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CHANGES IN THE VESTIBULAR SYSTEM WITH AGE: AN ABSTRACTED BIBLIOGRAPHY (Volume II)

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NAVAL AEROSPACE MEDICAL RESEARCH LABORATORY
PENSACOLA, FLORIDA

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AN ABSTRACTED BIBLIOGRAPHY (Volume II)

Naval Medical Research and Development Command
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20 July 1983

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PENSACOLA, FLORIDA 32508

AUTHOR: Babiychuk, A. N. 2.1

TITLE: Age limitations on flight personnel

REFERENCE: In: Parin, V. V. (Ed.), Problems in Aerospace Medicine (translation from National Technical Information TT:66-34698). NTIS, 1966.

SUBJECTS: (Number-age): N.A.

EXPERIMENTAL PROCEDURES: Review

FINDINGS:

"1. Upon rendering an expert opinion as to the fitness of a given pilot for flight activity it is necessary to consider first of all not his age but rather his physical condition and actual physical working ability.

2. "Most of the functional and physiological changes in flight personnel over 40 years of age, as indicated by numerous investigations and observations, were basically not pathological and were not an obstacle to the continuation of flying work."

COMMENT: Short review of Russian articles.
No mention of vestibular qualifications to fly.

INDEX: Review

AUTHORS: Birns, B., Blank, M. and Bridger, W. H. 11.1

TITLE: The effectiveness of various soothing techniques on human neonates

REFERENCE: Psychosomatic Medicine, 1966, 28, 316-322.

SUBJECTS: (Number-age): 35 full-term newborns (2-3 days old).

EXPERIMENTAL PROCEDURES:

Stimulus - arousal or irritable flick on foot followed by 1) tone, 2) sweetened pacifier, 3) immersing foot in warm water, 4) rocking or 5) control period.

Response - behavioral and heart rate measurements.

FINDINGS: "...it was found that all soothing stimuli were more effective than the control, but no one stimulus was more effective than any other."

COMMENT: Although the vestibular stimulus (rocking) was soothing at this young age, other stimuli appear equally effective.

INDEX: Early development

AUTHOR: Black, F. O. 11.2

TITLE: The aging vestibular system

REFERENCE: In: Han, S. S. and Coons, D. H. (Eds.). Special Senses in Aging, Univ. of Michigan, 1979.

SUBJECTS: (Number-age): N.A.

EXPERIMENTAL PROCEDURES: Review

FINDINGS:

"The major effects of age upon vestibular function appear to result in an overall loss of efficiency. This reduction in optimal body control probably results from multivariate factors: reduction in sensory cell and peripheral nerve populations, central nervous system changes and musculo-skeletal alterations which, in combination, represent the major contributors to age-related loss of body equilibrium control. To evaluate the relative role of degenerative changes in the vestibular system in bringing about the well-known dimunition of body motion control with increasing age will require extensive cross-sectional and longitudinal study."

COMMENT:

INDEX: Review

AUTHOR: Colavita, F. B. 28.1

TITLE: Sensory Changes in the Elderly

REFERENCE: C. C. Thomas, Springfield, Ill., 1978

SUBJECTS (Number-age): N.A.

EXPERIMENTAL PROCEDURES: Review

FINDINGS:

"Some degenerative changes have been noted in the vestibular nerves of elderly persons. Such changes have been implicated in decreased sensitivity to tilt. Another obvious example of a differential response to vestibular stimulation as a function of age can be seen in the case of reaction to oscillating motion such as swinging on a swing. As a general rule, most children like swings, while many adults do not. Not only do many adults not like swings, but a surprisingly large number of adults are actually made ill by swinging on a swing. The number of such adults seems to increase in older segments of the population."

COMMENT: This appears contrary to the view that motion sickness susceptibility decreases with age.

INDEX: Review

AUTHOR: Corso, J.F. 30.1

TITLE: Sensory processes and age effects in normal adults

REFERENCE: Journal of Gerontology, 1971, 26, 90-105.

SUBJECTS (Number-age): N.A.

EXPERIMENTAL PROCEDURES: Review

FINDINGS:

1. "This review is concerned primarily with studies in the areas of vision, audition, gustation, olfaction, pain, touch, and vibration in normal adults. The evidence indicates clearly that significant age decrements are found in many sensory and perceptual functions, but these functions have their onset at different ages and proceed at different rates."
2. No vestibular information.

COMMENT:

INDEX: Review

AUTHORS: Cunningham, D. R. and Goetzinger, C. P. 31.1

TITLE: Floor ataxia test battery

REFERENCE: Arch. Otolaryng., 1972, 96, 559-564.

SUBJECTS (Number-age): 300 children (25 males, and 25 females at ages 8, 10, 12, 14, 16, 18 years)

EXPERIMENTAL PROCEDURES: (1) Sharpened Romberg, (2) standing on one leg with eyes closed, (3) walk on floor eyes closed

FINDINGS:

"Successive age level groups did not differ significantly in performance in any consistent way."

COMMENT: This article extends the Fregly and Graybiel data ages 17 to 71 (see abstract 47) to the younger age groups specifically 8 to 18 years.

INDEX: Stability/Ataxia

AUTHOR: Curthoys, I.S. 31.2

TITLE: The development of function of horizontal semicircular canal primary neurons in the rat

REFERENCE: Brain Research, 1979, 167, 41-52.

SUBJECTS (Number-age): 97 rats (25 adults - 72 newborn or young)

EXPERIMENTAL PROCEDURES:
1. Rotation ($16.7^{o}/sec^{2}$ for 12 sec)
2. Single cell recordings from horizontal canal neurons (1165 neurons - mostly cell bodies in Scarpa's ganglion)

FINDINGS: (partial summary)

"Horizontal semicircular canal neurons can respond to angular acceleration stimulation at birth. In newborn rats no regularly firing cells could be found, but the percentage of these cells and their average resting rate increased during growth. Neurons in newborn rats differ from those in the adult by having a lower average resting rate, a lower sensitivity to long-duration angular acceleration and taking longer to reach peak increase in firing during the stimulus. Sensitivity reaches adult values by about 4 days although the canal dimensions continue to increase until about 20 days."

COMMENT:

INDEX: Rotation, early development

AUTHORS: Denenberg, V. H. and Karas, G. G. 32.1

TITLE: Effects of differential infantile handling upon weight gain and mortality in the rat and mouse

REFERENCE: Science, 1959, 130, 629-630

SUBJECTS (Number-age): 56 rats and 55 mice

EXPERIMENTAL PROCEDURES: Handling - days 1 to 10, or 11 to 20, or 1 to 20 plus control group - no handling

FINDINGS:

1. "For both species a monotonic relationship is found between amount of handling in infancy and weight in later life. The animals handled for 20 days were the heaviest, while the controls were the lightest."
2. "...handling during days 1 to 10 will lead to longer survival under total food and water deprivation but that lack of handling or prolonged handling will reduce survival time."
3. "...the more rapid an organism's development, the greater the effect of infantile experience."

COMMENT:

INDEX: Early development

AUTHORS: Elliott, M.B. and Elliott, K.A. 38.1

TITLE: Some pathological radiological and clinical implications of the precocious development of the human ear

REFERENCE: Laryngoscope, 1964, 74, 1160-1171.

SUBJECTS (Number-age): N.A.

EXPERIMENTAL PROCEDURES: Review

FINDINGS:
"Evidence is presented suggesting that after six months the axial presentation into vertex or breech depends upon labyrinthine-activated kicking by the foetus. The progressive dominance of vertex presentation appears due to increasing specific gravity of amniotic fluid. ...Persistent malpresentations result where the foetal labyrinth is damaged or malformed in utero. This is a convenient clinical manifestation on which to begin early investigation of congenitally acquired ear aplasias."

COMMENT:

INDEX: Histology, early development

AUTHORS: Forssberg, H. and Nashner, L.M. 46.1

TITLE: Ontogenetic development of postural control in man: Adaptation to altered support and visual conditions during stance

REFERENCE: Journal of Neuroscience, 1982, 2, 545-552.

SUBJECTS (Number-age): 17 children (male and female). Four 1 1/2 - 3 1/2 years; four 3 1/2 - 5 years; six 5 - 7 1/2 years, and three 7 1/2 - 10 years.

EXPERIMENTAL PROCEDURES: (a) Ataxia testing using force platform system (movable)
(b) EMG recordings
(c) Visual surround for visually-induced motion

FINDINGS:
"The structure of automatic postural adjustments in young children was, with the exception of greater variability, similar to that of adult subjects studied previously. However, young children below the age of 7 1/2 years were unable to suppress systematically the influence of inputs derived from the support surface or from vision when these provided inappropriate orientation information due to the motion of these surfaces."

COMMENT: For procedures and additional information see:
Nashner, L.M., Black, F.O. and Wall, E., III. Adaptation to altered support and visual conditions during stance: Patients with vestibular deficits. Journal of Neuroscience, 1982, 2, 536-544.

INDEX: Stability/ataxia

AUTHORS: Freedman, D.G., Boverman, H. and Freedman, N. 46.2

TITLE: Effects of kinesthetic stimulation on weight gain and on smiling in premature infants

REFERENCE: Paper presented at the meeting of the American Orthopsychiatric Association, San Francisco, CA., April 1966.

SUBJECTS (Number-age): Five sets of twins

EXPERIMENTAL PROCEDURES: Rocking (one twin was rocked twice daily for 30 minutes for 7-10 days)

FINDINGS:
"... the rocked twin...gained weight at a greater rate per day than did the control twin in every instance, although the advantage of the rocked group was only a temporary one."

COMMENT: These findings were reported by Solkoff et. al, Dev Psychol., 1969, 1, 765-766.

INDEX: Early development

AUTHOR: Gerathewohl, S.J. 49.1

TITLE: Psychophysiological effects of aging: Developing a functional age index for pilots: I. A survey of the pertinent literature

REFERENCE: FAA Office of Aviation Medicine Report No. FAA-AM-77-6, 1977.

SUBJECTS (Number-age): N.A.

EXPERIMENTAL PROCEDURES: Review

FINDINGS:
1. Functional age concept.
2. "Generally, abilities to perform highly skilled tasks rapidly, to adapt to new and changing environmental situations, to resist fatigue, to maintain physical stamina, and to perform effectively in a complex and stressful environment begin to decline in early middle life and continue to decline at a fairly steady rate thereafter."
3. "There is no 'psychophysiologic age index' available that can be reliably applied for determining the performance of airline pilots. However, the development of such an index appears feasible and therefore should be pursued."

COMMENT: 1. Part I of three part series.
2. Although this series contains no direct vestibular information it has many implications for how vestibular information could be gathered.

INDEX: General

AUTHOR: Gerathewohl, S.J. 49.2

TITLE: Psychophysiological effects of aging - Developing a functional age index for pilots: II. Taxonomy of psychological factors

REFERENCE: FAA Office of Aviation Medicine Report No. FAA-AM-78-16.

SUBJECTS (Number-age): N.A.

EXPERIMENTAL PROCEDURES: Review

FINDINGS:

"One of the major objectives of gerontological aviation psychology is to determine the psychological variables, functions, abilities, skills, and factors that underlie, constitute or are associated with pilot performance and proficiency. They must be identified, analyzed, and measured if functional age is to be substituted for chronological age as a criterion for terminating an aviator's career."

"By means of factor analyses, logical deductions, and clinical interpretations of the results obtained by various investigators, 14 factors are identified and described, namely (1) perception, (2) attention, (3) reaction, (4) orientation, (5) sensorimotor, (6) stamina, (7) cognition/mentation, (8) interpersonal relations, (9) decision making, (10) experience, (11) learning, (12) personality, (13) mechanical ability, and (14) motivation."

COMMENT: Part II of three part series.

INDEX: General

AUTHOR: Gerathewohl, S.J. 49.3

TITLE: Psychophysiological effects of aging - Developing a functional age index for pilots: III. Measurement of pilot performance

REFERENCE: FAA Office of Aviation Medicine Report No. FAA-AM-78-27.

SUBJECTS (Number-age): N.A.

EXPERIMENTAL PROCEDURES: Review

FINDINGS:

1. "If a functional age index for pilots is to be developed that can be used as a criterion for extending or terminating an aviator's career, means for the assessment of pilot proficiency must be available or devised. There are two major approaches used for this purpose today, namely, the qualitative evaluation of performance based mainly on subjective ratings, and the quantitative assessment of performance through objective recordings of pilot action and aircraft response."

2. "Owing to the capability of simultaneously monitoring the performance of the human operator and the aircraft, automatic inflight monitors are the ultimate in systems design and application. Their implications for the development of a functional age index for pilots are discussed."

COMMENT: Part III of three part series.

INDEX: General

AUTHORS: Gordon, T., and Foss, B.M. 49.4

TITLE: The role of stimulation in the delay of onset of crying in the newborn infant

REFERENCE: Quarterly Journal of Experimental Psychology, 1966, 18, 79-81.

SUBJECTS (Number-age): 18 experimental babies, 125 control babies (all full-term newborns)

EXPERIMENTAL PROCEDURES: Rocking (1/2 hour)

FINDINGS: 1. Rocking delayed the onset of crying
2. "Since rocking seems an effective means of stopping the baby from crying when it is not hungry or in pain, it would appear to answer to some of the stimulus needs of the young infant."

COMMENT:

INDEX: Early development

AUTHORS: Hall, T.C., Miller, A.K.H., and Corsellis, J.A.N. 57.1

TITLE: Variations in the human Purkinje cell population according to age and sex

REFERENCE: Neuropathology and Applied Neurobiology, 1975, 1, 267-292.

SUBJECTS (Number-age): Ninety cerebella - humans

EXPERIMENTAL PROCEDURES: Histology

FINDINGS:
"Wide individual variations were found in the same sex at all ages but a mean reduction of 2-5% per decade or of 25% over 100 years was identified. The figures suggested, however, that the reduction was curvilinear with the fall first becoming apparent about the sixtieth year. No evidence was found that the drop was related to vascular degeneration or to any other identifiable pathological process."

COMMENT:

INDEX: Histology

AUTHORS: Heywood, P., Pujol, R., and Hilding, D.A. 61.1

TITLE: Development of the labyrinthine receptors in the guinea pig, cat and dog

REFERENCE: Acta Otolaryng., 1976, 82, 359-367.

SUBJECTS (Number-age): Nine guinea pigs, five cat litters (N?), number of dogs not given.

EXPERIMENTAL PROCEDURES: Histology - light and electron microscope

FINDINGS:

1. "In spite of the differences in timing, the overall developmental pattern of the vestibular system appears to be similar in the three animals investigated."
2. Rate of development - dog slower than cat, cat slower than guinea pig.
3. "During development there was also an increase in the number of blood vessels and nerve fibers underlying the sensory epithelium."
4. "Overall in a given specimen it appears that receptor formation and myelination is slightly advanced in the vestibular system in comparison with the cochlea."

COMMENT:

INDEX: Histology, early development

AUTHORS: Heywood, P., Pujol, R., and Hilding, D. 61.2

TITLE: Early synapse formation in vestibular system of fetal guinea pig

REFERENCE: Brain Research, 1973, 51, 337-339.

SUBJECTS (Number-age): Guinea pigs (exact number of specimens not indicated) - prenatal

EXPERIMENTAL PROCEDURES: Histology - electron microscope

FINDINGS:

1. Synapse formation (between hair cell and primary afferent neuron) present as early as 11-14 days before birth.
2. "The synaptic structures observed in fetal guinea pigs 11 days before birth closely resemble those that have been described in adults."
3. "...in comparison with other small mammals, the guinea pig's central nervous system is unusually mature at birth."

COMMENT:

INDEX: Histology, early development

AUTHORS: Holm-Jensen, S., Skovgaard, L.T. and Peitersen, E. 62.1

TITLE: Synchronous optokinetic nystagmus

REFERENCE: Acta Otolaryng., 1981, 91, 255-266.

SUBJECTS (Number-age): Two groups - Group 1, 100 Ss 17-50 years old,
Group 2, 50 Ss 65-89 years old

EXPERIMENTAL PROCEDURES: Optokinetic nystagmus - target speeds of 10^{o}/sec and 20^{o}/sec

FINDINGS:
"No age or sex dependent asymmetry of the eye velocity was observed. Five of the participants from the older group were unable to produce a continuous and regular OKN."

COMMENT:

INDEX: Optokinetic

AUTHORS: Kaga, K., Suzuki, J.-I., Marsh, R.R., and Tanaka, Y. 68.1

TITLE: Influence of labyrinthine hypoactivity on gross motor development of infants

REFERENCE: Annals of the New York Academy of Sciences, 1981, 374, 412-420.

SUBJECTS (Number-age): Control group - 30 one year or less, 30 one to six years, and 10 adults. Experimental group (hearing impaired) - 14 less than one year; 21 one year old, 33 two to five years

EXPERIMENTAL PROCEDURES: Stimulus: Dampened - rotation test.
Response: Age at which head control was attained and walking recorded

FINDINGS:
"..in the present series, every child with absent function was late in reaching the gross motor milestones, as were most but not all of the children with reduced function."
"However, the delay seems to be compensated for easily by plasticity of the central nervous system and by development of proprioceptive, visual, and motor systems. Compensation in later childhood is quite good, so that special tests may be required to elicit any abnormality of gain due to vestibular dysfunction."
"In the first year of life, the number of beats and the duration of perrotatory nystagmus clearly increase with age. Postrotatory nystagmus is more variable in this period..."

COMMENT:

INDEX: Early development, rotation

AUTHOR: Karhunen, E. 69.1

TITLE: Postnatal development of the lateral vestibular nucleus (deiter's nucleus) of the rat

REFERENCE: Acta Otolaryngol., 1973, Supplement 313.

SUBJECTS (Number-age): 274 rats (8 newborn, 6 four-day-old, 7 seven-day-old, 8 ten-day-old, 5 twenty-day-old, 6 thirty-day-old, and 234 adults)

EXPERIMENTAL PROCEDURES: Histology (light and electron microscope)

FINDINGS:
This article describes numerous neural changes taking place during the first postnatal month. The findings are too numerous to condense to a short list. Please refer to article.

COMMENT: Excellent histology article

INDEX: Histology, early development

AUTHORS: Kodama, A and Sando, I. 70.1

TITLE: Postnatal development of the vestibular aqueduct and endolymphatic sac

REFERENCE: Annals of Otology, Rhinology, and Laryngology, 1982, 91, Supplement 96, 3-12.

SUBJECTS (Number-age): 31 human temporal bones (from 31 different children) from individuals ranging in age from 0 to 13 years

EXPERIMENTAL PROCEDURES: Histological sections of the vestibular aqueduct (VA) and the rugose portion (RP) of the endolymphatic sac

FINDINGS:
"The VA and RP undergo significant growth postnatally up to age 3 years." Wide individual variations in form at birth.

COMMENT:

INDEX: Histology, early development

AUTHORS: Korner, A.F. and Grobstein, R. 70.2

TITLE: Visual alertness as related to soothing in neonates: Implications for maternal stimulation and early deprivation

REFERENCE: Child Development, 1966, 37, 867-876.

SUBJECTS (Number-age): 12 newborn baby girls

EXPERIMENTAL PROCEDURES: Condition 1 - lifted crying baby to left or right shoulder, Condition 2 - moved crying baby to sitting position, Condition 3 - left crying baby laying on her back, recorded alertness and visual scanning behavior.

FINDINGS:
"...when crying infants were put to the shoulder, they not only stopped crying, but each of them also opened her eyes and alerted in the large majority of trials."
"Our data did not suggest that handling or the upright position alone induced a state of alertness. This was true because, in most cases, handling alone did not lower the infant's state of arousal sufficiently to reduce crying to the point of alertness."

COMMENT:

INDEX: Early development

AUTHORS: Korner, A.F. and Thoman, E.B. 70.3

TITLE: The relative efficacy of contact and vestibular-proprioceptive stimulation in soothing neonates

REFERENCE: Child Development, 1972, 43, 443-453.

SUBJECTS (Number-age): 40 2-to-4-day-old full-term infants

EXPERIMENTAL PROCEDURES: Six basic stimulation conditions: 1) vertical displacement with human contact, 2) horizontal displacement with human contact, 3) no displacement with human contact, 4) vertical displacement with no human contact, 5) horizontal displacement with no human contact, and 6) verbal stimulus, no contact or displacement. Thirty sec intervention periods. Measured crying time during and after each intervention.

FINDINGS:
"Vestibular stimulation had a highly potent soothing effect both during and after the interventions. Contact has a lesser effect during, and none following, the interventions. The results suggest that the soothing effects usually attributed to contact comfort may be largely a function of vestibular-proprioceptive stimulation which attends most contacts between mother and child."

COMMENT:

INDEX: Early development

AUTHORS: Korner, A.F. and Thoman, E.B. 70.4

TITLE: Visual alertness in neonates as evoked by maternal care

REFERENCE: Journal of Experimental Child Psychology, 1970, 10, 67-78.

SUBJECTS (Number-age): 64 two-to-three-day-old healthy full-term humans (40 crying, 24 sleeping)

EXPERIMENTAL PROCEDURES:

a. Observers assessed levels of alertness.
b. "...six interventions which entailed singly, or in combination, contact and vestibular stimulation with or without the upright position."

FINDINGS:

"In the context of soothing the infant, vestibular stimulation had a highly significant effect on alerting. Contact had little effect on evoking alertness except when combined with vestibular stimulation and the upright."

"The findings imply that, at least during the neonatal period, the vestibular stimulation which attends most caretaking activities may be more crucial than contact for certain aspects of early human development."

COMMENT: Well controlled study of newborns.

INDEX: Early development

AUTHORS: Kowler, E. and Martins, A.J. 70.5

TITLE: Eye movements of preschool children

REFERENCE: Science, 1982, 215, 997-999.

SUBJECTS (Number-age): Two preschool children (ages 4 years 7 months and 5 years 3 months)

EXPERIMENTAL PROCEDURES: Visual fixation, smooth pursuit eye movements, fixation on moving targets (used a double Purkinje image eye tracker)

FINDINGS:

1. "...children did not fixate as well as adults."
2. The children's spontaneous saccades were much larger but of roughly the same frequency as adults.
3. "The children's smooth eye movements were similar to the smooth eye movements of adults in that both have effective slow control."
4. "These results suggest that differences in the effectiveness of visual processing between preschool children and adults may be caused, at least in part, by incomplete oculomotor development."

COMMENT:

Mayer and Dobson (Invest. Opthalmol. Visual Sci., 1980, 19, 566 indicate that visual acuity reaches adult levels by about 2 years of age.

INDEX: Eye movements

AUTHORS: Kuechenmeister, C.A., Linton, P.H., Mueller, T.V., and White, H.B. 71.1

TITLE: Eye tracking in relation to age, sex, and illness

REFERENCE: Archives of General Psychiatry, 1977, 34, 573-579.

SUBJECTS (Number-age): 90 Ss (nine groups of ten patients each). For age comparisons the young individuals were 20-30 years old and the older individuals were over 50 years old.

EXPERIMENTAL PROCEDURES: Horizontal eye tracking
(a) 5 deg/sec and 20 deg/sec
(b) sinusoidal and triangular target movement
(c) ± 10 deg from center

FINDINGS:
"Though not always significantly so, the younger groups eye track better than the older, and men track better than women."
"...normal patients are significantly better eye trackers than schizophrenics, parents of schizophrenics, or Parkinson patients."

COMMENT:

INDEX: Eye movements

AUTHORS: Lannou, J., Precht, W. and Cazin, L. 73.1

TITLE: Development of optokinetic responses in vestibular nuclear neurons in the young rat

REFERENCE: Brain Research, 1980, 202, 217-222.

SUBJECTS (Number-age): 32 brown rats - 16 to 29 days old.

EXPERIMENTAL PROCEDURES:

1. Recording from vestibular nuclei (100 neurons)
2. Vestibular stimulation (0.1 Hz ± 100°, eyes covered)
3. OKN stimulation (constant velocity or ranging from 0.5 to 4°/sec sinusoidal stimuli at 0.05 Hz ± 7°)

FINDINGS:
1. The resting discharge rate increased with age (16 to 29 days).
2. "The present work has shown that, contrary to the vestibular system which shows some signs of function already at birth, the optokinetic afferent system to the vestibular nuclei is not even functioning at the time of eye opening (day 16) and still remains in that state for approximately another week."
3. "Responses of vestibular nuclear neurons (Vn) of the horizontal canal system to optokinetic stimulation could not be elicited before postnatal day 22. Between days 22 and 29 response magnitude gradually increased whereas response phase remained constant. At the end of the first postnatal month the sensitivity of the optokinetic responses was still much less than that measured in adult animals."

COMMENT:

INDEX: Opkinetic

AUTHORS: Lannou, J., Precht, W. and Cazin, L. 73.2

TITLE: The postnatal development of functional properties of central vestibular neurons in the rat

REFERENCE: Brain Research, 1979, 175, 219-232.

SUBJECTS (Number-age): 80 rats - Group I, 61 rats 1 to 13 days old; Group II, 18 rats 18 to 35 days old (on day 13 rat pups open their eyes)

EXPERIMENTAL PROCEDURES:

1. Extracellular single unit recordings - vestibular nuclei
2. "...horizontal angular accelerations ranging from 1.33 to 75 deg/sec^2 followed by a period of constant velocity and an abrupt stop, or sinusoidal rotation about the vertical axis (yaw stimulation) with various periods (5-40 sec) and amplitudes (50-200° peak to peak).

FINDINGS:

1. "The resting discharge was very low and irregular during the first postnatal days, increased gradually and became more regular throughout the first month and reached adult values approximately by the end of the first month."
2. "Threshold for frequency increase to angular acceleration and sensitivity of unit responses became lower and higher, respectively as time elapsed after birth. Adult values were reached approximately by the end of the first month."
3. "It is interesting to note that even such important events as the opening of the eyes are not reflected in changes in resting rate of central vestibular neurons indicating that vision is not very important for the generation of resting discharge of central vestibular neurons, at least in albino rat."

COMMENT:

INDEX: Rotation, early development

AUTHORS: Loizou, L.A. and Salt, P. 76.1

TITLE: Regional changes in monamines of the rat brain during postnatal development

REFERENCE: Brain Research (Short Communications), 1970, 20, 467-470.

SUBJECTS (Number-age): Two to ten brains at each sampling age (birth, 7, 10, 16, 22, 31 days and adult (14-20 weeks)

EXPERIMENTAL PROCEDURES: Histology - regional concentrations of noradrenaline, dopamine, and 5-hydroxytryptamine

FINDINGS:

"The concentration of all three MAs (monamines) in the brain rises considerably during the first few weeks of postnatal development. The telencenphalon attains the adult levels of the 3 MAs more slowly than either the medulla + pons or mesencephalon + diencephalon."

COMMENT:

INDEX: Histology, early development

AUTHOR: Miller, J.E. 81.1

TITLE: Aging changes in extraocular muscle

REFERENCE: Proceedings of the International Symposium, 1974, 24, 47-61.

SUBJECTS (Number-age): 37 monkeys (2 months - 17 years)
8 humans (5 months - 78 years)

EXPERIMENTAL PROCEDURES: Histology (histochemistry, light microscopy and electron microscopy)

FINDINGS:

"The diffuse changes that occurs (sic) throughout eye muscles may account for alterations of eye movement observed in the aged."

"The gradual intracellular shift in cells with myofibrillar preponderance of childhood to sarcoplasmic excess of senescent and the addition of increased extracellular fibrosis is probably associated with changes in plasticity as well as contraction and relaxation phenomenon."

"It is recommended that in selecting animals or subjects for experiments that involve eye movements or measurements upon the muscles or muscle fibers that a limited age group be selected. Otherwise there may be discrepancies between younger and older animals."

COMMENT:

INDEX: Histology

AUTHOR: Mohler, S.R. 83.1

TITLE: Functional aging: Present status of assessments regarding airline pilot retirement

REFERENCE: Aerospace Medicine, 1973, 44, 1062-1066.

SUBJECTS (Number-age): N.A.

EXPERIMENTAL PROCEDURES: Review

FINDINGS:

1. "Only if some significant progress by researchers occurs in (1) understanding the processes of senescence, (2) measuring the net "functional age" of a given individual with equipment suitable for general clinical use, and (3) relating 'functional age' to flight performance under given circumstances, can a serious effort be justified in instituting criteria other than chronological age for airline pilot retirement."
2. No vestibular information - however, interesting general discussion.

COMMENT:

INDEX: Review

AUTHORS: Moser, M.H. and Ranacher, G.R. 84.1

TITLE: Medical fitness examination of commercial pilots: New criteria for evaluation of vestibular tests

REFERENCE: Aviation, Space and Environmental Medicine, 1982, 53, 1215-1219.

SUBJECTS (Number-age): Clinical review paper - number of subjects not given.

EXPERIMENTAL PROCEDURES: Rotation - "pendular test" - 20 sec period, 56°/sec peak

FINDINGS:

1. "If the vestibular system function is completely normal, then capacity to compensate according to age is fully present. ...Actually, the compensation capacity of the eyes, strongly dependent upon age, reaches up to 80% in young patients and decreases to 20% in older patients."
2. Two figures show age related decrement in total nystagmus amplitude and compensation capacity.

COMMENT:

INDEX: Rotation, review, torsion swing

AUTHOR: Neal, M.V. 88.1

TITLE: Vestibular stimulation and developmental behavior of the small premature infant

REFERENCE: Nursing Research Report, 1968, 3, 1-5.

SUBJECTS (Number-age): 62 premature infants (28-32 weeks gestational age)

EXPERIMENTAL PROCEDURES: Rocking in a hammock (from 28/32 weeks to 36 weeks old). Maximum of 56 days motion. Duration of rocking each day was not indicated.

FINDINGS:

"The findings of this study indicate that the excitation of the vestibular cells by a particular body motion pattern may have a bearing on the development of the premature infant. Both the motor and the visual responses were highly significant (more advanced in treatment group)."

"...infants who received the regimen of vestibular stimulation had greater weight gains than did infants who did not receive this regimen of motion."

COMMENT: For additional details see Neal, M.V. Ph.D. dissertation, New York University, 1967.

INDEX: Early development

AUTHORS: Oakley, D.A. and Plotkin, H.C. 90.1

TITLE: Ontogeny of spontaneous locomotor activity in rabbit, rat, and guinea pig

REFERENCE: Journal of Comparative and Physiological Psychology, 1975, 89, 267-273.

SUBJECTS (Number-age): 43 rabbits, 20 rats, 11 guinea pigs

EXPERIMENTAL PROCEDURES: Measured general locomotor activity (quadrant movement)

FINDINGS:

1. Postnatal locomotor activity peaked at 5 days in the rabbit, 15-20 days in the rats and did not change for the guinea pigs.
2. These findings agree with the respective rates of neural maturation for these species.
3. "...it is interesting to note that the day on which the eyes open, ...does not correlate with the activity peak."

COMMENT:

INDEX: Early development

AUTHORS: Ornitz, E.M., Atwell, C.W., Walter, D.O., Hartmann, E.E. and Kaplan, A.R. 91.1

TITLE: The maturation of vestibular nystagmus in infancy and childhood

REFERENCE: Acta Otolaryng., 1979, 88, 244-256.

SUBJECTS (Number-age): 46 children (range 1 month to 11 years)

EXPERIMENTAL PROCEDURES: Rotation - recorded primary and secondary nystagmus.

FINDINGS:

"...First, the young infant has larger amplitude, higher velocity beats than the older child during both the primary and secondary nystagmus evoked by constant angular acceleration. Second, parameters describing both the primary and secondary nystagmus reach their peak values and terminate earlier in the infant than in the older child. Finally, although the slow component velocity during the secondary nystagmus is much slower than during the primary nystagmus at all ages, the secondary/primary nystagmus ratio is significantly greater in early infancy. This means that in infancy, as compared with later childhood, the vigor of the secondary nystagmus is disproportionately greater than the primary nystagmus."

COMMENT:

1. Excellent discussion with many good points on maturing vestibular responses.
2. They actually started with 84 infants and children - many were eliminated for drowsiness, eye closure, or excessive movement.

INDEX: Early development, rotation

AUTHORS: Ourth, L. and Brown, K.B. 92.1

TITLE: Inadequate mothering and disturbance in the neonatal period

REFERENCE: Child Development, 1961, 32, 287-295.

SUBJECTS (Number-age): 20 neonates - full term.

EXPERIMENTAL PROCEDURES:
1. Mothered group (10 Ss) - breast fed with moderate amount of handling which included rhythmical rocking. Non-mothered group (10 Ss) - bottle fed with no more handling than necessary for routine care and feeding.
2. Observer recorded average minutes/hour crying, average min/hour sleeping, average number of vomits/hr, minutes of handling/hour.
3. Duration of study 4.5 days following birth.

FINDINGS:
1. "The results showed that the non-mothered group cried significantly more than the mothered group, particularly when no external instigation was present."
2. The mothered group was handled three times as much as the non-mothered group (11.02 vs 3.15 min per hour).

COMMENT:

INDEX: Early development

AUTHOR: Pearson, G. 93.1

TITLE: Effect of age on vibratory sensibility

REFERENCE: Archives of Neurology and Psychiatry, 1928, 20, 482-495.

SUBJECTS (Number-age): 72 subjects (10 to 90 years)

EXPERIMENTAL PROCEDURES: Application of vibrating fork to lower extremities

FINDINGS:
"It was found that adolescents perceived the vibrations best. Decade by decade, there was a slight decrease in the sensibility over the lower extremities, and this decrease became striking after the age of 50 years. Many of these older persons had lost vibratory sensibility for this region."

COMMENT: Although this article does not address vestibular system aging, it is included becaise similar techniques could be applied to the head, and because sensibility of the lower extremeties is important to head stabilization.

INDEX: General

AUTHORS: Pederson, D.R. and Ter Vrugt, D. 93.2

TITLE: The influence of amplitude and frequency of vestibular stimulation on the activity of two-month-old infants

REFERENCE: Child Development, 1973, 44, 122-128.

SUBJECTS (Number-age): Exp 1, 42 full-term infants between 53 and 69 days old; Exp 2, 48 infants (50-69 days old); Exp 3, 44 infants (51-70 days old)

EXPERIMENTAL PROCEDURES: Vertical rocking
Exp 1. - 0, 2 or 5 inch displacement at 60 cycles/min.
Exp 2. - 3, 4 and 5 inch displacement at 30 and 60 cycles/min.
Exp 3. - 4 inch displacement at 0, 30, 50 and 70 cycles/min. Rater judgment of infants activity (ranged from sleep to extreme agitation).

FINDINGS:
"The results of these studies indicate that the effectiveness of rocking is determined by maximum acceleration."
The soothing effect of rocking (a) increased with higher frequency rocking; (b) increased with greater displacement of rocking.
"Vigorous rocking is an effective inhibitor of distress."

COMMENT: See Ter Vrugt and Pederson (1973) for lower frequencies. (Abstract 111.2)

INDEX: Early development

AUTHOR: Peto, A. 95.1

TITLE: To cast away: A vestibular forerunner of the superego

REFERENCE: Psychoanalytic Study of the Child, 1970, 25, 401-416.

SUBJECTS: N.A.

EXPERIMENTAL PROCEDURES: Summary of clinical speculations

FINDINGS:
"...the thesis of this paper: certain dynamic, adaptive, and structural aspects of primary process thinking indicate that one of the archaic forerunners of the superego has its genetic origins in the sensorimotor apparatus of the vestibular function."

COMMENT:

INDEX: General

AUTHORS: Pollack, J.G. and Diamond, C. 96.1

TITLE: An age comparison of the vestibulo-ocular counterroll reflex

REFERENCE: NAMRL Report 1292, 1983., Naval Aerospace Medical Research Laboratory, Pensacola, FL.

SUBJECTS (Number-age): Group 1 - 18 Ss (22-34 years old)
Group 2 - 18 Ss (50-74 years old plus one S with 90 years)

EXPERIMENTAL PROCEDURE: Static ocular counterroll

FINDINGS:
1. The older group demonstrated less counterroll than the younger group - the difference was small; however, it was statistically significant.
2. "It appears that the amplitude of the ocular counterroll reflex diminishes with age, but it's potential contribution to the establishment of age free medical standards remains problematic."

COMMENT:

INDEX: Counterroll

AUTHORS: Ponerleau-Malcuit, A. and Clifton, R.K. 97.1

TITLE: Neonatal heart-rate response to tactile, auditory, and vestibular stimulation in different states

REFERENCE: Child Development, 1973, 44, 485-496.

SUBJECTS (Number-age): 65 full-term infants

EXPERIMENTAL PROCEDURES: Recorded electrocardiogram during (1) auditory stimulus (2) tactile stimulus, and (3) vestibular stimulus (rocking). Measures of orienting or defensive responses taken while sleeping and before and after feeding.

FINDINGS:
"In sleeping Ss, the HR response was primarily accelerative to tactile and vestibular stimulation but unreliable to auditory stimulation."
"Before feeding, awake Ss decelerated to both types of stimuli (tactile and vestibular)."
"A decelerative response was also found to vestibular stimulation in sleeping babies tested before feeding,..."
"The newborn may be ready to react adaptively and attentively to stimuli that are biologically significant when they occur at moments when he is ready to process them."

COMMENT:

INDEX: Early development

AUTHORS: Reinis, S. and Goldman, J.M. 100.1

TITLE: The Development of the Brain

REFERENCE: Thomas, C.C. (Pub), Springfield, IL, 1980.

SUBJECTS (Number-age): N.A.

EXPERIMENTAL PROCEDURES: Review

FINDINGS:
"There is no direct evidence of vestibular function in the human fetus, as most studies in this area have used nonhuman subjects. Some authors (Elliott and Elliott, 1964) claim that even at the 5th week of gestation, the fetus begins to orient itself in the uterus and, by using its vestibular apparatus, assumes the usual position for birth. Malpresentations of the fetus at parturition in this context could be attributed to a defect in the vestibular system. Recent work with infants (Clark et al., 1977) has indicated that mild postnatal vestibular stimulation results in significant improvement in gross motor skills."

COMMENT:

INDEX: Early development, review

AUTHORS: Romand, R. and Dauzat, M. 100.2

TITLE: Modification of spontaneous activity in primary vestibular neurons during development in the cat

REFERENCE: Experimental Brain Research, 1982, 45, 265-268.

SUBJECTS (Number-age): 31 kittens ranging from 2 to 65 days old and 3 adult cats.

EXPERIMENTAL PROCEDURES: Microelectrode recordings from afferent vestibular nerve fibers or from cells in Scarpas' ganglion

FINDINGS:
"At birth, few regularly firing units were found while the percentage of intermediate and irregular units was high. During development, the percentage of units meeting the criterion of regularity increased steadily with age. At the same time the number of intermediate and irregular units decreased. The average resting rate of all categories of unit showed an increase in firing from birth up to the adult stage, i.e., around the second postnatal month."

COMMENT: "...development is faster in the rat...". Possible problem - very small fibers early in development are difficult to record from.

INDEX: Early development

AUTHORS: Romand, R., Sans, A., Romand, M.R. and Marty, R. 100.3

TITLE: The structural maturation of the stato-acoustic nerve in the cat

REFERENCE: Journal of Comparative Neurology, 1976, 170, 1-16.

SUBJECTS (Number-age): 13 cats - two at fetus stage and eleven ranging from a few hours to two years old.

EXPERIMENTAL PROCEDURES: Histology

FINDINGS:

"...study of the myelination process revealed that myelination begins earlier for the vestibular nerve than for the cochlear nerve: by the fifty-third day of gestation 64% of the vestibular fibers have already passed the promyelin stage whereas for the cochlear nerve this promyelin stage begins for the majority of fibers on the fifty-seventh gestation day. Afterward, maturation proceeds more rapidly for the cochlear nerve. In the case of both nerves, maturation is still incomplete at two months of age."

COMMENT: For cats birth generally occurs on day 63.

INDEX: Histology, early development

AUTHORS: Russo, S., and Dallenbach, K.M. 103.1

TITLE: Age and the effects of rotation

REFERENCE: American Journal of Psychology, 1939, 52, 83-88.

SUBJECTS (Number-age): 213 Ss from 5 to 21 years old

EXPERIMENTAL PROCEDURES: Rotation at 30 RPM followed by a) affective report; b) past-pointing; c) falling-reaction (cross coupled stimulus).

FINDINGS:

"...pleasantness tends to decrease with age and indifference to increase, while unpleasantness, after an initial sudden increase, tends to remain stationary. There is a strong indication that the affectivity of rotation shifts at the 11-year age-level."

"The differences between the sexes are insignificant. ...whatever it is that causes the affective shift, it must be something to which the two sexes are equally susceptible and sensitive."

No age differences reported for past-pointing or falling-reaction.

COMMENT:

INDEX: Rotation, motion sickness

AUTHOR: Schur, W. 104.1

TITLE: Pilots -- middle age -- flight fitness

REFERENCE: Translations on Eastern Europe: Scientific Affairs, Number 409, 1974 (National Technical Information Service).

SUBJECTS (Number-age): N.A.

EXPERIMENTAL PROCEDURES: Review

FINDINGS:
"Middle-age pilots evidence age-related decrease in fitness is of special concern in relation to their professional competence. That highly stressful flight activity accelerates aging is unquestioned."

COMMENT: No mention of vestibular changes with age.

INDEX: Review

AUTHORS: Sharpe, J.A. and Sylvester, T.O. 104.2

TITLE: Effect of aging on horizontal smooth pursuit

REFERENCE: Investigative Ophthalmology and Visual Science, 1978, 17, 465-468.

SUBJECTS (Number-age): 15 Ss (ages 19 to 32) plus 10 Ss (ages 65-77)

EXPERIMENTAL PROCEDURES: Smooth pursuit (horizontal). 20° amplitude, nine frequencies (from 0.125 to 2.5 Hz) yielding stimulus velocities of 5, 10, 20, 30, 40, 50, 60, 80 and 100 deg/sec.

FINDINGS:
1. "...significantly lower smooth pursuit velocities in the elderly when tracking triangular waveform targets of 20° amplitude at velocities of 10°/sec and over."
2. "The number of saccades per second was greater in the elderly group" (saccades are used to compensate when the smooth pursuit system starts to fail).

COMMENT: "Cerebral cortical atrophy, loss of cerebellar Purkinje cells, and degeneration of extraocular muscles are senile changes that may be responsible, individually or in concert."

INDEX: Eye movements

AUTHOR: Sheldon, J.H. 105.1

TITLE: The Social Medicine of Old Age

REFERENCE: Oxford University Press, London, 1948.

SUBJECTS (Number-age): 359 subjects (old age); (51.6% reported that they suffered from vertigo

EXPERIMENTAL PROCEDURES: Questionnaire

FINDINGS:
"It is clear from this discussion that the mechanism concerned in producing vertigo in old age is uncertain. It is suggested, however, that in the earlier age-groups - say, up to 75 years - the more important factors are those deriving from the earlier physical history of the subject such as vascular degeneration and long-standing disease of the middle-ear. It is suggested in addition that the whole labyrinthine apparatus is just as prone to senile degeneration as is the cochlea - though this does not appear to be recognized in the text books - and that this factor assumes increasing importance as the age-group advances, until at ages of 80 and over it provides the predominant cause. It appears that women are more prone to this combined degeneration of the inner ear than men; whereas both men and women are similarly affected in extreme old age by defects of hearing, men are much less affected than women by an associated defect of labyrinthine function."

COMMENT:

INDEX: Vertigo/dizziness

AUTHOR: Sher, A.E. 105.2

TITLE: The embryonic and postnatal development of the inner ear of the mouse

REFERENCE: Acta Otolaryng., 1971, Supplement 285.

SUBJECTS (Number-age): 22 embryos and 20 young mice (tissue from 11th day of gestation to the 10th day after birth).

EXPERIMENTAL PROCEDURES: Histology

FINDINGS:
"It was found that the membranous labyrinth develops all of the major components of the adult inner ear before birth and that postnatal development takes form of cytological differentiation rather than the formation of gross structures."

COMMENT: See reference section for several articles pertaining to development in inner ear of the mouse.

INDEX: Histology, early development

AUTHORS: Solkoff, N., Yaffe, S., Weintraub, D. and Blase, B. 108.1

TITLE: Effects of handling on the subsequent developments of premature infants

REFERENCE: Developmental Psychology, 1969, 1, 765-768.

SUBJECTS (Number-age): Ten premature infants (5 controls, 5 experimental)

EXPERIMENTAL PROCEDURES: Handling (a) experimental group (5 min/hour for initial 10 days after birth) plus control handling. (b) Control group - 3 hr intervals associated with feeding, etc.)

FINDINGS:
"The handled infants were more active, regained initial birth weights faster and were described as physically healthier in terms of growth and motor development than the controls. Home ratings of intensity and variety of stimulation were also higher for the handled infants at between 7 and 8 months of age."

COMMENT: The authors recognized that they had a very small sample.

INDEX: Early development

AUTHOR: Solomon, J.C. 108.2

TITLE: Passive motion and infancy

REFERENCE: American Journal of Orthopsychiatry, 1959, 29, 650-651.

SUBJECTS (Number-age): N.A.

EXPERIMENTAL PROCEDURES: Brief communication on clinical observations

FINDINGS:
"It is surprising to observe the sedative effect that high degrees of motion can have upon an infant. Similar degrees of motility may be very exciting to older children and even disturbing to adults."
"Toward the end of the first year of life, the pleasure of passive movement becomes replaced by the pleasure of active movement."
"This follows the principle of Newton's Second Law. If you actively push against something, it is as though something is pushing against you. In this way the infant accomplished the goal of not feeling completely alone. It is as though somebody is always there."

COMMENT:

INDEX: Early development

AUTHORS: Tegetmeyer, J., and Schwartze, P. 111.1

TITLE: Tonic vestibular control of eye position in postnatal developing rabbits

REFERENCE: Acta Otolaryng., 1982, 94, 289-297.

SUBJECTS (Number-age): 22 rabbits between 1st and 54th postnatal day

EXPERIMENTAL PROCEDURES: Cornea photographs following a series of head/body tilts (tilts were about either the pitch or the roll axis)

FINDINGS:
"...development of these static eye reflexes is not complete before the second month, though regular compensatory eye positions occur already after the second week of life."
"...the tonic innervation of eye muscles is mainly effected by statoreceptors of utricular maculae."

COMMENT:

INDEX: Counterroll

AUTHORS: Ter Vrugt, D. and Pederson, D.R. 111.2

TITLE: The effects of vertical rocking frequencies on the arousal level in two-month-old infants

REFERENCE: Child Development, 1973, 44, 205-209.

SUBJECTS (Number-age): 64 two-month-old infants (57 to 70 days old)

EXPERIMENTAL PROCEDURES: Stimulus: vertical rocking at 0, 0.5, 1 and 1.5 cycles/sec.
Response: effects on arousal level as measured by movement transducer and behavioral ratings

FINDINGS:
"More infants slept and fewer cried when rocked at higher frequencies." (Positive monotonic relationship).

COMMENT: See Pederson and Ter Vrugt 1973 for higher frequencies. (Abstract 93.2).

INDEX: Early development

AUTHORS: Tomada, K., Morii, S., Yamashita, T. and Kumazawa, T. 113.1

TITLE: Deviation with increasing age in histologic appearance of submucosal glands in human eustachian tube

REFERENCE: Acta Otolaryng., 1981, 92, 463-467.

SUBJECTS (Number-age): 74 eustachian tubes (34 individuals), 8 fetuses, 12 children, 4 young adults, 36 middle-aged adults and 14 elderly adults)

EXPERIMENTAL PROCEDURES: Histology

FINDINGS:

With increasing age there was a shift from a predominance of mucous cells to a predominance of serous cells in elderly adults.

"In the elderly, however, mucous and serous cells degenerated and atrophied in almost all cases. This suggests that the excretory function of the tube would deteriorate as a result of decreasing secretion of the glands and impairment of mucociliary transport system of the tubal lining. This deterioration may become the cause of obstructive and patent Eustachian tube."

COMMENT: It appears that the two extremes of age are more likely to have middle ear trauma which in turn could have an impact on inner ear function.

INDEX: Histology, early development

AUTHORS: Van de Calseyde, P., Ampe, W and Depondt, M. 116.1

TITLE: The nystagmic threshold in children during the damped sinusoidal stimulation

REFERENCE: Acta Oto-Rhino-Laryngologica Belgica, 1972, 26, 237-243.

SUBJECTS (Number-age): 34 children from 5 to 14 years old

EXPERIMENTAL PROCEDURES: Torsion swing test (damped), 20 sec period and total of approximately 15 cycles in darkness.

FINDINGS:

"As a result from our earlier investigations with adults, this study shows the nystagmic threshold tendency to be higher in correlation to the subjects age."

"We also noticed that the nystagmic threshold is situated very low in young children and the graph which indicates this value as a function of the age decreases very promply (sic) at the age between 5 and 10."

"With the damped stimulation method we often notice some problems to determine the nystagmic threshold in children."

COMMENT:

INDEX: Torsion swing

AUTHORS: Vijayashankar, N. and Brody, H. 118.1

TITLE: A study of aging in the human abducens nucleus

REFERENCE: Journal of Comparative Neurology, 1977, 173, 433-438.

SUBJECTS (Number-age): 20 brains; ages (newborn, 14 years, 31, 35, 43, 49, 54, 55, 57, 60, 62, 63, 64, 68, 71, 73, 79, 83, 83, 87).

EXPERIMENTAL PROCEDURES: Histology - human brainstem - abduceus nucleus

FINDINGS:

1. "While the nucleus almost doubles in length between birth and adulthood, there is no significant change in cell number after birth."
2. "...it appears that neuronal loss is not a concomitant of aging as has been described for the cerebral and cerebellar cortices."

COMMENT: Lacks young subjects.

INDEX: Histology

AUTHORS: Wright, C.G. and Hubbard, D.G. 123.1

TITLE: SEM observations on development of human otoconia during the first trimester of gestation

REFERENCE: Acta Otolaryng., 1982, 94, 7-18.

SUBJECTS (Number-age): 87 human fetuses (gestational age range 7 to 12 wks).

EXPERIMENTAL PROCEDURES: Scanning electron micrographs

FINDINGS:

"A few otoconia which contained calcium, were present in the utricle by the end of the seventh week. By 8 weeks, both the saccule and utricle contained otoconia and differentiation of the macular neuroepithelia was well underway. At all stages, the utricular otoconia appeared more mature and were more varied in size and shape than saccular otoconia. In 12-week specimens, the maculae were covered by otoconial membranes with clearly defined crystalline and gelatinous layers."

COMMENT:

INDEX: Histology, early development

SUBJECT INDEX

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Unclassified

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Until recently naval aviators have been subject to an automatic reclassification at age 45 (downgrade from Service Group I to III). In January, 1980, the Chief of Naval Operations removed the arbitrary age-based regulations and requested that the Bureau of Medicine and Surgery develop age-free criteria for flight classification of Navy and Marine Corps personnel.

The bibliographic abstracts in this report (Vol. 2) are the result of a continuing literature search on age-related changes in vestibular functioning.

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These reports were chosen for review because they represent tests of vestibular function, visual-vestibular interactions, or vestibular-proprioceptive interactions that are related to mechanisms basic to the voluntary control of aircraft motion.