The influence of visual perception for hands on spatial attention of peripersonal space

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Since human hands frequently interact with external objects, it is important to detect events that will occur near the hands as fast as possible. Previous studies have suggested that the visual detection of a target near a hand is facilitated relative to detection distant from the hand (Reed et al., 2006). However, their investigations have focused on the palm, because it is normally the contact surface of the hand. Our study investigated whether a facilitated detection would occur with the back of the hand, that has little interaction with objects, when it was facing towards targets. The results showed a different pattern between the palm of the hand and the back. In addition, this pattern appears to be related to the function of the back of the hand. These results have suggested that the functional characteristics of the surfaces of the hand affect detection of targets near the hand differently.

**Key words:** hand perception, spatial attention, peripersonal space

It has been recently suggested that the space near the body (peripersonal space) is represented differently from other regions of space. Reed et al. (2006) asked participants to visually detect a target presented on a monitor, while placing the participants' hand near it. Their results demonstrated that participants detect targets near the hand faster than the targets which were distant from the hand. They also observed that the effect was apparent when either proprioceptive or visual information about the hand could be used. These results have been supported by the reports of visual-tactile bimodal neurons that detect events near the hand, so that appropriate action for a desirable or threatening target could be taken. From this evidence, it is assumed that the functional characteristics of body parts strongly affect spatial attention in peripersonal space.

For humans, the palm of the hand often interacts with objects whereas the back has few functions when we use our hands. In this study, we used the covert orienting paradigm of Reed et al. (2006) to investigate whether functional differences between the palm and back of the hand have different influences on spatial attention near it.

**Method**

**Participants.** Eighteen right-handed students participated in the experiment.

**Apparatus and stimuli.** The stimuli consisted of a fixation point (2° × 2°) and two rectangles (2° × 1.7°). Each was at a distance of 5° from the fixation point. In the experiment, two wooden hands (a left and right hand) with rubber gloves were used as fake hands. They were fixed by a tripod stand on the table. The participants wore the same type of gloves during the experiment to decrease the visual differences between the fake and real hands. This experiment was conducted using PsyScope X46, and the stimuli were presented on a 17-inch CRT monitor. A Button Box was used as a response device.

**Procedure.** Each participant sat in a chair in front of the monitor, with their head fixed by a chinrest. One of the fake hands was placed near the outside of a target position and on the same side (i.e., a fake left hand was placed near the target on the left side), with its fingertips touching the monitor. In the palm condition, the palm side faced the target and in the back condition, the back of the hand faced the target.

The participants were presented with a central cross, flanked by two empty rectangles located 5° to
either side of it and they were instructed to fixate on the cross. Between 1,500 ms and 3,000 ms after the beginning of the trial, the border of one of the two rectangles darkened, cueing attention to that location. The target appeared 200 ms later. For valid trials, the target appeared in the cued square. For invalid trials, the target appeared in the square on the opposite side of the fixation cross. In addition, there were catch trials in which one square was cued but no target appeared. The participants were asked to indicate the presence of a target by pressing the button as quickly and accurately as possible. The experiment consisted of four conditions: (a) fake left hand back side towards target; (b) fake left hand palm side; (c) fake right hand back side; and (d) fake right hand palm side. In each condition, a participant responded by using their hand that was contralateral to the fake hand and the participant’s ipsilateral hand was placed on their thigh. These conditions were blocked and the order was counterbalanced. Within each condition of this experiment, 70% of the trials were valid cued trials, 20% were invalid cued trials, and 10% were catch trials.

**Design.** The experimental design included four factors: Cue validity (valid, invalid); Hand orientation (palm, back); Hand side (left, right); and Target side (left, right).

**Results and Discussion**

Figure 1 displays the results in each condition. A four-way repeated measures ANOVA was carried out on the mean RTs. The analysis revealed a main effect of Cue validity ($F(1,17)=36.30, p<.01$) and Target side ($F(1,17)=12.34, p<.01$). Although interactions between Cue validity $\times$ Target side, Hand side $\times$ Target side, and Cue validity $\times$ Hand side $\times$ Target side were all significant ($F(1,17)=22.72, p<.01; F(1,17)=10.01, p<.01; F(1,17)=9.96, p<.01$, respectively), they were mediated by the four-way interaction ($F(1,17)=7.96, p<.05$). In general, the facilitation effect as reported by Reed et al. (2006) was not found in both side conditions. However, this four-way interaction indicated different performance patterns for the palm and the back of the hand. Post hoc analysis revealed that in the invalid trials the targets that appeared in the left side were detected faster when the fake hand was placed at the right side and its back faced to the targets ($p<.05$). In this case, the cue appeared on the right side near the right fake hand, and soon after the target appeared on the left side. It seemed likely that the perception of this by the participants was that the target had moved from near the right hand to the left side. We use mainly the back of our hands to move objects near the hand to distant space. So, it is possible that the visual presence of the back of the hand was linked to an implicit movement of targets in invalid trials, and therefore led to facilitated detection in that condition.

These findings suggest a link between the functional characteristics of the hand and particular target properties related to it can change the distribution of attention near peripersonal space. That is, if the target is perceived as a consequence, or a cause, of hand posture, it is possible that detection of a target near the hand would be more facilitated.

**References**