OLFACTORY SENSITIVITY AT REST AND DURING SOUND STIMULATION

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Olfactory sensitivity depends on several factors. It can be influenced by training [5] and by the action of various drugs [4, 7].

The olfactory system has been studied comparatively little, owing to the difficult of controlling the olfactory stimulus.

The present article concerns olfactory sensitivity at rest and as affected by sound stimulation.

METHOD

An olfactometer of special construction was used, in which measured quantities of the odor could be introduced into a continuous air stream [1, 2, 3]. To study the effect of sound stimuli on smell sensitivity, pure tones from a sound generator, ZG-1, produced by the Gor'kovskii factory were used.

RESULTS

As a result of training, olfactory sensitivity increases by 2-3 micrometer divisions, and the threshold settles at a level characteristic of the subject. Sometimes variations of 0.01-0.02 mm in the threshold are observed, but usually, under constant conditions, no such alterations occur.

At the end of a working day, there is a small reduction in sensitivity. Elevation of the threshold usually amounts to 0.01-0.02 mm. Thus, for example, in the subject N., when smell sensitivity to meat odor was tested at 9 A.M., the threshold was 0.04 mm, while at 3.40 P.M. it was 0.05 mm.

In healthy persons, at the beginning of the investigation the threshold was higher than that established subsequently in the experiment. This phenomenon is particularly marked when the smell threshold for an odor is determined before the subject has been made familiar with it. Usually he does not perceive the odor when it is presented in a concentration 0.05-0.1 mm above threshold. Thus, subject N. (Fig. 1) during the tests failed to perceive an odor slightly above threshold (0.12 mm) at the first attempt. After a one-minute interval, he determined with certainty the appearance and disappearance of an odor of average strength (0.17 mm). Then gradually, the olfactometer was turned on at readings of 0.14, 0.12, and 0.1 mm, and each time the odor was perceived. At a micrometer reading of 0.09 mm there was no smell sensation, but after again presenting the smell at strength 0.10 mm, the subject was able to perceive it at a strength of 0.09 mm. There was a similar short period when there was no perception of the smell at a strength of 0.07 mm. At a micrometer reading of 0.05 mm, no sensation was evoked, and repeated stimulation likewise failed. The threshold in this particular case was 0.06 mm. The next threshold determination in this subject was started with an odor of moderate strength, which was accurately

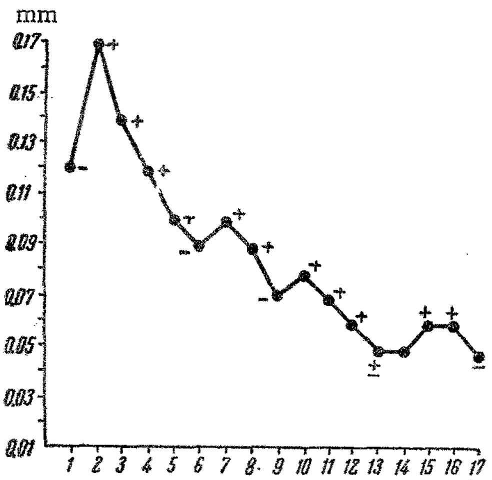

Fig. 1. Change in threshold sensitivity to an odor in the subject N. Ordinate – strength of odor of peppermint oil in relative units. Abscissa – first, second, third, etc. occasions on which odor was applied. (+) indicates subject perceives smell, (–) shows odor not perceived.

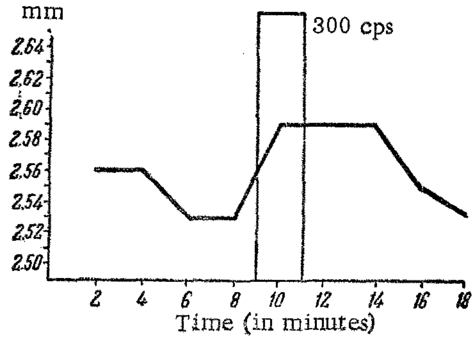

Fig. 2. Reduction in olfactory sensitivity to camphor after exposure to sound at 300 c/s. Ordinate – strength of smell in relative units. Abscissa – time of determination of threshold.

perceived, as was also an odor of strength 0.12 mm. Reducing the strength of the odor to 0.10, 0.07, 0.05, and 0.04 mm led each time to a short period during which the odor could not be perceived. The threshold was 0.03 mm.

The above example shows that at rest the olfactory threshold lies above the normal value for the subject. Therefore, when determining olfactory thresholds, it is essential to acquaint the subject with the odor beforehand.

It is known that the sensitivity of one sense organ is affected by stimuli acting on another [6]. To study the effect of sound stimulation on olfactory sensitivity, pure tones of frequencies 300, 1000, 4000, and 8000 c/s were used.

The olfactory sensitivity was determined 3 times: before applying the sound, during the sound stimulation, and finally, 3-4 times after the sound had ceased. The experiment lasted 20 minutes. Olfactory sensitivity was

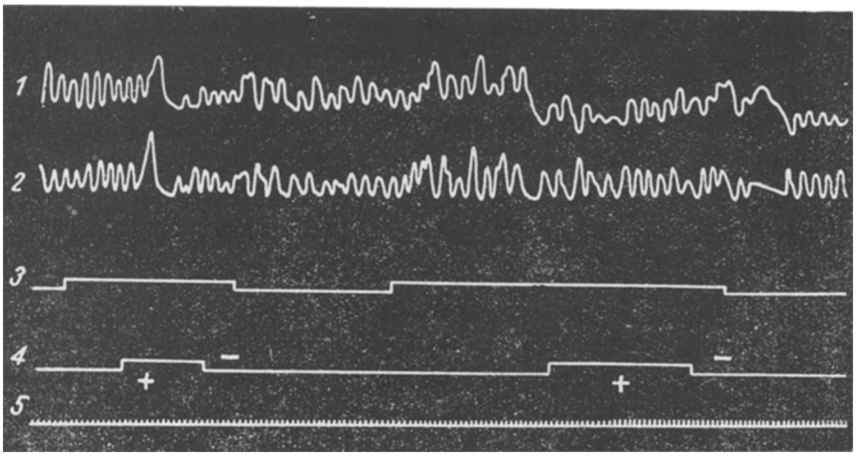

Fig. 3. Conditioned reflex adaptation to ammonia vapor odor. Curves, from above downwards: 1) thoracic respiration, 2) abdominal respiration, 3) mark indicating conditioned stimulus (sound), 4) marker indicating unconditioned stimulus (odor), 5) time marker (1 second), (+) – verbal response "it smells", (–) – verbal response "no smell".

measured every 2-3 minutes, in order to eliminate any effect due to adaptation. A more rapid method of determining smell thresholds was used: the concentrations of the vapor in the air stream were gradually raised, beginning with subthreshold concentrations. Subjects in whom olfactory sensitivity was reduced by subthreshold stimuli were excluded from the experiments. The effect of pure tones on olfactory sensitivity to odors of camphor, ionone, peppermint oil and oil of cloves was determined.

Sensitivity to vapors of camphor and ionone following auditory stimulation at a frequency of 300 c/s was reduced in almost all cases. Reduction of the sensitivity was greatest directly after the end of the sound, and usually remained lowered until the end of the experiment. There was no change in sensitivity during the exposure to the sound.

Sound stimulation at 300 c/s raised the sensitivity to peppermint oil and oil of cloves, the greatest increase in most experiments being reached 4-6 minutes after the end of the auditory stimulus, and in some cases at the end of the experiment. The increased sensitivity to these two oils also occurred during exposure to the sound.

Thus, under the influence of a single sound of one frequency, smell sensitivity to some substances is increased, while to others it is reduced (Fig. 2).

The effect of different stimuli on olfactory sensitivity has been little studied, and the present classification of odors has been constructed on the basis of subjective experience; the above experiment with sound establishes a new principle in the physiological classification of odors based on the quantitative interaction of sense organs.

After sounds of frequencies 1000, 4000, and 8000 c/s, the olfactory sensitivity to camphor was increased. That to ionone was increased only after sounds of 4000 and 8000 c/s.

According to the extent of the olfactory sensitivity change due to the sound stimulation, it should be possible to make a more precise classification of odors and to arrange the substances in order according to the extent of the change.

At each of the frequencies 300, 1000, 4000, and 8000 c/s, the sensitivity to both clove and peppermint oils was increased. This may be because these ethereal oils are of vegetable origin and consist of several components which include a variety of odors.

Changes in olfactory sensitivity may also form the basis of conditioned reflexes. The conditioned reflex effect of sound was established in connection with the odor of ammonia solution, which is primarily a stimulus acting on the trigeminal nerve. If switching on the sound is accompanied by the odor of ammonia, then a relationship may be observed between the perception of the odor and the application of sound stimulus. With each coincidence of the sound and the odor, the latent period becomes shorter, and when there is a small lag of 4-5 seconds, the latent period becomes further reduced. The reduction of the latent period is a conditioned reflex phenomenon, since it develops as a result of the coincidence of the conditioned and the unconditioned stimulus. If the two stimuli do not coincide, the shortening of the latent period is slower and less well shown. This effect was observed in numerous investigations of the olfactory threshold, in which more than 300 measurements were made.

Under certain conditions, not only may a shortening of the latent period be observed, but an increase in length may occur. This increase may be observed after a long pause during which neither conditioned nor unconditioned stimuli are applied.

If after a series of coincidence of sound and ammonia odor, the application of the sound is reinforced by giving ammonia after an interval of 30-40 seconds, then a considerable increase in the latent period occurs. Thus, for instance, in Test No. 38-3, when the delay was made equal to 35 seconds, the latent period had a value of 18 seconds, whereas when the two stimuli were given together, or after a short interval, the latent period was 5 seconds (Fig. 3). When the latent period increased, the subject noted that the smell became weaker and scarcely noticeable. This increase in latent period must be regarded as a conditioned reflex effect of the sound on adaptation because the effect of odors is to cause an adaptation and to reduce sensitivity. After a number of coincidences, the sound becomes a conditioned stimulus which alters olfactory sensitivity. This action of the sound may occur when there is a time lag between the stimuli, and is shown both by an increase in the latent period and a reduction in the strength of the odor.

SUMMARY

Olfactory tests at rest demonstrated the following: 1) with repeated tests there was a training effect, and sensitivity rose, 2) towards the end of the day, olfactory sensitivity was reduced, 3) when a single test only is given,

the olfactory threshold is very much higher. The olfactory sensitivity to the odor of peppermint and clove oils is increased by sound at 300 c/s, while the sensitivity to camphor and ionone is decreased. The author suggests a classification of odors to be based on the effect of sound on olfactory sensitivity. A conditional reflex decrease in the sensitivity to the odor of ammonium hydroxide was found to be produced by sound stimulation.

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