

Table S1. fNIRS studies from the last decade that examined cortical activation related to auditory speech.

a. NH participants listening via acoustic simulations of CI hearing (i.e., vocoded stimuli)

Study	Participants	Stimuli	Tested brain areas	Parameters for statistical analysis	Main findings
Zhou et al., 2022	23 NH adults	Natural and vocoded auditory speech in monaurally & diotically presented noise in SNR -10 dB & -15 dB.	Dorsolateral prefrontal cortex (DLPFC) & auditory cortex (AC)	- PCA & GLM on HbO & HbR - 8 SSC - Following analysis only on HbC data - Aligned rank transform tests on ROIs based on peak amplitude in the block average	Smaller responses in the left DLPFC than the AC. In the left DLPFC, greater differences between vocoded and natural stimuli. Greater responses at -15 dB vs. -10 dB SNR, compared to the left AC. In the three ROIs in the LPFC, greater responses to the vocoded versus natural speech. Greater responses on the right hemisphere compared to the left.
Lawrence et al., 2021	19 NH children	Natural and vocoded auditory speech, producing four levels of speech intelligibility.	Superior, temporal, and inferior frontal brain regions	- only HbO data - GLM analysis - No SSC - Channel-wise LMM	Activation in the left superior temporal cortex increased linearly with intelligibility. A significant non-linear relationship between speech intelligibility and cortical activation in a right frontal region. Significant lateralization of responses toward the left hemisphere in superior temporal and inferior frontal regions.
Defenderfer et al, 2021	38 NH young-adults	Natural speech in quiet, natural speech in noise (SIN) in SNR +10 dB and -4 dB, vocoded speech in quiet and SIN in SNR +7 dB.	Frontal and temporal brain regions	- HbO & HbR - GLM analysis, - One SSC - Channel-based data compared to image-based reconstruction - RM-ANOVAs on ROIs	Elevated cortical responses in the middle temporal gyrus (MTG) and middle frontal gyrus (MFG) were correlated with speech recognition of the vocoded SIN, and of the natural SIN at SNR-4 dB. Elevated activation in MFG during correct perception relative to incorrect perception of speech.
Lawrence et al., 2018	23 NH adults	Natural and vocoded auditory speech, producing five levels of speech.	Superior temporal, inferior, and frontal brain regions	- Only HbO data? (not specified) - GLM analysis - No SSC - Channel-wise LMM	Activation in superior temporal regions increased linearly with intelligibility. Activation in left inferior frontal cortex peaked at intermediate levels of intelligibility. Deactivation at intermediate levels of intelligibility, relative to silence in an array of posterior channels.

Study	Participants	Stimuli	Tested brain areas	Parameters for statistical analysis	Main findings
Defenderfer et al., 2017	31 NH adults	Natural and vocoded speech in quiet, Natural SIN.	A band of the temporal cortex, including superior temporal gyrus	- HbO & HbR - Channel-wise RM-ANOVAs on peak amplitude in the block average - No SSC	Significantly greater activation in the SIN condition compared to the easier listening conditions on multiple channels bilaterally, and in the correctly vs. the non-correctly perceived trials.
Wijayasiri et al., 2017	20 NH adults	Natural speech, vocoded speech. Participants instructed to attend to the speech or to a distractor.	Inferior frontal gyrus, superior frontal gyrus, superior temporal gyrus	- Only HbO data - GLM analysis - No SSC - Channel-wise LMM	With the focusing of attention, stronger cortical response in the left inferior frontal gyrus to the vocoded compared to the natural speech. No difference in activity to vocoded versus natural speech in superior temporal gyrus.
Pollonini et al., 2014	19 NH adults	Natural speech, vocoded speech, scrambled speech, environmental sounds.	Optodes aligned in the middle of the bottom row at the T3/T4	- HbO & HbR - GLM analysis - No SSC - SPM Identifying surface area of the significant regions - ANOVA	For HbO, the vocoded speech evoked the strongest cortical response in the left hemisphere, whereas natural speech evoked the strongest response in the right hemisphere. For HbR, larger activation with natural speech than with the other stimuli in both hemispheres.

b. CI users

Study	Participants	Stimuli	Tested brain areas	Parameters for statistical analysis	Main findings
Mushtaq et al., 2020	19 CI children, bilaterally implanted, prelingually deafened. 20 NH controls	Visual speech, auditory speech, signal-correlated noise, speech-shaped noise.	Superior temporal cortex	- Only HbO data - GLM analysis - No SSC - One-sided t-tests - LMM on ROIs	No significant difference between the groups in cortical activation to auditory speech, compared with non-speech stimuli.

Study	Participants	Stimuli	Tested brain areas	Parameters for statistical analysis	Main findings
Zhou et al. 2018	15 post-lingually deafened CI users, 14 NH controls	Auditory speech, visual speech, auditory + visual speech.	Left middle superior temporal lobe, right anterior temporal lobe, superior temporal sulcus and gyrus	<ul style="list-style-type: none"> - Only HbO data - Pearson correlations comparing block average to model HRF - Two-sample (two-tailed) t-tests & Two-sample (one-tailed) variance tests to determine ROIs - Pearson correlations on ROIs based on peak amplitude in the block average 	Larger mean activation levels to auditory speech in the right anterior temporal lobe and the left middle superior temporal lobe for the CI users compared with the NH listeners. Activation levels were significantly negatively correlated with CI users' auditory speech understanding.
Chen et al., 2017	20 CI users, unilaterally implanted post-lingually deafened, 20 NH controls	Visual stimuli, natural and reversed auditory speech, tonal bursts.	Temporal lobe headset centered at T7/T8	<ul style="list-style-type: none"> - HbO & HbR - GLM analysis - No SSC - The channel with the highest beta value was selected for each ROI - Independent-samples t-test on peak amplitude & peak latency 	Reduced activation to auditory stimuli in the auditory cortex for the CI participants compared to controls.
Van de rijt et al., 2016	5 post-lingually deafened CI users, 33 NH controls	Auditory speech, visual speech, auditory + visual speech.	21 NH: bilateral fNIRS. 12 NH and 5 CI: unilateral fNIRS covering a band of the temporal cortex	<ul style="list-style-type: none"> - HbO & HbR - GLM analysis - No SSC - Wilcoxon Rank Sum test on ROIs 	Similar cortical activity to auditory speech for the CI users and the normal-hearing subjects.
Bisconti et al., 2016	10 NH 10 post-lingually deafened CI users	Phonological awareness and passage comprehension.	Inferior and middle frontal regions, Superior and middle temporal regions	<ul style="list-style-type: none"> - Only HbO data - One-sample t-tests and ANOVAs on peak amplitude in block average for ROIs 	Similar patterns of brain activation during the tested tasks for both CI patients and NH controls.

c. both NH participants listening via CI simulation, and CI users.

Study	Participants	Stimuli	Tested brain areas	Parameters for statistical analysis	Main findings
Olds et al., 2016	32 CI users post-lingually deafened, 35 NH controls	Natural speech, vocoded speech, scrambled speech, environmental sounds.	Lateral temporal lobe and superior temporal gyrus	<ul style="list-style-type: none"> - HbO & HbR - GLM analysis - No SSC - Identifying surface area of the significant regions (T-statistic above a certain threshold) - ANOVA 	<p>Strong cortical responses to natural and vocoded speech for CI participants with good speech perception and NH controls. Smaller responses to scrambled speech and environmental sounds. For CI participants with poor speech perception- similarly large areas of cortical activation for all four stimulus types.</p>