

# An investigation of sensory deficits underlying the aphasia-like behavior of macaques with auditory cortex lesions

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Received 8 January 2001; accepted 8 February 2001

Bilateral auditory cortex lesions in Japanese macaques result in an aphasia-like deficit in which the animals are unable to discriminate two forms of their coo vocalizations. To determine whether this deficit is sensory in nature, two monkeys with bilateral lesions were tested for their ability to discriminate frequency and frequency change. The results indicated that although the animals were able to discriminate between

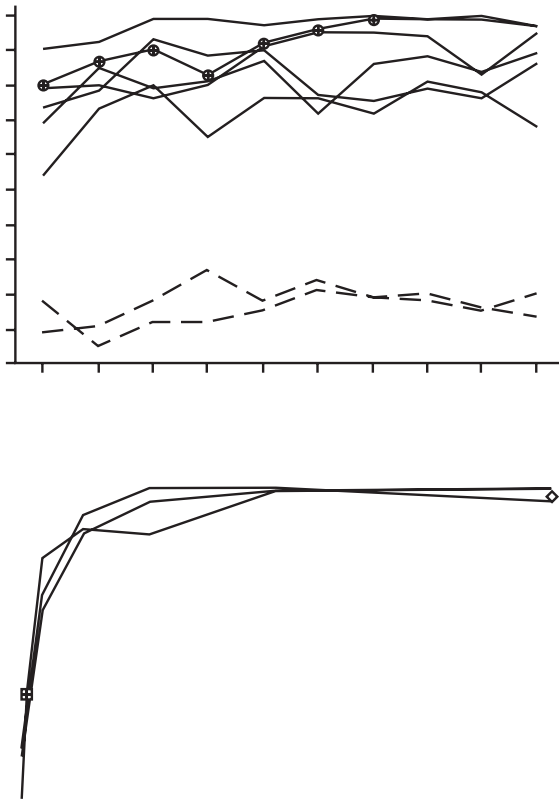
istered halothane via endotracheal cannula. The lesions, aimed at removing the posterior 3/4 of the superior temporal gyrus, were made under aseptic conditions by subpial aspiration with the aid of a surgical microscope. Following surgery the animal was given acepromazine and butorphanol as necessary to reduce discomfort. For comparison, two normal animals and four animals with unilateral lesions of the superior temporal gyrus were tested. Because the performance of unilateral animals did not differ from that of normal animals when stimuli were presented via a loudspeaker (thus reaching both ears), these animals were combined into a single comparison group. The animals were given a variety of auditory tests, some of which are described here.

Behavioral testing involved the use of a conditioned suppression/avoidance procedure [12]. For the discrimina-

in this and closely related macaque species [10,11] the lesion included core, belt and parabelt auditory fields. This was substantiated by the severe degeneration and shrinkage throughout the medial geniculate bilaterally [15]. Similar lesions were made in the second bilateral animal and the four unilateral animals, which are currently undergoing additional behavioral tests.

Coo discrimination: The animals were first tested for their ability to discriminate eight SLH coos from seven SEH coos, the same vocalizations previously used to demonstrate the aphasia-like deficit [3,4]. The results indicated that the animals with bilateral lesions were completely unable to discriminate the coos while the comparison animals performed the task easily (Fig. 3a). Because there was no sign of recovery during the 3 years since surgery, it appears that this deficit is permanent.

Pure tone thresholds: Bilateral auditory cortex lesions



performance) was 7.5 Hz for the comparison animals and 27.5 Hz for the animals with bilateral lesions. These results indicate a moderate elevation of difference limens after bilateral lesions. However, this change in threshold is not sufficient to account for the inability to distinguish the coo vocalizations because the frequency change in the coos ranged from 50 to 450 Hz, well above the elevated thresholds of the animals with bilateral lesions.

Steady tone vs frequency sweep: Because the coos have been characterized as frequency sweeps, thresholds were obtained for discriminating a 625 Hz tone from descending frequency sweeps that began at a higher frequency and ended at 625 Hz. As in a previous test, the stimuli were 300 ms in duration. Figure 3c shows that the average frequency difference limen (i.e. the frequency excursion

yielding a 0.50 level of performance) was 7.8 Hz for the comparison animals and 18.5 Hz for the animals with bilateral lesions. Similar thresholds (not illustrated) were found when ascending frequency sweeps (beginning at 625 Hz) and were substituted for the descending frequency sweeps.

Although the results of this test appeared to indicate that the animals with bilateral lesions could discriminate steady tones from tones that were changing in frequency, the test itself was not conclusive. Specifically, it was possible that they were performing the discrimination on the basis of absolute frequency cues (because the warning stimuli contained frequencies not present in the safe stimuli) rather than on the basis of whether the sounds were steady or changing in frequency. The final test was designed to examine that possibility.

Multiple steady tones vs descending frequency sweeps: