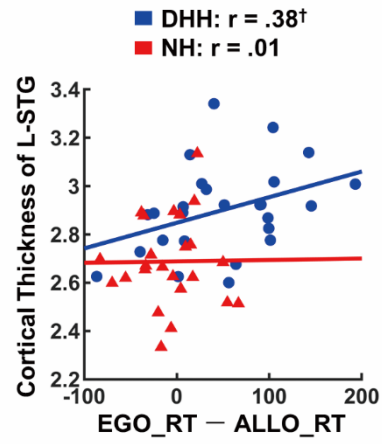


Supplemental Material For:

**Increased functional connectivity between the auditory cortex
and the frontoparietal network compensates for impaired
visuomotor transformation after early auditory deprivation**



Supplementary Figure 1. Correlation between the mean cortical thickness in the left STG and the egocentric task performance (“EGO_RT – ALLO_RT”). A marginally significant correlation between the two factors was observed in the DHH participants ($r = 0.38$, $p = 0.056$), while no significant correlation was observed in the NH participants ($r = 0.01$, $p = 0.956$). † : $p < 0.06$.

Validation analysis

The modules identified explicitly within each group were most similar between the DHH and the NH groups and most reasonably separated at the sparsity of 2% (Supplementary Fig. 2A). Therefore, the identified modules within each group at the sparsity of 2% were used to test the reliability of our findings further. Specifically, we selected four modules of interest (STG, DAN, FPN, and DMN) from each group of participants at the sparsity of 2% (Supplementary Fig. 2A, left and right panels). We constructed an anatomical conjunction mask for the four modules to get overlapping networks between the two groups (Supplementary Fig. 3A). In this way, common networks of interest were derived based on the modular partitions at the same sparsity threshold of 2% within each subject group. Subsequently, we computed the nodal- and the modular-level connectivity between the STG and each of the other networks (DAN, FPN, and DMN) by using the conjunction masks at the sparsity of 2% to examine the consistency of our findings. The same statistical thresholds were adopted to report the significant results as those in the manuscript, except for the STG-DMN connectivity.

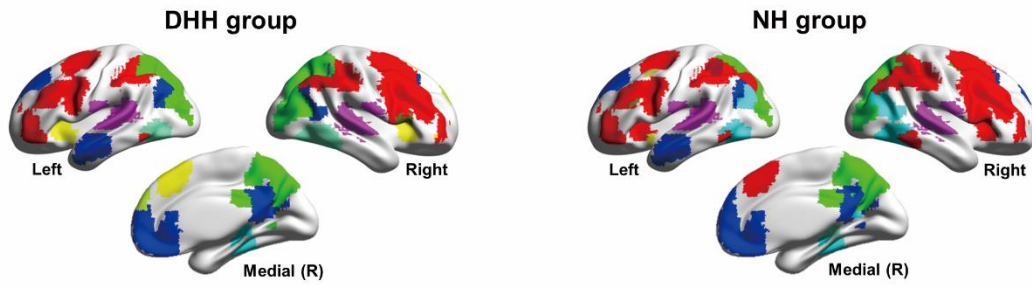
The results based on the conjunction masks replicated the key results based on group-level (collapsed across both groups) masks. Specifically, the more robust inter-module connectivity between the STG and the DAN (Supplementary Fig. 3B), and between the STG and the FPN (Supplementary Fig. 3C) was observed in the DHH group compared to the NH group during the resting state. Similarly, for the task-state data, the enhanced module connectivity between the STG and both the DAN (Supplementary Fig. 4A) and the FPN (Supplementary Fig. 4B) was also found in the DHH group, compared to the NH group, specifically during the egocentric task. Also, correlation analyses showed that the stronger the connectivity between the right MFG within the FPN and the STG in a DHH individual, the faster her/his egocentric judgment (Supplementary Fig. 4B, the scatter plot). No such effect was found in the NH group. In addition to the DAN and the FPN, the increased inter-module connectivity between the STG and the DMN,

specifically during the egocentric task, was also found in the DHH rather than the NH group, at a less conservative threshold at $p < 0.05$, uncorrected at the voxel level, cluster size more than 15 voxels (Supplementary Fig. 4C). Moreover, correlation results also showed that the stronger the connectivity between the PCC in the DMN and the STG in a DHH individual, the slower her/his egocentric judgment (Supplementary Fig. 4C, the scatter plot). No such effect was found in the NH group.

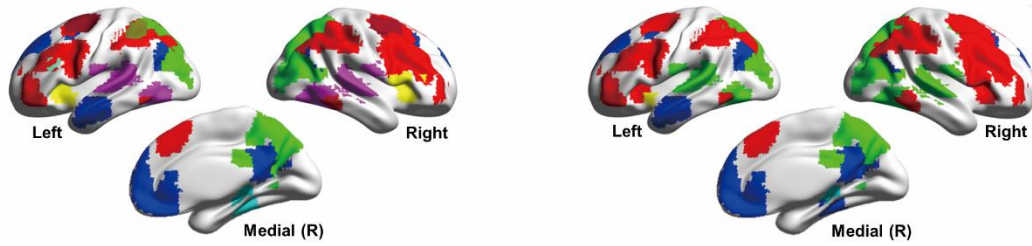
For the modular reconfiguration analyses, there was a significantly decreased inter-module connectivity between the STG and the FPN in the NH group when the brain state transitioned from the rest to the egocentric task, $t = 4.22$, $p < 0.001$ (Supplementary Fig. 5A, right). The DHH group, however, did not show such network reconfiguration, $t = 0.86$, $p = 0.40$ (Supplementary Fig. 5A, left). The other inter-module connectivity in the DHH and the NH participants was comparable between the resting-state and the egocentric task, with all $ps > 0.1$ (Supplementary Fig. 5B-C). No significant correlation was found between the modular reconfiguration and the individuals' egocentric performance in either group, all $ps > 0.1$.

Taken together, the two methods of calculating common modules between the two groups gave consistent result patterns. Therefore, we are more confident to propose that although the modular partitions are similar between the two groups, the inter-modular connectivity is largely reorganized in the DHH group.

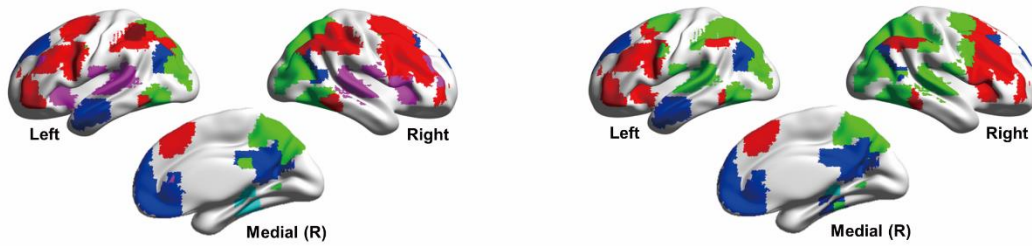
(A) Representative modules at the network sparsity threshold of 2%



(B) Representative modules at the network sparsity threshold of 3%



(C) Representative modules at the network sparsity threshold of 4%

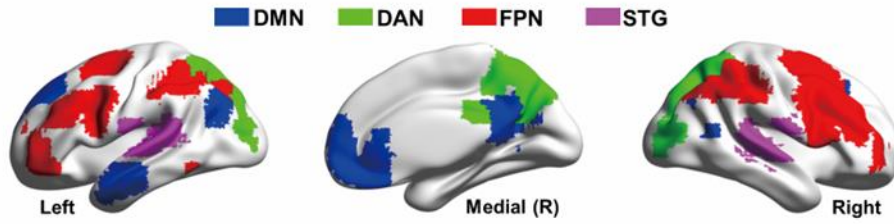


(D) Representative modules at the network sparsity threshold of 5%

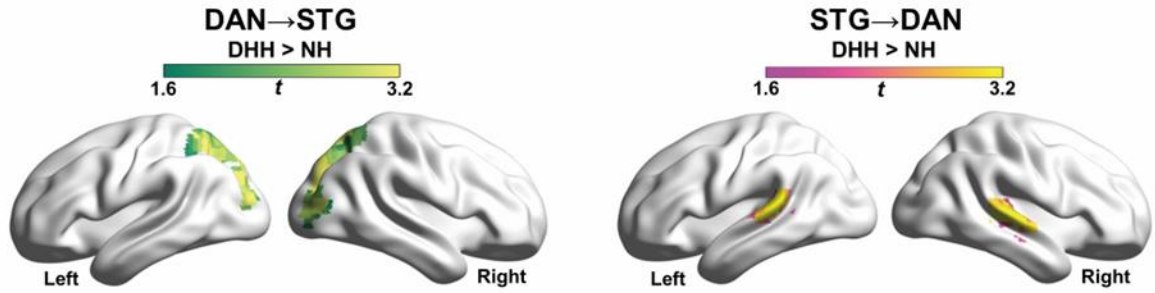


Supplementary Figure 2. Maps of representative modules from the resting-state data were shown for each group at the network sparsity of (A) 2%, (B) 3%, (C) 4%, and (D) 5%, respectively. Modules for the DHH group were displayed on the left side of each panel, while modules for the NH group were displayed on the right side of each panel. Each identified module was visualized using a distinct color.

(A) Common modular partitions for the two groups at 2% sparsity



(B) PC between STG and DAN

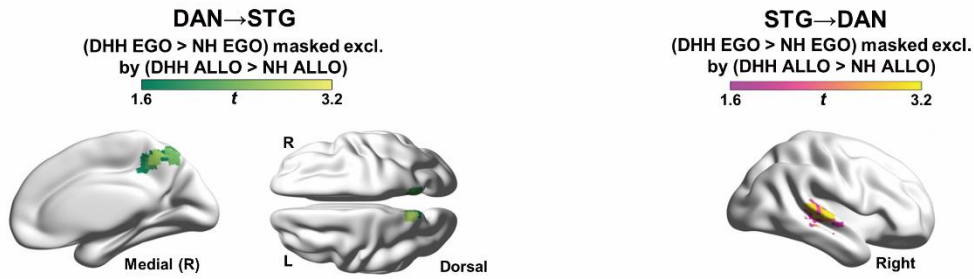


(C) PC between STG and FPN

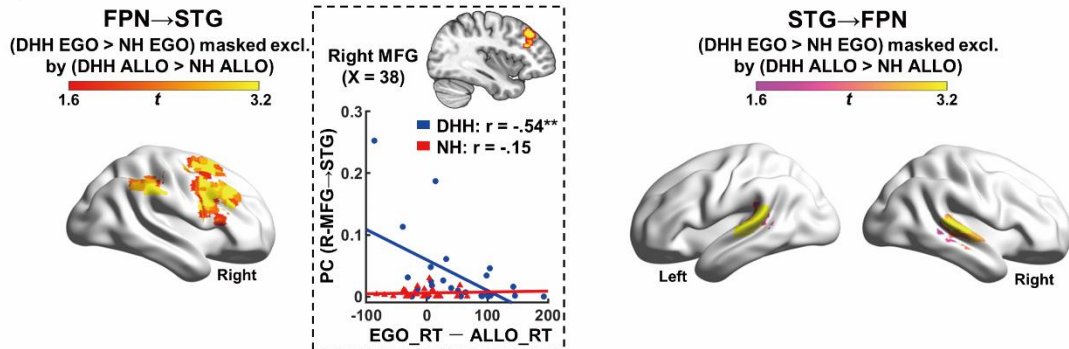


Supplementary Figure 3. The conjunction mask and resting-state results of module connectivity between the STG and the DAN and the STG and the FPN. (A) The anatomical conjunction mask consisting of the four common modular partitions for the DHH and the NH participants at the sparsity of 2%. (B) Participation coefficient (PC) between the STG and the DAN. *Left panel:* The bilateral MOG extending to the bilateral SPL and the precuneus within the DAN exhibited significantly higher PC values with the STG in the DHH than the NH group during the resting state. *Right panel:* The bilateral STG exhibited significantly higher PC values with the DAN in the DHH than the NH group during the resting state. (C) PC between the STG and the FPN. *Left panel:* The right IFG and right IPL in the FPN exhibited significantly higher PC values with the STG in the DHH than the NH group during the resting state. *Right panel:* The right STG exhibited significantly higher PC values with the FPN in the DHH than the NH group during the resting state.

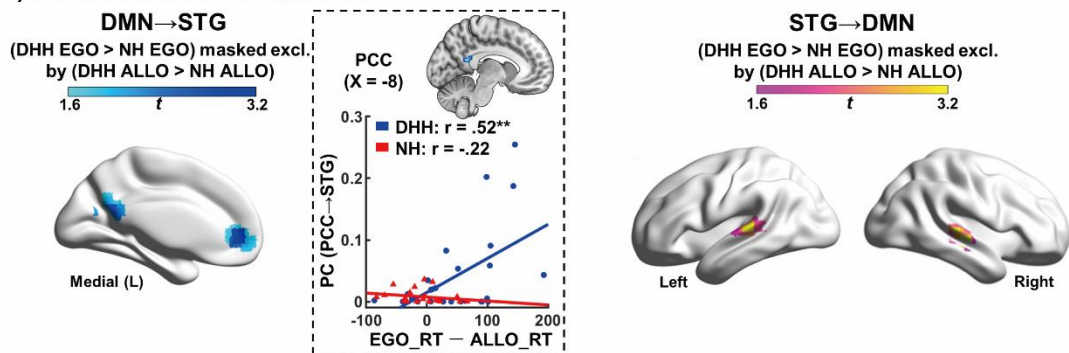
(A) PC between STG and DAN



(B) PC between STG and FPN

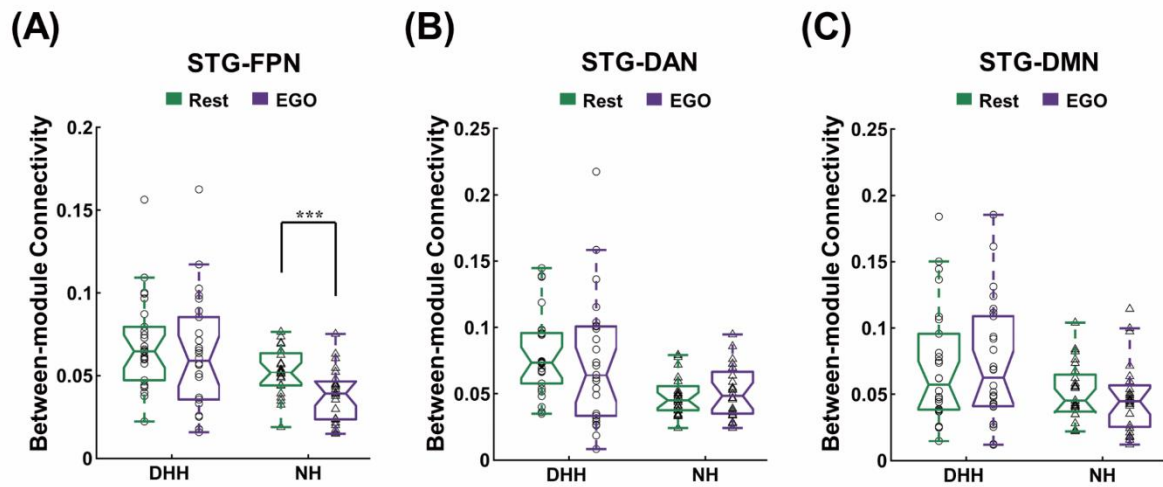


(C) PC between STG and DMN



Supplementary Figure 4. Task-state PC results between the STG and the DAN, the FPN, and the DMN. (A) PC between the STG and the DAN. *Left panel:* The interaction effect between the subject group (DHH vs. NH) and the visual tasks (EGO vs. ALLO). The precuneus within the DAN exhibited significantly higher PC values with the STG in the DHH than the NH group, especially during the egocentric rather than the allocentric task. *Right panel:* The right STG showed significantly larger PC values with the DAN in the DHH than the NH group, especially during the egocentric rather than the allocentric task. (B) PC between the STG and the FPN. *Left panel:* The interaction effect between the subject group (DHH vs. NH) and the visual tasks (EGO vs. ALLO). Extensive areas in the FPN, including the right MFG, IPL, and SFG, exhibited significantly stronger PC values with the STG in the DHH than the NH group, especially during the egocentric rather than the allocentric task. Moreover, the PC value from the right MFG in the FPN to the STG was significantly negatively correlated with the egocentric performance (“EGO_RT – ALLO_RT”) only in the DHH group but not in the NH group (the scatter plot). The stronger the right MFG-STG connectivity in a DHH individual, the faster the egocentric judgment. *Right panel:* The bilateral STG showed significantly larger PC values with the FPN in the DHH than the NH group, especially during the egocentric rather than the allocentric task. (C) PC between the STG and the DMN. *Left*

panel: The interaction effect between the subject group (DHH vs. NH) and the visual tasks (EGO vs. ALLO). Both the mPFC and the PCC in the DMN showed significantly stronger PC values with the STG in the DHH than the NH group, especially during the egocentric rather than the allocentric task. Moreover, the PC value from the PCC in the DMN to the STG was significantly positively correlated with the egocentric performance only in the DHH group but not in the NH group (the scatter plot). The stronger the PCC-STG connectivity in a DHH individual, the slower the egocentric judgment. *Right panel*: The bilateral STG showed significantly larger PC values with the DMN in the DHH than the NH group during the egocentric rather than the allocentric task. **: $p < 0.01$.



Supplementary Figure 5. Alterations in between-module connectivity during the egocentric task relative to the resting state in the two subject groups. (A) STG-FPN. (B) STG-DAN. (C) STG-DMN.

***: $p < 0.001$.