Headphones for tests of highest audible pitch and audio reaction time.

At right, viewer with computer-driven lens system for visual accommodation test.

Central module, with "INSTANT REPLAY" button (in upper corner).

Other language versions

The H-SCAN software is available for operation in several languages.

What customer needs to supply

For a complete list of the items that comprise the H-SCAN system, please see the price list. All needed hardware and software is included except for the following items to be supplied by the customer:

(1) **Computer** running a recent version of Windows, with available serial or USB port, and speakers with volume control. Hard drive space required is 1.8 GB. If a laptop is used, auxiliary speakers should be supplied as the speakers in most laptops are not adequate.

(2) **Video monitor** capable of 800x600x256 color graphics.

(3) **Ink-jet printer** with separate ink cartridges for color and black.

(4) Table and chair in a **quiet, distraction-free environment**.

Centers for Age Control

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H-SCAN 820 –

provides objective testing of 12 functional biomarkers of aging without need for a test technician.

LUNG FUNCTION TESTS

Press ANY button to continue.
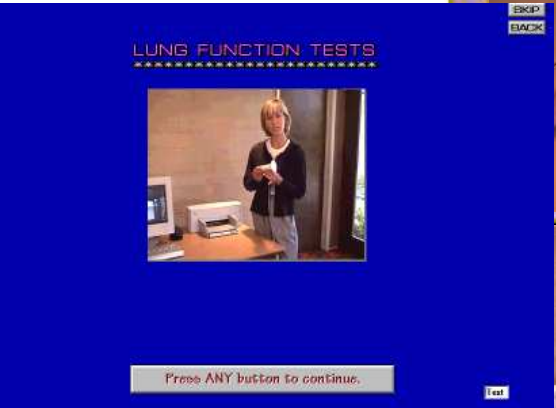
Appearing in movie-clips, our instructor explains and demonstrates how to do each test.

The H-SCAN test of visual accommodation.

Research applications

Functional declines with age proceed at different rates in different individuals. The eventual prospect of intervention in the aging process depends on the ability (1) to identify genes and biochemical processes that control aging and (2) to determine how to influence these processes by diet, exercise, life style, pharmacological means, and in time, by genetic engineering. The H-SCAN was developed as a research tool for such studies.

Biomarkers of aging tested by the H-SCAN are listed in the table below.

Applications to tests of individuals

In clinical evaluations of individuals, sources of data variability (see later section) must be taken into account, and longitudinal measurements, comparing the individual to him/herself over time, are generally more appropriate than comparisons to norms. Within these limitations,

THE H-SCAN BIOMARKERS:

1. Auditory reaction time
2. Highest audible pitch
3. Vibrotactile sensitivity
4. Visual reaction time
5. Muscle movement speed
6. Lung: forced vital capacity
7. Lung: forced expiratory volume, 1 sec
8. Decision reaction time
9. Decision movement speed
10. Memory
11. Alternate button tapping
12. Visual accommodation

tests of biomarkers of aging serve to:

TAILOR PROGRAMS: By highlighting areas of strength and weakness, test results allow the physician to tailor a program to the individual.

MONITOR PROGRESS: Repeating the tests at intervals documents changes achieved.

MOTIVATE PARTICIPANTS: The goal of improving from one test to the next serves as a strong motivator to stay with a program that offers this prospect.

Automatic test administration

H-SCAN tests are designed to be self-administering – meaning that no staff is needed to do anything but bring the participant to the instrument and enter a few items of information.

Besides saving staff costs, the object has been to achieve greater reproducibility of data through uniformity of procedures and instructions. Differences in the quality of instructions provided by different technicians are eliminated.

H-SCAN hardware is connected to a computer. Easy-to-follow instructions for doing the tests are presented by an on-screen instructor in movie format (participants need no familiarity with computers). Error-checking features incorporated in the program monitor every move and provide further instructions as needed to assure that each procedure is correctly performed.

Movie-clip instructions

In 50 short movie-clips, the software-resident instructor explains verbally what each of the 12 tests is about and, with the help of an on-screen assistant, demonstrates exactly how to perform

each test. Any of the movie-clips can be repeated by the test participant if desired by pressing the "INSTANT REPLAY" button.

Testing time averages about 45 minutes for the 12 tests.

H-SCAN testing is fun

Regardless of age, test participants regularly report that they enjoyed the experience - that the testing session was stimulating and fun.

How the H-SCAN biomarkers were chosen and validated

The primary consideration for selecting the 12 biomarkers of aging in the H-SCAN from among many biomarkers investigated by various groups, was that their decline impacts the quality of life.

Unlike blood and other biochemical tests, whose relevance to aging may be based on theory, it is more evident that changes in memory and other cognitive functions, lung function, reaction time, hearing, touch, vision, muscle movement speed, etc. are part of the aging process. In fact, what is universally recognized as aging, apart from appearance, is the loss of function.

Sources of data variability

Like most other physiological tests, the H-SCAN tests are subject to sources of unwanted variance, both between individuals and in the same individual over

time. Depending on the test, these arise from differences in alertness, fatigue, some disease conditions, and from other sources.

Inborn differences are a notable source of inter-individual variance. Individuals are born with different functional potentials. At an age of peak function such as 25 or 30, people differ dramatically in cognitive functions and virtually every other measure we can devise, and these inborn differences may or may not have anything to do with aging rate.
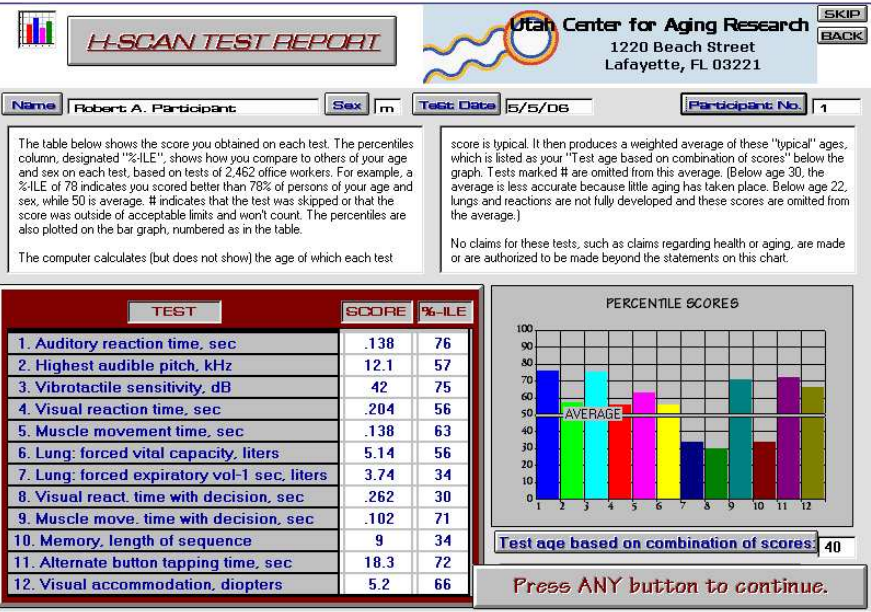
Do individuals whose composite biomarker score is below normal necessarily age more rapidly than individuals whose score is above normal? Not necessarily. In individuals, it is the rate of functional

changes over time that is the appropriate determinant of functional aging.

In scientific studies, variance usually is controllable and most sources of variance average out between groups.

Vibrometer for tactile sensitivity test.

Central module with circuits, LEDs, and push buttons.

At the end of testing, the H-SCAN automatically prints two pages of results The H-SCAN TEST REPORT (left) gives scores and percentiles based on a 2,462-person norm group. A bar graph of percentiles provides a quick overview of strengths and weaknesses. An estimate of functional age based on a combination of scores is shown below the graph.

The H-SCAN SPIROMETRY REPORT (right) provides a full spirometric evaluation, including volume-time and flow-volume curves for three efforts and a data table including 1st, 2nd and 3rd best, predicted, and percent of predicted values.
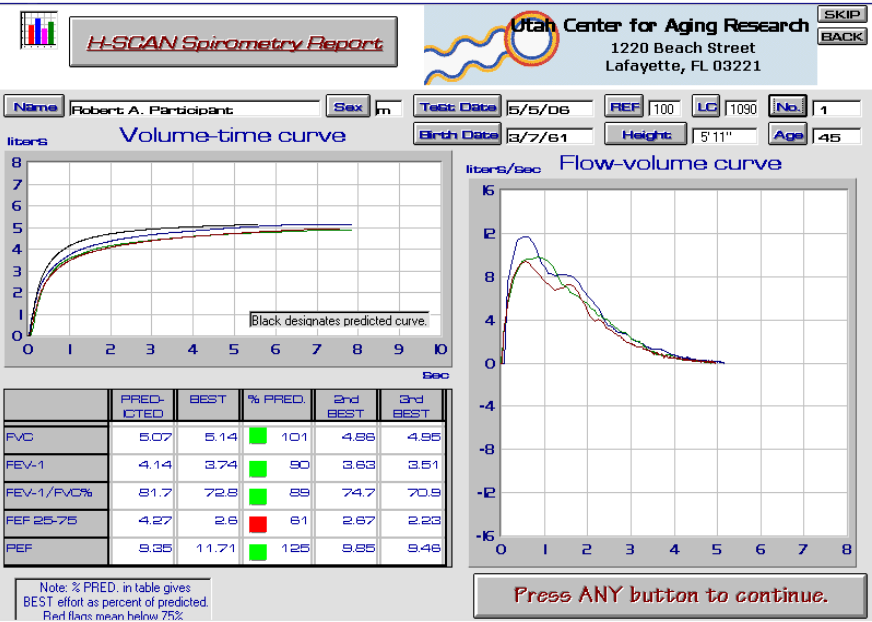
H-SCAN hardware

The electronic circuits that run all of the tests are conveniently housed in a sleek central module that links to the various transducers used in testing - headphones, vibrometer, viewer with computer controlled lenses, flow sensor for spirometry, push buttons, and LEDs.

Computer keyboard and mouse are not used except by staff to enter participant name, sex, birth date, and height at the start of testing and, optionally, to change test and printout configurations.

The design philosophy of the H-SCAN has been to emphasize simplicity of operation, gleaned from years of development and field experience. This applies also to setup, which is simple and fast.

Disposable flow sensor for spirometry tests.