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The One-Hertz Phenomenon

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The works of *Aggashyan* et al. [1] and *Mauritz and Dietz* [2] have shown that a modification of proprioceptive inputs from the legs leads to a modification in the control of tonic postural activity, which is particularly marked in the frequency band around 1 Hz. This information has been used to devise an experimental test seeking to analyze the effects of wearing safety shoes on the control of tonic postural activity. The experimental data show that what appears in the posturographic signal around 1 Hz is far from simple.

Materials and Method

Experimental Procedure. 100 healthy adult male subjects were recorded 4 times on a vertical forces platform in the following situations, tested in a random order: eyes closed and feet bare, twice ; eyes closed, wearing shoes, once; eyes open and feet bare, once. Each recording lasted 25.6 s during which the signal, sampled at 10 Hz, was digitalized and stored in a computer memory for subsequent processing.

Mathematical Processing. The mathematical processing of the statokinesimetric signal [3] was designed to produce the following for each recording: the mean position of the center of pressure, the root mean square, the surface of the statokinesigram, the length of the curve, the average speed and its standard deviation, the first 30 discrete values of the power spectrum between 0.04 and 1.20 Hz, by successive bands of 0.04 Hz.

Statistical Processing. The statistical processing has produced, in paired samples, a comparison of the 4 test situations taken 2 at a time. For each of the parameters the degree of significance was tested for the mean of the differences in relation to zero.

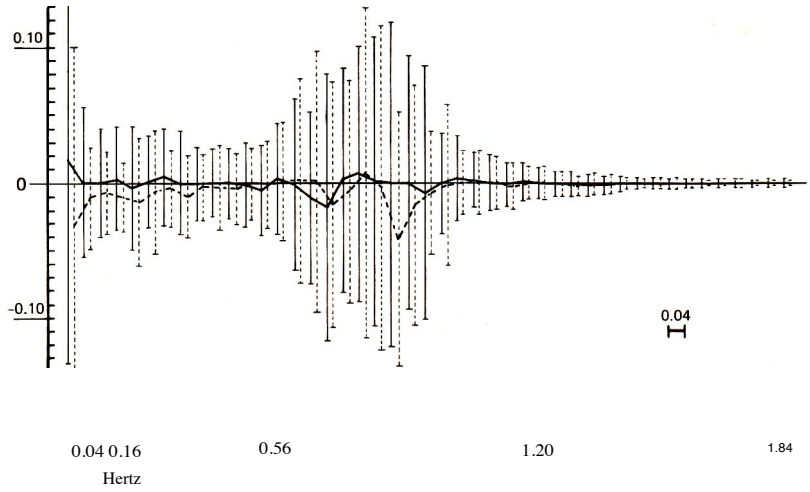

Fig. 1. Spectral difference: feet-bare/feet-shod situations. Each curve represents the mean and its standard deviation of the difference in the discrete values of the power spectrum of the left-right movements between: two identical situations (eyes cJosed, feet bare) - continuous line; two situations which differ only by the wearing of shoes - broken line. Around 1 Hz in each curve stationary random phenomena appear.

Results

The comparison of the two identical situations, eyes closed and feet bare, shows a mean of differences which is nil or practically nil for all the parameters The mean of the differences is also nil for the discrete values of the power spectrum, at least in the low frequencies, below 0.5 Hz (fig. 1). The phenomena studied showed a marked tendency to recur.

The wearing of safety shoes significantly modifies the control of tonic postural activity. The surface of the statokinesigram is reduced, as is the length of the curve and its speed. In conformity with the hypothesis derived from the works of *Aggashyan* et al. [1] and *Mauritz and Dietz [2],* the mean of the differences of the power spectrum is not nil in the frequency band around 1 Hz. The wearing of shoes reduces the energy expended on this frequency (fig. 1).

It looks as if all these results supported the starting hypothesis. But, in fact, opening the eyes modifies the control of tonie postural activity in exactly the same way as the wearing of shoes: the surface of the statokin-

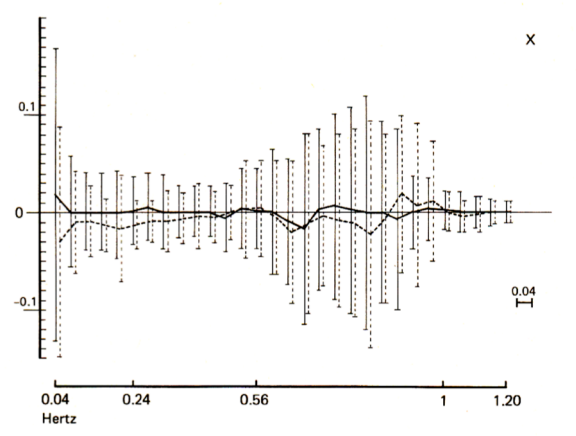

Fig. 2. Spectral difference: eyes-open/eyes-closed situations. Each curve represents the mean and its standard deviation of the difference in the discrete values of the power spectrum of the left-right movements between: two identical situations (eyes cJosed, feet bare) - continuous line ; two situations which differ only by the opening of the eyes - broken line. Around 1 Hz in each curve stationary random phenomena appear.

esigram, the length of the curve and its speed decrease in comparison with the eyes-closed situation. And the curves of spectral difference are below zero in exactly the same frequency bands: around 1 Hz and also under 0.5 Hz, whether the comparison is made between the situation eyes open and eyes closed (fig. 1 or between the situations feet bare and feet shod (fig. 2).

Discussion

The most remarkable result of these experiments is that the phenomena observed in the feet-shod situation are in no way specific. Opening the eyes or putting on shoes produce the same modifications in the control of tonic postural activity.

There is certainly something happening around 1 Hz, though the phenomenon observed does not result specifically from the feet afferents. What then is the significance of the one 1- Hz phenomenon?

Not only is it not specific, it is also arbitrary as can be seen from the two following factors: (1) It appears without any particular reason; even when the test conditions are identical the spectral difference curve fluctuates around 1 Hz (fig. 1,2). (2) The variance in the spectral difference is always very high in this frequency band, though the values of the power spectrum have already fallen by about 20 dB.

If we accept the simplifying hypothesis used by *Gurfinkel* **[4]** as a basis for his calculation in 1973, we must also accept that what is witnessed around 1 Hz corresponds essentially to muscular contractions provoked by disturbances of the balance. These muscular contractions, which contribute to the control of the position of the center of gravity, are not themselves controlled. They may share the arbitrary character of the disturbances which they counter and this is what was found in the course of these experiments.

In the statokinesimetric signal picked up by a vertical forces platform one may observe a stationary random phenomenon around 1 Hz. Is this phenomenon quite different from what was observed by others [1, 2]? Is it a coincidence that these two events occur in the same frequency band? That we cannot say, but what we do know is that there is something to think about.

References

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