

Cross-modal plasticity in the auditory cortex of pre- and postlingual deaf patients

Published: 20-06-2013

Last updated: 24-04-2024

The main objective of the fMRI experiment is to examine differences in the amount of visually evoked activation of the auditory cortex between hearing and deafened adults and between pre- and postlingually deafened adults. The main objective of the...

Ethical review	Approved WMO
Status	Recruitment stopped
Health condition type	Ear and labyrinthine disorders congenital
Study type	Observational non invasive

Summary

ID

NL-OMON47655

Source

ToetsingOnline

Brief title

Cross-modal brain plasticity in deaf patients

Condition

- Ear and labyrinthine disorders congenital
- Hearing disorders

Synonym

Deafness, hearing impairment

Research involving

Human

Sponsors and support

Primary sponsor: Universitair Medisch Centrum Utrecht

Source(s) of monetary or material Support: Ministerie van OC&W

Intervention

Keyword: Auditory, Brain, Deaf, Plasticity

Outcome measures

Primary outcome

The main study parameter of the fMRI experiment is the difference in Blood Oxygenation Level Dependent (BOLD) signal changes in the auditory cortex in response to visual stimuli between deaf adults and hearing controls.

The main study parameter of the memory experiment is the difference in percent correct scores in spatial and temporal memory tasks between hearing and deaf adults.

Secondary outcome

The secondary parameters of the fMRI experiment are the locations and spatial organization of visually evoked Blood Oxygenation Level Dependent (BOLD) signal changes in the auditory cortex in deaf adults and the difference in BOLD signal changes in the auditory cortex in response to visual stimuli between pre- and postlingually deaf adults.

The secondary parameter of the memory experiment is the difference in percent correct scores in spatial and temporal memory tasks between pre- and postlingual deaf adults.

Study description

Background summary

In two proposed experiments we investigate neural and cognitive changes that are caused by deafness. First, we will perform an fMRI experiment to study the neural activation in response to visual cues in adults that became deaf in early childhood (prelingually deaf), adults that became deaf at a later age (postlingually deaf) and hearing controls. Previous studies found activity in the auditory brain regions of deafened subjects in response to visual stimulation (Finney et al., 2001; Sadato et al., 2004). This indicates that when the auditory cortex is deprived from its original input a functional neuronal reorganization can occur, such that the auditory cortex is sensitive to new sensory modalities like vision. This capacity to reorganize and respond to new modalities is called cross-modal plasticity. In cochlear implant (CI) users, whose hearing is partially restored by the implant, cross-modal plasticity can negatively influence speech perception, especially in prelingually deaf patients (Kral & Sharma, 2012). In this fMRI experiment we will investigate which neural regions become active when subjects look at visual stimuli. Since cross-modal reorganization is thought to take place mainly between the age of 3.5 and 7 years (Kral & Sharma, 2012), we expect that the amount of visually evoked activation in the auditory cortex is highest in the prelingually deaf, lower in the postlingually deaf and almost absent in the hearing controls.

Second, we will perform a spatial and temporal memory experiment in which participants have to relocate objects on a computer screen, to examine the effects of cross-modal plasticity at the cognitive level. Deafened persons rely more on the visual sense than hearing persons (Arnold & Murray, 1998), and are therefore hypothesized to perform better at spatial tasks. However, for the temporal tasks we expect the deafened persons to perform worse than the hearing controls, as hearing is essentially based on temporal processing, and thereby temporal processing skills may at least partially depend on the auditory system (Conway & Christiansen, 2005; Conway et al., 2009). The postlingually deaf are expected to perform between prelingually deaf and normal hearing.

By comparing the neural and cognitive data we will examine to what extent cognitive outcomes are related to the amount of reorganization of the brain. This study might therefore contribute to a better understanding of the plasticity of the auditory cortex after deafness, which might contribute to refinement of therapy with use of CIs, specifically for the prelingually deaf CI users.

Study objective

The main objective of the fMRI experiment is to examine differences in the amount of visually evoked activation of the auditory cortex between hearing and deafened adults and between pre- and postlingually deafened adults.

The main objective of the memory experiment is to examine performance

differences in spatial and temporal memory tasks between hearing and deafened adults and between pre- and postlingual deafened adults.

Study design

This is an observational study performed at the University Medical Center (UMC) Utrecht, consisting of two experiments.

In the fMRI experiment, functional images of brain activity will be generated with a 7 Tesla MRI scanner. Deafened and hearing subjects will participate in a visual experiment, in which visual stimuli are presented during acquisition of the fMRI scans. Hearing control subjects also participate in an auditory experiment, in which acoustic tones are presented, in order to localize the auditory cortex.

In the memory experiment the same subjects that participated in the fMRI experiment will, after a short memorization phase, relocate objects on a computer screen in a specific spatial or temporal order. The memory experiment will be performed twice on two separate days in order to test reliability.

Study burden and risks

The total duration of the study is three hours, including the time that is needed for explaining and training the tasks. The total time in the 7 Tesla MRI scanner for the subject will be approximately 40 minutes. While in the scanner, participants can experience a temporary feeling of dizziness, taste of metal and hot and cold feelings. The narrow scanner can also cause claustrophobic feelings. However, there are no known risks involved in fMRI acquisition.

The memory experiment will be performed on a computer, basically like a computer game, so the possible risk is negligible. Next to financial compensation, participation in the experiment will offer no direct advantage for individual subjects.

No immediate benefits for individual subjects are to be expected from participation in this study. However, the knowledge on cross-modal plasticity derived from this study might contribute to the improvement of the hearing capacity of both prelingual and postlingual CI-users, through refinement of therapy with the cochlear implants.

Contacts

Public

Universitair Medisch Centrum Utrecht

Heidelberglaan 100
Utrecht 3584 CX
NL

Scientific

Universitair Medisch Centrum Utrecht

Heidelberglaan 100

Utrecht 3584 CX

NL

Trial sites

Listed location countries

Netherlands

Eligibility criteria

Age

Adults (18-64 years)

Elderly (65 years and older)

Inclusion criteria

In order to be eligible to participate in the complete study, a subject must meet all of the following criteria:

- Age between 18 and 60 years
- Normal or corrected to normal vision
- Normal literacy in the Dutch or English language; Additional inclusion criteria for the three studied groups:

Hearing control group

- Hearing thresholds for individual frequencies tested in standard audiometry (125, 250, 500, 1000, 2000, 4000, and 8000 Hz) ≤ 30 dB HL, and the average threshold over 500, 1000, 2000 and 4000 Hz ≤ 20 dB HL

Prelingual deaf group

- Congenital deafness or onset of deafness before the age of 4 years
- No use of hearing aids or in case of use of conventional hearing aid, a speech perception score below 60% ; Postlingual deaf group

- Onset of deafness after the age of 7 years

- No use of hearing aids or in case of use of conventional hearing aid, a speech perception score below 60%

Exclusion criteria

Not fulfilling the criteria of the standard 7 Tesla fMRI inclusion list, including the presence of any type of metal in the body, tattoos on the skin and pregnancy.

Study design

Design

Study type:	Observational non invasive
Intervention model:	Other
Allocation:	Non-randomized controlled trial
Masking:	Open (masking not used)

Primary purpose: Diagnostic

Recruitment

NL	
Recruitment status:	Recruitment stopped
Start date (anticipated):	12-08-2013
Enrollment:	30
Type:	Actual

Ethics review

Approved WMO	
Date:	20-06-2013
Application type:	First submission
Review commission:	METC NedMec
Approved WMO	
Date:	22-05-2019
Application type:	Amendment
Review commission:	METC NedMec

Study registrations

Followed up by the following (possibly more current) registration

No registrations found.

Other (possibly less up-to-date) registrations in this register

No registrations found.

In other registers

Register	ID
CCMO	NL43358.041.13