Kinematic properties of real and pantomimed prehension movements in parietal patients

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Aim
To study how visuo-perceptual and visuo-motor processings contribute to grip configuration in manual prehension, we investigated kinematic properties of real and pantomimed prehension [1, 2] by manipulating gaze direction [3, 4] and object familiarity [5].

Methods
Participant Two parietal patients and 18 control participants (six females; aged 25-66 years, all right handed) participated in this experiment. Lesion areas in patient MFL (female, 64 years, left handed) was found in the right hemisphere, including the parieto-occipital junction and the caudal part of the intra-parietal sulcus and of the superior parietal lobule. The lesion in patients MCS (female, 65 years, right handed) included a large portion of the inferior and superior parietal lobes in the left hemisphere. Apparatus Motion of each reflective marker (the tips of thumb and index finger, and wrist) was recorded by motion capture system (200 Hz). Liquid-crystal shutter goggles were used to manipulate participant’s view during each trial. We used a juice can (diameter: 65 mm), a can of Cachou® (45 mm), and a battery cell (size AA, 12 mm) as familiar objects and same-shape gray objects as non-familiar objects. Procedure Participants performed pantomimed prehension followed by real grasping. In the pantomime session, participants gazed at the target object or a fixation point (approx. 10 deg. from the target position, i.e. in the worst field of the two patients, see Fig. 1) for 3 sec. and were subjected to a 5-s visual occlusion (by shutter goggles), during which the object was removed (Fig. 2). Participants were then required to pantomime a reach-to-grasp action toward the location where the object had been presented. In the real grasping session, a 5-s delay was provided throughout the movement. Gaze direction was fixed throughout each trial including visual occlusion period. Analysis Slope of the regression of peak grip aperture (PGA) as a function of object size was calculated to assess grip scaling.

Results and Discussion
As for the control participants, a three-way ANOVA, with task (real, pantomime), gaze direction (central, peripheral), object familiarity (familiar, non-familiar) as within-participant factors, revealed the main effect of gaze direction [F(1, 17) = 25.8, p < 0.001], and the interactions between task and gaze direction [F(1, 17) = 15.1, p = 0.001], and between task and familiarity [F(1, 17) = 5.4, p = 0.03]. Specifically, when real grasping was performed, the slope value for the central condition was significantly higher than that for the peripheral one and the value for the non-familiar object was significantly higher than that for the familiar object (Fig. 3). Patient MFL, who was mainly damaged in dorso-dorsal stream, was more impaired during real grasping and showed improvement of grip scaling for pantomimed prehension especially in peripheral visual condition. Patient MCS whose lesion also includes in ventro-dorsal stream did not show such improvement and her pantomime in the peripheral condition was influenced by object familiarity (Fig. 4). The results suggest that different roles of dorso- and ventro-dorsal streams in action execution.

References