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Effects of stimulus duration and stimulus intensity level on recovery times for lingual vibrotactile threshold shift

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The time required for lingual vibrotactile thresholds of normal young adults to return to baseline levels of sensitivity was determined following presentations of a 250-Hz stimulus for durations of 5 and 15 sec at eight different intensity levels. Results indicated that stimulus duration and stimulus intensity levels significantly affected threshold recovery time. Longer recovery times were noted for stimuli of greater duration and intensity.

Increases in lingual vibrotactile thresholds of sensitivity have been reported to occur following suprathreshold stimulation (Fucci, Curtis, & McCaffrey, 1975; Telage & Gorman, 1986). Particularly, increased thresholds have been documented during lingual vibrotactile magnitude-estimation scaling tasks, with the amount of threshold shift being directly related to the intensity of the suprathreshold stimulus applied to the tongue (Fucci, Petrosino, Harris, Randolph-Tyler, & Wagner, 1989; Fucci, Petrosino, Schuster, & Randolph, 1991; Fucci, Petrosino, Schuster, & Wagner, 1990; Fucci, Petrosino, & Wagner, 1989). This phenomenon occurs in normal subjects independent of gender or age (Fucci et al., 1991).

A more complete understanding of the adaptation characteristics of the lingual tactile system requires information not only about threshold shift, but also about the actual time required for the system to return to baseline levels of sensitivity following threshold shift. The purpose of the present study was to determine the effects of stimulus duration and stimulus intensity on the time required for lingual vibrotactile thresholds of normal young adults to return to baseline levels of sensitivity following threshold shift.

METHOD

Subjects

A single group of 30 subjects participated in this study. The subjects ranged in age from 18 to 24 years (M = 20 years). All subjects had normal speech and hearing and reported no medical or physical conditions that could interfere with test results. None of the subjects had prior experience with vibrotactile testing procedures.

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Apparatus

The vibrotactile stimulus control unit included a sine-wave generator, an experimenter-controlled variable attenuator, a rise/fall gate, two universal timers, an audio amplifier, a power amplifier, and an electromagnetic minivibrator with a probe-contactor extension. The pulsed vibratory signal generated had a frequency of 250 Hz, a 50% duty cycle (on 500 msec and off 500 msec), and a rise/fall time of 50 msec. The vibrotactile measurement unit included an accelerometer, a cathode follower, a microphone amplifier, and a voltmeter. The auditory masking unit consisted of a masking generator and TDH-49P headphones. It was used to present a narrow band of noise centered around 250 Hz at 70 dB HL bilaterally. A detailed description of the vibrotactile equipment and procedures can be found in a review by Harris, Fucci, Petrosino, and Wallace (1986).

Procedure

Each subject was tested individually. The subject was seated in an adjustable chair and positioned so that the tongue could be placed against the bottom of a rigidly mounted disk. A hole in the center of the disk provided access for the probe contactor extension of the vibrator to the anterior midline section of the dorsum of the tongue.

An ascending method of limits was used to establish each subject's baseline lingual vibrotactile threshold of sensitivity. These obtained thresholds were necessary so that the intensity levels used in this study could be set in reference to each subject's threshold of sensitivity. They were also necessary for determination of the return to baseline from threshold shift following presentation of the experimental stimuli.

The experimental stimuli consisted of a 250-Hz signal presented for durations of 5 or 15 sec at the intensity levels of 6, 10, 16, 20, 26, 30, 36, and 40 dB SL. Half of the subjects received the 5-sec duration of the eight intensity levels first, and half of the subjects received the 15-sec duration of the eight intensity levels first. As a further control for any order effect, the intensity levels for each duration were presented to the subject in a randomized fashion.

Immediately following the presentation of each stimulus item, the subject was instructed to remove his/her tongue from the plastic disk. After 30 sec, the subject was instructed to place his/her tongue back into test position for a threshold check. The threshold check involved a 1-sec 250-Hz stimulus presentation at the subject's predetermined baseline threshold level. The subject was instructed to raise a hand if he/she felt the stimulus. If the subject did not indicate that the baseline threshold stimulus was felt at the initial 30-sec threshold check, ensuing checks were made at 30-sec intervals until the subject did indicate that the signal was felt at baseline threshold level.

RESULTS AND DISCUSSION

As can be seen in Figure 1, the time required for thresholds to return to baseline levels increased as stimulus duration or stimulus intensity was increased. A two-factor multivariate repeated measures analysis revealed a nonsignificant interaction effect ($p \geq .01$) and significant main effects for stimulus duration ($p \leq .01$) and stimulus intensity ($p \leq .01$).

The findings of this study have several implications. First, they add to our overall knowledge of how the lingual tactile sensory system adapts to vibratory stimuli of varying durations and intensities. Second, they allow experimenters to predict the time needed for lingual threshold shift recovery after each stimulus presentation. Third, they provide a normative baseline for comparisons of recovery times obtained from individuals with various kinds of communication handicaps. Finally, the findings of this study contribute to the overall goal of developing appropriate procedures for allowing lingual vibrotactile testing to become a viable part of routine clinical diagnostic procedures.

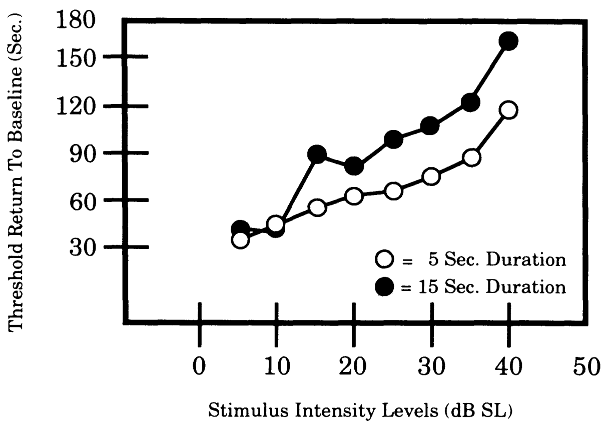

Figure 1. Time required for lingual vibrotactile thresholds to return to baseline levels as a result of increases in stimulus duration and suprathreshold stimulus intensity levels.

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