Horse hairs, smoke paper, pulleys, slide rules and museums – the pre-history of falls prevention research

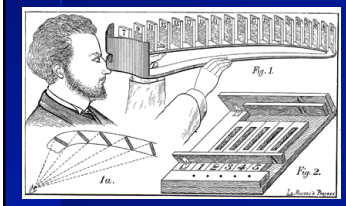
Professor Stephen Lord

Neuroscience Research Australia
Discover. Conquer. Cure.

Falls pre-history - Age-related changes in sensorimotor function and balance

Muscle strength	Quetelet, 1836
Visual acuity	Donders, 1864
Sway	Hinsdale, 1887
Reaction time	Galton, 1899
Vibration sense	Pearson, 1928
Proprioception	Laidlaw and Hamilton, 1937
Tactile sensitivity	Ronge, 1943
Vestibular function	Bruner and Norris, 1971

Early assessments of vision



Galton's vision tester

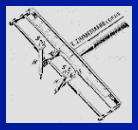
Donder's laboratory

Ageing and vision

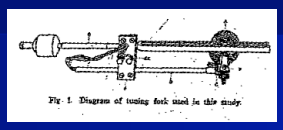
- Cross-sectional and longitudinal studies show that visual acuity shows a slight improvement from the younger ages up to 20 years of age, remains fairly constant up to 50 years and then steadily declines
- Even in the absence of documented pathology, most persons experience an age-related decline in visual acuity

Assessments of touch

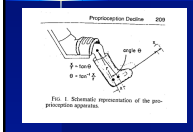
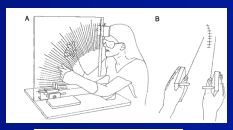
- Small discs of elder wood loaded with weights and lowered onto the surface of the skin - Aubert and Kammler (1858)
- Horse hair stylus with a counter weight - Blix (1884).
- Calibrated hairs on wooden rods - von Frey (1894)
  - silk thread, hair of women and children, horse hair
  - hair diameters were measured under a microscope and lengths adjusted to provide known pressures

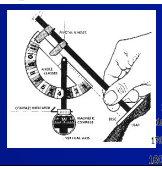
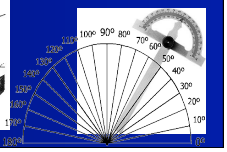


Assessments of vibration sense



Assessments of proprioception

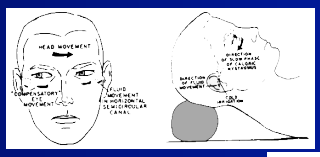



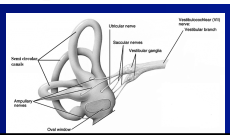




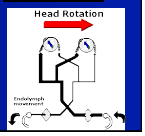
Ageing and peripheral sensation

- There are significant declines in touch, vibration sense (frequencies > 50 Hz) and proprioception with age
- Peripheral sensation is poorer in the lower limb at all ages and shows a greater age-related decline
- Variability in peripheral sensation increases with age
- Most studies have found no significant differences in peripheral sensation between men and women

Assessments of vestibular function



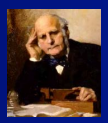
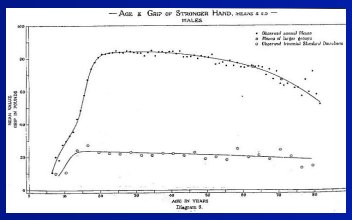



Ageing and vestibular function

- Most studies show that nystagmus responses show an increased responsivity to caloric and rotational stimulation till middle age followed by a decline in old age
- Vestibular optical reflex to sinusoidal motion provide a clearer picture of the relationship between vestibular function and age

Muscle strength



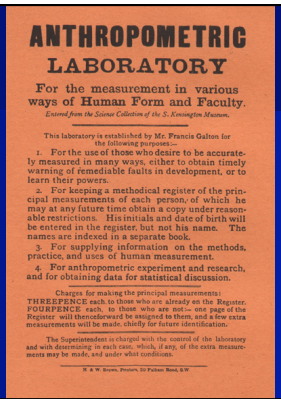




Ageing and muscle strength

- Hand grip strength is reduced by 16% and leg strength by 28% in men aged 60-69 compared with men aged 20-29
- In women, strength declines at a greater rate: hand grip strength declines by 20% and leg strength by 38% over the same age range
- Strength continues to decline beyond the sixties in both sexes
- Strength in women is about 60% of that in men

Reaction time

In 1899, Francis Galton assessed simple RT in 9,337 visitors to an international health exhibition and the South Kensington Museum in London.
Participants paid a small fee to "learn their powers", i.e. undertake a battery of tests of co-ordination and strength.



ANTHROPOMETRIC
LABORATORY

For the measurement in various ways of Human Form and Faculty.

Entered from the Science Collection of the S. Kensington Museum.

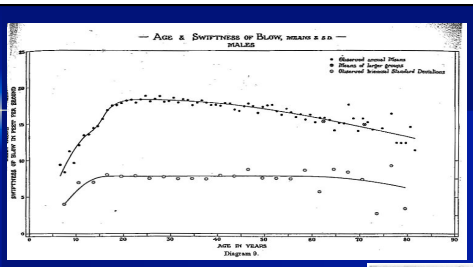
This laboratory is established by Mr. Francis Galton for the following purposes:—

1. For the use of those who desire to be accurately measured in many ways, either to obtain timely warning of remediable faults in development, or to learn their powers.
2. For keeping a methodical register of the principal measurements of each person, of which he may at any future time obtain a copy under reasonable restrictions. His initials and date of birth will be entered in the register, but not his name. The names are indexed in a separate book.
3. For supplying information on the methods, practice, and uses of human measurement.
4. For anthropometric experiment and research, and for obtaining data for statistical discussion.

Charges for making the principal measurements:
THREEPENCE each, to those who are already on the Register.
FOURPENCE each, to those who are not.—one page of the Register will thereafterward be assigned to them, and a few extra measurements will be made, chiefly for future identification.

The Superintendent is charged with the control of the laboratory and with discerning in each case, which, if any, of the extra measurements may be made, and under what conditions.

Galton's anthropometric laboratory



Ruger & Stoessiger, 1927

Ageing and reaction time

- Of all the studies on age-related changes in sensori-motor systems, reaction time has been studied the most
- significant increases in reaction time with age
- The degree of increase is influenced by test procedures, health status, inactivity, motivation

Sway

STATIC EQUILIBRIUM AS A USEFUL TEST OF MOTOR CONTROL

WALTER R. MILES, Ph.D.
Nutrition Laboratory of the Carnegie Institution of Washington, Boston, Mass.

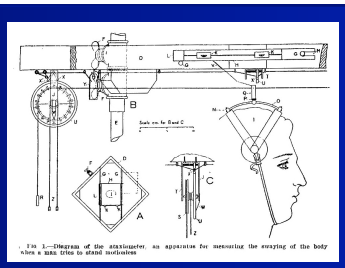


Fig. 1.—Diagram of the ataxiameter, an apparatus for measuring the swaying of the body when a man tries to stand motionless

Miles WR, 1922

FROM THE INSTITUTE OF PHYSIOLOGY, UNIVERSITY OF HELSINKI, AND THE RESEARCH CENTER FOR THE AGED, SOCIETAS GERONTOLOGICA FENNICA

STANDING STEADINESS IN OLD AND YOUNG PERSONS

by
K. BOMAN and E. JALAVISTO

(Received for publication October 23, 1953)

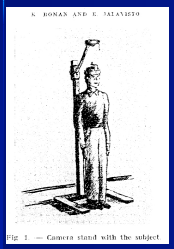
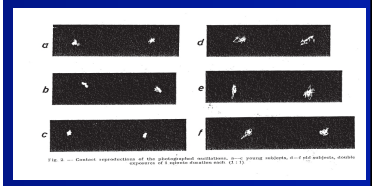
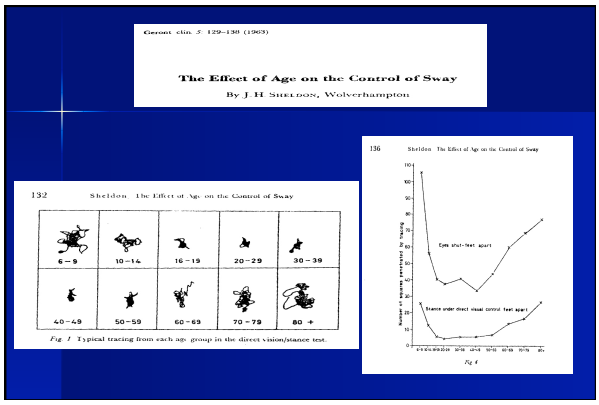


Fig. 1. — Camera stand with the subject

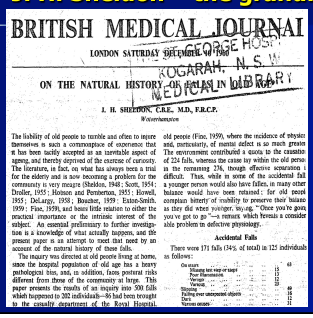




Ageing and sway

- Sway increases with age from about 30 years of age
- sway is increased in participants of all ages when they have their eyes closed
- Most studies have not reported gender differences in sway
- Sway variability increases with age
- The relationship between the ratio of sway with eyes open to sway with eyes closed with age (an index of dependence upon vision for postural stability) is unclear

Falls prevention: 1960 - time zero
J. H. Sheldon – the grandfather of falls


BRITISH MEDICAL JOURNAL

LONDON SATURDAY DECEMBER 31 1960

ON THE NATURAL HISTORY OF FALLS IN OLD AGE

J. H. SHELDON, C.B.E., M.D., F.R.C.P.

Wolverhampton

The liability of old people to tumble and often to injure themselves is such a commonplace of experience that it has been tacitly accepted as an inevitable aspect of ageing, and thereby deprived of the exercise of curiosity. The literature, in fact, on what has always been a trial for the elderly and is now becoming a problem for the community is very meagre (Sheldon, 1948; Scott, 1954; Dreller, 1955; Holmes and Pemberton, 1955; Howell, 1955; DeLargy, 1958; Boucher, 1959; Exton-Smith, 1959; Fine, 1959), and hence little relation to either the practical importance or the intrinsic interest of the subject. An essential preliminary to further investigation is a knowledge of what actually happens, and the present paper is an attempt to meet that need by an account of the natural history of these falls.

The inquiry was directed at old people living at home, since the hospital population of old age has a heavy pathological bias, and, in addition, faces postural risks different from those of the community at large. This paper presents the results of an inquiry into 500 falls which happened to 320 individuals—84 had been brought to the casualty department of the Royal Hospital, old people (Fine, 1959), where the incidence of physical and, particularly, of mental defect is so much greater. The environment contributed a cause in the causation of 224 falls, whereas the cause lay within the old person in the remaining 276, though effective generalization is difficult. Thus, while in some of the accidental fall a younger person would also have fallen, in many other balance would have been retained: for old people complain bitterly of inability to preserve their balance as they did when younger, saying, "Once you've given you've got to go"—a remark which reveals a considerable problem in defective physiology.

Accidental Falls

There were 171 falls (34% of total) in 125 individuals as follows:

"The literature on what has always been a trial for the elderly and is now becoming a problem for the community is very meagre"