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By Dr. WALTER B. CANNON

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SIXTY-EIGHT years ago a young chemist, Charles W. Eliot, was the new president of Harvard University. Almost from the first he undertook the hard task of revolutionizing medical education. In his report for the academic year 1870–71, he wrote that the corporation and overseers had "changed the title of the Parkman Professor of Anatomy and Physiology in the Medical School. Physiology having been made a separate branch of instruction, and an assistant professor having been appointed to teach it, the Parkman Professor will hereafter teach anatomy only." The change, it was explained, was made with the assent of Oliver Wendell Holmes, for twenty-four years the incumbent of the combined chair. And later in the report President Eliot added, "The appointment of an Assistant Professor of Physiology and the equipment of a physiological laboratory has put that department of instruction upon a much better footing than before."

The comment is justifiable that no great change was required to bring about a considerable improvement. The literary Parkman professor had lavished his flowery adjectives on bodily structure, and had paid only incidental tribute to bodily function. He was, indeed, impressed by the revelations of the microscope, which, he declared, has "cleared up many uncertainties concerning the mechanism of special functions." Unfortunately, however, nature had been reluctant. "If any prying observer," he wrote, "ventured to spy through his magnifying tubes into the mysteries of her glands and canals and fluids, she covered up her work in blinding mists and bewildering halos, as the deities of old concealed their favored heroes in the moment of danger." But progress was recognized. "Science has at length sifted the turbid light of her lenses, and blanched their delusive rainbows."

Though there is evidence that Dr. Holmes in his lec-

[1] An address given at the celebration of the fiftieth anniversary of the founding of the American Physiological Society, Baltimore, April 1, 1938.

For purposes of analysis, five of the scales were selected for resolution into principal components. These scales were:

Attitude toward the Bible	Scale No. 29
Attitude toward God (the reality of God)	Scale No. 21
Attitude toward Sunday observance	Scale No. 26
Attitude toward censorship	Scale No. 28
Attitude toward treatment of criminals	Scale No. 9

The Hotelling principal components for each of the batteries is given in Table 1.

TABLE 1

THE PRINCIPAL COMPONENTS FOR TWO COMPARABLE BATTERIES OF THURSTONE ATTITUDE SCALES

	γ_1	γ_2	γ_3	γ_4	γ_5
Principal Components for Battery A					
Root	2.97	.48	.37	.19	.12
Per cent. of total variance	72	11½	9	4½	3
Correlation of the γ's of Battery A with					
Bible A	.83	−.00	−.27	−.26	.17
God reality A	.87	−.01	−.28	.07	−.25
Sunday observance A	.69	.56	.14	.14	.07
Censorship A	.75	−.14	.45	−.18	−.09
Criminal A	.69	−.39	.04	.27	.14
	Γ_1	Γ_2	Γ_3	Γ_4	Γ_5
Principal Components for Battery B					
Root	3.03	.49	.30	.26	.06
Per cent. of total variance	73	12	7	6	2
Correlation of the Γ's of Battery B with					
Bible B	.86	−.22	.09	−.21	.17
God reality B	.89	−.25	.04	−.14	−.18
Sunday observance B	.76	.25	.35	.26	.00
Censorship B	.68	.53	−.23	−.16	.00
Criminal B	.69	−.20	−.33	.32	.02

Each individual's score was resolved into γ and Γ scores for each of the two batteries. The correlations between the γ and Γ scores were then computed. These are reported in Table 2.

TABLE 2

THE INTERCORRELATION OF PRINCIPAL COMPONENT SCORES DERIVED FROM TWO COMPARABLE TEST BATTERIES OF THURSTONE ATTITUDE SCALES*

	γ_1	γ_2	γ_3	γ_4	γ_5
Γ_1	.95	.01	−.01	.06	−.03
Γ_2	.01	.20	.65	−.20	.10
Γ_3	.02	.61	−.13	.05	−.02
Γ_4	−.04	.06	.16	.58	.15
Γ_5	.07	.01	−.04	−.22	.32

* Where γ refers to the principal components of Battery A and Γ refers to the principal components of Battery B.

In a sense, the correlations of Table 2 are an estimate of the reliability of the principal components, since they are correlations between a test and, presumably, a comparable form, *i.e.*, considering Γ_1 a comparable form of γ_1; Γ_2, a comparable form of γ_2; etc. The reliabilities thus are .95, .20, −.13, .58 and .32. Obviously all components beyond the first are too unreliable for individual prediction. In other words, information of the five scales might have been obtained best by one good test. Further, it should be noted that $r_{\Gamma_2\gamma_3} = .65$ and $r_{\Gamma_3\gamma_2} = .61$, indicating that an inversion in the order of importance of the principal components occurred in Batteries A and B.

If account is taken of the inversion the reliabilities of principal components are in order .95, .65, .61, .58 and .32 indicative of increasing error variance with decreasing importance of the principal components. This is to be expected, since each successive component contains less of true information and more of error variance. As a matter of fact, the Hotelling method squeezes the error to the last and least important component.

The intercorrelations of the γ's of Battery A are zero, except that $r_{\gamma_1\gamma_1}$, $r_{\gamma_2\gamma_2}$, etc., equal 1. Similarly, the intercorrelations of the Γ's of Battery B are zero, except that $r_{\Gamma_1\Gamma_1}$, $r_{\Gamma_2\Gamma_2}$, etc., equal 1. Yet certain of the intercorrelations between γ and Γ, excepting those between γ_1 and Γ_1, γ_2 and Γ_3, γ_3 and Γ_2, γ_4 and Γ_4 and γ_5 and Γ_5 differ significantly from zero.

The causes of the lack of stability in the results may be due, among others, to the lack of comparability in the scales, the relative unreliability of the scales, the smallness of the sample, the variability in the subjects and the like. Nevertheless, it seems reasonable to require an additional condition of statistical factor methods, *viz.*, reliability of components.

The reliability of principal components beyond the first is such as to lead one to believe that psychological nonsense may be a consequence of a too devoted dependence upon factor methods. Traits beyond the first will be inadequately identified and, hence, frequently misnamed.

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BOOKS RECEIVED

Actualités Scientifiques et Industrielles; 566, Philosophie et Histoire des Mesures; M. GUICHARD: I, *De la Sensation a la Méthode de Mesure.* Pp. 35; *567, II, Essai Historique sur les Mesures en Chimie.* Pp. 4–72; *568, III, Essai Historique sur les Mesures en Chimie.* Pp. 73–114. 10 fr. each. *529, Lecons de Chimie Physique,* J. DUCLAUX, *X, Mouvement Brownien.* Pp. 96. 25 fr. *556,* M. J.–A. GAUTIER, *Recherches Dans La Série de La Pyridine.* Pp. 78. 18 fr. Hermann, Paris.

DICKEY, DONALD R. and A. J. VAN ROSSEM. *The Birds of El Salvador.* Pp. 609. 29 figures. 24 plates. Field Museum of Natural History. $4.50.

MERRILL, ELMER D. and EGBERT H. WALKER. *A Bibliography of Eastern Asiatic Botany.* Pp. xlii + 719. The Arnold Arboretum of Harvard University. $12.50.

SHULL, A. FRANKLIN. *Heredity.* Third edition. Pp. xvii + 442. 168 figures. McGraw-Hill. $3.50.

SULLIVAN, J. W. N. *Isaac Newton, 1642–1727.* Pp. xx + 275. Macmillan. $2.50.

VAUGHAN, THOMAS W. and others. *International Aspects of Oceanography.* Pp. xvii + 225. 10 figures. 36 plates. National Academy of Sciences.