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Auditory processes in communication and the effect of hearing loss on the brain connectome

ANDREJ KRAL
Institute of AudioNeurotechnology & Dept. of Experimental Otology, ENT Clinics, Hannover Medical School, Hannover, Germany

Loss of top-down interactions in congenital deafness

Background: Congenital deafness affects the functional and anatomical properties of the auditory system (Kral et al., 2019, Ann Rev Neurosci). Recently, it has been suggested that congenital deafness affects predominantly corticocortical functional connections within but also beyond the auditory system (the connectome model of deafness, Kral et al., 2016, Lancet Neurol). This may lead to increased risk of cognitive deficits in deaf children (ibid.). Indeed, so-called induced responses, indicative of corticocortical interactions, were shown to be reduced in the auditory cortex of congenitally deaf cats (Yusuf et al., 2017, Brain). In the present study we directly investigated effective connectivity between primary and secondary areas of congenitally deaf cats (CDC).

Materials and Methods: In adult hearing cats (HC) and CDCs, responses to acoustic and electric stimulation (through a cochlear implant) were compared. Recordings were in the primary auditory field (A1) and the higher order posterior auditory field (PAF) using multielectrode arrays. Penetrations were histologically reconstructed in sections staind with Nissl and SMI-32 and recording positions were assigned to cortical layers. Analyzed were local field potentials. For effective connectivity pairwise phase consistency, weighted phase-lag index and nonparametric Granger causality were determined and compared.

Results: CDCs demonstrated a substantially reduced stimulus-related corticocortical coupling in the connectivity measures used; synchronization was replaced by desynchronization. Largest deficits were observed in sensory-related top-down interactions, in the alpha and beta band.

Discussion and conclusion: The data document that corticocortical interactions are dependent on developmental hearing experience. In absence of hearing the effective connectivity reorganizes. Auditory stimuli instead of increasing the interactions between auditory fields actually desynchronize them. This suggests that the congenitally deaf brain has difficulties in incorporating top-down information into auditory processing. The congenitally deaf brain has thus difficulties in involving context and auditory object representation into processing of acoustic features.

Host:

GABRIELE RUSSO
Department of Neurophysiology, Faculty of Medicine, Ruhr University Bochum

Guests are welcome!

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