Supplemental Information

Apparatus

The experimental apparatus was a horizontal table with a light-emitting diode (LED) target array hung above it. The target array was reflected onto the table using a half-reflecting mirror, which allowed subjects sight of their hand at the beginning of each trial but not during the trial itself. The array consisted of four red fixation LEDs (24° left, 12° left, 12° right and 24° right) at a distance of 43 cm from the subject’s body and one central (0°) green reaching target located slightly closer (2 cm) to the subject. The subject’s head was fixed using a chin rest vertically aligned with the 0° fixation and reaching LEDs. Reaching movements were recorded using an Ascension™ Flock of Bird’s magnetic tracking system. The position of a receiver attached to the right index finger of the subject (sampling frequency: 144 Hz) was measured relative to a transmitter located off-center on the digitizing table (1.2 m range, 1.8 mm accuracy). Horizontal eye movements were recorded binocularly through an electrooculogram (EOG) using a DC electro-oculograph system (sampling frequency: 50 Hz). AgAgCl skin electrodes were placed on the temples and were aligned horizontally with the eyes. A ground electrode was placed between the eyebrows on the centre of the head. Data were collected and analyzed offline.

Trial Design

Subjects were tested in three paradigms. The first paradigm, fixation task, was as follows: one of the four fixation LEDs was illuminated for 2 seconds and subjects were required to fixate on it. After 1 second, the central reaching target was illuminated for one second. Subjects were required to keep fixating on the location of the fixation LED and after both LEDs were extinguished and they heard an auditory tone (0.5 sec later), they were to reach to the location of the reaching target. The second paradigm – Saccade-central viewing task - began with the illumination of the green reaching target (2 seconds) followed by one of the red fixation LEDs (1 second). Subjects were asked to first fixate on the green reaching target and then saccade to the illuminated red fixation LED. After the extinction of
the red LED and the auditory tone, they were to reach toward the location of the green reaching target while maintaining fixation on the fixation position. The third paradigm – Saccade-Opposite viewing task – began in the same manner as the fixation task. After the fixation and reaching LEDs were extinguished, a second fixation LED with the same eccentricity was illuminated in the opposite side, e.g. if the 24° left fixation LED was first illuminated, then the second fixation position would be 24° right. The second fixation LED was illuminated for one second. Subjects made a saccade to the second fixation LED then maintained fixation at this position after the LED was extinguished. Following the auditory beep, subject reached to the remembered position of the central reaching target. All trials were presented in a block fashion which entailed presenting each fixation target 5 times in order from either left to right and back again or right to left and back again (alternating across paradigms). This block design was implemented to simplify the task for the patients. All trials took place in complete darkness.

Data Analysis

Data from the EOG system was converted into degrees of rotation relative to straight ahead and was analyzed offline to ensure that the subject made the correct saccades at appropriate times and subsequently remained fixated on the appropriate target or its spatial location (once the target was extinguished). Any trial in which the subject made an inappropriate eye movement was removed from analysis. For the arm, final horizontal reaching end points were converted from the 3D spatial position to angles, where the point of origin was the subject’s eye. All horizontal angles were calculated relative to straight-ahead using standard trigonometry.

Across all subjects, errors in depth were constant and the variability was small, meaning that the subjects reached in a similar and consistent manner in depth across all fixation targets. Overall our controls undershot the target in depth with a mean of 1.61 cm (SD = 1.07 cm). Patient OK undershot the target to a greater degree by 8.23 cm (SD = 1.47 cm) and patient CF overshot the target in depth by 13.18 cm (SD = 1.44 cm). In terms of horizontal errors, both patients showed a constant error
towards the left across all three tasks, undershooting the target with leftward fixations and overshooting with rightward fixations.