

DRAFT OF THE SUBMISSION

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Title

Massive crossmodal plasticity but no functional specialization in the occipital cortex of adventitiously blind humans

Introduction

In a recent study, we have observed that the “dorsal occipital stream” is not only crossmodally recruited for the processing of sounds, but also maintains its functional role for spatial processing in the absence of any visual input since birth (Collignon et al., submitted). The objective of the present study was to test adventitiously blind participants in order to determine (1) the amount of crossmodal plasticity that can be observed if one loses sight after the full development of the visual system, (2) if putative crossmodal plasticity in the occipital cortex of late blind subjects also respect functional specialization as observed in early blinds.

Methods

We scanned 10 late blind (LB), 12 congenitally blind (CB) and 15 blindfolded sighted control (SC) subjects in a single fMRI session. The run consisted of 30 successive blocks during which the

subjects had to alternatively process the spatial or the pitch attributes of sounds. The difficulty level of both tasks was controlled throughout the scan by adjusting the gap between the probe and the target using a dynamic psychophysical staircase procedure. Moreover the task was coded so that the same sounds were included in both conditions. Functional MRI-series were acquired using a Siemens 3-T TRIO TIM system. Multislice T2*-weighted fMRI images were obtained with a gradient echo-planar sequence using axial slice orientation (TR = 2200 ms, TE = 30 ms, FA = 90°, 35 transverse slices, 3.2 mm slice thickness, 0.8 mm inter-slice gap, FoV = 192×192 mm², matrix size = 64×64×35, voxel size = 3×3×3.2 mm³). Functional volumes were pre-processed and analysed using SPM8 implemented in MATLAB. The analysis of fMRI data, based on a mixed effects model, was conducted in two serial steps, accounting respectively for fixed and random effects. For each subject, changes in brain regional responses were estimated by a general linear model including the responses to the pitch and spatial conditions. Statistical inferences were performed at a threshold of $p < 0.05$ after correction for multiple comparisons over either the entire brain volume or over small spherical volumes, located in structures of interest.

Results

The contrasts [EB>SC (Spatial+Pitch)] and [LB>SC (Spatial+Pitch)] revealed the massive recruitment of the occipital regions for global sound processing in early and late blind subjects. Interestingly, a regression analysis on the [LB>SC (Spatial+Pitch)] contrast with the duration of blindness as regressor did not yielded any significant activity in the occipital cortex meaning that the extend of crossmodal plasticity observed in LB is not dependent of the blindness duration. The contrast [EB>LB (Spatial+Pitch)] revealed bilateral clusters of activations in the cuneus region whereas the contrast [LB>EB (Spatial+Pitch)] did not yielded any significant results. The group by condition interaction analysis [EB>SC (Spatial>Pitch)] and [LB>SC (Spatial>Pitch)] revealed that the spatial processing of sounds selectively recruits the right dorsal occipital regions in the EB group but not in the LB group.

Conclusions

These data suggest that massive crossmodal plasticity can also be observed in late acquired blindness, even if to a relatively lesser extend when compared to EB, especially in dorsal occipital regions. Importantly, our results show that vision has to be lost in an early sensitive period in life in order to transfer its functional specialization for space processing toward a non-visual modality. These fundamental results are clinically important now that a growing number of therapeutic interventions may restore vision after a period of visual deprivation.

References

Collignon O., Vandewalle G., Voss P., Albouy G., Charbonneau G., Lassonde M., Lepore F. Functional specialization for auditory-spatial processing in the occipital cortex of congenitally blind humans *Submitted.*