80%, respectively) as well as an increase in the latency of the response (160 and 290%, respectively). At 24 and 48 hr after diethyldithiocarbamate injection no effects on the conditioned avoidance response were observed (Table 1).

Since the metabolite causes depletion of brain noradrenaline, it is possible that the effects of diethyldithiocarbamate on the conditioned avoidance response may be due to its effect on this catecholamine; however, it also has effects on other copper-containing enzymes, and has been shown to be a copper chelator (Frieden, 1962). Further work is necessary to establish a preference between the alternatives.

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References

Carlsson, A., Lindqvist, M., Fuxe, K. & Hokfelt, T. (1966). *J. Pharm. Pharmac.*, **18**, 60–62.
Collins, G. G. S. (1965). *Ibid.*, **17**, 526–527.
Frieden, E. (1962). "The Complex Copper of Nature", in *Horizons in Biochemistry*, editors Kasha, M. & Pullman, B., pp. 461–496, New York: Academic Press.
Goldstein, M., Anagnoste, B., Lauber, E. & McKereghan, M. (1964). *Life Sci.*, **3**, 763–767.
Moore, K. E. (1966). *Ibid.*, **5**, 55–65.
Seiden, L. S. & Carlsson, A. (1963). *Psychopharmacologia*, **4**, 418–423.
Seiden, L. S. & Carlsson, A. (1964). *Ibid.*, **5**, 178–181.
Seiden, L. S. & Peterson, D. D. (1968). *J. Pharmac. exp. Ther.*, **159**, in the press.

Performance of the Ferranti-Shirley viscometer with automatic flow curve recorder unit

SIR,—A common method of investigating the rheological properties of materials which exhibit time dependent flow characteristics such as thixotropy is to use a rotational viscometer of, for example, the cone and plate type (see e.g. Boylan 1966, Talman, Davies & Rowan, 1967, Barry & Shotton, 1967). The Ferranti-Shirley viscometer (McKennell 1954, 1956, 1960, Van Wazer, Lyons & others, 1963) is designed so that when used in its automatic mode it is intended that the cone is accelerated at a uniform rate up to a preset maximum speed and then decelerated to zero speed at the same rate. A plot of torque on the cone against speed of the cone may then be displayed as a hysteresis loop on an X-Y plotter. This loop is then used to characterize the rheological properties of the system (Green, 1949, Green & Weltmann, 1946, Weltmann, 1960).

We have made a simple test on our instrument to check if acceleration and deceleration were constant (Barry, 1967). The sweep time was set at 600 sec, the indicator unit was switched to "check speed" and the maximum rev/min to 100, and the cone was set revolving; at the same time a stop watch (0·1 sec divisions) was started. The time was noted at every ten divisions of the speed scale and thus the time required for each increment of 10 rev/min obtained. The results are shown in Table 1.

Similar results were obtained using an alternative procedure. The cone rev/min was displayed as the Y coordinate on the X-Y plotter and the distance moved by the pen up this axis in equal increments of time (60 sec) was measured. Similar results were obtained with the same limits of reproducibility.

If the control unit was functioning linearly, each increment of 10 rev/min would require 60 sec; considerable deviation occurs even after allowing for the manufacturer's tolerance of 2% on all readings. However, the repeatability from run to run for the time required for any set increment was of the order of 2% except at the extreme ends of the scale. This repeatability was maintained over a period of six months.

TABLE 1. PERFORMANCE OF FERRANTI-SHIRLEY VISCOMETER IN AUTOMATIC MODE. Time required for each 10 division increment in cone speed.

Cone speed increment (revolutions per min)	Time required for each 10 division increment in cone speed (Theoretical time = 60 sec)	
	Upcurve	Downcurve
0–10	62·5	67·6
10–20	53·9	61·2
20–30	56·2	61·6
30–40	58·3	61·8
40–50	59·4	61·0
50–60	58·8	58·2
60–70	60·0	57·5
70–80	61·5	56·8
80–90	65·0	57·7
90–100	65·5	55·7

The characterization of the rheology of time dependent materials by means of hysteresis loops is at best a semiquantitative method in which the conditions of testing are chosen by the experimenter. When the Ferranti-Shirley viscometer is used in automatic mode simply to apply a standardized testing procedure the performance is adequate. However, when comparing results obtained with an instrument on different occasions or results from different instruments, the variation in the rate of increase or decrease in shear rates should be known.

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References

Barry, B. W. (1967). Ph.D. thesis, University of London. pp. 105–108.
Barry, B. W. & Shotton, E. (1967). *J. Pharm. Pharmac.*, **19**, *Suppl.* 110S–120S.
Boylan, J. C. (1966). *J. pharm. Sci.*, **55**, 710–715.
Green, H. (1949). *Industrial Rheology and Rheological Structures.* London: Chapman & Hall.
Green, H. & Weltmann, R. N. (1946). *Colloid Chemistry, Theoretical and Applied.* VI, 328–347. Editor Alexander J. New York: Reinhold.
McKennell, R. (1954). *Proc. 2nd. Intern. Cong. Rheol.*, 350–358.
McKennell, R. (1956). *Analyt. Chem.*, **28**, 1710–1714.
McKennell, R. (1960). *The Instrument Manual.* 3rd edn pp. 284–328. London: United Trade Press.
Talman, F. A. J., Davies, P. J. & Rowan, E. M. (1967). *J. Pharm. Pharmac.*, **19**, 417–425.
Van Wazer, J. R., Lyons, J. W., Kim, K. Y. & Colwell, R. E. (1963). *Viscosity and Flow Measurement.* A Laboratory Handbook of Rheology, pp. 122-129. London: Interscience.
Weltmann, R. N. (1960). *Rheology. Theory and Applications*, 3, 189–248. Editor: F. R. Eirich. London: Academic Press.

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