THE DYNAMICS OF AUDITORY MEMORY UNDER TENSION INDUCING CONDITIONS

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The retention of sounds of different pitch ranging from 700 to 2,000 Hz was investigated in previous study (1). We used the method of comparison of two stimuli following one another after an interval of 10, 20, 40, 80, 160 and 320 s. In various experiments the two compared sounds differed either in pitch, or in pitch and loudness. Retention did not change significantly at the intervals from 10 to 40 s. When the interval between stimuli reached 80 s, the number of errors rapidly increased. From the 80 s interval the longer the inter-stimulus interval the greater the number of errors. As shown in Fig. 1, similar results were obtained under three conditions: (i) the compared stimuli were equal in loudness and differed from each other only by one semitone (curve I); (ii) the stimuli differed from each other in pitch by two semitones and in intensity — the pattern stimulus was by 25 dB less intensive than the second stimulus (curve II); (iii) the pattern stimulus was by 25 dB more intensive (curve III).

The fact that similar results were found in three different experimental situations points to the importance of that particular time interval between compared stimuli in the memory process, and suggests that it is connected with two different physiological mechanisms. It is possible that we are dealing here with a "switch-over" from one kind of memory mechanism to another.

A verification of this hypothesis was undertaken in the reported experiment. We expected that the application of a tension-arousing factor in the break between the compared sounds would influence in the memory in a different way after an interval lasting up to 80 s than after
a longer time. As a tension arousing stimulus we used an electric shock.

The subjects were 26 students aged 20–27 (10 females in experimental group, 10 females and 6 males in the control group), who met the following requirements: (i) absence of any systematic musical education; (ii) ability to perceive the difference between two sounds presented immediately one after another and differing by two semitones. An electric shock was administered to the experimental group. The control group was not subjected to shock. Only female students were chosen for the experimental group on the assumption that the electric shock had on them a more tension-inducing effect than on males.

![Graph](image)

**Fig. 1. Distribution of errors as compared with the length of interval between the paired stimuli. For explanations see text. From Budohoska et al. (1).**

The experiment was conducted in a sound-proof room. Each subject was examined individually. The subjects were sitting at a distance of 1.5 m from a loudspeaker. The stimuli were pure sinusoidal tones of 60 dB intensity. Six tones: 784, 932, 1,109, 1,318, 1,568 and 1,865 Hz were used as pattern stimuli. The second stimulus in each pair (called test stimulus) was either identical with, or by two semitones higher or lower than the pattern one. Each tone sounded for 3 s. The inter-stimulus in-
tervals lasted 10, 20, 40, 80, 160 or 320 s. The subject was asked to say whether the second of the presented stimuli was identical, higher or lower than the first one. In order to eliminate traces of the sounds previously heard, a recording of poetry was played to the subject for about 2 min between each pair of stimuli. After every three quarters of an hour there was a 10-min break, during which the subject could leave the room and relax.

The experimental group was given an electric shock. Its voltage varied from 30 to 42 V, according to the individual’s sensibility. The subject was told in advance that such a shock would be administered in some trials with no relation to the correctness of the answer. Each shock lasted for 0.05 s and the intensity of the current was adjusted individually. The electrodes were fitted on the forearm. Eighteen electric shocks were administered to each subject in the course of 90 trials, at irregular intervals. The shocks were applied in each of the six quoted interval durations. Subjects were shocked always during the interval between the stimuli: 5 s after the pattern stimulus, in the middle of the interval, or 5 s before the test stimulus. Modifications in subjective tension were measured by GSR registered from the fingers. The resistance recorded after the instruction has been read to the subject, was adopted as the base line of measurements.

In the experimental group skin resistance was found to depart from the base line (75–350 kΩ) as a rule by 5 to 25%, following the application of electric shock, though in some cases much stronger responses were recorded (40–50%). We compared the distribution of errors in the 18 “shock” trials in the experimental group with the errors in the 72 shock-free trials in the same group (Fig. 2). The curves obtained in this way were quite similar. Independent comparisons of percentages of errors committed by subjects in shock and in shock-free trials at each interval showed that they differed statistically in no case (P > 0.01, Wilcoxon test, two-tailed). Apparently, increased tension (as recorded by GSR) was present during all the trials, which seems quite possible if we consider that the subject could never be sure in which trial he would be shocked. Thus we are entitled to combine all the trials and compare the overall results of the experimental group with those of the control group where identical stimuli were used under the same procedure, but without shock. The two sets of data are plotted in Fig. 3. It may be seen that in the control group (continuous line) there was a sudden increase in the number of errors at the interval lasting 80 s. This increase was statistically significant as shown by comparison of percentages of errors committed at 40 and 80 s intervals (P < 0.01, Wilcoxon test, two-tailed). Surprisingly the application of electric shock did not change the overall course of the
curve. The sudden rise in the number of errors between a 40 s interval and a 80 s interval was also observed in the experimental group (dotted line) \((P < 0.01, \text{ the same method})\). Nevertheless, in a heightened tension the memory was on the whole better than under other conditions. It was especially marked at the shorter inter-stimulus interval. Intergroup differences were statistically significant for the shorter intervals: 10, 20 and 40 s \((\chi^2 = 10.41; P < 0.01)\) and not significant for the longer intervals 80–320 s.

![Figure 2](image)

Fig. 2. Distribution of errors in judging tone pitch at different intervals between stimuli. Continuous line, trials without shock; dotted line, trials with shock.

The fact that a sudden increase in the number of errors was found in the present experiment as well as in the previous one (1) points to the importance of this particular time (between 40 and 80 s) in the remembering process for nonverbalized acoustic stimuli. Moreover these data support the views held by many authors that dynamic memory is not a homogeneous process and suggest that different mechanisms underlie the memory of simple sinusoidal tones over intervals from 10 to 40 s and from 80 s to about 5 min. This results from the fact that the adminis-
tration of electric shock improved retention only at inter-stimulus intervals of 10, 20 and 40 s.

Without taking for granted — for the time being — the question of differential memory mechanisms operating during the dynamic memory, we are confident that the series of experiments carried out in our Laboratory has demonstrated the validity and practical utility of an experimental model which enables us to trace the dynamics of retention at a crucial point in memory processes, i.e., during the period when one mechanism of memory disappears to give way to another.

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