The effect of mirrored visual feedback on the EEG correlates of pointing direction.

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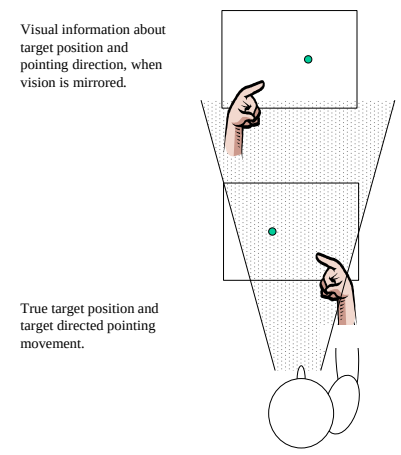
Introduction

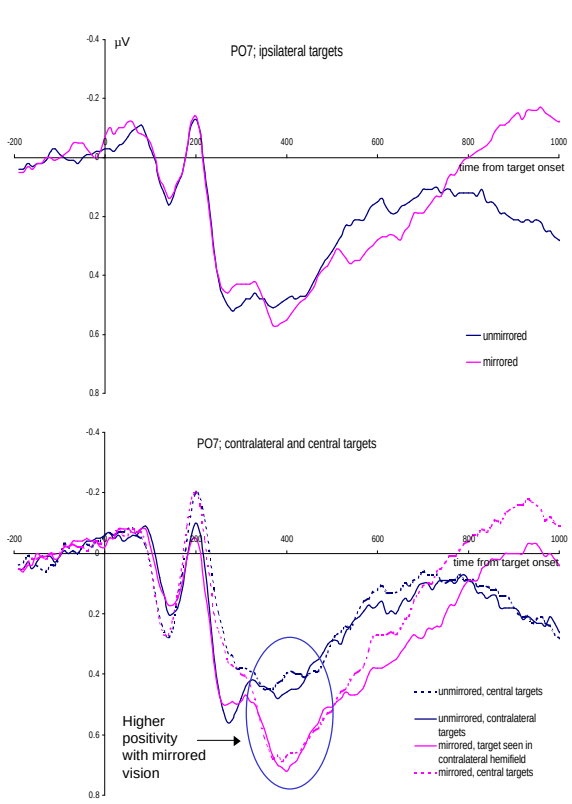
Looking through laterally mirroring prisms produces at least two changes in the phenomenal appearance of the world: When pointing with your right arm, for example, visual feedback will indicate that it is your left arm that is moving. But not only will the 'wrong' limb seem to be moving, it will also move in the diametrically opposite direction. In order to behave properly under these circumstances, some kind of recalibration has to occur. It is possible that this recalibration alters the lateralization of the neural activity that controls these movements.To test for this, we recorded event-related potentials (ERPs) and event-related lateralisations (ERLs) of the EEG during pointing movements with and without laterally mirrored vision. Targets were presented either centrally or laterally.



Methods and setup

We recorded EEG during pointing to lateral targets (± 1,7 deg. from the center) and a central target on a screen. The target was presented randomly at one of the 3 possible positions. Vision was mirrored by a prism device attached to the head rest. Subjects pointed as quickly and accurately as possible with their left and right hands in separate blocks. To investigate the hemispheric differences, activity at electrode sites ipsilateral to the response side or the target was subtracted from the corresponding contralateral electrodes.

Results



We found effects of mirrored vision on ERPs as well as on the lateralization of neural activity (ERLs). When vision was mirrored, the positive peak around 400 ms in the ERPs increased for central targets and targets seen in the contralateral hemifield of the response side (see Fig. 1, bottom). Additionally, the relative involvement of the hemisphere ipsilateral to the SEEN target position (objective position is reversed with mirrored feedback) increased (see Fig. 2). Both effects were maximal in the parietal and parieto-occipital cortex, which is involved in visuomotor integration.

Fig. 1: ERPs at site PO7 for targets presented in the contralateral, central and ipsilateral hemifield of the used arm.

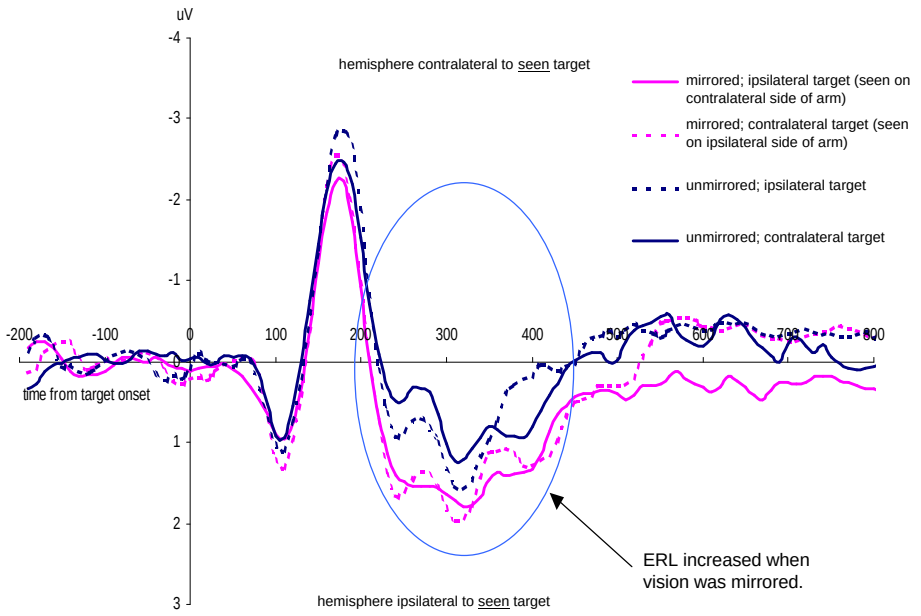


Figure 2. Difference potentials (ERLs) at sites PO7/8.

At centro-parietal and central sites (motor areas), we found a greater early ERL about 170 ms after target onset if targets were presented in the hemisphere ipsilateral to the response side than with contralateral targets (see Fig. 3). When vision was mirrored, this effect was not significant. This is evidence for a different visuomotor processing of target positions when vision is mirrored.

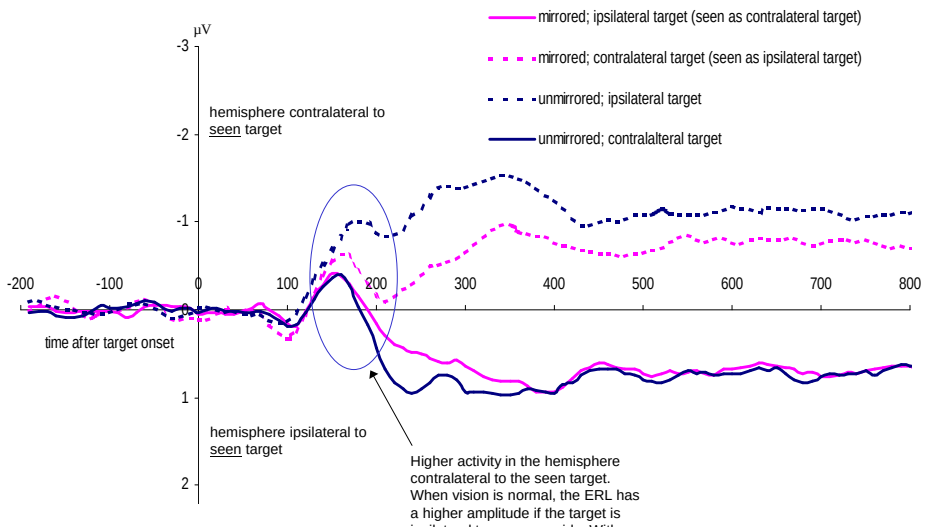


Figure 3. ERLs at site C1/2.

Discussion

Mirrored visual feedback seems to modify visuomotor processing during pointing:

The ERL at about 170 ms after target onset for ipsilateral targets (i.e., seen in the hemisphere ipsilateral to the response side) decreased if vision was mirrored. This might reflect the the influence of mirrored vision on the (automated) activation of motor areas by target localization processes. Such an automated activation might be inhibited by mirrored visual feedback, because target localization no longer activates the correct response and visuomotor coordination has to be recalibrated.

Mirrored vision also modified ERPs and ERLs around 300-400 ms after target onset in parietal and parieto-occipital areas. It is known that parietal cortex is involved in visuomotor integration. These modifications might therefore reflect the increased processing effort in visuomotor coordination when vision is mirrored.

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