Trigeminal Chemoreceptors Cannot Discriminate between Equally Intense Odorants[a]

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Both electrophysiological[1] and psychophysical[2] evidence have demonstrated that trigeminal receptors in the nasal cavity respond to odorants. These free nerve endings constitute part of the "common chemical sense," whose major function is often purported to be the protection of the organism from noxious chemicals.[3] Despite these demonstrations of trigeminal chemoreception, it is not clear whether trigeminal receptors can discriminate between odorants matched for equal intensity. The present electrophysiological and behavioral experiments using tiger salamanders were designed to address this issue.

In electrophysiological experiments, integrated multiunit activity was recorded from the ophthalmic branch of the trigeminal nerve. Concentration-response curves were obtained for each of four odorants (amyl acetate [AA], cyclohexanone [CH], butanol [BU], and *d*-limonene [LI]) delivered to the nose via an air dilution olfactometer (also used in the behavioral experiments). The concentration of each compound necessary to produce an equivalent response (150% of a CH standard, $\approx$ 1,100 ppm) was then used as the background (cross-adapting) stimulus in cross-adaptation experiments pairing CH and AA or LI and BU.

A cross-adapting stream of one odorant severely reduced responsiveness to both itself and its partner (FIG. 1). At concentrations below background, responding was eliminated. Only concentrations above background increased neural activity above baseline.

For behavioral experiments, salamanders were trained to avoid AA (or LI) but not to respond to CH (or BU). In tests subsequent to concentration-response trials, both groups discriminated between odorant pairs that were matched for equal intensity, that is, concentrations that elicited 80% avoidance.

The animals were then given bilateral olfactory nerve cuts. After lesioning, higher concentrations ($\approx$ 1 log unit) were necessary to elicit 80% avoidance. In addition,

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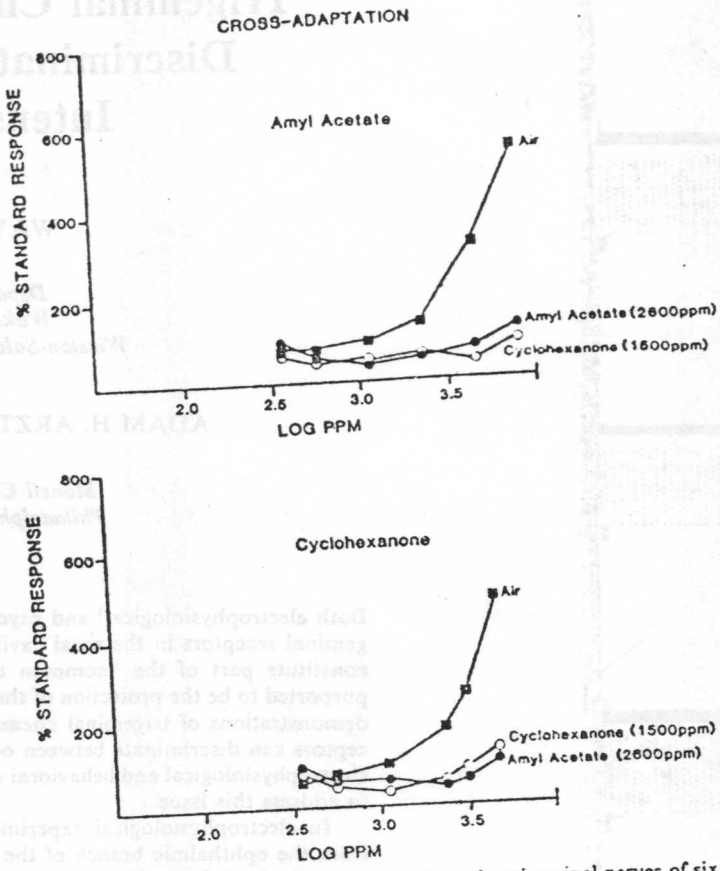

FIGURE 1. Mean integrated multiunit responses from the trigeminal nerves of six salamanders to increasing concentrations of AA and CH. Response magnitude is presented as a percent of the response to the standard stimulus, ≈1,100 ppm CH. Stimuli were presented against a background of either air, AA, or CH. The background concentrations of AA (≈2,600 ppm) and CH (≈1,500 ppm) elicited responses of equal magnitude as determined in earlier tests.

salamanders with severed olfactory nerves could no longer discriminate between odorants matched for equal intensity (concentrations that elicited either 80% or 90% avoidance) (FIG. 2).

On the basis of these electrophysiological and behavioral results, we conclude that trigeminal chemoreceptors are unable to discriminate between odorants matched for equal intensity. At least for the odorants used here, trigeminal chemoreceptors discriminate odorant quantity, not quality. We propose that qualitatively, all odorants are the same for the trigeminal system and speculate that the mechanism of stimulation is similar for all odorants.

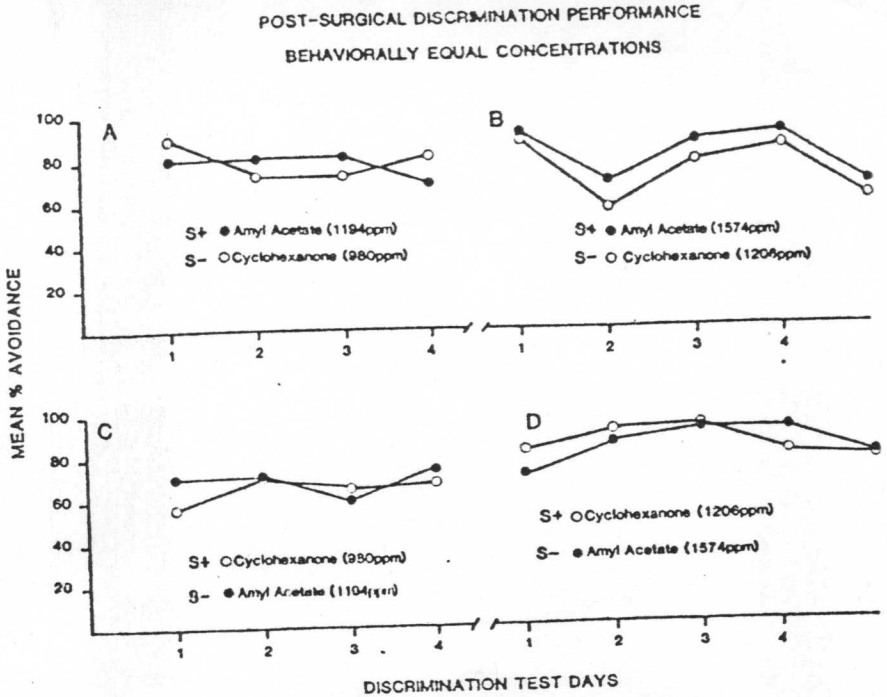

FIGURE 2. Postsurgical discrimination between AA and CH. Odorant concentrations were "equal," in that they elicited 80% avoidance (top panels) or 90% avoidance (bottom panels) during concentration-response tests.

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