditory acuity as a concern are mentioned (p. 261).

226. BENNETT, P. B.
Hazards of inner space.

"Sometimes the tremors were accompanied by dizziness, nausea, and even vomiting [to depths between 90 and 240 meters] during the latter part of the exposure or during decompression (p. 66)."

227. BRIERLEY, J. B., and A. N. NICHOLSON.
Neuropathological correlates of neurological impairment following prolonged decompression.

In addition to a report of cerebellar and other CNS pathology this paper contains a useful bibliography. For connection of cerebellum and vestibular system see Wang and Chinn (1956, #361); Brodal, et al. (1962, #383); and Brodal (1966, #427). For bubbles in the cerebellum, see Erdman (1913, #29).

228. COCKETT, A. T. K., R. T. KADO, and R. M. NAKAMURA.
The patho-physiology of decompression sickness.

229. FRUCTUS, X., and J. C. RICCI.
Reflexions sur deux cas de maladie de la decompression (M.D.D.)
In Bulletin Medsubhyp 1, pp. 10-12, French Association for Subaquatic and Hyperbaric Medicine Service, 13 Marseille, December, 1969.

230. GRIFFITHS, P. D.
Clinical manifestations and treatment of decompression sickness in compressed air workers.

The author distinguishes between type I (e.g., pain) and type II (e.g., chokes, CNS) symptoms. Claims the latter are more traumatic and appear earlier post-dive. It may follow that: (a) type II could be a useful premonitory sign of type I if workers could be encouraged to be candid; (b) some type II symptoms may appear more benign than type I and the worker may ignore them unless type I symptoms occur, with the result that the incidence of type II symptoms is underestimated.

231. KIDD, D. J., and D. H. ELLIOTT.
Clinical manifestations and treatment of decompression sickness in divers.

A good review of diagnostic classification with data. They consider that 'the staggers' "...is a disturbance of labyrinthine function with vertigo, nystagmus, nausea and vomiting (p. 471)."

232. LANG, J., I. ROZSAHEGYI, and T. TARNOCZY.
Investigations of the hearing loss of caisson-workers.

233. MORRISON, L. E.
The ears, the nose, and the diver.
Eye Ear Nose Throat Mon. 48:508-511, September 1969. N.Y.

1970-1972


The authors found no difference in the vestibular ocular reflex at 10 ata induced by head (relative to neck) displacement—but see Hinoki and Terayama (1966, p. 11). This study should be repeated with whole body stimulation to minimize cervical inputs. Then characteristics of the fast phase and slow phase velocity should be studied (RK), in addition to slow phase displacement. See also Kotaskova (1970, p. 51).


Authors state that during the compression phase: "Rapid movements of the head were followed by a slightly delayed sense of re-orientation (p. 23)." "Decompression. One subject (P.S.) developed symptoms indicating loss of sense of balance including nausea and vomiting, especially whilst the eyes were open (p. 24.)." "Lying motionless helped. Decompression was attempted and helped somewhat, but caused syncopal symptoms in the other subject.


The authors report: in a 2-hour exposure to 31 ata, 2 subjects were symptom free; in a four-hour dive to 31 ata, vertigo, tremor, and tachycardia appeared in one subject and nausea in the other; in a third group of 2 subjects, both had tremor, 1 had tachycardia and the other vertigo and nausea; of 3 subjects exposed to 31 ata with excursions to 36 ata, 1 had nausea and vertigo.


This study questions the results of Lippold (1970, p. 247) and Mulholland and Evans (1965, p. 169) regarding eye movements and EEG.

241. EICHEL, B. S., and LANDES, B. S. 
Sensorineural hearing loss caused by skin diving. 

Of two cases of unilateral hearing loss one person had dizziness and balance problems.

242. ELINSKII, M. P. 
Decompression disorders after exposures to a "safe pressure" or a "safe altitude."

Describes some neurological disturbances and provides the translated title of Russian literature appearing within the past twenty years.

243. ENDERS, L. J., and E. RODRIGUEZ-LOPEZ. 
Aeromedical consultation service case report: Alternobaric vertigo. 

Claims alternobaric vertigo incidence may be underestimated. Contributing factors and differential diagnoses are discussed.

244. GRAYBIEL, A. (Ed.) 
Fourth symposium on the role of the vestibular organs in space exploration. 
Naval Aerospace Medical Institute, Pensacola, Fla., September 24-26, 1968. 

This volume plus Graybiel (1965, #417; 1966, #576; 1967, #450) are the best collection of studies of the vestibular apparatus. See also Camis (1930, #299).

Hyperbaric epilepsy and narcosis. 

Several articles which deal with CNS effects (in man and animals) from hyperbaria are contained in this translation.

246. LEHMANN, H. J., K. HELD, and G. WERNER. 
Neurologische Folgezustande der Taucherkrankheit. (Neurological conditions resulting from diver's disease. Trans. by Mrs. A. Woke, NWR, 1972.) 

This study shows that neurological deficits involving the vestibular apparatus and its connections occur in connection with a career in compressed air work (see also Lang, 1971, #278).

247. LIPPOLD, O. 
Origin of the alpha rhythm. 

Changes in EEC are symptoms of the HPNS syndrome, and this study suggests that eye movements are related to EEC changes. The relationship of eye movements to vestibular stimulation is well known (cf. Robinson, 1968, #595).

248. OVERRATH, G., H. MATTHYS, and A. A. BUHLMANN. 
Saturation experiment at 31 ata in an oxygen-helium atmosphere. 

Mentions vestibular symptomatology as part of the high pressure nervous system syndrome.
249. PLANTE-LANCIAMP, T., P. MAESTRACCI, and H. NICOLAI-HARTER.
Deux cas de destruction labyrinthique après plongées.
In Bulletin Madusshyp No. 4, Edite par la Comex B. P. 143 Marseille, 13
Marseille, December 1970.
This article describes two instances of labyrinthine damage. In addition, other articles in this Bulletin contain mention of vestibular difficulties.

250. STANG, P. R., and L. L. WIENER.
Diver performance in cold water.
A good bibliography on cold water performance. Data showed also that one of 14 people were nauseated (p. 393)—perhaps due to caloric irrigation of the vestibular system. (RK)

251. U. S. NAVY.
U. S. Navy diving manual.
Very small mention of vestibular functions is made in this publication.

252. VOROSMARTI, J., and M. E. BRADLEY.
Alternobaric vertigo in military divers.

253. ZALTSMAN, G. L.
Initial manifestations of hyperbaric epilepsy in man.
This compilation (90 pp.) contains chapters from a book of about 300 pages. Most of the articles deal with the CNS effects of compressed air and gas mixtures (e.g., helium and argon), are excellent, and will repay careful reading. (RK) Symptoms of the high pressure nervous system syndrome are reported, particularly with regard to performance and EEG changes. Few references to subjective symptoms "heaviness in the head (p. 49)" and "nausea (p. 50)" are mentioned. Reports of "fullness of the head" are reported (cf. e.g., Wendt, 1951, #345), often in connection with motion sickness.

254. ZINKOWSKI, N.
No air and bad air.

255. ADOLFSON, J. A.
Inert gas narcosis—A review.
Some of the symptoms mentioned are, most likely, of vestibular origin. A good bibliography.

256. ALVIS, H. J. (Ed.)
Hazards of valsalva maneuver. (Editor’s Note.)
Describes the hazards of valsalva when used to clear the ears.

257. ANON.
Unique diving mask reduces jaw fatigue.
Oceanol. Int. 6(3):34, 1971.
Announcement of a new mask by General Aquadyne, Inc., to minimize jaw fatigue. (cf. Pinto, 1966, #436; Costen, 1934, #302; Fields, 1958, #117.)
258. ANON. 
OPNAV Form 9940/1(4-70) Combined diving log--accident injury report. 
10, 19 September 1971.

A case of vertigo is reported.

259. ANON. 
Four divers to try for 5,000 foot "dry" dive. (Man in the Sea.) 
Oceanol. Int. 11-12 August 1971.

This is a report of the same dive described by Sundmaker (1972, #291) 
where vestibular problems occurred.

260. ANON. 
"Dry" dive to 5,025 feet yields valuable data. 
Oceanol. Int. 16-17, September 1971.

Describes the vestibular symptomatology of the University of Pennsylvania 
Institute for Environmental Medicine dive.

261. BEHNKE, A. R. 
Decompression sickness: Advances and interpretations. 

An excellent review and modern version of a previous paper by Behnke (1947, 
#72), but with less discussion of the earlier investigators (e.g., von 
Schroetter).

262. BEHNKE, A. R. 
Personal communication regarding diving physiological decrements (e.g., 
vestibular fluid volume, bone marrow squeeze, and problems of the inner 

263. BENNETT, P. B. 
Psychological, physiological, and biophysical studies of narcosis. 
In C. J. Lambertsen (Ed.) Underwater physiology, pp. 457-469. New York; 

Reporting on the work of others in helium diving, Bennett mentions... 
"dizziness and nausea during compression (p. 465)."

264. BENNETT, P. B., and E. J. TOWSE. 
The high pressure nervous syndrome during a simulated oxygen-helium dive to 
1500 feet. 

A good review of the literature precedes a report of "vestibular decom-
pression sickness, resulting in vertigo, nausea, vomiting and photophobia 
(p. 387)" from 1500 feet in one of two subjects. The remainder of the 
paper deals mainly with a study of other aspects of the HPNS.

265. BENNETT, P. B., and E. J. TOWSE. 
Performance efficiency of men breathing oxygen-helium at depths between 
100 feet and 1500 feet. 

"Dizziness" and "nausea" reported by both divers (p. 1154).
266. BRAUER, R. W., R. O. WAY, M. R. JORDAN, and D. E. PARRISH.
Experimental studies on the high pressure hyperexcitability syndrome
in various mammalian species.
In C. J. Lambertsen (Ed.) Underwater physiology. pp. 487-500. New York:

Behavioral measures of vestibular stimulation in animals are difficult to
assess (e.g., dizziness, nausea), but perhaps are present in connection
with the high pressure hyperexcitability syndrome (see p. 498) as they are

267. BROWN, F. M.
Vertigo due to increased middle ear pressure: Six-year experience of the
Aeromedical Consultation Service.

Case histories of alternobaric vertigo are described.

268. CAVE, F. M.
Some comments on a skin-diving death.

This paper should be read in conjunction with Fields (1958, p. 537, #117)
since the latter offers a mechanism by which the death might be explained.
Cave offers a different explanation.

269. CHOUTEAU, J., J. M. OCANA de SENTICARY, and L. PIRONTY.
Theoretical, experimental and comparative study of compression as applied
to intervention dives and saturation dives at great depths.
Physiological Studies Report N. 1.71 CEMAC, March 25, 1971. (Trans. from
French by M. E. M. Hashmall, ONR contract NO014-67-A-0214-0009 with the
Biological Sciences Communication Project Medical Center, The George
Washington University, Wash. D. C.)

Describes deep dives where symptoms of the high pressure nervous system
(HPNS) syndrome have been observed and includes as part of the syndrome
"nausea, vertigo..." (p. 1). Considers HPNS resembles neurovegetative
symptoms of the vagotonic type (p. 35), and it is known that vagotonic
effects tend to adapt, as in motion sickness.

270. COVEY, C. W.
Simulated dives indicated man can work down to 5,000-foot depths.

The vestibular problems of the 1200 foot University of Pennsylvania,
Institute for Environmental Medicine dive are reported.

271. DEMARD, P.
Hyperbarie et oxygenotherapie hyperbare en oto-rhino-laryngologie.
Doctoral thesis, 1968. 185 p. (Hyperbaria [life under high pressure]
and therapy with oxygen at high pressure in oto-rhino-laryngology.)

The latter portion of this thesis deals with barotrauma. It has an ex-
haustive bibliography, and case histories and epidemiology are included.
The particular interest is the section on "Barotrauma of the Internal Ear"
(p. 211 of the NAVSHIPS Translation).
272. EDMONDS, C.
Vertigo in diving.
Royal Australian Navy School of Underwater Medicine, Balmain, N. S. W.

An outstanding review article—probably the best single source regarding
the medical implications of the vestibular apparatus in compressed air
work. A nosology for differential diagnosis of vertigo in diving is
offered (p. 7), and this or a similar classification should be adopted.
Case histories are included; etiologies and countermeasures are suggested.

273. FRUCTUS, X., and P. FRUCTUS.
Research program on using various gaseous mixtures for very deep dives.
Trans. from French by L. J. Robbins. NAVSHIPS Translation No. 1276, 58.

Vertigo, disorientation, and vomiting mentioned throughout. Additionally,
the high pressure nervous system syndrome is described, and symptoms of
drowsiness are emphasized. The soporific effect of vestibular stimulation
is well known and should be considered.

274. FRUCTUS, X. R., R. W. BRAUNER, and R. NAOMIET.
Physiological effects observed in the course of simulated deep chamber dives
to a maximum of 36.5 atmospheres in a helium-oxygen atmosphere.
In C. J. Lambertsen (Ed.) Underwater physiology. pp. 545-550. New York:

Vestibular problems during decompression (p. 546) are mentioned. Also the
"somnolence" (p. 547) mentioned may be of similar etiology to "drowsiness"
in motion sickness (Graybiel, 1966, #576).

275. HEMPLEMAN, H. V., W. J. EATON, J. M. MORRISON, P. R. BENNETT, and R. N.
BARNARD.
Experimental observations on men at pressures between 4 bars (100 ft.) and
47 bars (1500 ft.).
Royal Naval Physiological Laboratory, Alverstoke, England. Report No. 1-71,
1971.

Vestibular problems reported.

276. JOHNSTON, D. G., and W. D. BURGER.
Injury and disease of scuba and skin divers.

A good section on ear injury.

277. KENNEDY, R. S., W. P. MORONEY, R. M. RALE, H. G. GREGOIRE, and D. G. SMITH.
Comparative motion sickness symptomatology and performance decrements
occasioned by hurricane penetrations in C-121, C-135, and P-3 Navy aircraft.
Naval Aerospace Medical Research Laboratory, Pensacola, Fla., NAMRL-1194,
July 1971.

278. LANCE, J., G. ROZSAHGYI, and T. TAPNOZCZY.
Kochleovestibulare Befunde bei Caissonarbeitern. (Cochleovestibular con-
ditions in caisson workers. Trans. by Mrs. A. Weke, NMMI, 1971.)
(available from Verlag URBA & SCHWARZENBERG, Kommanditgesellschaft, A-1096,
Wien, Frankgasse 4.)

Shows that residual vestibular problems exist in a population of "432, pre-
dominantly under 40, trouble free caisson workers (p. 9)." Refers to a larger
report (100 pp.) of the author and contains a few other references to their
own work.

Vestibular post-dive disorders were obtained in guinea pigs similar to vestibular loss found in a previous study of squirrel monkeys.


Vestibular problems (nystagmus and vertigo) in a dive two weeks previous (p. 1259) did not recur. Some mention of auditory problems.


Reports that "90% of the medical problems of the sport diver are centered around the middle ear (p. 3)."


Even though a conservative criterion was employed, vestibular derangement incidence appears to be increasing. A very good discussion of possible etiologies is included.


The use of this technique should be explored, particularly if one wishes to establish the base rate of vestibular symptomatology (vertigo, ataxia, etc.).


This article reports, among other things, right mandibular numbness. It should be compared with Pinto (1966, #436) and Costen (1934, #302):


35
287. ALVIS, H. J. (Ed.)
Simulated dives to 5,000 feet.

Mentions the vestibular disturbances in the dive conducted at the University of Pennsylvania, Institute for Environmental Medicine.

288. ALVIS, H. J. (Ed.)
Aseptic bone necrosis.

Reporting on a symposium at USN Submarine Base, New London, it was described that 5 to 20% of compressed air workers have aseptic bone necrosis even though they experience no symptoms and may not have experienced decompression sickness. The possibility exists that vestibular deficits are present in the same way in a diver population. (RK)

289. KENNEDY, R. S., and A. R. FRECILY.
Depressed vestibular function in Navy divers as reflected by caloric irrigation thresholds.
In press.

290. KENNEDY, R. S., and J. A. DIACHENKO.
A review of diver vestibular accidents.
In press.

291. SUNDMAKER, W. K. H.
Vestibular function.
Presented at the Special Summary Program-Predictive Studies III, University of Pennsylvania, State College, Pa., 5-7 April 1972.

Of four men exposed to a simulated depth of 1200 ft, three experienced several vestibular problems (nausea, dizziness, nystagmus) with residual effects apparent post-dive. The problems did not appear to coincide with changes in pressure. The symptoms were somewhat similar to those of cupulolithiasis (Schuknecht, 1960, #493), although other diagnoses e.g., Costen's syndrome (1934, #302), epidemic vertigo, bubble formation, etc., are possible.

See also:

ADDENDUM TO CATEGORY I

291a. KONHUBER, H. H.
Neurologie des Kleinhirns. (Neurology of the cerebellum. Trans. and summarized by Mrs. A. Woke, NMRI, 1972.)

The old structure in archi- or vestibulo-, paleo- or spinocerebellum is still useful for clinical orientation. Superior and inferior vermiform processes belong to the spinocerebellum. Both work together to maintain equilibrium and body posture. Lesions produce disturbances in equilibrium. The inferior vermiform process is also connected with position nystagmus. The middle vermiform parts, especially folium and tuch, have a special function: apparently they serve the sight motor field. The anatomically found somatotopic structure of the superior vermiform process is clinically relevant.

291b. VISONZIL, E.
Über eine umschriebene Ansammlung von Otolonien im hinteren harten Bogengang. (A transcribed accumulation of otoconia at the posterior membranous semicircular canal. Trans. and summarized by Mrs. A. Woke, NMRI, 1972.)

The occurrence of a globular formation at the posterior semicircular canal, near the common pillar is reported. The author found this change in three cases of severe nephrogenous hypertonia and in one case of lupus erythematoses. It was found that large masses of otoconia build up this globe, whereby layers of albumin traverse this formation and simultaneously appear to represent the connective mass. The pathogenesis of otoconia migration and masses of albumin is discussed, and the apparently glandular formation at this location of the semicircular canal. This article should be compared with one on cupulothiasis (Schuknacht, 1969, #493).
CATEGORY II. CLINICAL INVESTIGATION OF VESTIBULAR SYMPTOMATOLOGY.

1900-1909

292. BARANY, R.
Berlin: Verlag Von Oscar Coblantz, 1906.
An early report of diagnostic tests.

293. GRAY, A. A.
The labyrinth of animals. Vol. I.
The source for the anatomy of the labyrinth for many animals. The auditory and vestibular portions are described and the dimensions of all the parts are listed.
In man, the caliber of a canal is about 1.4 mm; in mouse, about .25 mm.

1910-1919

294. WILSON, J. G., and F. H. PIKE.
IV. The effects of stimulation and extirpation of the labyrinth of the ear and their relation to the motor system.
Philos. Trans. R. Soc. Lond. A 203:121-159, 1912. N.Y.

295. SCOTT, S.
Vertigo and nystagmus associated with inflation of the Eustachian tube.
It occurs.

1920-1929

296. CHARousek, H.
Zur mechanik des Druckproblems. (The mechanics of pressure symptoms. Trans. by Mrs. A. Woka, NHRI, 1972.)

297. GUILD, S. R.
Observations upon the structure and normal contents of the ductus and saccus endolymphaticus in the guinea-pig (cavia cobaya).
The circulation of the labyrinth is described. The article provides important leads in the diagnosis of vestibular symptoms of decompression sickness. (RK) Good bibliography, long article.

298. GUILD, S. R.
The circulation of the endolymph.
Am. J. Anat. 39:57, 1927b. N.Y.

1930-1939

299. CAMIS, M.
The physiology of the vestibular apparatus.
An old, excellent, and only formal text of the vestibular system. It is largely not out of date. (RK)
300. HUGHSON, W.
A note on the relationship of cerebrospinal and intralabyrinthine pressures.

301. HUGHSON, W., and S. J. CROWE.
Experimental investigation of the physiology of the ear.

The section on methods for measuring the relationship of cerebrospinal fluid pressures and intralabyrinthine pressures is interesting. (RK)

302. COSTEN, J. B.
A syndrome of ear and sinus symptoms dependent upon disturbed function of the temporomandibular joint.

Following removal of the posterior teeth temporomandibular joint problems can occur and vertigo, among other symptoms, has been reported. Long-term mouthpiece use could produce similar problems. (RK)

303. SPIEGEL, E. A.
Vertigo in brain tumors, with special reference to the results of labyrinth examination.

A good article with good references by a person long concerned with the central connections of the vestibular apparatus.

304. MCINTYRE, A. K.
The quick component of nystagmus.

305. SPIEGEL, E. A., and J. B. PRICE.
Origin of the quick component of labyrinthine nystagmus.

The relationship of the fast phase of nystagmus to central arousal centers is discussed.

1940-1949

306. JOHNSON, F. H., D. E. S. BROWN, and D. A. MARSLAND.
Pressure reversal of the action of certain narcotics.

Perhaps a clue to the etiology of some symptoms associated with protracted exposures to high pressures will be found in this and related studies.

307. MCNALLY, W. J., and E. A. STUART.
Physiology of the labyrinth reviewed in relation to seasickness and other forms of motion sickness.

A good review paper for vestibular physiology as well as motion sickness.

308. SMITH, H. W., and C. W. MANNING.
The relationship between daily urinary output and the incidence of decompression sickness.
No. 2 Clinical Investigation Unit, RCAF, August 1942. (Cited in Adler, 1964)

See Warwick (1942, #309; 1943, #311).
309. WARWICK, O. H.
The apparent relationship of fluid balance to the incidence of decompression sickness.
No. 2 Clinical Investigation Unit, RCAF, Regina. Report to NRC, April 1942.
(Cited in Adler, 1964)
High fluid excretion rates appear to afford some protection from DCS Contrast with hydrops in Meniere's disease.

310. WEVER, E. G., C. M. BRAY, and M. J. LAWRENCE.
Effects of pressure in the middle ear.
J. Exp. Psychol. 30:40, 1942. (Cited by A. Pagano, 1959) N.V.

311. WARWICK, O. H.
Further studies on the relationship of fluid intake and output to the incidence of decompression sickness.
(Cited by Adler, 1964)
See Warwick (1942, #309).

312. KOS, C. M., and H. D. SMITH.
Aviation otolaryngology.
Handbook AAF School of Aviation Medicine, Randolph Field, Tex., 1944.
A good handbook. It would be useful if modified for high pressure and underwater otolaryngological examination.

313. MORALES, H. F., E. N. RATHBUN, R. E. SMITH, and H. FACE.
Studies on body composition. II. Theoretical considerations regarding the major body tissue components, with suggestions for application to man. Sp.
U. S. Naval Medical Research Institute, Bethesda, Md., Report No. 2, Project X-191, 7 August 1944. N.V.

314. OGDEN, F. W.
Tubal resistance and aero-otitis media.
U. S. AAF School of Aviation Medicine, Randolph Field, Tex.
Report No. 1, Project 268, 24 June 1944. N.V.

315. TEED, R. W.
Factors producing obstruction of the auditory tube in submarine personnel.

316. BATEMAN, G. H.
The effect of sinusitis on flying personnel.
J. Laryngol. Otol. 60:110, 1943. N.V.

317. NIELSEN, J. C.
Studies of the aetiology of acute otitis media. 191 pp.
Copenhagen: Ejnar Munksgaard, 1943. N.V.

318. SENTURIA, B. H.
Etiology of externa otitis.
U. S. AAF School of Aviation Medicine, Randolph Field, Tex., Project 349,
Report No. 1, 15 pp., 15 January 1945. N.V.

319. BIERMAN, H. R., and I. W. BRICKMAN.
The relationship of dental malocclusion to vacuum-otitis media and the use of dental splints during descent from altitudes.
This paper should be considered with Pinto (1966, #436) and Costen (1934, #302).
320. BROWN, B. R.
The incidence and relation of syncope to decompression sickness.

Syncope reactions and vestibular symptomatology are very similar and may be
confused in decompression sickness.

321. EAGLE, W. W.
Secretory otitis media.

322. KELLY, W. J.
The results of dental therapy in 50 cases of otosclerosis in submarine
personnel based upon a new functional concept of Eustachian tube blockage.
U. S. Navy Submarine Base, New London, Conn. Medical Research Dept. Project
X-434 (Sub. No. 89), Interval Report No. 1, 21 January 1946a. N.Y.

323. KELLY, W. J.
Dental treatment of trigeminal, tinnitus, otalgia and obscure neuralgias.
U. S. Navy Submarine Base, New London, Conn. Medical Research Dept. Project
X-434 (Sub. No. 90), Interval Report 2, 31 January 1946b. N.Y.

324. KELLY, W. J.
A rapid dental treatment for the prevention of otosclerosis media.
U. S. Navy Submarine Base, New London, Conn. Medical Research Dept. Project
X-434 (Sub. No. 90), Interval Report No. 3, 1 February 1946c. N.Y.

325. KELLY, W. J.
An evaluation of a dynamic concept of dental treatment based upon a functional
classification of malocclusion.
U. S. Navy Submarine Base, New London, Conn. Medical Research Dept. Project
X-434 (Sub. No. 90), Interval Report No. 4, 15 February 1946d. N.Y.

326. STERNSTEIN, H. J.
Management of common eye, ear, nose, and throat conditions in naval practice.

327. AHLEN, G.
On the connection between cerebrospinal and intra-labyrinthine pressure and
pressure variation in the inner ear.

Injuries and diseases of the tympanic membrane.
Febiger, 1947a. N.Y.

Diseases of the Eustachian tubes.
In Diseases of the nose, throat and ear. pp. 642-651. Philadelphia: Lea &
Febiger, 1947b. N.Y.

330. CATCHPOLE, H. R., and I. GERSh.
Pathogenic factors and pathological consequences of decompression sickness.

An excellent review paper and of particular use when considered along with what
is known about vestibular physiology in making a differential diagnosis for the
most likely source of a "bubble" with regard to vestibular symptoms, although
the latter are not described as such. They claim that bubbles are about .025 mm
in diameter and plug up arterioles of the same order of magnitude. Semicircular
canals in humans are about 1 mm in diameter (Gray, 1907, #293; 1908, #782). A
good review of the pathology regarding the central nervous system (pp. 373 ff.),
and an exhaustive bibliography.
331. SIMPSON, W. L. and J. E. WUCHER.  
A study of the eustachian tubes and their orifices and lumens in patients  
with large operative defects giving direct visualization.  

332. CARRUTHERS, D. G.  
Diseases of the middle ear.  
In Diseases of the ear, nose, and throat, pp. 201-210. Baltimore: The Williams  
& Wilkins Co., 1948a. N.Y.

333. CARRUTHERS, D. G.  
The complications of supplicative otitis media.  
In Diseases of the ear, nose, and throat, pp. 211-238. Baltimore: The  
Williams & Wilkins Co., 1948b. N.Y.

334. FARRIOR, J. B.  
Lymphoid eustachian salpingitis: its effect on tubal patency.  
Arch. Otolaryngol. 48:212-232, 1948. N.Y.

335. LEWIS, R. S.  
Common accidents to the ears and their treatment.  
Med. Pr. 219:579-582, 1948. N.Y.

336. WEVER, E. G., M. LAWRENCE, and K. R. SMITH.  
Effects of negative air pressure in the middle ear.  

337. JONES, M. F., and F. C. EDMONDS.  
Acoustic and vestibular barometry: air pressure effects on hearing and  
equilibrium on unoperated and fenestrated ears.  

338. LEMPERT, J., E. G. WEVER, M. LAWRENCE, and P. E. MELTZER.  
Perilymph: Its relation to the improvement of hearing which follows fenestration  
of the vestibular labyrinth in clinical otosclerosis.  

Discusses effects of pressure changes within the vestibular labyrinth occasioned  
by surgery. There may be leads here for understanding vestibular problems which  
occur at high pressure. (RK)

1950-1959

339. CHANG, H. T., R. MARGARIA, and S. GELFAN.  
Pressure changes and barotrauma resulting from decompression and recompression  
in the middle ear of monkeys.  

The mechanism of barotraumatic otitis media is described and studied.

340. ENGSTROM, H., and S. HJORST.  
On the distribution and localization of injected dyes in the labyrinth of the  
guinea pig.  
Acta Otolaryngol. (Stockh) Suppl. 95:149, 1950. N.Y.

341. HOOPLE, G. D.  
Otitis media with effusion—a challenge to otolaryngology.  

342. HALLPIKE, C. S., H. S. HARRISON, and E. SALTER.  
Abnormalities of the caloric test results in certain varieties of mental  
disorder.  
343. HAYASHI, S.
Statistical study of mastoid cell development in cases of chronic otis media,
as observed in X-ray pictures.
N.V.

344. MCCANCE, R. A., and E. M. WIDDOWSON.
Composition of the body.

345. WENDT, C. R.
Vestibular functions.
In S. S. Stevens (Ed.) Handbook of experimental psychology. pp. 1191-1223.

346. DIX, M. R., and C. S. HALLPIKE.
The pathology, symptomatology and diagnosis of certain common disorders of the
vestibular system.

Reviews the original works of Meniere regarding diagnosis of Meniere's disease.
Includes also a discussion of other vestibular disorders.

347. HYDE, R. W.
Aeroticis media: A critical review.

348. BORISON, H. L., and S. C. WANG.
Physiology and pharmacology of vomiting.

This pathway can be involved in DCS from vestibular or other stimulation.

349. CROSBY, E. C.
Nystagmus as a sign of central nervous system involvement.

350. ANDERSEN, H. C., O. JEPSEN, and F. KRISTIANSEN.
The occurrence of directional preponderance in some intracranial disorders.

351. LEE, C. J. M., and E. P. SHARPEY.
The effects of the valsalva manoeuvre on the systemic and pulmonary arterial
pressure in man.

352. MILLER-GUERRA.
Le syndrome cerebelleux et le syndrome vestibulaire.
(Cited by A. Pagano, 1959.) N.V.

353. SEYMOUR, J. C.
Observations on the circulation in the cochlea.
Instructor's manual for high altitude physiology training in low pressure chambers. Device 9-A series.
Department of the Navy, Special Devices Center, Port Washington, N. Y.,
NAVEXOS P-1260, April 1954.
A very good and simple description (with figures) of the mechanism of baro-
trauma is offered (pp. 7-9). It also is interesting that vestibular symptoms of DCS are not mentioned as such (pp. 10-12).

355. IRWIN, J. W., F. L. WEILLE, and W. S. BURRAGE.
Small blood vessels during allergic reactions.

356. PERLMAN, H. B., and R. S. KIMURA.
Observations of the living blood vessels of the cochlea.
This article is of use for mapping potential bubble transport. (RK)

357. RYAN, G. H. S., and S. COPE.
Cervical vertigo.

358. WHITE, C. S., J. E. ROBERT, and H. W. MEREDITH.
The relation between dental overbite and aerotitis media.

359. GRAY, L. P.
Extra labyrinthine vertigo due to cervical muscle lesions.
Shows that a combination of vertigo, nausea, and tinnitus can result from localized cervical lesions.

360. VAN EGMOND, A. A. J., and W. F. B. BRINKMAN.
On the function of the saccus endolymphaticus.
Suggests that the function of the saccus is a suction to provide protection within the labyrinth. Pressure changes might perturb function.

361. WANG, S. C., and H. I. CHINN.
Experimental motion sickness in dogs. Importance of labyrinth and vestibular cerebellum.
The connections of the vestibular system with the cerebellum are reported.

362. DEWITT, G.
Acquired sensitivity to sea sickness after an influenza infection.
Perhaps vestibular symptomatology in general is potentiated by illness of flu type. This may be an additional reason not to dive when ill, since decom-
pression sickness type II symptoms often resemble motion sickness symptoms and other similar syndromes have been connected with decompression sickness (e.g., migraine, syncope).

363. TAYLOR, N. B. G., J. HUNTER, and W. H. JOHNSON.
Antidiuresis as a measurement of laboratory-induced motion sickness.
This article shows that a vestibular stimulus (which results in motion sickness) also produces a release of ADH. The antidiuresis which occurs in connection with DCS may also be related to vestibular or vagal stimulation. (RK)
364. ALPERS, B. J.
Symptoms and signs associated with vertigo.

365. CAWTORNE, T.
Vertigo. (President’s address)
A very good description of the phenomenon.

366. FREEBERG, N. E.
Environmental and pilot aspects of the vertigo accident.
Vertigo cases which resulted in aviation accidents are reported.

367. SYNDER, J. P.
Dive reaction scale study. Project NS185-005 Subtask 5, Test 10.
A scale such as this should be re-introduced to diving medicine for many reasons: (a) diagnoses can be made more reliably; (b) saturation diving forms of DCS are less clear cut and probably more serious than previously (see Rubenstein & Summit, 1971, #282), and a rating scale such as this would be useful; (c) a similar approach would be useful for diagnostic classification of perceptual distortions which occur under water. (RK)

368. GERANDIT, B.
Vestibular mechanisms.
In Field & Magoun (Eds.) Handbook of physiology. Vol. I: Neurophysiology.

369. KUIJLMAN, J.
The importance of the cervical syndrome in otorhinolaryngology.
The relationship of vestibular and cervical systems should be considered in the diagnosis of decompression sickness symptomatology. (RK)

370. WING, K. G.
Studies of basic cochlear physiology and the energy-metabolism of the cochlear response in the cat.
A good and long paper (94 pp.), which utilized oxygen and nitrogen to study various responses of the ear in the cat. A large reference list.

1960-1969

371. CODY, D. T. R., and H. L. WILLIAMS.
Cogan’s Syndrome.
A review of previous literature with the addition of four new case histories of "nonsyphilitic interstitial keratitis" (p. 447). Symptoms include vertigo, ataxia, tinnitus, nystagmus, and bilateral sensory neural deafness. Complaints referable to eyes or ears may be premonitory signs. "From the available evidence it would seem that this systemic disease is periarteritis nodosa (p. 473)."

372. FERNANDEZ, C., R. ALZATE, and J. R. LINDSAY.
Experimental observations on postural nystagmus.
USAF Aerospace Medical Center, Brooks AFB, Tex., 60-23, January 1960.
373. JERGER, J., and T. TILLMAN.
A new method for the clinical determination of sensorineural scuity level (SAL).

Characteristics of inflammatory diseases of the nasal sinuses in submariners.

375. LABA, L., and J. RUSZEL.
About permanent injury of the ear in divers.

376. BERGSTEDT, N.
Studies of positional nystagmus in the human centrifuge.
The most complete reference to the influence of alcohol on vestibular functioning.

377. COLLINS, W. E., W. E. CRAMPTON, and J. B. POSNER.
Effects of mental activity on vestibular nystagmus and the electroencephalogram.
The implication of nystagmus and arousal is discussed and should be considered
with reports of lowered arousal in the HPNS syndrome.

378. JONES, G. M.
Pressure changes in the middle ear after altering the composition of contained
gas.
Studied the "normal" steady state partial pressure of oxygen in the middle
ear (ca. 55 mm Hg).

379. KRAUS, R. M.
Early diagnosis of hydrops of the labyrinth.
USAF Aerospace Medical Center, Brooks AFB, Tex., Review 1-61, February 1961.
Hearing losses appear to precede vertigo in Meniere's disease.

and M. G. RAPPAPORT.
Pressure of the labyrinthine fluids.

381. ALLEN, G. W., and M. HABIBI.
The effect of increasing the cerebrospinal fluid pressure upon the cochlear
microphonics.

382. BERNSTEIN, L.
The otology and diagnosis of vertigo.
Discusses epidemiology and methods of differential diagnosis of vertigo
(vesibular versus central nervous system origin).

383. BRODAL, A., O. POMPEIANO, and F. WALBERG.
The vestibular nuclei and their connections, anatomy and functional correlations.
384. BURGER, D., and J. W. VAN DEN BERG. 
Experimental huskiness. (Hoarseness.) 

385. DAVEY, L. M., and W. J. GERMAN. 
The vestibular system and its disorders. 
An excellent article with a very complete bibliography.

386. FLUUR, E. 
The mechanism of nystagmus. 
Different control centers for vertical and horizontal nystagmus are reported.

387. FUREY, J. A., and R. N. KRAUS. 
A clinical classification of vertigo. 
School of Aerospace Medicine Review No. 7-61, U. S. A. F. Aerospace Medical Division (AFSC), Brooks AFB, Tex., AD287069, April 1962.
An excellent treatment of description and differential diagnosis. Of more than passing interest are the sections on epidemic vertigo (p. 1316) vestibular neuronitis (p. 1320) and pseudo (p. 1321) and atypical (p. 1322) Meniere's syndrome.

388. JERGER, J. 
Hearing tests in otologic diagnosis. 

389. PHILIPSSZON, A. J. 
Compensatory eye movements and nystagmus provoked by stimulation of the vestibular organ and the cervical nerve roots. 
This study should be compared with the study of Adolfson, Bjarver, Fluur, and Goldberg (1970, #235). In the latter, head and neck movements were made in hyperbaric air.

390. PINTO, O. F. 
A new structure related to the temporomandibular joint and middle ear. 
If some vestibular problems under water and pressure are shown to be related to Costen's (1934, #302) syndrome, then this article is important. See also Pinto (1966, #436).

391. SANDSTROM, J. 
Cervical syndrome with vestibular symptoms. 
A good paper which points out that the locus for some so-called vestibular symptoms is the cervical region.

392. SCHUKNECHT, H. F. 
Positional vertigo: Clinical and experimental observations. 
An early paper describing the symptoms which were later (Schuknecht, 1969, #493) called "cupulolithiasis."
393. ARNVIG, J.
Transitory decrease of hearing after lumbar puncture.

The author shows that changes in lumbar region can result in functions associated with nerve VIII (nausea and hearing loss).

394. COLES, R. R. A.
Ears and their after effects.

395. COLLINS, W. E., and J. B. POSNER.
Electroencephalogram alpha activity during mild vestibular stimulation.


396. ELIA, J. C.
Practical treatment of otitis externa.

397. FLINN, D. E., and C. J. WOACK.
Neurological manifestations of dysbarism: a review and report of a case with multiple episodes.

Because the symptoms of migraine and vestibular involvement are similar, particularly in connection with decompression sickness, this report is useful.

398. FLISBERG, K., S. INGELSTEDT, and U. ORTEGREN.
The valve and "locking" mechanisms of the Eustachian tube.

399. HARRISON, M. S., and I. NAPTALIN.
Meniere's disease.

Shows a relationship between fluid retention and vertigo in Meniere's disease.

400. NOZUT, M.
Title and article in Japanese.

English Abstract: Observations were made on 51 patients with sudden onset of deafness that was combined with some vestibular disturbances at the Out-patient Department of Otolaryngology at the Tokyo University Medical School Hospital; attentions in these examinations were particularly focused on the types of nystagmuses and the conditions to which the vestibular organs may be disturbed. Directions of the nystagmus varied from simple horizontal to rotatory, direction changing and vertical. From the nature of nystagmus manifested in this way in cases of sudden deafness, the authors believe that, the pathology of this disease is extremely complicated depending upon the degree and the location of the lesion which may be localized in the cochlea or the vestibule; that it may be the influence of some disturbances in the central region particularly the brain stem should also be seriously considered.

401. PHILIPSSOON, A. J., and J. H. BOS.
Neck torsion nystagmus.

Vertigo and nystagmus are generally, but not always, of vestibular origin. Because spinal lesions in DCS can occur, this factor should be considered. (RK)
402. SERRINS, A. J., R. HARRISON, AND J. R. CHANDLER.  
Cogan's syndrome. An audiological evaluation and review of current concepts.  
A disease entity where neurological deficits other than those which involve  
nerve VIII appear absent. The symptoms have some communalities with studies  
of otological deficits in caisson workers. (RK)

403. STEARNS, P. E., and C. F. KASPAREK.  
Catalog of scientific publications, 1942-Present.  
U. S. Naval School of Aviation Medicine, Pensacola, Fla., 31 December 1963.  
(Original publication date; updated periodically.)

This catalog of scientific publications contains more citations of studies  
regarding the vestibular apparatus than any other.

404. SZEKELY, E. G., and A. A. SPIEGEL.  
Vertical nystagmus induced by injection of stimulating substances into the  
striatum, third, or lateral ventricle.  

405. THOMAS, J. J.  
Chemical mechanisms in oxygen toxicity.  

406. ALLEN, G. W.  
Endolymphatic sac and cochlear aqueduct.  
Arch. Otolaryngol. 79:322-327, 1964. N.V.

Surgical anatomy of the endolymphatic sac and perilymphatic duct.  
Laryngoscope 74:480-497, 1964. N.V.

408. COLES, R. R. A.  
Eustachian tube function.  
Inability to equalize a standard pressure level is cause for rejection from  
diver training. It might be interesting to determine whether a negative linear  
relationship exists between hyperbaric vestibular involvement and the magnitude  
of pressure equalization beyond the standard minimum. (RK)

409. JONGKHEIS, L. B. W., and A. J. PHILIPSZOON.  
Electronystagmography.  
Acta Otolaryngol. (Stockh) Suppl. 189, 1-111, 1964. N.V.

410. LUNDQUIST, P. G., P. S. KIMURA, and J. WERSALL.  
Experiments in endolymph circulation.  
Acta Otolaryngol. (Stockh) Suppl. 188, 1964. N.V.

411. MACFIE, W. C. D. D.  
E. N. T. problems of diving.  
The embryology of the ears, nose, and throat is discussed. The author indicates  
that the mechanical reasons for 94% of the separation from diving training "lay  
in the ear, nose, and throat (p. 851)." Barotrauma to parts of the ear is  
discussed. Case histories which also include vestibular difficulties are  
discussed.
412. ANSON, B. J., J. A. DONALDSON, R. L. WAKFENA, and T. R. WINCH.
The vestibular and cochlear aqueducts: their variational anatomy in the adult
human ear.
Laryngoscope 75:8, 1965. N.Y.

413. BERNSTEIN, L.
Simplification of clinical caloric test.

414. DAVIDSON, R. A.
Ventilation of the normal and blocked middle ear. A review of mechanisms.

415. EDWARDS, C. H.
The differential diagnosis of vertigo.
In W. G. Scott-Brown, J. Ballantyne, and J. Groves (Eds.) Diseases of the ear,

416. GERNANDT, B. E., M. IGARASHI, and H. W. ADES.
Effects of prolonged caloric stimulation upon oculomotor, vestibulospinal, and
segmental spinal activity.
U. S. School of Aviation Medicine, Pensacola, Fla., and National Aeronautics

417. GRAYBIEL, A. (Ed.)
Symposium on The Role of the Vestibular Organs in the Exploration of Space.
U. S. Naval School of Aviation Medicine, Pensacola, Fla., Report No. NASA SP-77,

This volume plus Graybiel (1966, #576; 1967, #450; 1968, #588) are the best
collection of studies on the vestibular apparatus. See also Camis (1930, #299).

418. GRAYBIEL, A., R. S. KENNEDY, E. C. KNOBLICK, F. E. GUEUDRY, JR., W. MERTZ,
M. E. MCLEOD, J. K. COLEHOUR, E. F. MILLER, II, and A. R. PREGLY.
Effects of exposure to a rotating environment (10 RPM) on four aviators for a
period of twelve days.

Decreased urinary output in connection with a bizarre vestibular stimulus (p. 742)
is reported. Radonski and Bennett (1970a, #504) show increased sodium retention
with pressure, and Warwick (1942, #309; 1943, #311) shows that high fluid exchange
rates afford some protection from altitude decompression sickness.

419. GUEUDRY, F. E.
Psychophysical studies of vestibular function.

A very good review paper.

420. MONTANDON, A., P. MONTANDON, G. KAPHAN, and J. LIBOIS.
Nystagmus central et nystagmus peripherique. (English summary.)

421. MORRISON, A. R., and O. POMPEIANO.
Vestibular influences on vegetative functions during the rapid eye movement
periods of desynchronised sleep.

This paper, and Pompeiano and Morrison (1965, #171) show a relationship between
the vestibular nuclei and REM sleep and should be consulted for leads regarding
the relationship of their findings to the microsleep reported as a symptom of
the High Pressure Nervous [system] Syndrome by Fructus and Fructus (trans. 1971,
#273) and Bennett and Towse (1971a, #264). (RK)
422. PICKARD, B.
Physiology of equilibration.

423. SCOTT-BROWN, W. G., J. BALLANTYNE, and J. GROVES. (Eds.)
*Diseases of the ear, nose and throat*. Vol. II.

There are many excellent chapters in this book.

424. SIMPSON, J. F.
Meniere's disease.

This excellent chapter reviews the description of the disease by Meniere and indicates that Meniere was planning to relate the disease to certain forms of migraine—also a symptom seen in connection with DCS (see Engel, 1944, #61). Further, the analogy of the disease to glaucoma and too much fluid and the findings in fluid exchange in caisson workers (Adler, 1964, #154; Warwick, 1942, #309; 1943, #311) is interesting.

425. WOLFSOHN, R. J., D. MEYERS, W. D. SCHLOSSER, and R. A. WINCHESTER.
Vertigo.

An excellent paper which discusses the provocative clinical tests to use as well as differential diagnoses from the results. Figures are by Netter.

426. WUSTROW, F., and M. WESTHUES-KOELN.
Druckmessungen im perilymphraum des horizontalen bogengangs des menschen bei der rotation. (Pressure measurements in the perilymphspace of the horizontal semicircular canal of man at rotation. Trans. by Mrs. Anna Woke, NMRI.)

The author shows that pressure changes in the perilymph accompany changes in rotation, therefore, other factors which change pressure in the perilymph could perturb vestibular function.

427. BRODAL, A.
Anatomical aspects of functional organization of the vestibular nuclei.

428. FLÜÜR, E., and L. MENDEL.
Relation between strength of stimulus and duration of latency time in vestibular rotatory nystagmus.

429. HENRIKSSON, N. G., and L. GLEISNER.
Vestibular activity at experimental variation of labyrinthine pressure.

Changes in pressure within the labyrinth caused by the introduction of fluid to the posterior canal resulted in variable activity in the horizontal semicircular nerve. See also Schuknecht (1962, #392; 1969, #493).

430. HENRIKSSON, N. G., L. GLEISNER, and G. JOHANSSON.
Experimental pressure variations in the membranous labyrinth of the frog.

If a bubble is suspected at the end organ this article should be consulted for pro and con evidence. (RK)
431. HINOKI, M., and K. TERAYAMA. 
Physiological role of neck muscles in the occurrence of optic eye nystagmus. 

This influence of neck muscle stimulation on nystagmus is discussed (cf. Adolfson, et al., 1970, #235).

432. ISHII, T., H. SILVERSTEIN, and K. BALOGH. 
Metabolic activities of the endolymphatic sac. 

433. KLOCKHÖFF, I., G. ANGGARD, and L. ANGGARD. 
Recording of cranio-labyrinthine pressure transmission in man by acoustic impedance method. 

434. LAWRENCE, M. 
Effects of interference with terminal blood supply on organ of corti. 

Emphasizes the importance of adequate blood supply for structures within the labyrinth.

435. MCCABE, B. F. 
The quick component of nystagmus. 

436. PINTO, O. F. 
Temporomandibular joint problems in underwater activities. 

The strain placed on the temporomandibular joint from protracted mouthpiece use is similar to the strain which can occur following removal of posterior teeth. The latter results in problems termed Costen's Syndrome (1934, #302), one of the symptoms of which is dizziness and vertigo. See Pinto (1962, #390).

437. RIVERA, J. C., and W. L. DENNISON. 
Gas embolism and related accidents. 
In *Diving Medicine Notebook*, p. 208. U. S. Naval Submarine Medical Center, Groton, Conn., 1966. N.V.

438. SILVERSTEIN, H. 
Biochemical and physiologic studies of the endolymphatic sac in the cat. 
*Laryngoscope* 76:498, 1966. N.V.

439. WOLFE, J. W. 

A relationship of the cerebellum to vestibular function is reported. Other relationships are described in the Introduction and Discussion.

440. YULES, R. B., C. Q. KREBS, and F. P. GAULT. 
Reticular formation control of vestibular system. 

Because of arousal changes with deep dives (high pressure nervous system syndrome) this article should be consulted for possible vestibular implications. See also Morrison and Pompelano (1965, #421).

441. ANSON, B. J., D. G. HARPER, and T. R. WINCH. 
The vestibular system: Anatomic considerations. 

An excellent description of the gross anatomy.
442. BERGAN, J. J., J. S. LEVY, O. H. TRIPPEL, and M. JURAYJ. 
Vascular implications of vertigo. 

443. BUCY, P. O. 
Vertigo with diseases of the central nervous system. 
A short definition of vertigo. An introductory paper to the symposium on vertigo, 
all of which is reported in this volume of the journal.

444. CARPENTER, M. B. 
Central connections of the vestibular system. 
A very good paper from a symposium on vertigo (Vol. 85).

445. DUVALL, A. J., and V. T. RHODES. 
Ultrastructure of the organ of corti following intermixing of cochlear fluids. 

446. FIELDS, W. S. 
Arteriography in the differential diagnosis of vertigo. 

447. FIELDS, W. S., W. RUBIN, and R. J. WOLFSO. 
Essentials of the examination and evaluation of the patient with vertigo. 

448. FISHER, C.M. 
Vertigo in cerebrovascular disease. 

449. GERNANDT, B. E. 
Central regulation of the vestibular system. 

450. GRAYBIEL, A., H. F. SCHUNKERCH, A. R. FREGLY, E. F. MILLER, and M. E. MCLEOD. 
Streptomycin in Meniere's disease. 

451. HARKINS, W. B., and H. M. YANOF. 
Current exploratory work on pressure measurements in the inner ear. 

452. HILGER, J. A. 
The vertigo of endolymphatic hydrops. 

453. HINCHCLIFFE, R. 
Validity of measures of caloric test response. 

454. HITSELBERGER, W. E. 
Tumors of the cerebellopontine angle in relation to vertigo. 

455. INGELSTEDT, S., A. IVARSSON, and Bjorn JONSON. 
Mechanics of the human middle ear. 
"Pressure Regulation in Aviation and Diving, a Nontraumatic Method" is the sub- 
title of this long article.

53
456. JERGER, J.
The audiological examination as an aid in diagnosis.

457. JONGKEL, L. B. W.
Vestibular tests.

Good description of vertigo and differential diagnoses.

458. KAWAMOTO, K.
The atypical epithelial formations of the utricle.

Possible cite for bubble formation? (RK)

459. KIMURA, R. S.
Experimental blockage of the endolymphatic duct and sac; its effect
on the inner ear of the guinea pig. A study of endolymphatic hydrops.

460. KOBURG, E., J. HAUBRICH, and B. KERBARCH.
Autoradiographische Untersuchungen Zum Stoffwechsel des Ductus und saccus
endolymphaticus.
Acta Otolaryngol. (Stockh) 64:146-156, 1967. N.V.

461. LINDSAY, J. R.
Paroxysmal postural vertigo and vestibular neuronitis.

462. LITTON, W. R., and B. F. MCCABE.
Thermal vestibulometry: Technique and clinical aspects.

463. NORRIS, C., and W. RUBIN.
Notes on nystagmography.

464. SCHUMACHER, G. A.
Demyelinating diseases a cause for vertigo.

Myelin has a high fat content and could be a locus for bubble formation. (RK)

465. SHAMBAUGH, G. E.
The symptoms of vertigo.

466. SIMMONS-BLAIR, F., and C. J. MONGEON.
Endolymphatic duct pressure produces cochlear damage.

467. WALKER, A. E.
Summation of the symposium on the vertiginous patient.

468. WLODYKA, J.
Neuronitis vestibularis.
469. WOLF, S.
The bradycardia of the dive reflex: a possible mechanism of sudden death.
Cond. Reflex 2:88-95, 1967. N.Y.

470. ALTDMANN, F.
Diagnostic significance of vertigo.

471. ANSON, B. J., D. G. HARPER, and T. R. WINCH.
Developmental and adult anatomy of the membranous labyrinth in man.

472. ARSLAN, H.
Experimental Meniere's disease.

473. BENSEL, C. K., E. DZENDOLET, and H. L. MEISELMAN.
Body sway during long-term standing and as affected by pure tones.

This study contains a good reference list to the early studies of postural equilibrium. The application to "stagers" and body sway at depth is great. Also because of noise in chambers, this paper (which deals with the so-called "Tullio effect") is of methodological interest. (RK)

474. COCKETT, A. T. K., N. L. MANGELSON, L. E. SWANSON, and R. T. KADO.
The diagnosis of experimental pulmonary aero-emboli following decompression by radio-isotopic lung scanning.

Perhaps this procedure could be modified for vestibular studies. (RK)

475. FIELDS, W. S.
Vertigo related to alteration in arterial blood flow.

476. FREGLY, A. R., and A. GRAYBIEL.
Acute alcohol ataxia in persons with loss of labyrinthine function.

It is axiomatic that divers are heavy drinkers, and the relationship reported here should be considered. See also Voth (1965, #172).

477. HALLPIKE, C. S.
The Caloric Test: A review of its principles and practice with especial reference to the phenomenon of directional preponderance.

478. HARRISON, M. S.
Benign positional vertigo.

See also Schuknecht (1962, #392).

479. LINDSAY, J. R.
Meniere's Disease: Pathology and manifestations.
480. LINDSAY, J. R.
Pathology of vestibular disorders vertigo of peripheral origin: Histopathology.
A good description (re: differential diagnosis) of episodic vertigo, postural vertigo, and distortion of one or both labyrinths. (RK)

481. MCCABE, B. F.
Clinical aspects of the differential diagnosis of end-organ vertigo.
A very good paper.

482. NAFTALIN, I., and M. S. HARRISON.
Biochemistry of the labyrinthine fluids.

483. PARKER, D. E., W. P. COVELL, and H. E. von GIERKE.
Exploration of vestibular damage in guinea pigs following mechanical stimulation.
Describes the effects on swimming ability and the righting reflex in guinea pigs whose otoconia (maculae) are lost due to mechanical (acceleration) stimulation. No regeneration of lost otoconia appeared to occur. Noise was without effect. Vibration produced a transient loss in behavior.

484. STAHLE, J.
Electronystagmography—its value as a diagnostic tool.

485. STAHLE, J.
Vestibular neuritis.

486. WEISS, A. D.
Neurological aspects of the differential diagnosis of vertigo.
Various pitfalls in the diagnosis of neurological involvement when a patient presents with vertigo are discussed. (RK)

487. WOLFPSON, R. J.
Labyrinthine surgery for vertigo.

488. WOLFPSON, R. J. (Ed.)
The vestibular system and its diseases. (Second printing.)
A textbook of vestibular function and otoneurology. Many chapters are important sources. "...the program falls naturally into categories...anatomical studies and research; diagnostic methods...; pathophysiology; and therapy. (p. 350)."

489. FREDRICKSON, J. M., H. H. KORNHUIBER, and R. L. GOODE.
Nystagmus: Diagnostic significance of recent observations.
A good paper for differential diagnosis.
490. JONKERS, L. B. W.
Cervical vertigo.

The possibility of vertigo resulting from stimuli (e.g., bubbles) in "neck structures (p. 1482)" should be considered. (RK) Jonkers offers probable etiologies (p. 1482). "...nystagmus, homolateral post pointing, and a tendency to fall toward the injected [cervical fissure] side (p. 1474)" can also occur.

491. JONKERS, L. B. W.
Vestibular physiology and tests.

492. MCFADDEN, W. J.
An evaluation of vestibular testing.

A very good treatment of the kinds of tests which can be used for diagnosis and positive vestibular function. Many are adaptable for clinical use and expensive, complicated apparatus is not always required. (RK)

493. SCHUKNECHT, H. F.
Cupulolithiasis.

The symptoms of this disease bear a strong resemblance to those experienced in the deep dive reported by Sandmaker (1972, #291). Perhaps a similar mechanism is involved whereby the effects of pressure cause otocinclus (as do other substances with high specific gravity) to accumulate in the ampulla of the posterior semicircular canal. (RK)

494. STEGEMANN, J., and U. TIBES.
Die Veränderung der Herzfrequenz beim Tauchen und Atmehalten nach körperlicher Anstrengung. (Changes of heart rate during diving and breath-hold after exercise. Trans. by Mrs. Anna Woke, NORD, 1971.)

The vagal influence on diving is discussed.

1970-1972

495. BARLOW, J. S.
Vestibular and non-dominant parietal lobe disorders.

Describes the relationship of neurological deficits to spatial disorientation. Similar symptoms may occur in connection with compressed air work. (RK)

496. BRUNER, A., and T. W. NORRIS.
Lateralization of hearing loss and vestibular nystagmus in test pilots.

Shows that vestibular and auditory deficits are correlated.

497. CLARK, B.
The vestibular system.

A good modern review of vestibular studies. No studies of diving are included.

498. FLUUR, E., and L. MENDEL.
Crescendo time for per-rotatorily elicited nystagmus.
499. FLUUR, E., and A. MELLSTROM.
Vestibular bidirectional sensitivity.
Shows that "it is not possible to cause a nystagmus in both directions from only
one semicircular canal (p. 363)" with galvanic stimulation.

500. PREGLY, A. R., and A. GRAYBIEL.
Labyrinthine defects as shown by ataxia and caloric tests.
Shows the validity and reliability (with caloric) of ataxia testing.

501. FRUCTUS, X., and J. C. RICCI.
Reflections on two cases of caisson disease.
Bulletin Mesubhyp No. 1, December 1969. French Association for Subaquatic and
Hyperbaric Medicine, Salvator Hospital, 13 Marseille (9e) Trans. from French,
NIC Trans. No. 3070, Naval Intelligence Command Hqtrs., Wash., D. C.,
22 June 1970.
Points out the danger of the Valsalva maneuver when resurfacing.

502. IGARASHI, M., B. R. ALFORD, T. WATANABE, and P. M. MAXIAN.
Direction of ataxic gait after unilateral partial destruction of the vestibular
system in squirrel monkeys.
Provides validity and diagnostic utility of ataxia tests.

503. MAN, A., and G. LEVENTON.
On vestibular response to mechanical irritation.
A negative finding, but of some importance. Should be replicated with a more
sensitive indicator like the oculogyral illusion. (RK)

504. RADOMSKI, M. W., and P. B. BENNETT.
Electrolyte changes in humans under hyperbaric conditions.
Sodium and calcium retention are reported in connection with hyperbaric air,
but not hyperbaric helium.

505. RADOMSKI, M. W., and P. B. BENNETT.
Metabolic changes in man during short exposure to high pressure.
The authors state the otoliths of the utricle are calcium carbonate concretions.
If decreases in calcium excretion can occur with high pressure perhaps increases
in calcium deposits within the body can also occur. If so, perhaps these
changes might perturb normal vestibular function. (RK)

506. RESCHKE, M. F., and D. E. PARKER.
Stimulation of the vestibular apparatus in the guinea pig by static pressure
changes: head and eye movements.

507. STAHEL, J.
Vestibular function on earth and in space.
A good collection of papers concerning many aspects of vestibular function.
508. TIBBLING, L.
Observations on central mechanisms common to vestibular and optokinetic nystagmus.

509. UDO DE HAES, H. A., and H. SCHONE.
Interaction between statical organs and semicircular canals on apparent vertical and nystagmus.

510. WADA, J. A., A. TERAO, H. SCHOLTMEYER, and W. C. TRAPP.
Reversible auditory seizure susceptibility induced by hyperbaric oxygenation.

511. ANDERSON, J. R.
Case report of student aviator with unusual psychosomatic symptoms.

Vestibular symptoms were considered to be precipitated by fear. The application to diving may be direct.

512. ANON.
Carbon monoxide in the Corvair.

The vestibular symptoms reported here are very similar to the "staggers" and other vestibular derangements seen in DCS.

513. BENNETT, P. B., and S. P. GRAY.
Changes in human urine and blood chemistry during a simulated oxygen-helium dive to 1500 ft.

Among other changes recorded, it was shown that at 1500 feet there was retention of calcium. Otoliths are calcium carbonate concretions; perhaps there is a connection so that changes in otolith crystallisation can occur.

514. BROWN, F. M.
Vertiginous flyer: A review of 6 years' experience of the Aeromedical Consultation Service.

A good epidemiologic study with a citation of 6 cases of alternobaric vertigo.

515. BRUNER, A., and T. W. NORRIS.
Age-related changes in caloric nystagmus.

Idiopathic progressive vestibular degeneration in a young man: loss of vestibular sensation not the basis for detection.

517. GUEDRY, F. E., JR., and A. J. BENSON.
Nystagmus and visual performance during sinusoidal stimulation of the vertical semicircular canals.

Because of the difference between fast phase-up and fast phase-down nystagmus responses, this approach may provide a way of measuring differentially superior vs. inferior canal function by mechanical means.
518. HAWKINS, J. E., JR.
The role of vasoconstriction in noise-induced hearing loss.

Shows the influence of oxygen on cochlear function.

519. HIGGINS, L. L., C. KNOX, and W. W. SIMMONS.
Acoustic-optical imaging techniques for decompression studies.

520. HILLS, B. A.
Concepts of inert gas exchange in tissues during decompression.

521. HILLS, B. A.
Decompression sickness: a fundamental study of "surface excursion" diving and the selection of limb bends versus C.N.S. symptoms.

Limb bends (type I) generally outnumber (NS type II) bends. This paper suggests a way to study the latter.

522. ISHIYAMA, E., and E. W. KEELS.
Preliminary results on intralabyrinthine temperature changes in the vestibular labyrinth during caloric stimulation.

523. LANDAU, J. V.
Hydrostatic effects on cellular function.

This report may be relevant if cellular changes within the vestibular apparatus are shown to occur under pressure. (RK)

524. LANGER, P. H., and F. T. MANSURE.
Hazards of valsalva maneuver.

525. MATHOG, R. H., and R. L. CRAMER.
Testing of the vestibular system.

The title is self explanatory but the article also calls attention to the fact that cerumín (p. 744) in an ear can modify a caloric response in the laboratory. This factor should be considered as a possibility in deep-sea diving where water has access to the ear and if there is a plug of wax in one ear it could result in a differential stimulus to the semicircular canals. (RK)

526. MONEY, K. E., L. BONEN, J. D. BEATTY, L. A. KUEHN, M. SKOLOFF, and R. S. WEAVER.
Physical properties of fluids and structures of vestibular apparatus of the pigeon.

527. SHAPPELL, S. O.
Hemoglobin affinity for oxygen during angina pectoris.
528. VAIL, E. G.  
Hyperbaric respiratory mechanics.  

529. COMEX (Hyperbaric Research Center), Versailles, France.  
100 hours at 500 meters. Chamber saturation dive at 1640 ft (50.68 ATA).  

Vestibular symptoms are not mentioned in this report but "incoordination"  
and lessening of awareness (p. 6)" as a part of the HPNS syndrome is. See  
also Morrison and Pompeiano (1965, #421), and Yules et al., (1966, #440).

See also:

References 29, 67, 76, 79, 95, 102, 117, 130, 131, 148, 159, 160, 162, 171, 181, 182,  
227, 235, 246, 247, 256, 271, 272, 282, 530, 531, 532, 534, 539, 542, 544, 546, 551, 556,  
557, 564, 566, 567, 568, 573, 574, 575, 577, 582, 584, 586, 591, 595, 596, 597, 598, 608,  
614, 616, 618, 622, 668, 730, 755, 777, 782, 797, 824, 835, 874, 878, 905, 919, 926, 947.
CATEGORY III. TESTS OF POSITIVE FUNCTION OF VESTIBULAR APPARATUS.

1920-1929

530. ROORDA, P.
Der Einflub der Drehung auf den Zeigeversuch von Barany. (The influence of turning on the pointing test of Barany. Trans. by Mrs. A. Weke, NMRF, 1971.)
Archives Fur Ohren, Hals-und Kehlkopfhilkunde 113:97-103, 1925.

Describes the effects of a rotatory (i.e., vestibular) stimulus on past pointing.

531. TULLIO, P.
I riflessi sonori.
Amer. J. Physiol. 90:542, 1929. (In Italian. Abstract of communications from International Physiological Congress.)

An early reference to the adequacy of sound serving as a vestibular stimulus. Since pressure chambers can have high noise levels, one should control (or at least be cognizant of) this relationship in provocative vestibular testing performed in the presence of noise. (RK)

1930-1939

532. CATTELL, M.
The physiological effect of pressure.

A good source for the preparation of a battery of tests constructed to measure vestibular function (in particular) or CNS functions (in general) at or after pressure. (RK)

533. MOWRER, O.H.
A comparison of the reaction mechanism mediating optokinetic nystagmus in human beings and in pigeons.

Species differences and baseline data are presented. Mechanisms are discussed.

534. WENDT, G. R.
The form of the vestibular eye movement response in man.
Psychol. Monogr. 47:311-328, 1936.

This paper should be consulted if eye movements of suspected vestibular origin during (or pre-post) a dive are to be studied. (RK)

535. DOHLMAN, G.
On the mechanism of transformation into nystagmus on stimulation of the semicircular canals.

Describes the origin of the CNS pathways of the slow phase. The mechanics of the vestibular apparatus are discussed.

1940-1949

536. GRAYBIEI, A. and D. HUPP.
The oculogyral illusion: A form of apparent movement which may be observed following stimulation of the semicircular canals.

This paper describes a sensitive measure of semicircular canal function. It shows also that illusory responses can occur for angular velocities which could be experienced in a submersible. (RK)
337. GRAYBIEL, A., B. CLARK, and K. MACCORQUODALE.  
The illusory perception of movement caused by angular acceleration and by  
centrifugal force during flight. I. Methodology and preliminary results.  
"The method is adaptable to a number of types of studies concerned with the in-  
fluence of angular acceleration and g on visual perception (p. 177)," for example,  
submersibles. (RK)  

338. PENN, W. O., R. GALAMBOS, A. B. OTIS, and H. RAHN.  
Corneoscleral potential in anoxia and acapnia.  
Because the gas mixture can influence the standing potential in the eye this  
factor must be considered when recording vestibular eye movements under pressure  
and with different gas mixtures. (See Kennedy, 1972, Appendix B, #622, for a  
bibliographic review.) On the other hand, this measurement may be a useful  
index of the change. See also Dolatkowski, et al. (1966, #572), and Adolfson,  
et al. (1970, #235), who recorded eye movements.  

339. JONGKEES, L. B. W.  
Which is the preferable method of performing the caloric test?  

1950-1959  

540. WORCHEL, P., and K. M. DALLENBACH.  
Vestibular sensitivity in the deaf.  
Correlation between tasks are reported.  

541. MOORE, E. W., and R. L. CRAMER.  
Perception of postural verticality: effects of flying experience upon reduction of  
error.  
U. S. School of Aerospace Medicine, Brooks AFB, Texas, Report No. TDR-62-72,  
June 1952.  

542. THOMSEN, K. A.  
The caloric test a. m. Hallpike, et al. in a normal material.  

543. BEKESY, G. V.  
Subjective cupulometry. Threshold, adaptation, and sensation intensity of the  
vestibular organ for rotations in the horizontal plane.  
A good test of vestibular function.  

544. McNALLY, W. J.  
Some facts and fancies about the utricle.  
The other paper by McNally (1969, #492) should also be consulted.  

545. ASCHAN, C. M. BERGSTEDT, and J. STAHLE.  
Nystagmography: Recording in clinical neuro-otological examinations.  
Acta Otolaryngol. (Stockh) Suppl. 129, 1956. N.V.  

546. HENRIKSSON, N. G.  
Speed of slow component and duration in caloric nystagmus.  

63
547. HAHN, C. W., and C. J. CANZELLA.
An examination of the technique of cupulometry.
U. S. Naval School of Aviation Medicine, Pensacola, Fla., Joint Report No. 42,
30 May 1956.
A good test of vestibular function.

548. STAHLE, J.
Electro-nystagmography in the caloric and rotatory tests.
Acta Otolaryngol. (Stockh) Suppl. 137, 1958. M.V.

549. de RIVERA, J.
The postural sway test and its correlations.
This test measures suggestibility in addition to being a measure of postural equilibrium. It might be a good test as part of a battery for use in compressed air experiments for both reasons. (RK)

1960-1969

550. CRAWFORD, W. A.
False perception of the horizontal and vertical planes in a dynamic setting.

551. CAVAGNA, G., F. SAIBENE, and R. MARGARIA.
A three-directional accelerometer for analyzing body movements.
A useful paper for building apparatus to measure postural equilibrium either as an indicator of vestibular/CNS symptomatology under pressure, or to measure pre-, post-changes, or to evaluate symptoms. (RK)

552. JONSSON, B., and B. STEEN.
Function of the hip and thigh muscles in Romberg's test and "standing at ease."
An electromyographic study.
Of interest for testing postural equilibrium during or after a dive. (RK)

553. KENNEDY, R. S., and A. BRAYBIEL.
Validity of tests of canal sickness in predicting susceptibility to airsickness and seasickness.
The relationship of caloric responsivity to motion sickness susceptibility is shown.

554. MCLEOD, M. E., and J. C. MEEK.
A threshold caloric test: results in normal subjects.
U. S. Naval School of Aviation Medicine, Pensacola, Fla., and National Aeronautics and Space Administration, Report No. 72, NASA Order No. R-47, 9 July 962.
Threshold responses can occur to as little as 1.5°C either side of body temperature. This could be a source of problems in cold water or gas. (RK)

555. CANTRELL, R. P.
Body balance activity and perception.
556. DAVY, L. M.
Evaluation of bicaloric test of vestibular function.

Probably the best normative data published for the caloric test (N > 400)—the procedure is well described. Notes regarding differential diagnosis are given. (RK)

557. GUEDRY, F. E., and C. S. HARRIS.
Labyrinthine function related to experiments on the parallel swing.
U. S. Naval School of Aviation Medicine, Pensacola, Fla., BuMed Project MRO05.13-6001 Subtask 1, Report No. 86, 25 September 1963.

Validation of parallel swing studies by showing normals and persons with labyrinthine defects produce different responses.

558. HARRIS, C. S., R. K. AMBLER, and F. E. GUEDRY.
A brief vestibular disorientation test.
U. S. Naval School of Aviation Medicine, Pensacola, Fla., BuMed Project MRO05.13-6001, Report No. 82, 1 May 1963.

This test may be useful in selecting persons who are insensitive to vertigo, or training persons to be more tolerant of vertigo. Transfer of training could occur to vertigo which was induced by pressure, cold water, uncomfortable motion, etc., from that induced mechanically. (RK) This transfer could be in the form of increased physiologic tolerance or improved perceptual awareness.

559. HINOKI, H., and M. KITAHARA.
An application of strain-gage-type instruments to the analysis of the equilibrium function in human subjects and animals.

Describes apparatus construction for measuring postural equilibrium.

560. MILLER, B. P., and A. CRAYBIEL.
The role of the otolith organs in the perception of horizontality.
U. S. Naval School of Aviation Medicine, Pensacola, Fla., Report No. 80, 19 March 1963.

A good paper for constructing behavioral tests which measure normal otolith function. (RK)

561. BROWN, J. H., and G. H. CRAMPTON.
Quantification of the human nystagmic response to angular acceleration.
Prediction formulae and nomograph.

A transfer function for semicircular canal function and input is presented.

562. DZENDOLET, E.
Effect of dramamine on the objective electric vestibulogram.

Used sway as a provocative test. Showed threshold change (higher) with drug.

563. GUEDRY, F. E., JR., R. S. KENNEDY, C. S. HARRIS, and A. CRAYBIEL.
Human performance during two weeks in a room rotating at three RPM.

Describes the results of the use of tests of vestibular function (postural equilibrium, past pointing) before, during, and after bizarre vestibular stimulation.
564. MCLEOD, N. B., and M. J. CORREIA.
Use of caloric test in evaluating the effects of gravity on cupula displacement.
U. S. Naval School of Aviation Medicine, Pensacola, Fla., Report No. 94, and
NASA, 2 April 1964.
A technique which can be used in diagnosis and possibly as part of a test battery
during compressed air work. (RK)

565. MILLER, E. F., and A. GRAYBIEL.
Magnitude of gravito inertial force, an independent variable in egocentric visual
localization of the horizontal.
U. S. Naval School of Aviation Medicine, Pensacola, Fla., Report No. 98,
31 July 1964.
A good paper for study of vertical and horizontal spatial orientation. Many other
papers by these authors appear in Stearns and Kasparek (1963, #403).

566. FLUUR, E., L. MENDEL, and L. LAGERSTROM.
Reproducibility of duration of latency time in unidirectional per-rotatory
nystagmus.

567. FREGLY, A. R., and R. S. KENNEDY.
Comparative effects of prolonged rotation at 10 RPM on postural equilibrium in
vestibular normal and vestibular defective human subjects.
Validity of ataxia testing.

568. PICKARD, B.
Methods of examination of the ear.
In W. C. Scott-Brown, J. Ballantyne, and J. Groves (Eds.) Diseases of the ear,

569. WOLFSON, R. J., W. D. SCHLOSSER, and R. A. WINCHESTER.
Vertigo.
A reissue of Wolfsone, et al. (1965, #425).

570. CABARROU, P.
Etude electro-encéphalographique de l'ivresse des grandes profondeurs.
Maroc Med. 45:529-536, July 1966b.

571. CRAMPTON, G. H.
Does linear acceleration modify cupular deflection?
From the Second Symposium on The Role of the Vestibular Organs in Space Exploration,

572. DOLATKOWSKI, A., J. TORBUS, K. DEGA, and S. KLJAMAN.
Hibarli Naczas Odruchu Wzrokowo-Miealowego u Kurkow. (The influence of hyper-
baria on the eye-muscle reflex period in divers.)
The connections of the oculomotor system (III, IV, and VI nerve nuclei) with the
vestibular system are well known (cf. Wendt, 1951, #345; Robinson, 1968, #595),
and should be considered relative to the findings here of increased eye muscle
reflex latency with increased pressure. Of relevance also are changes in eye
muscle potential with luminance and with gas mixture (Kennedy, 1972, Appendix B,
#622, for review). Since electromyography is used in provocative tests
of vestibular function, if vestibular tasks are performed at pressure using eye
muscle potential as a measure, then the data of Dolatkowski are relevant. (See
Penn, et al., 1949, #538). (RK)
573. ESKIN, A., and D. C. RICCIO.
The effects of vestibular stimulation on spontaneous activity in the rat.

This study showed that behavioral indications of vestibular stimulation in animals could be reliably obtained. A similar methodology for study of vestibular problems in animals due to decompression could be followed. (RK)

574. FREGLY, A. R., and A. GRAYBIEL.
An ataxia test battery not requiring the use of rails.

This well standardized test is a good model to follow if one wished to have an entire neurological battery of tests which could be administered prior to entrance into a diving career or even before exposure to a specific environment. It should be considered with other papers by Fregly in this review. (RK)

575. FREGLY, A. R., A. OBERMAN, A. GRAYBIEL, and R. E. MITCHELL.
Thousand aviator study: non vestibular contributions to postural equilibrium functions.

Correlation of ataxia and other variables (e.g., body build) are shown.

576. GRAYBIEL, A. (Ed.)
Second symposium on the role of the vestibular organs in space exploration.

This document and others in the series (I, III & IV) are the modern analogues of a textbook of vestibular functions. (cf. Camis, 1930, §299.)

577. GRIGOR'EV, Y. G., and Y. V. FARBER.
Vestibular function in man during a 120-day period in a hermetically sealed chamber.

Confinement per se appeared to affect a change in vestibular function. This could be a factor in long-term submergence studies. (RK)

578. NIXON, C. W., C. S. HARRIS, and H. E. von GIERKE.
Rail test to evaluate equilibrium in low-level wideband noise.

The authors demonstrate the use of this test to measure performance in an exotic environment.

579. GRAYBIEL, A., E. F. MILLER, II, B. D. NEWSOM, and R. S. KENNEDY.
The effect of water immersion on perception of the oculogravic illusion in normal and labyrinthine-defective subjects.

Individual differences in normals on this test suggest that it might be useful in monitoring vestibular-connected perception during (or pre- post-) compressed air work. It may also be useful as a selection device. (RK)
580. NAPIER, J.
The antiquity of human walking.

Of some importance for studies of postural equilibrium.

581. NELSON, J. G.
The effect of water immersion and body position upon perception of the gravitational vertical.

Because of the difficulties in determining body position under water, perhaps individual performances could be related to success in diving careers, and so used as a selection test. (RK)

582. PEITERS, E.
Vestibuloapinal reflexes.

Good references to his earlier work. A simple test for monitoring suspected vestibular involvement as well as for diagnosis post hoc of residual damage.

583. RICCO, D. C., M. ICARASHI, and A. ESKEL.
Modification of vestibular sensitivity in the rat.

Because the rat is often the animal of choice in studies of the experimental analysis of behavior, this reference to vestibular responsivity is included. (RK)

584. RENSEL, C. K., and E. DZENDOLET.
Power spectral density analysis of the standing sway of males.

Because of "staggers" and increasing body sway at increasing depths (Adolfson, et al., 1970, #235) tests of this type would be useful for monitoring subjects during a dive, as well as for pre- and post-dive (permanent and temporary) changes. (RK)

585. CLARK, B., and J. D. STEWART.
Magnitude estimates of rotational velocity during and following prolonged increasing, constant, and zero angular acceleration.

Shows the sensitivity of the semi-circular canals to turning.

586. FODOR, F.
Electronystagmography: Its perspective, advantages, and limitations in routine vestibular testing.

587. FREGLY, A. R., and A. GRAYBIEL.
Labyrinthine defects as shown by ataxia and caloric tests.
U. S. Naval Aerospace Medical Institute, Pensacola, Fla., NAMI-994, NASA Order R-93, 22 August 1968b.

588. GRAYBIEL, A.
Vestibular mechanisms in human behavior.

A summary of provocative tests.
589. HINCHCLIFFE, R.
Mystagmus rate as an index of caloric test response.

590. HUMPHREYS, L. G.
Comparison of three methods to determine thresholds for perception of angular acceleration.

591. IGARASHI, M., A. GRAYBIEL, and P. R. DEANE.
Screening of squirrel monkeys (Saimiri sciureus) for vestibular function studies.
Also see Igarashi, et al. (1970, #502).

592. JONGKEES, L. B. W.
Parallel swing test.
In R. J. Wolfson (Ed.) The vestibular system and its diseases. pp. 218-228.

593. MILLER, E. F.
Ocular counterrolling.

594. MILLER, E. F., A. R. FREGLY, and A. GRAYBIEL.
Visual horizontal-perception in relation to otolith function.

595. ROBINSON, D. A.
The oculomotor control system: A review.
If eye movements of vestibular (or other) origin are studied during (or pre- post) compressed air work this paper is useful. (RK)

596. CLARK, B.
Factors influencing the perception of angular acceleration in man.
San Jose State College, Department of Psychology, San Jose, Calif., August 1969.

597. FLUUR, E., and L. MENDEL.
Relation between strength of acceleration and duration of postacceleratory nystagmus.

598. FLUUR, E., and L. MENDEL.
Reproducibility of duration of postacceleratory nystagmus.

599. MILLER, E. F., II.
Evaluation of otolith organ function by means of ocular counterrolling measurements.

600. YUGANOV, Y. M., S. S. MARKARYAN, E. V. LAPAYEV, and I. A. SIDEL'NIKOV.
Outlook for the development of vestibular selection methods in aviation.
601. AMBLER, R. K., and G. E. GUEDRY, JR.
Reliability and validity of the brief vestibular disorientation test compared
under 10-RPM and 15-RPM conditioning.
U. S. Naval Aerospace Medical Research Laboratory, Pensacola, Fla., Report No.
1115, USAARL Ser. No. 71-7, 14 August 1970.

This disorientation test could be used to determine susceptibility to vertigo
in divers. It could also show pre-post changes due to a career in diving, if
a control group was available. (RK)

602. APPIAIX, A., and P. DEMARD.
L'examen d'aptitude a la plongee sous-marine. (In French.)

The authors suggest LMT testing (among other things) for divers, and describe
results which counterindicate diving.

603. COHEN, M.
Hand-eye coordination in altered gravitational fields.
Naval Air Development Center, Johnsville, Pa., Report No. NADC-AC-7007, June

This test is similar to the pointing test of Barany (See Roorda, 1925, #530),
and could be used as part of a battery which measures this function pre-, per-, and
post-compressed air work. The intended application was aviation and space,
but it is relevant to underwater investigation. (RK)

604. FLUUR, E.
The interaction between the utriculi and the saccule.

605. FLUUR, E.
Multiple choice rotation chair.

606. GRAYBIEL, A., C. W. STOCKWELL, and G. E. GUEDRY, JR.
Evidence for a test of dynamic otolith function considered in relation to
responses from a patient with idiopathic progressive vestibular degeneration.
U. S. Naval Aerospace Medical Research Laboratory, Pensacola, Fla., NAARL-1119,
October 1970.

607. NASHNER, L. M.
Sensory feedback in human posture control.
Massachusetts Institute of Technology Thesis No. MVT-70-3, Cambridge, Mass.,
June 1970.

608. OOSTERVELD, W. J., J. B. JANEKE, and L. B. W. JONKEES.
On the vestibular threshold.

609. PARIN, V. V., and M. D. YEMEL'YANOV.
Physiology of vestibular analyzer.

610. SOMMER, H. C., and C. S. HARRIS.
Comparative effects of auditory and extra-auditory acoustic stimulation on human
equilibrium and motor performance.
Aerospace Medical Research Laboratory, Wright-Patterson AFB, Ohio, Report No.

Because of the interaction of balance changes due to vestibular and auditory
stimulation (e.g., in pressure chambers), this article should be consulted. (RK)
611. BANKEs, D. J., C. C. BROWN, and Z. M. FRACToR.
Differential effects of multiple and single irradiations upon the primate
equilibrium function.
USAF School of Aerospace Medicine, Brooks AFB, Texas, SAM-TR-71-7, AD 722058.
March 1971.

Describes an indicator methodology which could be used to study vestibular
problems of compression in animals.

612. BUCKWOOD, F., and C. EDMONDS.
Some otological investigations in divers.
Royal Australian Navy School of Underwater Medicine, Balmoral, N. S. W., Report
No. 2/71, 1971. (Cited in Edmonds, 1971)

Discusses vestibular testing under water and pressure.

613. SLSKER, W.
Power laws for the perception of rotation and the oculogyral illusion.

Provides human transfer functions for graded, single angular acceleration stimuli.

614. HILL, J. C.
A dynamic model of the human postural control system.
Presented at the Joint National Conference on Major Systems, Anaheim, Calif.,

Of importance if changes in postural equilibrium due to pressure occur or are
being studied.

615. SCHROEDER, D. J.
Alcohol and disorientation-related responses. I. Nystagmus and "vertigo" during
caloric and optokinetic stimulation.

616. CLARK, B., and J. D. STEWART.
Comparison of the sensitivity of rotation of pilots and nonpilots.

Shows that vestibular sensitivity does not change appreciably with exposure,
history, or age and thus is a good and relatively invariant index of function.
A test of this type would be useful to check for vestibular damage due to a
career in diving. Also shows overall sensitivity of vestibular apparatus to
turning stimuli. (RK)

617. FREGLY, A. R.
Vestibular ataxia and its measurement in man.
In H. H. Kornhuber (Ed.) Handbook of sensory physiology. Vol. VI. Vestibular

Probably the best single source for measurement of postural equilibrium in man.
An extensive bibliography. (RK)

618. FREGLY, A. R., A. GRAYBIEL, and M. J. SMITH.
Walk on floor eyes closed (WOFEC): A new addition to an ataxia test battery.

See other articles by senior author. This paper is also related to the question
of swimmer navigation. (RK)
619. FREGLY, A. R., and M. J. SMITH.  
Chronological age influences on ataxia test battery intercorrelations.  
U. S. Naval Aerospace Medical Research Laboratory Report, Pensacola, Fla., in press.  
See other papers by senior author.

620. FREGLY, A. R., M. J. SMITH, and A. GRAYBIEL.  
Revised normative standards of performance of men on a quantitative ataxia test battery.  
U. S. Naval Aerospace Medical Research Laboratory, Pensacola, Fla., Report No. NAAL-1160.  (Submitted to Acta Otolaryngol. (Stockh), in press.)  
See other references by the senior author.

Effects of some antimotion sickness drugs and secobarbital on postural equilibrium at ground level and at 12,000 feet (simulated).  
U. S. Naval Aerospace Medical Research Laboratory Report, Pensacola, Fla., in press.  
See other papers by senior author.

622. KENNEDY, R. S.  
The relationship between habituation to vestibular stimulation and vigilance: individual differences and subsidiary problems.  

See also:  

ADDENDUM—CATEGORY III

622a. CLARK, B., and M. A. NICHOLSON.  
Aviator's vertigo: A cause of pilot error in naval aviation students.  

622b. MOTTRAM, J., and G. SINGER.  
Judgments of body and object verticality in the presence of discordant visual information.  
CATEGORY IV. PERCEPTUAL ILLUSIONS OCCasionED BY THE ENVIRONMENT
SOME OF WHICH MAY BE OF VESTIBULAR ORIGIN.

1910-1919

623. STIGLE, R.
Versuche über die Beteiligung der Schwerempfindung an der Orientierung des
Menschen in Räume. (Experiments dealing with the participation of the sen-
sation of gravity in the orientation of man in space. Trans. by Mrs. A. Woke,
1972.)
Archiv. fur die gesamte Physiologie 148:573-584, 1912.

An early paper which describes the existence of a "special spatial sense organ
(p. 575)" which the author studied under water. He used the best swimmers of
the Vienna Row Club "DONAU" as subjects (p. 575). He dipped the subjects under
water and rotated them for 1 to 1 1/2 minutes, then had Ss indicate which way
was up. Gross errors were made, and the subjects were frightened. These data
differed from those reported by Exner, therefore, additional tests were made
with subjects under water for longer periods, strapped to a board rotating
vertically or as a spit. The Ss (Hungarian divers) were able to respond to the
upright correctly, although accuracy was not perfect. Mentions also that fear
and apprehension contributed to errors. (PK)

1920-1929

624. KOCH, H. L., and J. UPKESS.
A comparative study of stylus maze learning by blind and seeing subjects.
J. Exp. Psychol. 9:118-131, 1926.

Stylus maze performance is generally poorer in blind than blindfolded subjects,
although having "some visual experience before the onset of blindness" helps.
Similar relationships may be applicable under water. (MK)

The properties of space in kinaesthetic fields of force.
Am. J. Psychol. 41:95-105, 1929.

1930-1939

626. Maccurdy, J. T.
Disorientation and vertigo, with special reference to aviation.
The introductory contribution to a discussion of disorientation and vertigo at
the joint meeting of the Physiological and Psychological Sections of the
British Association for the Advancement of Science, Leicester, England, 1933.

627. GIBSON, J. J., and O. H. "OWNER.
Determinants of the perceived vertical and horizontal.
Psychol. Rev. 45:300-322, 1938.

An excellent early reference on the perception of the upright with complete
bibliography.

1940-1949

628. Graybiel, A., and B. CLARK.
The autokinetic illusion and its significance in night flying.
U. S. Naval School of Aviation Medicine, Pensacola, Fla., Report No. 3, Project
X-148(AV-VA-3), 7 February 1945.

A significant paper which reviews visual effects which occur in unarticulated
visual environments. The thrust of the paper is aviation, but diving environments
have much commonality. ("K)
629. VINACKE, W. E.
The concept of aviator's "vertigo."
U. S. Naval School of Aviation Medicine, Pensacola, Fla., Report No. 7, 8 May 1946a.

630. VINACKE, W. E.
Illusions experienced by aircraft pilots.
U. S. Naval School of Aviation Medicine, Pensacola, Fla., Report No. 9, 31 May 1946b.

631. VINACKE, W. E.
Predicting the susceptibility of aviators to "vertigo": A preliminary study.
U. S. Naval School of Aviation Medicine, Pensacola, Fla., Report No. 10,
21 June 1946c.

632. VINACKE, W. E.
"Vertigo" as experienced by naval aviators.
U. S. Naval School of Aviation Medicine, Pensacola, Fla., Report No. 12, 3 July 1946d.

This and other papers by the author report a questionnaire approach that could well
be modified for underwater studies of vertigo. (RK)

633. VINACKE, W. E.
"Fascination" in flight.
U. S. Naval School of Aviation Medicine, Pensacola, Fla., Report No. 13, 1946e.

634. CLARK, B., and A. GRAYBIEL.
The effect of angular acceleration on sound localization: the audiogyril illusion.

Under certain conditions this effect can lead to disorientation; particularly
when using sound localization for navigation. (RK)

635. CLARK, B., and A. GRAYBIEL.
Studies of human adaptation to centrifugal force. I. Visual perception of the
horizontal.
U. S. Naval School of Aviation Medicine, Pensacola, Fla., Research Report No.
N'0 001.059.01.22, November 15, 1949b.

Indicates that the vestibular system is useful in orientation but also describes
an illusion (oculogravle) which could occur in submersibles and lead to
disorientation. (RK)

636. WITKIN, H. A.
Perception of body position and of the position of the visual field.

A good source for studies of perception of the upright under water.

1950-1959

637. PASSEY, G. E.
The perception of the vertical: IX. Adjustment of the visual vertical from
various magnitudes of body tilt.
U. S. Naval School of Aviation Medicine, Pensacola, Fla., Joint Project Report
No. 15, NM 001 063.01.15 (formerly NM 001 037), March 10, 1950.

This whole series of studies is of importance for underwater perception. About
thirty studies from these two authors have appeared. See Stearns and Kasparek
(1963, #403) for additional titles.

638. MANN, C. W., and G. E. PASSEY.
The perception of the vertical: V. Adjustment to the postural vertical as a
function of the magnitude of postural tilt and duration of exposure.

Shows influence of tilt on perception of upright.
639. GIBSON, J. J.
The relation between visual and postural determinants of the phenomenal vertical.

640. BITTERMAN, D. E., and P. WORCHEL.
The phenomenal vertical and horizontal in blind and sighted subjects.
Shows the dependence of vision in orientation but also shows that blindfolded
sighted subjects are more disrupted than blind subjects when they are tilted.

641. CLARK, B., and A. GRAYBIEL.
"Fascination": A cause of pilot error.
U. S. Naval School of Aviation Medicine, Pensacola, Fla., Report No.
NM 001.059.01.35, 15 May 1953.
The similarities of a pilot flying into a target/tow banner (which occur with
some frequency in aviation training) and "perceptual narrowing in novice divers"
(Weltman & Egstrom, 1966, #705) are strong enough to suspect a similar mechanism.
(RK) This study used over 500 subjects.

642. WITKIN, H. A., H. B. LEWIS, M. HERTZMAN, K. MACOVER, P. B. MEISSNER, and
S. WAPNER.
This and Witkin (1949, #636) and Witkin et al. (1962, #674), report individual
differences in perception of the upright which may have important applications
for diver selection and training. (RK)

643. ASHER, H. M.
Off effect giving rise to a sensation of blackness.
Demonstrates that "perceptual narrowing" or "tunnel vision" can be of neural
origin and can occur when a person stares fixedly. This could also occur if
attention if fixed. (RK) (cf. Weltman & Egstrom, 1966, #705.)

644. CLARK, B., and A. GRAYBIEL.
Vertigo as a cause of pilot error in jet aircraft.
U. S. Naval School of Aviation Medicine, Pensacola, Fla., Report No. 44,
15 August 1956.
This paper should also be consulted because of the possibility of vertigo in
submersibles. (RK) Additionally, it describes a useful technique for question-
naire construction which could be used to study vertigo as symptomatology of
DCS. (RK)

645. FEENY, B.
Buffalo divers use underwater sled.
Skin Diver 5:21, Sept. 1956. N.Y.

646. MANN, C. W.
U. S. Naval School of Aviation Medicine, Pensacola, Fla., 30 June 1956.
The report lists all 43 studies in this series, many of which deal with orienta-
tion to vertical and horizontal.

647. CLARK, B., and A. GRAYBIEL.
The break-off phenomenon.
Divers should be interviewed to determine whether a similar phenomenon also
occurs at depth. (RK)
648. CLARK, B., and A. GRAYBIEL.  
Vertigo as a cause of pilot error in jet aircraft.  
See Clark and Graybiel (1956, #644) for a more complete explanation of questionnaire construction.

649. KOHL, O. A., and F. SEARLE, JR.  
Subjective and articulation tests of deep and shallow water divers communication.  
Because underwater sound communication is poor, perhaps vestibular and/or cutaneous communication should be explored. (RR)

650. WOELLNER, R. C.  
The perception of vertical in the presence of increased accelerative forces.  
U. S. Naval School of Aviation Medicine, Pensacola, Fla., Report No. 45, 31 October 1957.

651. MARGARIA, R.  
Wide range investigations of acceleration in man and animals.  
This is a significant paper—not often referenced in the compressed air literature (probably because it was intended to apply to aviation and space flight). (RK) It contains information of interest in several categories, e.g., (a) sense of position under water (p. 860), and (b) evoked cerebellar responses have lower thresholds in migratory than non-migratory birds (p. 863 ff).

652. MARGARIA, R., T. GUALTIEROTTI, and D. SPINELLI.  
Protection against acceleration forces in animals by immersion in water.  
See also Margaria (1958, #651).

653. MELVILL JONES, G.  
Disorientation in flight.  
Presented at the First International Congress of Aeronautical Sciences, Madrid, Spain, 8-13 September, 1958.  
A good discussion of the problem relative to aviation, and applicable to diving.

654. NUTTALL, J. B.  
The problem of spatial disorientation.  
There are many similarities between diving and aviation. Because of a relatively larger research effort in the latter, important leads for the former can often be found. This paper and others deal with disorientation (e.g., Melville Jones, 1957, #112; 1958, #653; and Lundgren, 1965, #166; 1966, #184).

655. PIRENNE, H. H., H. C. MARRIOTT, and E. F. O'DOHERTY.  
Individual differences in night-vision efficiency.  
Offers a neural explanation for an effect similar to "percentual narrowing" (Neitzman & Egstrom, 1966, #705).

656. BECKMANN, E. L.  
Escape from ditched aircraft.  
Institute of Aviation Medicine, R. A. F., Farnborough, England, 1959. N.Y.
Ability of deaf swimmers to orient themselves when submerged in water.

Clearly shows the importance of vestibular organs for orientation underwater.
In addition, since individual differences are reported, tests of this orientation ability in normal individuals could be employed as a selection device for diving training. (RK)

1960-1969

658. CLARK, B., and A. GRAYBIEL.
Visual perception of the horizontal during prolonged exposure to radial acceleration on a centrifuge.
U. S. Naval School of Aviation Medicine, Pensacola, Fla., Report No. 54, 18 August 1960.

Same as Clark and Graybiel (1957, #647).

659. GRAYBIEL, A., B. CLARK, and J. J. ZAPRIELLO.
Observations on human subjects living in a "slow rotation room" for periods of two days.

Findings of dizziness, etc., at low rates of angular velocity (1 & 2 RPM) suggest this may be an area of concern in submersibles if the latter turn at comparable rates. (RK)

660. SCHOCK, C. J. D.
Perception of the horizontal and vertical in simulated subgravity conditions.

Most of this paper contains raw data. The purpose of the study was connected with space flight; however, the tests were carried out underwater.

661. WHITESIDE, T. C. D.
The effect of weightlessness on some postural mechanism.

The author describes past pointing errors in zero gravity. Neutral buoyancy may produce similar problems. (RK)

662. BROWN, J. L.
Orientation to the vertical during water immersion.
U. S. Naval Medical Research Laboratory, Groton, Conn., Report No. 355, 10 May 1961.

This very significant study shows that orientation underwater is sometimes very poor. It contains suggestions for improvement of perception, and further research needed.

663. CHAPLINSKY, R. M., D. A. MORWAY, E. L. BECKMAN, R. DEFOREST, and K. R. OOBURN.
The effects of water immersion on performance proficiency.

664. GRAVELINE, D. E., B. BALKE, R. E. MCKENZIE, and B. HARTMAN.
Psychobiologic effects of water-immersion-induced hypodynamics.

Mainly shows cardiovascular effects, but a good source for other water immersion studies. (RK)
665. GRAYBIEL, A., and CLARK, B.
Perception of the horizontal or vertical with head upright, on the side, and inverted under static conditions and during exposure to centripetal force.
U. S. Naval School of Aviation Medicine, Pensacola, Fla., and National Aeronautics and Space Administration, NASA Order No. R-1, 15 August 1961a.

666. GRAYBIEL, A., and B. CLARK.
Symptoms resulting from prolonged immersion in water: The problem of zero G asthenia.
Describes some psychological effects from enforced prolonged water immersion.

667. GUEDRY, P. E., JR., and E. K. MONTAGUE.
Quantitative evaluation of the vestibular Coriolis reaction.
Of importance if the angular velocity of submersibles reaches threshold values.

668. BLEGVAD, B.
Caloric vestibular reaction in unconscious patients.
Suggests that arousal can potentiate the caloric vestibular reaction and so a diver in panic may be more susceptible to caloric induced vertigo. Also shows the diagnostic use of the test. (UK)

669. CORSO, J. F.
Bodily position and auditory thresholds.

670. DAVSON, H. (Ed.)
The eye.
The Troxler phenomenon is described, which is behaviorally similar to "graying out," "tunnel vision," or "perceptual narrowing," and occurs when one gazes fixedly (cf. Welkman & Egstrom, 1966, #705).

671. HAMMER, L. R.
Perception of the visual vertical under reduced gravity.
A good review paper with some reference to mutual buoyancy studies.

672. KENNEDY, R. S., and A. GRAYBIEL.
Symptomatology during prolonged exposure in a constantly rotating environment at a velocity of one revolution per minute.
Shows that disorientation and motion sickness are minimal or absent at this angular velocity except for extremely susceptible persons. Perhaps submersibles should use this as an upper limit unless countermeasures are employed. (UK)

673. PIPERNE, M. H.
Light-adaptation.
The Troxler phenomenon reported here has much in common with "perceptual narrowing" (Welkman & Egstrom, 1966, #705).
Psychological differentiation: Studies of development. 

See Witkin et al. (1954, #642), and Witkin (1949, #636).

675. ANON. 
Handbook of instructions for aerospace systems design. Vol. III. Reduced 
gyration. 

Many studies are reported where water immersion was used to simulate zero gravity. 
These studies are also of interest for their application to underwater studies, 
but are not often referenced in underwater reviews. (FK) They include studies 
of perceptual, cardiovascular, and performance problems.

676. CHAMBERS, R. M. 
Psychological problems in disorientation. 
U. S. Naval Air Development Center, Johnsville, Pa., NADC-MA-6321, AD 42968, 
31 December 1963. 

A good review paper with well-described mechanisms and nomenclature.

677. FERGUSON, J. C., and R. M. CHAMBERS. 
Psychological aspects of water immersion studies. 
U. S. Naval Air Development Center, Johnsville, Pa., Report No. MA-6328, 
30 December 1963. 

Shows considerable disorientation in the water, especially in the head down 
and back position (p. iii)." These studies were concerned with effects of 
weightlessness in space flight but many used water immersion to simulate sub- 
gravity and as such have application for underwater physiology and psychology. (FK)

678. MILLER, E. F., and A. GRAYBIEL. 
Rotary autokinesis and displacement of the visual horizontal associated with 
head (body) position. 

The effects of prolonged water immersion on the ability of human subjects to 
make position and force estimates. 

Shows that past pointing is in error underwater, but adapts.

680. WHITESIDE, T. C. D., A. GRAYBIEL, and J. I. NIVEN. 
Visual illusions of movement. 
U. S. Naval School of Aviation Medicine, Pensacola, Fl., and National Aeronautics 
and Space Administration, NSAM-577, NASA R-93, 21 October 1963. 

A review paper which also speculates on mechanisms and implications.

681. BAUERMEISTER, M. 
Effect of body tilt on apparent verticality, apparent body position, and their 
relation. 
J. Exp. Psychol. 67(2):142-147, 1964.

682. FLETCHER, J. L., G. D. ROBERSON, and H. LOEB. 
Effects of high intensity impulse noise and rapid changes in pressure upon 
stapedectomy monkeys. 
U. S. Army Medical Research Laboratory, Fort Knox, Ky., Report No. 610, August 21, 
1964.
683. GUEDRY, F. E., JR., R. S. KENNEDY, C. S. HARRIS, and A. GRAYBRIEL.
Human performance during two weeks in a room rotating at three RPM.

This report shows that some difficulties exist with an angular velocity as low as 3 RPM and should be considered in connection with submersibles. (Same as #563, Category III.)

684. KATZ, M. S., W. METLAY, and P. A. CIRINCIONE.
The effects of stimulus and field size on the accuracy of orientation in the homogeneous environment.
Communications Psychology Division, Human Factors Laboratory, Orlando, Fla., NAVTRADEVCEN IH-13, AD 607739, July 1964.

See Metlay, et al. (1964, #685).

685. METLAY, W., M. S. KATZ, P. A. CIRINCIONE, and G. C. TOLHURST.
Vertical orientation in a homogeneous environment.

Empty or near-empty fields are experienced by divers.

686. SCHONE, H.
On the role of gravity in human spatial orientation.

687. SZIKLAI, C., S. WAPNER, J. H. MCPARLAND, and H. WAPNER.
Effect of tonus changes on perceived location of visual stimuli.

Interaction of postural and visual systems is reported.

688. AVANT, L. L.
Vision in the Gansfeld.

Empty or near empty fields are experienced by divers.

689. MACKWORTH, N. H.
Visual noise causes tunnel vision.

This paper is relevant to any study where amorphous visual environments exist. It is particularly relevant to the "perceptual narrowing" finding (Weltman & Egestrom, 1966, #705).

690. PROPST, A. S.
A preliminary study of man in the sea, diver personnel and training implications.

Describes a "depth disorientation phenomenon" (pp. 18, 19, and 22) in connection with Seabab II.

691. STEPHENS, W. M.
Research submarines.
See Frontiers 11:228-241, July/Aug. 1965. N.Y.
692. STEWART, J. D., and B. CLARK.  
Coriolis effects during pitch and roll maneuvers in a piloted flight simulator.  

Applicable to submersibles.

693. WYKE, M.  
Comparative analysis of proprioception in left and right arms.  

Pointing accuracy a function of target position and head movement. The influence of neutral buoyancy on these results should also be studied. (RK)

694. CONTICELLI, M., and E. M. GLORIA.  
Visual performance in the empty field and in partially structured fields. III.  
Task involving Vernier acuity.  

See Conticelli and Zoli (1966, §695).

695. CONTICELLI, M., and M. T. ZOLI.  
Visual operating characteristic in the empty field.  

Visibility underwater can be analogous to an empty field.

696. DAY, R. H., and N. J. WADE.  
Visual spatial aftereffect from prolonged head-tilt.  

697. DOWD, P. J., E. W. MOORE, and R. L. CRAMER.  
Effects of flying experience on the vestibular system: A comparison between pilots and non-pilots to Coriolis stimulation.  

The differences in susceptibility to Coriolis stimulation between experienced and inexperienced aviation personnel may be applied to submersible training and selection of divers. (RK)

698. HOWARD, I. P., and W. B. TEMPLETON.  
Human spatial orientation.  

An excellent text which describes the interrelationships of vestibular and visual stimulations. Tests of vestibular function are included. The chapter on orientation (p. 419 ff.) on weightlessness is particularly relevant for diving medicine.

699. MARGARIA, R.  
Human locomotion on the earth and in subgravity.  

See other papers by Margaria.

700. MILLER, E. F., and A. GRAYBIEL.  
Magnitude of gravito-inertial force, an independent variable in egocentric visual localization of the horizontal.  
701. MILLER, E. F., and A. GRAYBIEL.
Role of the otolith organs in the perception of horizontality.
Am. J. Psychol. 79:24-37, 1966b.
This paper and others by these authors should be consulted for the mechanism of
orientation to the vertical and horizontal in humans, as well as for an understand-
ing of the disorientation problems which may occur in this capacity under
neutral buoyancy. (RK)

702. MILLER, E. F., A. R. FREGLEY, and A. GRAYBIEL.
Visual horizontal perception in relation to otolith function.
U. S. Naval Aerospace Medical Institute, Pensacola, Fla., Report No. 989,
23 December 1966.

703. MOORE, E. W.
Responses to Coriolis stimulation in flying personnel with different levels of
proficiency.
USAF School of Aerospace Medicine, Brooks AFB, Texas, SAM-TR-66-36, AD 634406,
April 1966.
The author reports increased tolerance with flying experience and similar effects
may occur in similar environments (e.g., submarines). Flying experience was
correlated with age, and although not mentioned as such, may also have been a
factor. (RK)

704. WEENE, P., and R. HELD.
Changes in perceived size of angle as a function of orientation in the frontal
plane.

705. WELTMAN, G., and G. H. EGSTROM.
Perceptual narrowing in novice divers.
These effects can influence orientation whether to the upright or in terms of a
direction sense. (RK)

706. ARNOLD, H. A.
Manned submarines for research.
The addition of motion to the other attributes of the underwater sensory environ-
ment may increase the perceptual problems.

707. CLARK, B., and A. GRAYBIEL.
The egocentric localization of the visual horizontal in normal and labyrinthine-
defective observers as a function of head and body tilt.
U. S. Naval Aerospace Medical Institute, Pensacola, Fla., Report No. 991,
Shows the importance of the vestibular system in orientation (as in Clark & Graybiel,
1967b, #708).

708. CLARK, B., and A. GRAYBIEL.
Egocentric visual localization in normals and partially blind during a change in
direction of gravitoinertial force.
U. S. Naval Aerospace Medical Institute, Pensacola, Fla., Report No. 1006,
Shows the importance of the vestibular system in orientation.
709. GRAYBIEL, A. (Ed.)
Third symposium on the role of the vestibular organs in space exploration.
U. S. Naval Aerospace Medical Institute, Pensacola, Fla., NASA SP-152, 24-26
January 1967.
This volume, plus Graybiel (1965, #417; 1967, #450; 1968, #588), are the best
collection of studies of the vestibular apparatus. See also Camis (1930, #299). (RK)

710. GRAYBIEL, A., E. F. MILLER, II, B. D. NEWSOM, and R. S. KENNEDY.
The effect of water immersion on perception of the oculogravic illusion in
normal and labyrinthine-defective subjects.
U. S. Naval Aerospace Medical Institute, Pensacola, Fla., Report No. 1016,
September 1967.
One "normal" subject had more difficulty in orientation underwater than did
the other three. (Same as #579.)

711. GUEDDY, F. E., JR.
Relations between vestibular nystagmus and visual performance.
U. S. Army Aeromedical Research Unit, and U. S. Naval Aerospace Medical Institute,
Nystagmus elicited by rotation degrades visual performance. It is felt that
if vertigo and nystagmus occur in divers from pressure, bubbles or other means,
a similar outcome can be expected. (RK)

712. PESCH, A., and R. TOHER.
Analysis of star boat performance and characteristic response.
General Dynamics Electric Boat Division, Groton, Conn., F417-67-060, October 30,
1967.
Figures 18, 19, and 20 suggest that in a 30-second 180° turn, the angular velocity
in the last 10 seconds approaches the threshold for Coriolis stimulation of the
semicircular canals (Mads, 1952, #92) which could in turn produce vertigo. (RK)

713. STEEDMAN, W. C.
Absolute judgments of size in a restricted visual environment.

714. ANON.
Rotational extravagance.
Describes how fear, information overload, and a vestibular stimulus can summate
and interact with hazardous consequences.

715. ANON.
Research submersibles; A report from General Dynamics.
Undersea Technol. 9:77, May 1968. N.Y.

716. BARNUM, F.
The epidemiology of USAF spatial disorientation aircraft accidents.
Presented at the 1971 Aerospace Medical Association Meeting in Houston, Texas,
1 January 1958-1 December 1968.
Although present-generation submersibles do not approach the aerobatic freedom
of high performance aircraft, this report suggests that a violent maneuver is
not always necessary for disorientation. Leads and potential problem areas
for underwater vehicles can be found here. (RK)
717. CLARK, R., and J. D. STEWART.
Comparison of sensitivity for the perception of bodily rotation and the oculogyral
illusion.

The fact that two indicators of rotation sensitivity have different thresholds
can result in disorientation in moving vehicles, particularly when cues are
altered or absent (e.g., underwater). (RK)

718. HARRIS, C. S., and H. C. SOMER.
Human equilibrium during acoustic stimulation by discrete frequencies.
Aerospace Medical Research Laboratories, Wright-Patterson AFB, Ohio, Report

Because noise can produce changes in equilibrium, and because pressure chambers
are noisy, one must control the effect of noise in order to measure the effects
of pressure on equilibrium. (RK)

719. IWANE, M., H. ONO, and M. SAWADA.
Effects of Coriolis stimulus during mild centrifugal G-load upon stick performance.
Institute Library, AC-922, Federal Aviation Administration, Oklahoma City,
Okla., 1969.)

This paper shows that head movements incident to angular velocity (not very
different from the rate of turn in submersibles--RK) can influence tracking.

720. LETKO, W., and A. A. SPADY, JR.
Walking in simulated lunar gravity.
Presented at the Fourth Symposium on the Role of the Vestibular Organs in Space

721. MILTICH, A. J.
Human auditory threshold shifts following changes between upright, supine and
inverted bodily positions.

Auditory thresholds are higher in the inverted position—a position not uncommon
in diving. The influence of the vestibular system was not ruled out
satisfactorily. (RK)

722. NELSON, J. G.
Effect of water immersion and body position upon perception of the gravitational
vertical.

Demonstrates the difficulties in orientation to which way is up when immersed
in water. A good bibliography.

723. PESCH, A. J.
Human factors research and simulation in the design of small submersibles.
General Dynamics Electric Boat Division, Groton, Conn., May 7, 1968.

See Pesch and Toher (1967, #712).

724. RADLOFF, R., and R. HELMREICH.
Marine life.
In R. Radloff and R. Helmreich Groups under stress: *Psychological research in
SEALAB II*. Century Psychology Series. New York: Appleton-Century-Crofts,
1968.

Reports on disorientation in SEALAB II, pp. 62, 63.
725. ROSS, H. E., and P. LENNIE.
Visual stability during bodily movement underwater.

726. ANON.
Chapter 1: submersibles.

727. ANON.
Sub-surface ocean vehicle.

728. BARRETT, G. V., P. A. CASE, C. L. THORNTON, and H. E. KERBER.
Evaluation of a motion simulator not requiring cockpit motion.

Because motion sickness and vertigo might occur in submersibles, and on barges
before a dive with dire consequences, a training or screening device may be
useful for diving medicine. (RK)

729. BROSQUE, L., and K. H. HANSEN.
The effect of change in body orientation upon the perceived direction of
autokinesis.

Because a swimmer's attitude underwater with respect to gravity is different than
when under terrestrial conditions, this paper is of interest. (PK)

730. BYNIM, J. A., and J. A. STEPH.
Painted helicopter main rotor blades and flicker-induced vertigo.

The authors indicate that under special conditions "vertigo" can be induced by
flicker.

731. CONTICELLI, H., and R. BRANCATO.
Autokinesia in the empty field.

See Conticelli and Zoli (1966, #695).

732. DOTY, R. L.
Effect of duration of stimulus presentation on the angular acceleration threshold.

Results should be compared to angular velocity of submersibles for purposes
of design criteria and perhaps selection of crew members. (""")

733. MCCOY, D. F., and K. C. LANCE.
Stimulus generalization of gravity.

734. MILES, S.
*Underwater medicine* (3rd ed.).

Discusses the effect of neutral buoyancy on perception, and other perceptual
illusions occasioned in water. "Mention "interest in dizziness has in recent
years subsided," but "cannot be lightly dismissed," and "is worthy of future
consideration" (p. 94). A very good book. (RK)
735. MOSER, R., JR.
Spatial disorientation as a factor in accidents in an operational command.

A similar effort might be undertaken for divers.

736. PETERS, R. A.
Dynamics of the vestibular system and their relation to motion perception,
spatial disorientation, and illusions.

737. PICK, H. L., JR., D. H. WARREN, and J. C. HAY.
Sensory conflict in judgments of spatial direction.

The hierarchy of sensory modalities is shown in this study and as expected,
vision is very important. However, the influence of proprioception over
audition has application for underwater where the influence of the former
is minimized. (RK)

738. RAHNHE, W. O., JR.
Adventures of Alvin.

739. REASON, J. T., and A. GRAYBIEIL.
Magnitude estimations of Coriolis sensations.
U. S. Naval Aerospace Medical Institute, Pensacola, Fla., and National Aeronautics

One of a series of studies on this phenomenon by these authors.

740. ROSS, H. E., S. D. CRICKMAR, N. V. SILLS, and E. P. OVEN.
Orientation to the vertical in free divers.

The authors report inverted (relative to gravity) performances are poorer than
upright. Their findings are essentially supportive of the studies by Nelson
(1968, §722), Brown (1961, §662), and others.

741. TRAUT, O. F., JR., and W. J. BRUICH, JR.
Water immersion reduced-gravity simulation.

A very good review. Although intended for an aerospace audience, it is directly
applicable to diving. (RK)

742. YESSENOW, M. D.
A study of the relationship between nystagmus eye movements and the oculo-renal
illusion.
Submitted in partial fulfillment of the requirements for the degree of Doctor
of Philosophy, University of Rochester, New York, 1969.

1970-1972

743. ANON. (Staff - Deep Vehicles Branch of the U. S. Naval Oceanographic Office.)
"Manned submarines and underwater surveying."

Illustrates the characteristics of submarines. In addition to possible problems
from Coriolis stimulation due to head movements incidental to angular velocities
(e.g., during turns), the presence or absence of ports may also lead to illusory
disturbances connected to the vestibular apparatus. (RK)
BERNOTAT, R. K.  
Rotation of visual reference systems and its influence on control quality.  
There could be an application of the findings to instrument design in submersibles and perhaps for free swimming divers. (RK)

CLARK, B., and J. D. STEWART.  
Thresholds for the perception of angular acceleration about the three major body axes.  
See Clark and Stewart (1968b, #717).

COLLINS, W. E.  
Effective approaches to disorientation familiarization for aviation personnel.  
Department of Transportation, Federal Aviation Administration, Oklahoma City, Okla., Report No. N° 70-17, November 1970.  
The training program reported here may be useful in connection with duty in submersibles. (RK)

EBENHOLTZ, S. M.  
Perception of the vertical with body tilt in the median plane.  
Shows data regarding egocentric horizontality and variables which influence this ability.

FRANKLIN, S. S., H. E. ROSS, and G. WELTMAN.  
Size-distance invariance in perceptual adaptation.  
Adaptation to perceptual distortion is related to water and face mask distortion.

GRIGOR’EV IU, G., IU V. FARBER, and N. A. VOLOKHova.  
Moscow, Izdatel’svo Meditsina, 1970.  
Of some interest regarding Coriolis forces and submersibles. (Abstract only seen.)

KENNEDY, R. S.  
Visual distortion: a point of view.  
U. S. Naval Aerospace Medical Institute, Pensacola, Fla., Report No. 7600,  
Monograph #15, 6 January 1970.  
A review of the literature on visual distortion with references to vestibular distortions also. Speculations on mechanisms and counter-measures are made.

KOTASKOVA, J.  
Some psychological aspects of isolation in hyperbaric conditions.  
Mentions disorientation.

MCKAY, C. L.  
Decrease in perceived distortion with repeated exposure: application for Naval diver training.  
U. S. Naval Submarine Medical Center, Groton, Conn., Report No. 613, 16 February 1970.
753. **MELVILL JONES, G.**  
Dynamic cross-coupling in the semicircular canals.  
In D. E. Busby (Ed.) *Recent advances in aerospace medicine*, pp. 233-248.  
If vertigo occurs in future generations of submersibles this report will aid in explaining the mechanisms. (RK)

754. **MELVILL JONES, G.**  
Origin significance and amelioration of Coriolis illusions from the semicircular canals: A non-mathematical appraisal.  
Countermeasures are suggested.

755. **OOSTERVELD, W. J.**  
Threshold value for stimulation of the horizontal semicircular canals.  
This experiment showed that laboratory threshold values are not very different from those obtained in flight. The threshold given is lower than the turn rate for some operational submersibles. (MK)

756. **STOCKFELL, C. W., and F. E. GUEMY, JR.**  
The effect of semicircular canal stimulation during tilting on the subsequent perception of the visual vertical.  
*Acta Otolaryngol.* (Stockh) 70:170-175, 1970.  
This factor should be considered in underwater experiments investigating perception of the upright where subjects are often tumbled.

757. **WADE, N. J.**  
Effect of prolonged tilt on visual orientation.  
One of many studies by this author with a good review and explanation of the mechanisms.

758. **WADE, N. J.**  
The effect of different psychophysical methods on visual orientation during tilt.  

759. **WATERLAND, J. C., and G. W. SHAPIROS.**  
Diplane center of gravity procedures.  

760. **WHITESIDE, T. C. D.**  
Blur zone.  
An interesting review and theoretical paper which raises a question about what is available for “seeing” when a subject is in motion. Although written for aviation, the slower speeds (but poorer visibility) of divers may make this a diving problem also. (RK)

761. **BENSON, A. J., and F. E. GUCDRY, JR.**  
Comparison of tracking-task performance and nystagmus during sinusoidal oscillation in yaw and pitch.  
Insofar as submersibles will occasion stimuli such as these, degraded performance might be expected. (RK)
762. CLARK, B.
Pilot reports of disorientation across 14 years of flight.

A reference list of review articles on this problem is in the paper, as is
a reference to the construction of a questionnaire which could be modified
to study similar problems in divers. (RK)

763. ZENKOLOT, E.
Comments on Sjoberg's hypothesis for the mechanism of the inversion illusion
under zero-gravity conditions.

The mechanism underlying the "inversion illusion under zero-gravity" may have
direct relevance for the difficulties experienced by divers in judging the up-
right. Perhaps the otoliths only signal the plane of the gravity vector and not
its direction. (RK)

764. GALL, R. R., B. V. USTIUSHIN, L. M. GAVRIOLOVA, and E. I. KHELE'SKII.
K voprosu ob otsenke vestibularnoi ustoichivosti. (The problem of estimating
vestibular stability. A71-28414.)

Different human tolerances to Coriolis stimuli (as might be encountered in a
submersible) are discussed.

765. KELLOGG, R. S.
Vestibular influences on orientation on zero gravity, produced by parabolic flight.
In H. E. Adler (Ed.) Orientation: Sensory basis. Ann. N. Y. Acad. Sci. 188:217-223,
1971.

There is application of his findings to underwater environments.

766. LEIBowitz, H.
Size constancy and visual space.

767. MILLER, E. F., II, and A. GRAYBIEL.
Goggle device for measuring the visually perceived direction of space.
U. S. Naval Aerospace Medical Research Laboratory, Pensacola, Fla., Report No. 1151,
November 1971.

This device, modified for water and pressure, would be useful for investigating
spatial orientation. (RK)

768. SEIREC, A., A. BAZ, and D. PATEL.
Supportive forces on the human body during underwater activities.

769. STEWART, J. D.
Human perception of angular acceleration and implications in motion simulation.

Of application for design of underwater vehicles.

770. WINTS, T. C., and W. R. THURLOW.
The effects of eye position and expectation on sound localization.

The influence of sound position versus eye and head position on localization
are reported.
771. WELTMAN, G., J. E. SMITH, and G. H. EOSTROM.
Perceptual narrowing during simulated pressure-chamber exposure.

See also Weltman and Eostrom (1966, #705).

772. WOODS, J. D., and J. N. LYTHGOE (Eds.)
Underwater science.

773. ADOLPSON, J., and T. BERGHACE.
Man's sensory processes in the underwater environment.
New York: John Wiley & Sons, in press.

The chapter on spatial orientation underwater discusses the influences of the
vestibular system. A chapter on somesthesia contains reference to vestibular
function underwater and pressure (body sway, vertically), as well as some
examples of disorientation.

774. ADOLPSON, J. A., T. BERGHACE, and L. GOLDBERG.
Effects of increased ambient air pressures on standing steadiness in man.

Changes in balance as a function of ata occurred. Because noise affects balance
(Tullio, 1929, #531; Bensei, et al., 1968, #584), the influence of chamber noise
(‘Hurry, 1970, #956; Summit and Reimers, 1971, #964) on equilibrium (Harris,
et al., 1968, #718) should be ascertained also. (RK)

775. E. C. O. R., INC.
Underwater propulsion systems. Specification sheet, EOR-1.
Melbourne, Fla., 1972.

This announcement describing the EOR-1 suggests that turning rates higher than
2 RPM can occur in submersibles and should be compared with threshold data for
producing Coriolis vestibular illusion (‘Heda, 1952, #92; Stewart and Clark,
1965, #692).

776. MORANT, R. E., and J. ARONOFF.
Starting position, adaptation and visual framework as influencing the perception
of verticality.
J. Exp. Psychol., in press.

Because of the relationship of this ability to certain personality variables
(e.g., field independence) there may also be application for diver selection. (RK)

777. SCHROEDER, D. J.
Some effects of alcohol on nystagmus and vertigo during caloric and optokinetic
stimulation.

Divers as a group tend to drink heavily and because alcohol can influence vestibular
reaction (at times inhibiting and at times facilitating), this should be
considered.
778. SHENTON, E. H.
   The story of the deep submersible.

779. VAUGHAN, W. S., JR., and A. E. HAVOR.
   Diver performance in controlling a wet submersible during four-hour exposure
to cold water.

See also:
References 35, 69, 72, 112, 117, 162, 224, 235, 250, 272, 273, 302, 345, 365, 367,
403, 486, 495, 507, 531, 536, 537, 550, 552, 553, 554, 555, 558, 573, 585, 590, 596,
603, 610, 622, 708, 725, 740, 773, 781, 788, 790, 799, 801, 802, 810, 824, 832, 835,
842, 848, 855, 857, 858, 861, 941, 955, 960.
CATEGORY V. THE USE OF THE VESTIBULAR SYSTEM AS AN INERTIAL GUIDANCE SYSTEM.

1850-1900

780. GALTON, F.
The art of travel: or, Shifts and contrivances available in wild countries.
London: John Murray, Albermarle Street, 1856.

Early reference to methods of navigation in humans and animals, e.g., moss on trees (p. 126), etc.

781. GUDLUND, F. O.
Die Cirkularbewegung als tierische Grundbewegung, ihre Ursache, Phanomenalitat und Bedeutung. (The circular movement as the basic movement of animals, its cause, phenomenon and importance. Trans. by Mrs. A. Voke, R.M.I., 1972.)
Z. Biol. (Munich) 35:419-458, 1897.

Shows that organisms travel in a circle and suggests the functional importance of such a tendency to permit them (in the case of certain animals) to rejoin the herd. Mentions (p. 439) that deep sea divers see fish swimming in circles in response to illumination by diver’s lanterns.

1900-1909

782. GRAY, A. A.
The Labyrinth of animals. Vol. II.

See Gray (1907, Vol. I. #23).

1910-1919

783. TOWNSHEND, C. C.
Fundamental methods of orientation & "imaginary maps."
Science 38:808-897, 1913.

Discusses the different methods employed in navigation in humans. Some methods are better (e.g., imaginary maps) for some functions and poorer for others. Application for free hunting and reconnaissance divers may be found. (MK)

784. ABGEBALDEN, E.
Beobachtungen zur Frage der morphologischen und funktionellen Asymmetrie des menschlichen Körpers. (Observations concerning the question of the morphological and functional asymmetry of the human body. Trans. by Mrs. A. Voke, R.M.I., 1971.)
Pflügers archiv für die gesammte physiologie 177:213-216, 1919.

An early study showing directional preponderances and preferences in humans. In particular the tendency within individuals to ascend different stairways is used to launch a discussion of the basis of this response preference.

1920-1929

785. BULLINGTON, V. E.
A study of spiral movement in the Ciliate Infusoria.
Arch. Protistenk. 50(3):219-274, 1925.

The author reports most of the one-celled organisms studied (164 ciliates) tend to spiral movement in a leftward (counterclockwise) direction. The ratio is about 2:1. This study was performed in the Northern Hemisphere (largely at Cold Spring Harbor). The author does not mention that the rotation of the earth could be a factor, but if ciliates in the Southern Hemisphere turn mostly rightward this would suggest that organisms are capable of responding to very low levels of Coriolis force. Future study appears warranted and if positive findings are obtained, there may be practical application for navigation in humans. (MK)
786. WEBER, C. O.
The properties of space and time in kinesthetic fields of force.

787. RABAUD, E.
How animals find their way about.

788. SCHAEFFER, A. A.
Spiral movement in man.

In this long and significant article the author reviews the functional significance of directional preponderance (turning) in man and animals. In addition to discussing spiral movements across phylla (amoeba to man), the author also discusses experiments on blindfolded persons walking and swimming. An excellent bibliography is presented; many articles are in German. Experiments in man on turning during swimming and rowing are reported, mechanisms are discussed. (PK)

789. KNOTTS, J. R., and W. R. MILES.
The maze-learning ability of blind compared with sighted children.

Better performance was obtained by blind than blindfolded persons, and recently blind persons appeared to learn better than blind prior to age five.

1930-1939

790. LIND, F. H.
Physical asymmetries and disorientation.

An important paper applicable to diver navigation and orientation. For example, one interesting finding: right turning predominates in walking, but left turning in swimming is due most likely to the fact that left legs are longer and right arms are stronger (p. 59), although the relationship is not perfect (also see Schaeffer, 1928, #788; and others).

791. DESLVA, H. R.
A case of a boy possessing an automatic directional orientation.
Science 73:393-394, 1931.

Although the ability was not as good as claimed, it shows how one's "sense of direction" can profit by use of the ability.

792. DUNCAN, B. K.
A comparative study of finger-maze learning by blind and sighted subjects.

1940-1949

793. GREGG, F. H.
Overcoming geographical disorientation.
J. Consult. Psychol. 4:66-68, 1940.

Shows the influence of the vestibular system when "intently thinking (p. 66)" of a "geographic direction (p. 65)."

794. RYAN, T. A., and M. S. RYAN.
Geographical orientation.
Am. J. Psychol. 53:204-215, 1940.

A study on humans.
795. LORD, F. E.
A study of spatial orientation of children.
A good paper for future studies of navigation in free swimming divers. (PK)
Several additional references.

796. GRIFFIN, D. R.
The sensory basis of bird navigation.
Evaluates kinaesthetic and other theories of homing. Excellent bibliography.

1950-1959

797. MENZIO, P.
Labyrinthine reactions induced in man by means of minimal thermal stimuli and
the influence of previous modification of temperature in the external auditory
canal.
Arch. Fisiol. 51:154, 1951. H.V.

798. WORCHEL, P.
Space perception and orientation in the blind.
Among other findings the author suggests that time estimation is the method
employed in navigation.

799. CLARK, B., and P. D. MALONE.
Topographical orientation in naval aviation cadets.
U. S. Naval Air Station, Pensacola, Fl., Report No. 001 099.01.30, 2 June 1952.
A test is reported which purports to measure a personality or life style trait
"sense of direction." The hypothesis was that high scores could be related to
success in aviation training. No relationship was found. However the trait, if
it exists, may be more critical for divers than pilots since the latter have more
navigation aids and therefore can depend less on their sense of direction. (PK)

800. WORCHEL, P.
The role of the vestibular organs in space orientation.
J. Exp. Psychol. 44(1):4-10, 1952.

801. DALLENBACH, K. H.
The phenomenal vertical and horizontal in blind and sighted subjects.

802. McREYNOLDS, J., and P. WORCHEL.
Geographical orientation in the blind.
Because divers are often rendered effectively blind by the poor visibility of
some water, there is much to be learned regarding navigation from this literature.
(RK) This study and others by Worchel have good bibliographies.

803. ROUSE, D. L. and P. WORCHEL.
Vearing tendency in the blind.
There is a directional tendency to veer even in blind persons and this tendency is
relatively consistent within a subject. Perhaps a "personal equation" identified in
a diver could improve the diver's ability to navigate. (RK)
804. BERG, J., and P. WORCHEL.
Sensory contributions to human maze learning: a comparison of matched blind,
deaf, and normals.
J. Gen. Psychol. 54:81-93, 1956.

There is application for underwater swimmer navigation, as well as for the
training of blind divers. (RM)

805. GUERRRY, F. E., and G. RICHMOND.
Differences in response latency with different magnitude angular acceleration.
U. S. Army Medical Research Laboratory, Panama, Fla., Report No. 301,
2 November 1957.

Shows response of subject to various magnitudes of turning (angular acceleration)
stimuli.

806. MARGARTA, R.
Prolonged after-effect of centripetal and tangential accelerations on cerebellar
potentials.
Final Report, Contract AF 61(154)-968, AF Air Research & Development Command,
AD 152 246, Summary of work from 1 June 1956 to 30 September 1957.

"Rotatory and post-rotatory cerebellar activity in birds [is] investigated (p. 1)"
and reported. Responses are obtained in cerebellar cortex as low as .01-.02 g.

807. GRIFFIN, D. R.
Listening in the dark: The acoustic orientation of bats and men.

See Chapter 12, "Echolocation in the Blind."

808. GRIFFIN, F. E., and S. J. GITMAN.
Derivation of 'subjective velocity' from angular displacement estimates made
during prolonged angular accelerations: adaptation effects.
U. S. Army Medical Research Laboratory, Fort Knox, Ky., Report No. 376, 21 November
1958.

The accuracy of subjective stimuli of turning is given.

1959-1969

809. FRAENKEL, G., and D. L. GANN.
The orientation of animals.

810. DIFENBACH, W. S.
The ability of submerged subjects to sense the gravitational vertical.
Cornell Aeronautical Laboratory, Inc., Buffalo, N.Y., "Report No. M-1355 V-1,
2 September 1961.

Shows how poor is orientation to the vertical when subjects are immersed in water
and tilted.

811. FRAENKEL, C. S., and D. L. GANN.
The orientation of animals: Kineses, taxes, and compass reactions.

Probably the best single reference work for a basic understanding of the problem
and for implication to human navigation. Excellent references.
812. BERITOFF, J. S.
Spatial orientation of man and animals.

Shows (in a film) the importance of a functioning labyrinth (human and dog) for traversing a route.

813. HOWLAND, C. H., and B. HOWLAND.
The reaction of blinded goldfish to rotation in a centrifuge.

814. MENALDY, L. R.
Displacement of migratory birds.

815. PRATT, J. G.
Research on animal orientation, with emphasis upon the phenomenon of homing in pigeons.
Duke University, Raleigh, N. C., ONR Research Project No. 301-244, 18 October 1962.

816. ADLER, H. E.
Sensory factors in migration.

A review of the sensory system involved in animal migration. An excellent bibliography. His reports of time estimation (i.e., internal clocks) are useful in theoretical formulations regarding the use of the vestibular system as an initial guidance system. (**) I

817. AULBRECHT, H., et al. (Eds.)
Orientierung der Tiere Animal Orientation.

All papers in this symposium have English summaries although some articles are in German. There are several very good papers.

818. BERITACHVILI, I. S. (BERITOV)
Les mecanismes nerveux de l'orientation spatiale chez l'homme.

The English summary describes how deaf-mutes with bilateral labyrinthine defects were unable "to walk along the route along which they were led or carried (p. 248)." However, otherwise normal deaf-mutes could (i.e., not labyrinthine defective). Same author as Beritoff (1962, #812).

819. BARLOW, J. S.
Inertial navigation as a basis for animal navigation.

Offers a theory and model regarding the use of the vestibular system in animal migration and navigation.

820. MARGARIA, R., and G. A. CAVAGNA.
Human locomotion in subgravity.

See other papers by Margaria.

821. SCHMIDT-KOENIG, K.
Sun compass orientation of pigeons upon displacement north of the Arctic Circle.
822. BARLOW, J. S.
Inertial navigation and animal navigation.


Similar to Barlow (1964, #819).

823. BATSCHELET, E.
Statistical methods for the analysis of problems in animal orientation and certain biological rhythms.


Some of these methods can be applied to studies of navigation in free swimming divers.

824. CRATTY, B. J.
Perceptual alterations of veer by interpolated movement experience.


This report is short but has many applications for diving medium. It suggests important leads for research, particularly for aiding navigation in free swimming divers. (OK)

825. SHOOP, C. R.
Orientation of anabysstoma racleatum: Movements to and from breeding ponds.


826. BARLOW, J. S.
Inertial navigation in relation to animal navigation.


Similar to Barlow (1964, #819).

827. BROWNE, J. H.
Amplitude estimation of angular velocity during passive rotation.


Browne's article shows that the subjects' reports of a vestibular stimulus (i.e., turning) is proportional to the stimulus, and the error of the estimate is small. This report and others in this section suggest that the ability to navigate by "direction sense" is better than the use made of it in practical situations. (OK)

828. HELEN, J. T., AND E. L. PETERSSON.
The navigation of penguins.


Although a sun compass is used when available during long dark winter nights another mechanism may be involved at other times. (OK)

829. STORM, R. M. (Ed.)
Animal orientation and navigation.


Some very excellent papers appear in this book and the bibliographies are good. Inertial theories are discussed occasionally (cf. pp. 35-37: especially p. 54).

830. CARR, A. F.
So excellent a fisher. (A natural history of sea turtles.)


Describes the various theories of navigation/migration in green turtles. Speculates on how the animals find Ascension Island—a "small crumb out in the tea between Africa and South America (p. 159)" and near the equator. One of the theories offered uses the vestibular system.
831. GENTRY, R. L.
Underwater auditory localization in the California sea lion.

832. LOCKLEY, R. M.
Animal navigation.
The chapters on "A sense of balance (p. 66)" and "A sense of time (p. 72)" are most important for a study of human navigation. (RK)

833. TOLSTOY, L.
Master and man.
Circular movement in humans was well enough known to Tolstoy that it served as the theme of this story.

834. ANDERSEN, B. G.
Diver performance measurement: Underwater navigation, depth maintenance, weight carrying capabilities.
Navigation accuracy averaged 5.21° over a 780-foot course. If bias was constant within a diver perhaps a knowledge of a "personal equation" could improve accuracy. Further, if cause of error could be attributed to relative strength of the legs, perhaps a diver could be trained to modify his headings. (RK)

835. GRAYBIEL, A., E. F. MILLER, B. D. NEISHON, and R. S. KENNEDY.
The effect of water immersion on perception of the oculoprovinc illusion in normal and labyrinthine-defective subjects.
Shows that orientation to the upright in water is better in normal than in persons with labyrinthine defects.

836. HIXSON, W. C., and J. I. NIVEN.
Instrumentation for measurement of vestibular-significant forces in helicopters.
This system might be adapted for underwater use and could then serve as a navigation aid.

837. JANDER, R.
Über die Ethometrie von Schlusselreizen, die Theorie der telotaktischen Wahlhandlung und das Potenzprinzip der terminalen Cumulation bei Arthropoden. (On the ethometry of sign stimuli, the theory of telotactic choice, and the power principle of the terminal cumulation in Arthropoda.)

838. KAVANA, J. L., and C. E. FISCHER.
Program clocks in small mammals.
For the vestibular system to be able to serve as a useful inertial guidance system it must respond to the linear and angular forces and must also have an accurate timing device. This paper shows how accurate some clocks in animals can be. (T)

839. MCDONALD, D. L.
ANDERSEN, B. G., F. L. ALLEN, and J. C. LAND.*
Diver performance measurement: transporting neutrally buoyant objects, manual movement by heavy objects.

Effects of weight-carrying on navigation is reported.

BEBIAN, C., and R. TOFT.
Sensory mechanisms of homing in salmonid fish. I. Introductory experiments on the olfactory sense in grilse of Baltic salmon (Salmo Salar).

Sensory mechanisms of homing in salmonid fish. I. Introductory experiments on the olfactory sense in grilse of Baltic salmon (Salmo Salar).


CLARK, D., and J. D. STEWART.
Effects of angular acceleration on man: Thresholds for the perception of rotation and the oculogyral illusion.


See Clark and Stewart (1963b, 8717).

DROSCHER, V. B.
The panic of the senses.

Chapters 8 and 9 on Migration and Navigation, respectively, are of interest.

GUIDRY, P. E., JR., G. C. OTHMS, and J. H. NORMAN.
Assessment of semicircular canal function: I. Measurements of subjective effects produced by triangular waveforms of angular velocity.

U. S. Naval Aerospace Medical Institute, Pensacola, Fla., NAMT-1073, USAARL 69-7, AD 695388, June 1969.

A useful method for studying the analogue of the vestibular apparatus as an inertial guidance system.

HOLUBAR, J.

This recently translated work reports on the accuracy of timing behavior in man and animals. A supplemental bibliography is appended. An important source for studies of navigation by vestibular cues. (**) 846.

MAYNE, R.
The analogy of the vestibular organs to an inertial guidance system.

This excellent paper makes the point that this analogy has not been discussed much in vestibular physiology. It follows and should be added that the application of these findings to problems of diver navigation could have important implications and applications. (**)

MAYNE, R.
The analogy of the vestibular organs to an inertial guidance system.
Presented at the World Congress of Oto-Rhino-Larynology, Mexico City, August 1969b.

Essentially the same as Mayne (1969a, 8846), however an updated version of both will appear in Handbook of sensory physiology. VI. Vestibular system. Berlin: Springer-Verlag, in press.
848. OWENS, G. G. and F. E. GUEDRY, JR.

Adaptation of this method using trains of stimuli could be worthwhile in studying information processing with vestibular stimulation relative to navigation by "dead reckoning" or "direction sense." Individual differences could be useful for purposes of selection. (UK)

849. PARTHRODGE, L. D., and J. H. KIN'.
Dynamic characteristics of response in a vestibulomotor reflex.

1970-1972

850. GOULD, J. L., M. HINZBETH, and M. C. MACLEOD.
Communication of direction by the honey bee.

851. HASLER, A. D., R. H. HARRALL, A. B. SASKO, and A. E. DIZON.
Orientation cues and tracking of migrating salmonid fishen.

852. JANDER, R.
Ein Ansatz zur modernen Elementarbeschreibung der Orientierungshandlung. (An attempt at a modern elementary description of orientation activities.)

853. JANDER, R., Michael FABUTIUS, and Monika FARTIUS.
Die Bedeutung von Gliederung und Kantenrichtung fur die visuelle Formerscheidung der Wespe Dolichovespula saxonica am Flugleib. (The significance of disruption and contour-direction for visual form discrimination near the nest entrance in the wasp [Dolichovespula saxonica].)

854. JANDER, R., and T. VOLT-HEINRICH.
Das straubl-specifiche visuelle Perceptor-system der Stabheuschrecke (Carausius morosus). (The shrub-specific visual perceptor-system of the stick insect [Carausius morosus].)

855. LEGGIERE, T., J. MCAHUFF, H. SCHNECK, and J. VAN RYZIN.
Sound localization and homing of scuba divers.

A useful model for future studies of vestibular orientation and navigation capabilities.

856. LISSAMAN, P. B. S., and C. A. SCHOLLBERGER.
Formation flight of birds.

857. PARKER, D. E.
Interactions between electrical and mechanical vestibular stimulation: observations on rabbits and men.

Because mechanical (physiologic) and electrical stimulation of the vestibular apparatus is possible, and because the response tends to be proportional to the stimulus, water adaptable (e.g., ELF) stimuli may be useful to human divers as a navigation aid. (IK)
858. Parsons, R. D.
Magnitude estimates of the oculogyral illusion during and following angular accelerations.

The accuracy of the human vestibular system to respond to turning stimuli is good and the system should be studied as a navigation aid. (**)  

859. PROTHUS, S. D.
Possible effects of rate of global spin.

If he is correct about differential responses to global spin, then perhaps such mechanisms could aid in human geographic orientation and navigation. (**)

860. ROBERTSON, D. C.
A self-contained underwater swimmer guidance system.

This is a good article concerning a self-contained swimmer guidance system using sound localization which could be modified to study the ability of the vestibular system to do similar or redundant work, or to add another dimension. Remote transmission might also be attempted. (PK)

861. ROSS, H. E., D. J. DICKINSON, and B. P. Nipp.
Geographical orientation under water.

Although errors occur in geographical orientation under water, it would be interesting to repeat this study with the purpose of studying ways to improve performance, e.g., training in time estimation, advice on personal wearing tendencies, etc. (**)  

862. SMITH, A.
The seasons. Rhythms of life: Cycles of change.

Chapter 4 on Migration is interesting.

863. SOLIDAY, S. H.
Navigation in terrain-following flight.

864. WILLIAMS, T. C., and J. W. WILLIAMS.
Radio tracking of homing and feeding flights of a neotropical bat, Phyllostomus hastatus.

865. ADLER, H. E. (Ed.)
Orientation: Sensory basis.

866. ANON.
Bird navigation during distorted vision (contact lens).

Describes the ability of birds to navigate even when vision is disrupted.

867. BRYAN, F. A.
Some orientational influences of nonvisual, terrestrial electromagnetic fields.
A comparison of the portonaut and Navy maze tests.  
STD 71 11, June 1971.

This test, plus tests of geographical orientation (Clark, 1971, #762), may be  
useful selection devices for divers. (PM)

The homing salmon and EEG responses to homestream water.  
Presented at the New York Academy of Sciences Conference on Orientation: Sensory  
Basis, New York City, February 3-10, 1971.

Comparison of cupulometric and psychophysical thresholds for perception of  
rotation and the oculogyral illusion.  

Show that the vestibular system (semicircular canals) is very sensitive to  
turning. This study has application for diving as: (1) a provocative test of  
vestibular function which pressure could perturb; (2) to show that vestibular  
sensitivity might be useful for navigation under water. (PM)

The sensory basis of orientation in amphibians.  
In H. E. Adler (Ed.) Orientation: Sensory basis.  

A good bibliography.

Nystagmus responses during triangular waveforms of angular velocity about the  
Y- and Z-axes.  
U. S. Naval Aerospace Medical Research Laboratory, Pensacola, Fla., Report No.  
1138, USAARL Serial No. 72-1, 22 July 1971.

Shows the accuracy of vestibular apparatus to angular velocity stimuli.

Comparison of subjective responses to semicircular canal stimulation produced by  
rotation about different axes.  

Demonstrates the reliability of human responses to angular acceleration stimuli.

Use of triangular waveforms of angular velocity in the study of vestibular function.  

Chemosensory orientation in sharks.  

The role of the semicircular canals in the angular orientation of fish.  
In H. E. Adler (Ed.) Orientation: Sensory basis.  

Visual pattern recognition and directional orientation in insects.  
In H. E. Adler (Ed.) Orientation: Sensory basis.  
878. LEHNER, F. N. and D. S. DENNIS. 
Preliminary research on the ability of ducks to discriminate atmospheric pressure changes. 

Ducks responded to .4 psi of pressure. This has implications for learning but perhaps also for barotraumatic otitis media. (RX)

879. PAYNE, R. and D. WEBB. 
Orientation by means of long-range acoustic signaling in Balaen whales. 
In H. E. Adler (Ed.) Orientation: Sensory basis. 

A good bibliography.

880. SCHLICHTIE, H. J., and K. SCHMIDT-KÖNNIC. 
Zum Heimfindevermogen der Briefnube. (The home-recall ability of the carrier pigeon. Trans. by Mrs. A. Woke, NMRI, 1971.) 

The article points out the importance of vision in bird navigation.

881. SCHMIDT-KÖNNIC, K. 
Session on "Photoreceptors." 
In H. E. Adler (Ed.) Orientation: Sensory Basis. 

882. SCHUSTERMAN, P. J., and W. P. BAILLIE. 
Aerial and underwater visual acuity in the California sea lion (Zalophus Californianus) as a function of luminance. 
In H. E. Adler (Ed.) Orientation: Sensory basis. 

883. SIMMONS, J. A. 
Echolocation in bats: Signal processing of echoes for target range. 

884. SIMMONS, J. A., and J. A. VERNON. 
Echolocation: Discrimination of targets by the bat, Eptesicus fuscus. 

885. SIMMONS, J. A., E. G. WEWER, and J. M. PYLKA. 
Periodical cicada: Sound production and hearing. 

886. SOUTHERN, W. E. 
Gull orientation by magnetic cues: A hypothesis revisited. 
In H. E. Adler (Ed.) Orientation: Sensory basis. 

A good bibliography.

887. STASKO, A. B. 
Review of field studies on fish orientation. 
In H. E. Adler (Ed.) Orientation: Sensory basis. 

A good bibliography.

888. TAVOLGA, W. N. 
Acoustic orientation in the sea catfish, Galeichthys fellea. 
In H. E. Adler (Ed.) Orientation: Sensory basis. 
889. WARD, R. R.
The living clocks.

An accurate inertial guidance system is only as accurate as the timer. (RX) This discusses various timers in organisms.

890. ANON.
(A question and answer regarding vestibular system in flounders.)
Sea Secret 16(1), 1972.

The response to a question regarding the directional specificity of the migration of the eye and optic nerve in flounders is of interest (p. 14).

891. BLAKESLEE, E.
Sensitivity of pigeons to direction of movement considered in relation to inertial guidance theories of animal navigation.

892. EMLEN, S. T.
Birds. Their migration is at least as complex as human navigation and probably no more mysterious.

Mentions the importance of celestial cues in navigation but agrees that other cues (e.g., vestibular) could be important.

893. GALLER, S. R., K. SCHMIDT-KOENIC, C. J. JACOBS, and R. E. BELLEVILLE.
Animal orientation and navigation.

In this long report (600 pp.) studies of virtually all forms of navigation and orientation of homing and migratory animals are discussed. No reports deal specifically with man.

894. WILTSCHKO, W., and R. WILTSCHKO.
Magnetic compass of European robins.

The magnetic compass of European robins does not use the polarity of the magnetic field for detecting the north direction. The birds derive their north direction from interpreting the inclination of the axial direction of the magnetic field lines in space, and they take the direction on the magnetic north-south axis for "north" where field lines and gravity vector form the smaller angle. (Author's abstract.)

See also:

CATEGORY VI. AUDITORY STUDIES WHICH HAVE RELEVANCE FOR UNDERSTANDING VESTIBULAR FUNCTION UNDERWATER.

1800-1899

895. LESTER, J. C., and V. GOMEZ.
Observations made in the caisson of the new East River bridge as to the effects of compressed air upon the human ear.
Arch. Otol. 27(1):1-19, 1898.
ENT examinations were performed in a caisson with persons previously examined at normal pressure. Labyrinthine disturbances are mentioned (pp. 17-16).

1900-1909

896. POLI, C.
Risultati dell'esame preventivo nei lavoratori sotto pressione.
Atti XII Congr. Soc. Ital. ORL., 1908. (Cited by A. Pagano, 1959.) N.Y.

1910-1919 None.

1920-1929

897. POHLMAN, A. G., and P. W. KRANZ.
The effect of pressure changes in the external auditory canal on acuity of hearing.

1930-1939

898. MITCHELL, J. H.
Streptococcal dermatoses of the ears.

899. THOMPSON, E., H. A. HOWE, and W. HUGHSON.
Middle ear pressure and auditory acuity.
Increased or decreased pressure can impair one's functional ability to about the same extent.

900. BEINKE, A. R.
Medical problems relating to diving, underwater construction, and submarines.
The effects of pressure change on air spaces (specifically, auditory tubes and sinus passages) are discussed.

901. LOVELACE, W. R., and C. W. MAYO.
Aero-otitis media: its alleviation or prevention by the inhalation of helium and oxygen.

1940-1949

902. HALL, J. F., JR.
The use of helium-oxygen mixtures in aviation for the prevention of painful ear symptoms.

903. ALMOUR, R.
The "blocked ear" of the caisson worker.
Laryngoscope 52:75-81, 1942b.
904. BENNKE, A. R.
Investigations concerned with problems of high altitude flying and deep diving;
application of certain findings pertaining to physical fitness to the general
military service.
A review paper of more importance for auditory than vestibular problems. (RK)

905. LOCH, W. E.
Effect of experimentally altered air pressure in middle ear on hearing acuity in
man.

906. LOCH, W. E.
The effect on hearing of experimental occlusion of the Eustachian tube in man.

907. ANON.
Diver's ear (otic barotrauma).
This article suggests that tympanic changes occur in persons exposed to compressed
air who do not have the "knack of ear clearing (p. 14)." For inexperienced persons
following a descent of about 10 feet or more, "100 percent...will show drum
changes [and the] common appearance is that of acute otitis media (p. 13)."

908. KOS, C. M.
Effect of barometric pressure changes on hearing.
Tr. Am. Acad. Ophth. 49:75-81, 1944. (Cited by Fulton; cited by Pagano, 1959.)

909. MITCHELL, D. F.
Aerodontalgia.

910. KENNON, R. H., and C. M. OSBORN.
Relation of aerodontalgia to aerosinusitis.
A possible contributing factor in cases of DCS. (RK)

911. SANDLER, H. C.
Toothaches at low atmospheric pressure.

912. LIEBERMAN, A. T.
Aero-titis media in pressure chamber "flights."

913. PATTON, R. A.
Purulent otitis media in albino rats susceptible to sound-induced seizures.

914. CHANG, W. S., R. MARGARIA, and S. GELFAN.
Pressure changes and hemorrhage in the middle ear of monkeys resulting from de-
compression and recompression.

915. HITSCHLER, W. J.
The relationship of swimming and diving to sinusitis and hearing loss.
916. THUILLIER, A.
Sinusite barotraumatique. Medecine aeronautique.
N.Y.

1950-1959

917. KUROZUMI, S.
What influences on the hearing acuity were found when the pressure in the tympanic cavity was changed experimentally?

918. ADAMS, W. S.
The etiology of swimmer's exostoses of the external auditory canals and of associated changes in hearing. Part I.

In addition to perceptive loss of hearing there are also reports of vertigo.

919. ADAMS, W. S.
The etiology of swimmer's exostoses of the external auditory canals and of associated changes in hearing. Part II.

See also Adams (1951a, #918).

920. TONNDORF, J.
The influence of service on submarines on the auditory organ.
In Symposium on submarine medicine, Folio VII, U. S. Naval Forces, Germany. (Technical Section, Medical). Date uncertain, 1951.

921. COLEMAN, J.
Auditive disorders in the compressed air illness.

922. BERTRAND, M.
Contribution a l'étude des sinusites barotraumatiques.

923. PAGANO, A.
Ulteriori ricerche audiometriche nei barotraumi da cassoni.

924. HALLBERG, O. E.
Sudden deafness of obscure origin.

925. BURKE, D. T.
Barotrauma.

926. TAYLOR, G. E.
The otolaryngologic aspects of skin and scuba diving.

Although mainly concerned with the auditory portion of nerve VIII function, this is a very significant and complete article and there is much of interest regarding the vestibular system, particularly effects of barotrauma. Over 60 references and case histories are reported. (RK)
927. CAMPBELL, P. A.
Sinus barotrauma.
In Otolaryngology. Vol. 3, Ch. XII. Hagerstown, Md.: W. F. Prior Co., Inc., 1960b. N.Y.

928. APPAIX, A., M. GRINDA, J. HENIN, and P. NOURRIT.
Les barotraumatismes cochlaires. Données cliniques. (Cochlear barotraumas, clinical data.)

929. ROSATRA, A. B., and G. B. STAFANI.
Endolymphatic sudden deafness: clinical study.

930. JARRETT, A. S.
Reverse-ear syndrome and the mechanism of barotraumas.

931. MONTAGUE, W. E., and J. F. STRICKLAND.
Sensitivity of the water-immersed ear to high- and low-level tones.

932. BOND, C. F.
Clinical problems of SCUBA diving.

The author briefly mentions the importance of the ear in diving.

933. BUSNELL, R. G. (Ed.)
Acoustic behavior of animals. 933 pp.

934. SERGEANT, R. L.
Speech during respiration of a mixture of helium and oxygen.
U. S. Naval Medical Research Laboratory, Groton, Conn., Report No. 412, 14 October 1963.

935. ALFANDRE, H. J.
Aerotitis media in submarine recruits.
U. S. Naval Submarine Medical Center, Groton, Conn., Report No. 450, 29 May 1965.

Reports the epidemiology study of 432 cases.

936. SMITH, P. F.
Bone conduction, air conduction, and underwater hearing.
U. S. Naval Submarine Medical Center, Groton, Conn., Report No. 65-12, 8 October 1965.

937. WILKE, V. M., and M. STIEFEL.
Horstorungen bei tauchsportlern. (Disturbances in hearing of sport divers.)

938. ADOLFSÖK, J., and E. FLUUR.
Hearing discrimination in hyperbaric air.

The authors did speech discrimination at 4, 7, and 11 ata. They found a difference at 7 and 11 ata.
939. BEAL, D. D., W. G. HEMENWAY, and J. R. LINDSAY.
Inner ear pathology of sudden deafness.

940. DUNS, R.
ORL-probleme beim Tauchsport. (ENT problems in diving sport.)

941. HARRIS, C. S., and H. E. von GIERKE.
The effects of high intensity noise on human equilibrium.
The influence of noise on equilibrium is discussed.

942. SPERATI, G., and G. PEPINO.
L'ottite esterna dei Sommazzatori. (Otitis externa of skin divers.)

943. NIXON, C. W., W. E. MABSON, F. TRIMBOLI, J. E. ENDICOTT, and B. E. WILCH.
Observations on man in an oxygen-helium environment at 380 M. Hg total pressure:
IV. Communications.
USAF School of Aerospace Medicine, Brooks AFB, Texas, SAM TR 67-205, 1968.

944. SERGEANT, R. L.
Limitations in voice communications during deep submergence-helium dives.

945. SERGEANT, R. L.
Voice communication problems in spacecraft and underwater operations.

946. HARDACRE, L. E., and J. HALPERN.
The evaluation of a dynamic visual display of transient underwater acoustic signals.

947. HARRIS, J. D.
Hearing loss in decompression.
A very good review of the effects of pressure on hearing. More than 80 references, many of which are of interest for vestibular functions. (NK)

948. HOLLIDEN, H., and J. F. BRANDT.
Effect of air bubbles in the external auditory meatus on underwater hearing thresholds.

949. MURTY, V. S. N.
Otitic barotrauma with bilateral perforations (a case report).

950. RIU, R., L. FLOTTE, R. GUILEME, R. BADRE, and R. LEDEN.
La trompe d'eustache dans la plongee. (Eustachian tube during diving.)

951. SLESKOVIC, Z.
Barotraumatic osteocnenje slusnog organa u ronilaca. (Barotraumatic damage of hearing organ in divers.)

No English abstract available.
952. SMITH, P. F.
U. S. Naval Submarine Medical Center, Groton, Conn., Report No. 569, 28 February 1969.

953. WEBSTER, J. C.
Silent, present, and future.

1970-1972

954. BAUER, B. B.
Comments on "Effect of air bubbles in the external auditory meatus on underwater hearing thresholds."

Failed to replicate the finding of Hollien and Brandt (1963, #948). The latter "measured no significant difference in underwater threshold (p. 1465)."

955. HARRIS, J. D., and R. L. SERGEANT.
Sensory behavior of naval personnel: Monaural/binarial minimum audible angle of auditory response.

956. MURRY, T.
Noise levels inside Navy diving chambers during compression and decompression.

Very high noise levels were obtained in diving chambers (they can be more than 100 db, A-scale), and noise does affect vestibular functions (cf. Harris and von Gierke, 1967, #941).

957. SMITH, P. F.; R. HOWARD, M. HARRIS, and D. WATERMAN.
Underwater hearing in man: II. A comparison of temporary threshold shifts induced by 3500 hertz tones in air and underwater.

958. SUMMIT, J. K., J. M. ALEXANDER, E. T. FLYNN, and J. M. HERRON.
Repetitive excursion dives from saturated depths on helium-oxygen mixtures.
Phase II: Saturation depth 200 feet, saturation depth 150 feet.

959. WATERMAN, D., and P. F. SMITH.
An investigation of the effects of a helium-oxygen breathing mixture on hearing in naval personnel.

960. HARRIS, C. S.
Effects of acoustic stimuli on the vestibular system.
Aerospace Medical Research Laboratory, Wright-Patterson AFB, Ohio, Report No. A7-1, 1971.

Harris' findings showed that nystagmus and egocentric verticality were not disrupted by noise, but postural equilibrium was.

961. HOLLIE, N., and H. ROTTMAN.
Underwater sound localization in humans.

962. MCCORMICK, J. G., T. L. HIGGINS, H. S. DAUGHERTY, and P. E. JOHNSON.
Cochlear dysfunction associated with decompression from 300-ft. hyperbaric chamber dives.
963. MILLER, R. E.
Cochlear potentials at 11 atmospheres.

A good bibliography. Losses of 15 to 20 db are reported.

964. SUMMICKT, J. D., and S. D. REIMERS.
Noise: A hazard to divers and hyperbaric chamber personnel.

Noise levels in chambers and helmets are high (>90 db), and result in temporary
threshold shifts.

See also
References 10, 14, 19, 27, 28, 33, 42, 48, 51, 54, 57, 59, 62, 63, 65, 66, 68, 69,
73, 74, 81, 110, 114, 127, 128, 129, 130, 131, 154, 157, 178, 182, 315, 359, 394, 398,
403, 518, 718, 721, 855.

ADDENDUM—CATEGORY VI

965. DELONCA, C.
Considerations sur les manoeuvres dites d'equilibration de l'oreille chez le
plongeur.
Part of a longer COMEX—CÉNEX report. (Unable to identify title; probably after
1966. Ed. Note.)

The article stresses the importance of the patency of the Eustachian tube in diving
operations and the dangers of Valsalva to the ear (barotrauma) and the cardio-
vascular system (generation of syncope). They counsel their divers in other methods.
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