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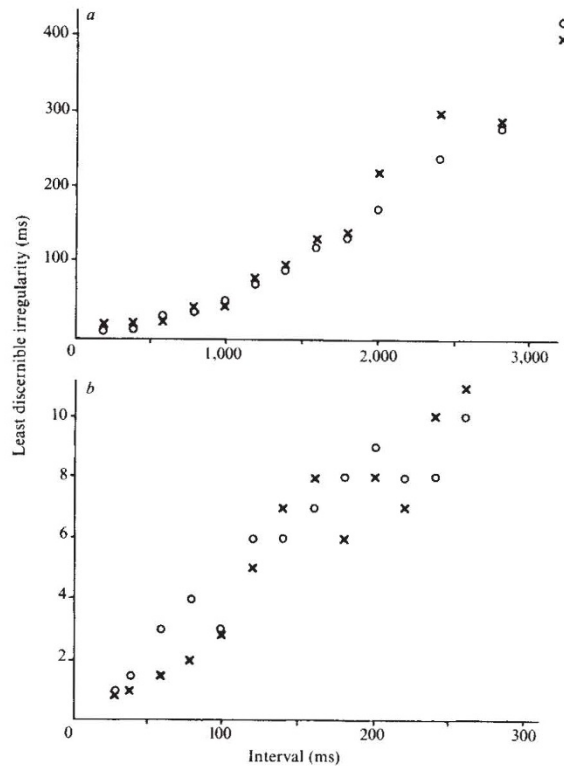


Fig. 1 The accuracy with which rhythm can be heard, or brief times assessed, plotted as least discernible deviation from regularity of a metronome, of which every fourth beat interval between beats. *a*, Intervals 260–3,200 ms; *b*, intervals 30–260 ms. Two runs are shown by the same operator on is controllably irregular, against overall tempo shown as different days. Considerable practice is needed to obtain results as consistent as these. ○, first run; ×, second run.

GENERAL

Time as heard in speech and music

THE time intervals of consequence in music range from about 50 ms, the fastest that notes may be separately fingered on the piano, to about 1 s, the tempo of slow largo. Poetry is customarily recited with beats every 600–800 ms, and the semi-isochronous stresses of speech rhythm are, according to Classe, of the order of 600 ms apart¹. We take pride in the accuracy with which we can produce and appreciate these intervals or deviate from them at will. That we require an auditory information storage of brief duration, briefer than that customarily named short-term memory, is known, Neisser calling it echoic memory²; but, as distinct from our other kinds of memory which memorise events in rank order of occurrence only, what our talent for music and speech shows is that in this brief storage we possess, with a working range of a second or so, a comprehension of those things we have just heard, arranged quite accurately in true time relationship.

This was explored by devising an electronic metronome in which every fourth beat was irregular by a controllable amount, the overall tempo or interval being also under control. It was set up connected to a loudspeaker in a studio with good listening conditions, and to a timer. The interval is first set to the required figure and the irregularity to zero, using the timer. The timer dial is then obscured, and the operator's task is to increase the irregularity himself until it becomes just evident to his ear. He may repeat until satisfied. Subdividing the intervals either overtly (by foot-tapping) or covertly (for which the operator's integrity must be relied on) is barred. This least discernible irregularity is then read from the timer.

A plot of two sequences of readings for various intervals obtained by the author after several weeks' practice is

shown in Fig. 1. Similar plots obtained by other operators indicate that the limit of discrimination is biologically imposed. The experiment is difficult to perform but the effect of practice is to improve the consistency of results, not the discrimination under test.

The form of the plot is striking. There are no periodicities as might be expected from cyclic brain timing mechanisms, suggested by Lenneberg³. In fact the approximately exponential shape indicates that the brain mechanism involved in timing partakes of the nature of a simple analogue device, possibly of a decay time or delay line type.

I suggest that the above named arrangement of events in true time relationship occurs within this mechanism, displayed as it were against an exponentially decaying scale of the 3 s or so preceding the present instant; and that this, being man's only such arrangement, provides, in effect, our sensation of time.

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