

## DEVICE AND METHOD FOR ASSESSING COGNITIVE SPEED

This is a continuation-in-part of copending application Ser. No. 07/633,363 filed on Mar. 1, 1991, abandoned.

### BACKGROUND OF THE INVENTION

The present invention relates to a cognitive speedometer for the assessment of cognitive processing speeds, and more particularly to a portable electronic cognitive speedometer.

U.S. Pat. No. 4,770,636 discloses a cognometer useful in the repeated testing of memory and concentration, as needed to identify declining cognitive function that may require medical evaluation for dementia, delirium, other medical or psychiatric illness, or the cognitive side-effects of medications. The apparatus therein described permits repeated cognitive monitoring to be carried out not only in a medical setting, but also alone at home, through the provision of a device for automated, easily repeated testing. The cognitive functions determined by the apparatus set forth therein are memory and concentration, rather than the speed of the cognitive functions. While memory and concentration are particularly useful foci in many instances, particularly those involving the elderly or the severely affected, in other instances the primary focus should be on the speed with which a cognitive function is performed. For example, airplane pilots, racing car drivers and many others are required to make decisions not only accurately, but also rapidly.

The cognometer provides self-based testing expressly to compensate for the cognitive slowing often present in aged or cognitively impaired persons, although response speed was measured and reported in order to enable identification of excessive slowing which could be an early indication of an impaired cognitive processing. By way of contrast, the present invention is directed to a cognitive speedometer for the assessment of cognitive processing speed with fineness and sensitivity. This is accomplished by determining the cognitive processing speed independently of the time required to physically respond to the test stimulus. Such a test must measure only the ability in question and not be affected by other considerations, such as the physical functions of the individual being tested. For example, if a person has manual dexterity problems which interfere with his reproducing a displayed number on a keyboard, an excessive time to key in an answer in response to a presented arithmetic problem does not necessarily reflect on the speed of his cognitive processing. Thus, it is critical that any cognitive speedometer test isolate the cognitive function.

Automated testing should provide reliable, rapid, and automatic administration, scoring, and reporting so that repeated testing can be carried out reliably in precisely the same way as frequently as desired, at home as well as in medical settings. This permits self-testing by the general public, and monitoring of patients with suspected cognitive impairment, at home as well as in medical offices, clinics, emergency rooms, hospital wards, psychiatric facilities, or nursing homes.

In order for the test to have validity as an indication of cognitive processing speed, as independent as possible of intelligence, education and the like, the cognitive function to be performed during the test should be short, simple and capable of being performed in only

one manner. To this end, the apparatus should test a unit or single cognitive operation as opposed to a complex set of cognitive operations which might be strongly affected by the intelligence of the test taker, the manner in which he approached the problem or performed the arithmetic operation, etc. For example, certain arithmetic problems can be solved more easily and faster by successive approximation until the right answer is obtained than through the set of arithmetic operations intended by the problem framer—e.g., a long division problem or a solution to a complex equation.

The measurement of cognitive speed by conventional techniques—such as comparison of simple and multiple choice reaction times, Sternberg's memory scanning paradigm, or speed of mental rotation—have not proven to be entirely satisfactory. Some of these methods appear to measure the time needed to carry out more than one cognitive operation because they require a cognitive decision in addition to the operation(s) involved in their mental comparisons. Some of these rely on yes/no responses which allow guessing with a high probability of correct guessing rather than accurately measuring cognitive speed. Thus, the need remains for a cognitive speedometer which is designed to measure the speed of a single cognitive operation without reflecting the time needed to enter the result, requires specific numerical responses that cannot be guessed or anticipated, and does not require the kind of decisions needed for yes/no responses. The measures provided by such a cognitive speedometer should reflect the speed of a single cognitive operation, without additional variance due to decision latencies, and without contamination by rapid guesses, so that the latencies should provide more accurate statistics, and the fastest responses should provide a more accurate measure of maximum cognitive speed.

Accordingly, it is an object of the present invention to provide a reliable, rapid, automatic administration, scoring and reporting test for self-testing at home or elsewhere of cognitive processing speed.

Another object is to provide such a test which assesses the cognitive processing speed in performing a cognitive operation without reflecting physical ability.

A further object is to provide such a device which tests the cognitive processing speed in performing a unit or single cognitive operation (as opposed to a set of cognitive operations).

### SUMMARY OF THE INVENTION

It has now been found that the above and related objects of the present invention are obtained in a first embodiment of a cognitive speedometer for the assessment of cognitive processing speed. The speedometer is an electronic device programmed for repeated, rapid, automated assessment and monitoring of cognitive processing speed. The speedometer includes display means, such as a LED or CRT screen, and means for entering data, such as a keyboard. Means generate original data and display on the display means the original data for copying by a user on the data entry means. Means, operable only on the displayed original data correctly copied by the user on the data entry means, generate and display on the display means different data on which the user is to perform at least one unit cognitive operation and then enter the resultant data on the data entry means. Means, operable only on the correct resultant data entered by the user on the data entry means, determine the time required for the user to perform the