Plasticity of the visual cortex after the visual restoration by the gene therapy

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Purpose

Brain plasticity is the potential of the brain to change its connections based on experience or environmental influences. Visual cortex continues to develop throughout childhood, but the plasticity of the visual cortex in adulthood is limited. On the other hands, early blindness causes compensatory increase in the auditory cortical representation, and it possibly occurs by an expansion of nonvisual areas into previously visual territory. Thus, it is important to take the plasticity of the visual cortex into consideration with recovering retinal function. We researched on the plasticity of the visual cortex to evaluate response of the visual cortex to sound after blindness, and after visual reproduction by use of genetically blind rat.

Methods

We used wild type RCS $^{+/+}$ rats and RCS $^{rdy/rdy}$ rats, the latter of which start degeneration of photoreceptor cells at 2 to 3 weeks of age and go completely blind at about 3 months of age. Blind rats recovered the visual function by intravitreal injection of AAV-mVChR1, which expresses a modified Channelrhodopsin developed by our group. After introducing mVChR1 gene into the ganglion cells, we measured Visual Cortex Responses (VCR) by visual stimulus to confirm recovery of the visual function. We also measured Visual Cortex Responses by auditory stimulation (Audi-VCR).

Results

Amplitudes of Audi-VCR of blind rats were significantly larger than wild type rats, and the increase was maintained up to 7 months of age. 2 months after introducing mVChR1 gene, we confirmed recovery of the visual function by measuring VCR. There was no significant difference in the visual function between the blind rats and the recovered rats when we measured Audi-VCR.

Discussion

The comparison of the results of Audi-VCR in the blind rats and the recovered rats suggests that visual cortex takes on a role of audibility after blindness. In addition, a part of visual cortex converted to function in auditory perception after blindness appears to continue to do so even after recovery of the visual function while the rest of visual cortex keeps the original function, judging from no significant difference in the visual function between the blind rats and the recovered rats.

Conclusion

Since a part of visual cortex converted to function in auditory perception after blindness appears to continue to do so even after recovery of the visual function, it might be necessary to perform rehabilitation to let the affected visual cortex regain the original function.