Genetical components of physiological tremor

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Summary. Physiological tremor was measured in 14 pairs of monozygotic twins, 14 pairs of dizygotic twins, and 14 pairs of control subjects matched for age and sex. Postural finger tremor was measured in each pair using a sub-miniature accelerometer and subjecting the amplified signals to power spectral analysis. Significant genetical influences were found for the proportion of tremor at frequencies near the peak frequency of 9–10 Hz. No genetical effects were found at other frequencies or for the absolute amount of tremor. The results suggest that physiological tremor between 8 and 13 Hz is genetically influenced and that tremor at these frequencies is determined by different mechanisms than those at other frequencies.

Although tremor has been studied scientifically for over a century (Ferrand, 1868), we are still not certain how normal physiological tremor is caused and how it is maintained. The evidence that we have is conflicting but it appears that such tremor is the resultant of several different mechanisms. They include 'hunting' in the servo-loop between a stretch stimulus and reflex corrective muscular action (Halliday and Redfearn, 1956; Lippold, Redfearn, and Vučo, 1957; Lippold, 1970a), ballistocardiographic effects transmitted passively from cardiorespiratory forces (Brumlik, 1962; Van Buskirk and Fink, 1962; Yap and Boshes, 1967), and mechanical influences, particularly at higher frequencies of tremor (Stiles and Randall, 1967). One consistent feature of physiological tremor is the presence of a main peak at or near 9 Hz which persists under a wide range of experimental conditions (Sutton and Sykes, 1967). The relationship between tremor near the peak frequency and that at other frequencies has also been disputed; some workers have suggested that fast and slow physiological tremors are harmonics of the peak frequency of tremor (Merton, Morton, and Rashbass, 1967).

In view of the uncertainty about the origins of the different frequencies of physiological tremor it is surprising that there have been no genetical

studies of the phenomenon. Essential or heredo-familial tremor, which appears to be qualitatively similar to physiological tremor but exaggerated in degree (Marshall, 1962), has long been known to be influenced strongly by genetical factors (Dana, 1887; Critchley, 1949; Larsson and Sjögren, 1960) but even in this condition the precise nature of the genetical components is unclear.

Genetical investigations have potential value in elucidating many of the unanswered questions posed by these studies, not the least of which is the relationship between tremor and the electroencephalogram (EEG). Lippold (1970b; 1973) has provided strong evidence, which although disputed has yet to be explained, that the alpha rhythm is an artifact produced by tremor of the extra-ocular muscles. As the alpha rhythm is genetically influenced (Lennox, Gibbs, and Gibbs, 1945; Young, Lader, and Fenton, 1972) physiological tremor would have to be similarly influenced if it was the cause of the alpha rhythm.

Method

Fourteen pairs of monozygotic (MZ) twins, 14 pairs of dizygotic (DZ) twins, and 14 pairs of controls, aged 17–44 (mean 24.1 years) were investigated. All the twins were contacted through the Medical Research Council Twin Register at the Institute of Psychiatry, apart from the two authors and their co-twins. All measurements of tremor were made by P.J.T. who was unaware of the zygosity of the twins until the end of the study. J.K. selected the twins so that there were 14 pairs of supposed or previously confirmed monozygotic and dizygotic twins with

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the sexes equally represented in both groups. In all except two pairs of subjects (presumed MZ) zygosity was confirmed by blood group analysis of ABO, MNS, P, Rhesus, Lutheran, Kell, Lewis (a and b), Duffy (a and b), and Xga systems. The 14 pairs of control subjects were matched for age (± 5 years) and sex.

Postural finger tremor was measured by a technique described in full elsewhere (Tyrer and Bond, 1974). A sub-miniature accelerometer was taped to the middle finger of the left hand and tremor measured while the hand was held horizontally without visual reference and with the forearm supported down to the level of the wrist. The analog signals representing acceleration were amplified and filtered before on-line power spectral analysis using a PDP 12A laboratory computer (Digital Equipment Corporation).

Subjects rested for 10 min before testing and tremor in each pair of twins and control subjects was measured at the same time of day. However, times of recording varied from 14.00–22.00 hours for different twin pairs, and between 09.00 and 15.00 hours for the control group.

Results

The tremor values were all logged before statistical testing to normalise the distribution of the data. Intra-class product moment correlation coefficients (r) were measured between each of the twin and control pairs for (1) the amount of tremor (power, ie, finger acceleration squared) in each of the 2 Hz frequency band-widths between 2 and 32 Hz and (2) the proportion of total tremor in these band-widths. Comparison was therefore made for both the frequency profile and amount of tremor.

No genetical differences were detected in amount of tremor. Small positive intra-class correlations for total amount of tremor were found in both twin and non-twin groups ($r_{MZ}=0.24$; $r_{DZ}=0.38$; $r_{NT}=0.27$). On the other hand, the proportion of tremor

at each frequency showed a gradation from high correlation in the MZ twins down to no correlation in the control group. These differences were most pronounced in the main frequency range of normal tremor, between 8 and 13 Hz. No such correlation was found at other frequencies (Tables I and II).

TABLE I
INTRA-CLASS CORRELATIONS FOR PROPORTION
OF TREMOR AT DIFFERENT FREQUENCIES

Frequency (Hz)	Intra-class Correlation Coefficients (r)— Proportion of Total Tremor		
	MZ	DZ	NT
2 and 3	+0.25	+0.02	+0.24
4 and 5	+0.09	+0.03	+0.08
6 and 7	+0.16	+0.42	+0.33
8 and 9	+0.62**	-0.29	+0.06
10 and 11	+0.43	+0.25	+0.27
12 and 13	+0.61*	+0.49	+0.09
14 and 15	+0.35	+0.44	-0.20
16 and 17	-0.14	-0.19	+0.18
18 and 19	-0.19	-0.25	-0.21
20 and 21	-0.04	-0.14	-0.20
22 and 32	-0.12	-0.02	+0.04

* $p < 0.05$

** $p < 0.02$

The frequencies are given in 2 Hz bandwidths except for that between 22 and 32 Hz, at these frequencies tremor activity was so little that the 10 Hz bandwidth is taken for analysis.

TABLE II
INTRA-CLASS CORRELATIONS FOR PROPORTION
OF TREMOR BETWEEN 8 AND 13 Hz

Frequency (Hz)	Intra-class Correlation Coefficients (r)		
	MZ	DZ	NT
8	+0.45	+0.18	+0.09
9	+0.65**	-0.33	-0.06
10	+0.21	+0.14	+0.30
11	+0.47	+0.24	+0.14
12	+0.60*	+0.41	+0.07
13	+0.58*	+0.17	+0.08

* $p < 0.05$.

** $p < 0.02$.

FIG. 1. Power spectral profiles of finger tremor for monozygotic (MZ) and dizygotic (DZ) twins and unrelated subjects (NT) matched for age and sex.

Discussion

The results suggest that genetic factors are important in determining tremor near the peak frequency of 9–10 Hz but do not affect tremor at other frequencies. Genetical influences affect the frequency profile of tremor rather than amount of tremor. The positive correlations for amount of tremor found in the three groups can be explained by common variation; this includes diurnal changes which alone are sufficiently great to account for the correlation found (Tyrer and Bond, 1974). Because of such variation it would be unjustified to infer that genetical influences differ in essential and physiological tremor, but tremor would need to be measured at different times in the same individuals to compensate for other factors.

Despite these fluctuations in the absolute amount of tremor genetical effects are present for the relative amount of total tremor at some frequencies. Thus it appears that the frequency profile of tremor alters little with changes in amplitude and may be specific for each individual. The constancy of this frequency profile has been shown by Marsden and his co-workers by repeated measurements of tremor in the same individual (Marsden *et al*, 1969). Genetical effects on this profile are most marked near the peak frequency and the absence of such effects at other frequencies argues against the idea that subsidiary tremor peaks are harmonics of tremor at the peak frequency. Whether or not the genetical factors influencing postural tremor are similar to those affecting the alpha rhythm of the EEG cannot be answered from this study, but the subject merits further enquiry.

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