J. Neurol. Neurosurg. Psychiat., 1959, **22**, 33.

PHYSIOLOGICAL TREMOR IN CHILDREN

BY

JOHN MARSHALL

From the Academic Unit in Neurology, Institute of Neurology, Queen Square, London

A rhythmic tremor at about 10 c./sec. is a well-known feature of muscular contraction in healthy adults. In some subjects the amplitude of the tremor is such that it is discernible by the naked eye, while in others sensitive methods of recording are required for its detection. While studying this phenomenon Marshall and Walsh (1956) noticed that the tremor in six normal children was slower than that in adults. As this fact has important implications as to the mechanism of the tremor in both children and adults, a more extensive study of physiological tremor in children has been made and is reported here.

Material and Methods

The method which has been used to record the tremor measures acceleration rather than displacement and full details of the technique are given by Marshall and Walsh (1956). Essentially the method consists in the use of an accelerometer double diode valve (Mullard DDR 100) the anodes of which are deflected by acceleration in one plane. Movement of the valve upsets a bridge circuit, and the electrical output is fed through an Ediswan electroencephalographic amplifier to an ink writer. The valve is 9·5 cm. long and 3·3 cm. in diameter; it weighs only 65 g., and can be held comfortably in the palm of the hand.

The child sat in a chair grasping the valve in the palm of the right hand, the limb being maintained by the subject fully outstretched in the pronated position. The tremor recorded was, therefore, that imparted by the whole of the limb musculature and not by a single muscle group. Care was taken that the anodes of the valve were always in the same plane. The child was asked to keep the valve as steady as possible and the recording was then made. The age of the child was noted and in the majority of cases his height was also measured.

The frequency of the tremor was subsequently measured by laying a transparent cursor ruled off in seconds over the tracing and counting the number of waves in a second. Several samples in each record were measured, and difficulty was not encountered by runs of different wave frequencies being present in the records. At the time of making the measurement the observer was not aware of the age or height of the child.

Results

The tremor of 287 children with ages ranging from 2 to 16 years was recorded. The number of children in each age group is shown in Fig. 1. The children comprised a random group attending a Christmas party, and groups from a primary school. a secondary grammar school, and a boarding school. No selection of children was made except to ensure that each age group was adequately represented. It was immediately apparent that in general the tremor is slower in children than the 10 c./sec. seen in normal adults. When the frequency of the tremor is plotted against age it is found that the various frequencies are not evenly scattered throughout the age groups, rather there is a large number of children with tremor at a frequency of 5 or 6 c./sec. (Fig. 1). Children with tremor of this frequency are found in all age groups from 2 years up to 16 years, but the great majority are in the 2-9-year age groups. After 9 years an increasing proportion of children in each age group has a tremor of a higher frequency, until when 16 years is reached it is uncommon to find a frequency of 5 or 6 c./sec. Moreover, the number of children with a tremor of a frequency of 7 or 8 c./sec. is relatively small, suggesting that a fairly abrupt change is made from the 5 or 6 c./sec. rhythm to the adult rhythm of 10 c./sec. Comparing the mean tremor frequency in the 2-9-year age group with that of the 10-16 age group shows the difference to be highly significant ($P<0{\cdot}001$).

The relationship between age and frequency of tremor is revealed more clearly by plotting the mean frequency for each age group against age as in Fig. 2. This confirms that there is not a simple linear relationship between age and tremor frequency, but that the data can be fitted by two straight lines, one for the 2-9-year age groups and the other for the 10-16 age groups. The difference between the slopes of these two lines is highly significant ($P<0{\cdot}001$). A considerable number of random observations outside the present series indicates that certainly by the age of 18 years the

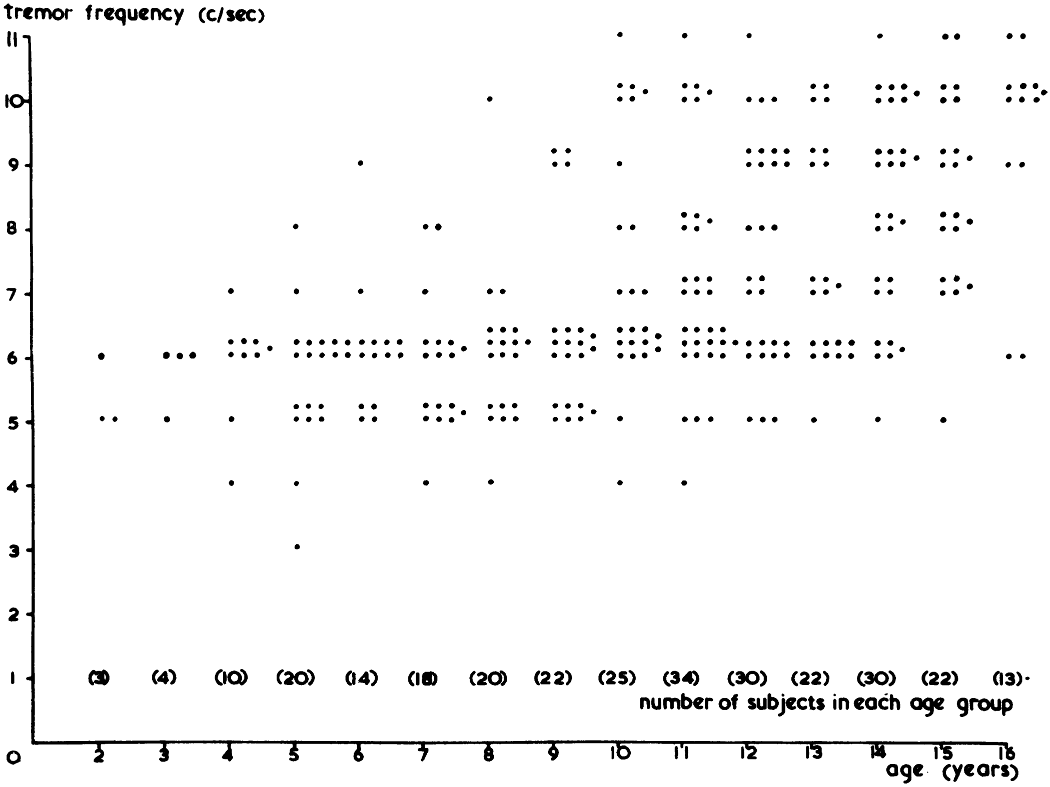

FIG. 1.—Graph showing the number of children with each tremor frequency in each age group.

adult rhythm of 10 c./sec. is established and is maintained throughout the remainder of a healthy life, hence the line if continued beyond the 16-year-old group would become parallel to the abscissa.

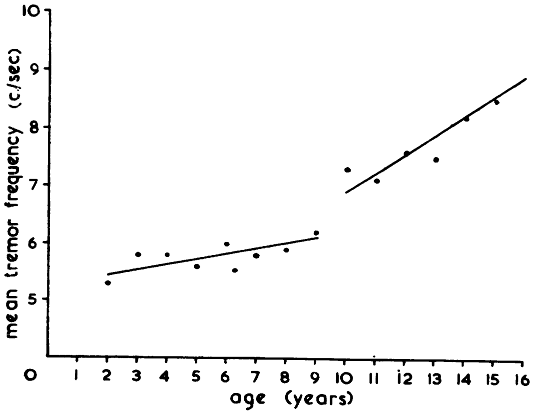

FIG. 2.—Graph showing the abrupt change in the mean tremor frequency for each age group which occurs about the age of 9 years.

The fact that the tremor frequency is not linearly related to age raises the question as to whether tremor frequency is more closely correlated with height than with age, for there is a considerable scatter of height in any age group. The height was therefore measured in 201 of the children over the age span of 5 to 16 years, and ranged from 41 to 73 inches. Plotting frequency against height reveals a less close correlation than between frequency and age. In three age groups (10, 13, and 14 years) the correlation coefficient between height and frequency was calculated and was not significant ($P<0 \cdot 1$).

Discussion

The interest of these observations is largely in the light they throw on the mechanism responsible for physiological tremor. The possibility that the weight of the valve, while trivial for an adult, was sufficient to influence the tremor in children, especially the smaller ones, can be immediately discounted. The valve weighed only 65 g. which is an insignificant weight even for a small child. Moreover, both Marshall and Walsh (1956) and Halliday and Redfearn (1956) have shown that loading a limb, while increasing the amplitude of the tremor, has no significant influence upon its frequency. The slower tremor in children was not, therefore, due to the relative weight of the valve.

Halliday and Redfearn (1956) suggested that the tremor in adults is due to oscillation round the " servo-loop " from muscle spindle to muscle. They produced evidence (Halliday and Redfearn, 1958) that physiological tremor was lost in some patients with tabes dorsalis in whom there was clinical evidence of interruption of the reflex arcs. It is hard to reconcile the present findings in children with this hypothesis. Conduction velocity in peripheral nerves is proportional to fibre diameter (Cragg and Thomas, 1957). Fibre diameter increases up to about the age of 6 years after which there is no appreciable change; hence it follows that conduction velocity is also stable after this age. As the neural pathways concerned in spinal reflexes increase in length during growth, the reflex time must also increase, and this, in fact, has been shown to occur (Wagman, 1954). Wagman used the latency of the " H reflex " as a measure of reflex time and found, for example, a reflex time of 17 m.sec. at the age of 6 years and one of 23 m.sec. at the age of 9 years. If, therefore, the physiological tremor were dependent on oscillation round the spinal reflex arc, the tremor should be faster in the shorter reflex arc of children than it is in the longer adult reflex arc. The reverse has, in fact, been shown to be the case, hence it is difficult to accept the view that physiological tremor is due to oscillation around the spinal reflex arc.

An alternative consideration is that the 5 or 6 c./sec. tremor found in children is not a slower version of the physiological tremor seen in adults, but is rather a separate phenomenon with its own neural mechanism. It may be that the tremor of childhood is suppressed or replaced by the adult tremor, and this hypothesis would accord with the observation that the distribution of tremor frequencies among the age groups undergoes a fairly abrupt change from the 5 or 6 c./sec. to the 10 c./sec. rhythm. In this regard it is worth pointing out that some pathological tremors have a frequency of about 5 or 6 c./sec. and become apparent as a result of neural structures being damaged by disease. It may be that the 5 or 6 c./sec. tremor of childhood is based on a more primitive neural mechanism, the activity of which is suppressed about the age of 9 years by the development of more adult neural mechanisms. The present evidence does not permit a definite answer to this question but it is clear that mechanisms other than a simple servo-loop must be involved in physiological tremor.

Summary

The tremor of the outstretched hand has been recorded in 287 children. The predominant frequency of the tremor up to the age of 9 years is about 6 c./sec., thereafter the frequency changes fairly abruptly, and by the age of 16 years most children have a tremor frequency of 10 c./sec. The significance of the observations in relation to the mechanism of physiological tremor is discussed.

I wish to thank Mrs. D. Joyce for the statistical analysis and Mr. J. I. MacNaughton for technical assistance.

References

Cragg, B. G., and Thomas, P. K. (1957). *J. Physiol. (Lond.)*, **136**, 606
Halliday, A. M., and Redfearn, J. W. T. (1956). *Ibid.*, **134**, 600.
——, —— (1958). *J. Neurol. Neurosurg. Psychiat.*, **21**, 101.
Marshall, J., and Walsh, E. G. (1956). *Ibid.*, **19**, 260.
Wagman, I. H. (1954). *J. Neurophysiol.*, **17**, 66.