directions is obvious. It must depend on the gradient of chemical activity along the fiber, and the amount of increase of this activity at the point of stimulation.

I believe the nerve impulse is a propagation of chemical change—the propagation being due to a restoration of an equilibrium disturbed by the increase of metabolism at the point of stimulus. This propagation is always toward the point where there is less chemical activity, as measured by carbon dioxide production.

[1] *Amer. J. Physiol.*, 35, 340.

A POINT SCALE FOR MEASURING MENTAL ABILITY

By Robert M. Yerkes

PSYCHOPATHIC DEPARTMENT, BOSTON STATE HOSPITAL

Presented to the Academy, December 4, 1914

Alfred Binet, in 1905, devised a method of roughly estimating the intellectual capacity, or degree of mental development, of the child in terms of age. The method depended upon the application of series of single tests or measures, each series being especially arranged for a particular year of age. If a subject could satisfactorily meet the requirements for his age, he was considered up to the standard. Obviously he might measure either a certain number of years above or below the expected intellectual age.

The Binet measuring scale of intelligence has been revised, perfected, and adapted by various individuals, and now after nearly ten years of practical application, it stands as the only convenient and reasonably expeditious method of classifying children with respect to intelligence. It possesses, however, many serious defects which may not now be enumerated, since the purpose of this abstract is to present a brief description of a new method which is based, on the one hand upon the work of Binet and his associates, and on the other upon a suggestion made by the late E. B. Huey. We may call this new method the point scale for measuring mental capacity. It has been developed at the Psychopathic Hospital, Boston, as one result of the demand for reasonably detailed and reliable information concerning the mental characteristics of individuals both immature and mature. The scale consists of a single series of measurements to be made on all subjects. Each measurement is evaluated according to a graded scale, and the maximum credit obtainable in an examination is one hundred points. The various measurements in question are distributed among the most important intellectual functions (affectivity being omitted), so that the several aspects—memory, imagination, perception, association, suggestion, judgment, ideation—may be measured.

The value of the point scale depends upon reliable norms. Two boys, from poor surroundings, each of the age seven years, six months, subjected to examination, obtain, for example, the one a credit of twenty-two points and the other a credit of fifty-nine points. By reference to our norms, we discover that boys of the age in question born to English-speaking parents of poor or medium circumstances, should obtain a score of 36—while those born to parents of good or superior circumstances should obtain 45. Since these norms, as is evident, take account of sex, age, language, and social status, it is clear that the first individual is nearly 40 per cent below our reasonable expectation in intellectual ability, whereas the second individual is instead about 37 per cent above what we should expect.

It thus is clear that instead of stating that an individual is a certain number of years and months above or below age, as in the Binet method, we can definitely state the relation of a given individual examined to a more or less inclusive group in which he belongs. This value we call the coefficient of mental ability. It is obtained by dividing the individual's score by the average or norm for his group. We may also, if it is desirable, state the exact frequency of occurrence in the group of the degree of intelligence indicated, as for example, one in one hundred, with respect to inferiority or superiority, as the case may be.

A single measure chosen from our scale must serve to indicate its chief features. We choose the test for the span of auditory memory. The subject is required to repeat, after the experimenter, groups of digits ranging in number from three to seven. These are presented by the experimenter orally, clearly and distinctly, at the rate of two per second. If the subject fails to repeat correctly the first group of a given number, he is given a second trial with another group containing the same number. If he succeeds with that, the experimenter passes on to a group containing one additional digit, and so on. One point credit is allowed for each of the five groups correctly reproduced. If a subject fails in both trials for a given number of digits, the observation is terminated. The test for memory-span is:

	1st trial	*2nd trial*	*Credit*
(a)..........	374	581	(1)
(b)..........	2947	6135	(1)
(c)..........	35871	92736	(1)
(d)..........	491572	516283	(1)
(e)..........	2749385	6195847	(1)

The preliminary scale, which we have thoroughly tested by applying it to about eight hundred normal children and adults and to more than three hundred abnormal individuals, has proved so serviceable that we are now attempting to develop a more highly perfected and inclusive series of measurements which shall be universally applicable and shall take account of the affective as well as the intellectual functions.

Since the object of our work was the development of a practically serviceable method of measuring mental ability for use in hospitals, clinics, schools, reformatories, prisons, and wherever a rough estimate of mental status is demanded, it does not seem worth while to present results in this article.

The principles involved in the universal point scale are as follows:

1. A single series of measurements to be made on all subjects examined.

2. Gradation of each member or part of the scale with respect to difficulty so that measurement may be made, with equal facility, of the capacity of the child of three and the adult.

3. Partial credits according to the extent and nature of the response.

4. Distribution of the several measurements equally among the chief groups of mental processes: for example, according to the following four categories of processes, one-fourth of the measurements being devoted to the processes under each. (*a*) Sensibility, perceptivity, discrimination, association (receptivity); (*b*) Memory, in several of its aspects, and imagination (imagination); (*c*) Simple feeling, emotion, sentiment, volition, and suggestibility (affectivity); (*d*) Ideation, judgment, reasoning (thought).

5. Arrangement of the several measurements of the scale, probably twenty in all, in the four groups suggested above, namely, (*a*) receptivity; (*b*) imagination; (*c*) affectivity; (*d*) thought. So that, one-fourth of the scale being devoted to each group of processes, the credits achieved by an individual may conveniently be represented by a simple formula. Assuming that the maximum number of credits obtainable is two hundred and that individual X achieves one hundred and fifty-three points, his mental formula might be written thus:

$$X = \text{R.}43 + \text{I.}48 + \text{A.}22 + \text{T.}40 = 153.$$

Such a formula would indicate to the examiner that X is especially deficient or peculiar in affective characteristics.

6. The measuring scale shall be arranged on four pages, those measurements dealing with one of the four categories of mentality occupying a page. On each sheet, the several measurements shall be arranged in order of increasing difficulty, and the same shall hold of the order of arrangement within any given part of the series, that is, any one of the twenty types of measurement.

7. The measurements shall be chosen, so far as possible, with a view to simplicity of materials and ease and uniformity of observation.

8. The scale shall be dependent for its value upon safely determined norms.

COLOR VISION IN THE RING-DOVE (Tutur risorius)

By Robert M. Yerkes

PSYCHOLOGICAL LABORATORY, HARVARD UNIVERSITY

Presented to the Academy, December 4, 1914

The psychophysiological literature, both naturalistic and experiental, on color vision in infra-human animals, is surprisingly extensive. But even more surprising is the extreme uncriticalness of the methods which have been employed. A realization of this condition of affairs within the past decade led simultaneously to the development, by C. Hess, in Europe, and by R. M. Yerkes in association with J. B. Watson, and more recently by G. H. Parker, in America, of spectral methods for the comparative study of color vision. These methods enable the experimenter to measure and control his stimuli in their various aspects and to observe with reasonable accuracy organic response to specific stimuli. The method now in use in this country, developed by Watson and me, may be named from the nature of the stimulus and the form of reaction demanded 'the method of discriminating spectral stimuli.' It involves the use of a special form of prism spectrometer with devices for selecting, spacing, reversing, and displaying any two portions of the spectrum, with means of controlling the selected stimuli qualitatively and intensively, of measuring them in photometric and energy units, and of so presenting them to the reacting animal that it may, if capable of so doing, recognize them and react appropriately.[1]

Until very recently, it has been the prevalent opinion even among scientific persons that many, if not most of the vertebrates, possess fairly highly developed color vision, which in many instances is closely