Supplementary Methods

Eligibility criteria

Eligible patients were those who (1) were older than 20 years of age; (2) had visual field defects, such as homonymous hemianopia or quadrantanopia due to chronic stroke (≥3 months after stroke onset); (3) were clinically stable, as confirmed by a neurologist (D-W Kang); (4) had no cognitive impairments (i.e., scored >24 points on the Korean version of Mini-Mental State Examination); and (5) had no ophthalmic disorders, such as cataract, glaucoma, or macular degeneration.

Visual perceptual learning protocol

As for the visual perceptual learning (VPL) protocol, we used dual simultaneous stimulation tasks for the training: peripheral stimulation for training and central stimulation for fixation. Peripheral stimulation was a vertical-horizontal orientation discrimination task (ODT) ("horizontal" vs. "vertical") assigned to the defective visual field for visual training. In contrast, the central stimulation task was a distinguishing task between similar Korean letters ("ㄱ" or "ㄷ") placed in the center of the visual field to ensure that the participant's gaze was fixed on the central part of the display. The target screen consisted of centrally located Korean letters within a circle (radius=0.4 degrees) and a peripherally located grating (10×10 degrees^2; centered at 10 degrees of corresponding quadrants apart from the fixation). The background color, fixation circle, and letters were varying shades of gray (127, 100, and 140 of 256 grayscale [i.e., 0 to 255], respectively). The grating at the periphery was filled with horizontally or vertically oriented patterns (2.5 Hz of a sine wave in 10 degrees). The spatial length of intensity changes (i.e., λ, from minimum to maximum intensity, or from maximum to minimum intensity) was 2 degrees of the visual angle. We devised a computer-based protocol in which the VPL training location was determined on defective quadrants based on each participant's HVF test results.

Visual stimuli were presented on a screen (37×29.6 cm^2 with visual angles of 50×40 degree^2 using a liquid crystal display [LCD] monitor) at a viewing distance of 40 cm. In each trial, the ready, target, and response screens were presented sequentially. While keeping their eyes fixated on the center of the stimulus display (i.e., fixation location), participants were asked to respond to dual tasks on the target screen for each trial by pressing 2 of 4 buttons on a response button box: 1 to identify the fixation letter and the other to indicate the orientation of the gratings. These task stimulus types were determined randomly for each trial.

A daily training session was composed of 6 training runs; each consisted of 26 trials on defect quadrants and 6 trials on normal quadrants. Thus, patients with hemianopia undertook a total of 384 (=6×[26×2+6×2]) trials per day for 2 impaired and 2 normal quadrants, while those with quadrantanopia undertook 264 (=6×[26×1+6×3]) trials per day for 1 impaired and 3 normal quadrants. The next respective trial began immediately after each participant's responses were captured. Breaks between runs were allowed as required by participants. Participants with hemianopia required approximately 30 minutes of daily training, while those with quadrantanopia required about 25 minutes daily. Only those ODT responses accompanied by correct central fixation responses were used to determine ODT outcomes.

Contrast level adjustment

After each of the 12 training sessions within a given training period, calibration was performed to adjust the stimulus contrast to the correct ratio of approximately 70% for optimizing the VPL training difficulty. During this process, the 72 trials consisted of 30 trials each for the two quadrants in a defect field and 6 trials each for the two quadrants in an intact field. The determined contrast levels were used for the next 12 training sessions. The task paradigm for adjustment was identical to other training sessions, but the contrast-to-background intensity of the gradient pattern was adjusted during the test. Specifically, the initial contrast level of the texture stimuli was 50%; this was then exponentially adjusted based on the 3–1 staircase rule (i.e., 25% contrast level after 3 consecutive correct responses from 50% and 100% contrast level after an incorrect response). A contrast level of 100% represented the maximum contrast-to-background intensity of the gradient pattern (0–255 sine wave intensity range). Meanwhile, about 0.78% represented the minimum contrast-to-background intensity of the gradient pattern (126–128 sine wave intensity range).