The upper plate could be moved between two stops. At the extreme left-hand stop the washing bottle with the odorant was connected to the tube leading to the mixing bottle. At the extreme right-hand stop pure air was led to the mixing bottle. A powerful electrodynamic driving unit moved the upper plate between the two stops, completing one full cycle per second. When the stopping times at the two extreme positions were equal the amount of air mixed with odor entering the mixing bottle was half as much as when the electrodynamic driver pushed the upper Teflon sheet to a stationary position at the left side. Thus by adjusting the duty cycle, during which the electrodynamic driver was activated and the upper plate pushed to the right side, it was possible in a very short time to control the gas mixture in the mixing bottle quantitatively. By means of movements on a dial a simple pulse generator controlled the duty cycle of the electric current fed by a transistorized amplifier to the electrodynamic driving system. The mixing bottle was made large enough to mix the two gases, so that no sensation of fluxion was present.

To present the odors in a well-defined time pattern, the apparatus in Fig. 3 was used. The air from the mixing bottle was now led to the lower Teflon plate, which had a second opening into which pure air was led from a washing bottle. Again, an electromagnetic driving unit could move a plastic tube from the opening with the pure air to an opening with the odor. Since the driving unit was powerful and the friction between the Teflon plates small, the switching time from one opening to the other was quite small. A plastic tube led directly to the nostril, and it was fixed in position by means of a rubber band round the head.

For the localization experiment, two similar sets of the apparatus described in Figs. 2 and 3 were built for the

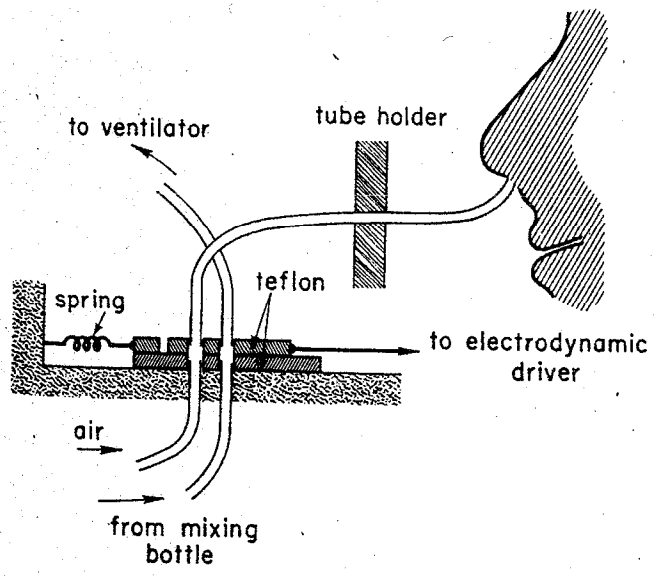

FIG. 3. Valve made from Teflon plates used to produce olfactory stimuli. An electrodynamic driving system with large power reduced the operating time of the valve to a minimum.

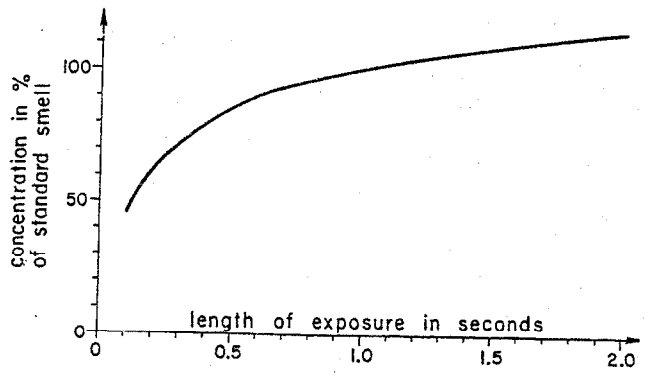

FIG. 4. Increase in olfactory sensation magnitude as a function of duration of the stimulus.

two nostrils. The gas flow was controlled by measuring the bubbles coming from the tubes when the end of the tube was put under water. There was no change in gas flow during the switching of the electromagnetic drivers. A pulse generator made it possible to produce a time delay between the switchings of the two driving units, which could be adjusted on a dial in 0.1-msec steps. For the observation of localization, only the time delay between the stimuli on the two sides is critical and not the absolute switching time of the switch.

In adjusting the apparatus the first step was to match the concentrations on the two sides so that, for a given presentation time, the smell was equally strong when the two stimuli were presented, each to its separate side, one after the other. Such an adjustment is always necessary, since one cannot be sure that the airflow is the same in the two nostrils. After this adjustment the time delay between the two sides was adjusted so that the odor sensation appeared midway between the two nostrils. This time delay was taken as the zero point. All the observations were taken from this point by increasing or decreasing the time delay relative to one side. To avoid any disturbance by noise, ear muffs were used. No vibrations were transmitted to the tubes leading to the nose. In all the experiments emphasis was on the investigations of the phenomena as such.

ONSET TIME OF OLFACTORY SENSATION

From electrophysiology it is known that the presentation of an olfactory stimulus produces nervous discharges within a short time. The number of the discharges decreases with time, showing adaptation (3, 5), but the sensation magnitude of the smell has quite a long onset time. It can increase with time for a constant stimulus for several seconds. In this respect it is correct to say that smelling is a slow process.

To measure the onset time of the sensation magnitude to each side, two stimuli of the same duration were presented, one after the other, and adjusted to equal sensation magnitude. After preliminary adjustment the duration of the stimulus on one side was decreased, as shown on the abscissa of Fig. 4. The stimulus on the other side, which was of constant duration, was adjusted to inten-