reset position, the counter is set up for automatic starting and resetting through the socket of the terminal dekatron unit, the connexions being made by means of a 12-pin miniature Jones plug. The counter starts operating when the terminal *PLA9* is earthed and is reset by removing the earthing temporarily from *PLA10*. In the 'start' circuit there is a Post Office 'Uniselect' driven by 40 V. d.c. pulses from a time clock. The contacts in the 'Uniselect' are connected in such a way that, after a 2.5-sec. interval, the 'start' circuit is completed for a period of 10 sec. The 'start' circuit also contains a high-speed relay, which is actuated by a 40-V. d.c. current, 'made' when the stylus touches the sides of the hole. The relay closes the 'start' circuit and the counter operates. When the stylus is not touching the edge of the hole, the relay contacts are open, and the counter stops. Readings are thus obtained directly (in units of 0.01 sec.) of the time in a 10-sec. test period during which the stylus is in contact with the hole.

Experiments were carried out on 58 students aged 19-32, 54 of whom were aged 23 or less. The test procedure was as follows. Students were divided into pairs, one acting as subject and the other working the apparatus. The controlled testing situation for the stationary position recommended by Seashore and Adams¹ was adopted, with the exception that the apparatus allowed each subject a 2.5-sec. interval to become accustomed to the operation of the timer. A test run consisted of four replicate trials, each comprising one reading apiece in the five holes the dimensions of which are given in Table 1*a*. After a control run, the subject swallowed a tablet, which might contain either a stimulant drug or a placebo. An hour later a further test run was carried out. In the conditions of the experiment, a 'placebo effect' could be demonstrated, contact times being significantly decreased ($P < 0.001$) at the second test run. No learning or fatigue effects during either run could be demonstrated.

Table 1. CORRECTION FACTORS FOR A 'STYLUS AND HOLE' STEADINESS TEST
Results of 232 observations on 58 subjects. To obtain a standardized score the contact times for each hole are multiplied by the appropriate correction factor and the results are summed

(a) Hole diameter (1/64 in.)	12	11	10	9	8
(b) Mean contact time in a 10 sec. test period (0.01 sec)	224.9	97.7	46.0	29.2	20.8
(c) $1/(b) \times 100$	0.445	1.023	2.174	3.425	4.808
(d) Correction factors (Spaeth and Dunham, ref. 2)	0.5	1	5	10	20
(e) Correction factors based on (c)	1	2	4	7	10

Mean contact times for each of the five holes were calculated from the control runs, comprising 232 readings in each hole (see Table 1*c*). Some arbitrary assumption is necessary to render comparable the five respective means. At first sight it would appear simplest to use multiplication factors proportional to the reciprocals of the observed mean contact times so that, after correction, the readings from each hole would give, on the average, the same numerical result. The correction factors recommended by Spaeth and Dunham² (Table 1*d*) do not obey this relation. An alternative series of integer factors which possesses approximately the desired property is given in Table 1*e*. It is possible, however, that investigation of the wave form of upper limb tremor in relation to the geometry of the apparatus might show that some other basis for correcting the reading was preferable.

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J. D. ACLAND

Department of Pharmacology and Therapeutics,
The University,
Sheffield 10. Nov. 17.

¹ Seashore, R. H., and Adams, R. D., *Science*, **78**, 285 (1933).

² Spaeth, R. A., and Dunham, G. C., *Amer. J. Physiol.*, **59**, 467 (1922).

STATISTICS

Fitting ν Linear Relations to n Variables all liable to Error

IN a recent communication, B. E. Kelly¹ has directed attention to W. E. Deming's sadly neglected monograph "Statistical Adjustment of Data" (1943), and comments that Deming's procedure leads to the solution found by P. A. Wayman² for the best-fitting straight line to a series of observations of two variables both subject to variable error. This is not correct: Deming neglected the variation of his weighting factor W_i with the slope of the fitted line, and his result (p. 180) is a weighted regression. We have re-examined the problem of multivariate linear relations: when both variables are subject to independently variable errors we obtain a result the bivariate case of which agrees with Wayman's (which so far as we can find had not previously been described); when the ratio of the standard deviations of error in the several variables is constant for all sets of measurements, we find that for n variables connected by ν linear relations the best-fitting $(n - \nu)$ -flat is defined by the ν latent vectors of the covariance matrix corresponding to its ν smallest latent roots; and we have been able to find a procedure suitable when not all the variables were measured at every point (a situation very common in studies of the correlation of chemical composition and physical properties of minerals). Certain non-linear relations of mineralogical importance are under investigation.

D. E. Barton and C. L. Mallows³, discussing methods of curve-fitting other than least-squares, mention J. Berkson's method⁴ of the 'controlled variable'. This method is based on the assumption that if in a series of experiments we adjust one variable as nearly as we can to a series of pre-selected 'control' values (one measurement at each) it will be proper to assume that the error of measurement is independent of the observed value, but that if no such 'control' is attempted the error of measurement is, necessarily, independent of the true value and not of the observed value; we are unable to find any justification for this postulate, and believe this procedure to be wholly invalid.

M. H. HEY

Department of Mineralogy,
British Museum (Nat. Hist.),
London, S.W.7.

E. N. HEY

Radcliffe Infirmary,
Oxford.

¹ Kelly, B. E., *Nature*, **184**, 1086 (1959).

² Wayman, P. A., *Nature*, **184**, 77 (1959).

³ Barton, D. E., and Mallows, C. L., *Nature*, **184**, 1086 (1959).

⁴ Berkson, J., *J. Amer. Statist. Soc.*, **45**, 164 (1950). Cf. Lindley, D. V., *Biometrika*, **40**, 47 (1953).