AUDITORY ACTIVATION OF VISUAL CORTEX IN EARLY ENUCLEATED RATS.

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Introduction- A number of studies have shown that human subjects who have lost one sensory modality early in life show supra-normal performance in their residual modalities (Lessard, et al, 1998). One suggestion that has been advanced to explain this behaviour is that these modalities take over the deafferented cortex and the increase in brain matter is at least in part responsible for this superior performance (Leclerc et al, 2000; Cohen et al, 1997). In the rat, Yaka et al., (1999), recorded auditory responses in early enucleated cats in two extra-striate visual areas and in V1, although the number of cells and the quality of the responses were rather limited in this area. This lack of robust cross-modal activation in V1 is somewhat surprising given the imaging results in humans and those obtained at the anatomical level described above. The aim of the present study, therefore, was to determine whether cells in the visual cortex of early enucleated rats respond to auditory stimulation.
Materials and methods- Bilateral enucleation was performed in neonatal (P2-P3) anaesthetized Long Evans rats. Extra-cellular recordings were carried out in the cortex of anaesthetized (110 mg/kg ketamine and 25mg/kg xylazine) adults (6-8 months old). A craniotomy was performed over the left visual and auditory cortices (A: -2 to –9, L: 0 to 7) leaving the dura intact. Spikes were isolated from background noise by an on-line time-amplitude discriminator. Recording sessions were conducted within a sound attenuation chamber with its inner walls covered with sound-damping foam to reduce echoes. Electrostatic speakers (TDT, model ES1) were situated on a semicircular vertical perimeter which could be rotated around the animal at a distance of 57cm from the nodal point of the head. Broad-band noise stimuli, generated using a calibrated TDT sound system, (60 dB SPL, duration: 90 ms, rise/fall: 5 ms; presentation rate: 0.5 Hz) were presented in free-field to the contralateral ear on the horizontal plane 90º in azimuth.
Results- Electrophysiological data were collected from 74 penetrations (178 cells) in the visual cortex of four bilaterally enucleated rats. A substantial proportion (39.3%) of these cells were activated by auditory stimulation. The responses of these cells were robust but their latencies were generally longer than those encountered in the auditory cortex. All cells recorded (n = 30 cells) in the auditory cortex (Au1 and Au2) were activated by noise bursts.
Discussion- These results clearly indicate that cross-modal reorganization occurs when one of the modalities is eliminated early in life. This confirms the electrophysiological and imaging studies carried out in humans. A number of mechanisms have been proposed through which this can occur. One is the rerouting of afferents as they proceed from the periphery to cortex. However, the longer latencies observed in the latter areas as compared to Au1 and Au2 also suggest that a more indirect route might be operating. This may involve the stabilization of normally transitory connections from auditory to visual cortex or increased activation of complex loops involving auditory cortex, higher order polymodal areas and feedback inputs from these to visual areas (Cohen et al. 1997).