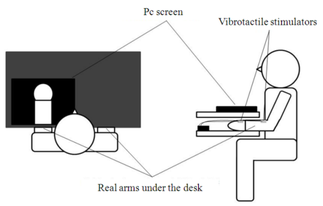
Modulation of tactile information processing by 'visual' body touch

Valeria Bellan[1,2], Carlo Reverberi[1], G. Lorimer Moseley[2], Alberto Gallace[1]
[1] Department of Psychology, University of Milano – Bicocca, Milan, Italy
[2] Sanson Institute for Health Research, University of South Australia, Adelaide, Australia

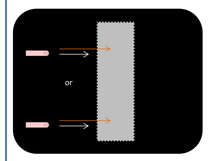
Several studies have shown that watching one's own body part improves tactile acuity and discrimination abilities for stimuli presented on that location (Blakemore et al., 2005). Kennett and colleagues (2001a) have shown that their participants could detect a tactile target delivered on their arms more effectively when they could directly see that part of the body, as compared to when its vision was prevented ('Visual Enhancement of Touch', VET). Moreover, Schaefer et al.'s findings (2005) support the idea that the VET is linked to the observation of touch, rather than to the depiction of the body part per se.
Secondly, we took into account the issue of whether the effect of watching another person's body on tactile information processing can be somehow related to an extension of body ownership towards the body part seen on the display, namely the relationship between the VET effect and body ownership. By mean of the Rubber Hand Illusion procedure (RHI) (Botvinik et al., 1998), Longo et al. (2008) found a significant enhancement of acuity when the illusion was induced compared to a control condition where the illusion was not generated. The authors suggested that the VET effect depends on seeing 'one's own' hand, rather than seeing 'a whatever' hand. So they stated that there is a functional relation between the bodily self and tactile perception. Interestingly, it should be noted here that Moseley et al. (2008) found a slow down of tactile information processing due to alterations of body ownership when a spatial discrimination task was used.
The aim of our research was to verify whether seeing another person's hand being touched (on a pc screen) can affect the processing of tactile information presented on the participant's body when the spatial discrimination of the stimuli is required. We also analyzed if an illusion of embodiment of the hand on the screen occurred and whether this had also an effect on the processing of tactile stimuli. Finally we investigated whether the position of the screen and the fact of viewing an object in place of a human hand on the pc screen could affect the tactile processing itself.

Materials and Methods

Experimental Setup and Tasks (Identical in the three experiments)



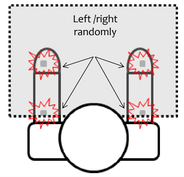
Visual Stimulus



A finger touching/approaching without touching a ***hand or an object*** *on the screen*

At the same time

Vibrotactile stimulus



Stimulus presented on hands and arms, ***press left/right mouse button***

Then

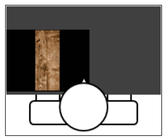
Questionnaire
(if the visual stimulus was a hand)

- ✓ 10 questions about the sense of ownership towards the hand on the screen
- ✓ Likert scale from '*Totally disagree*' to '*Totally agree*'

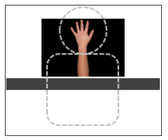
EXP– 1

Participants: 15 healthy right-handed volunteers (13F), age = 22.3 ± 3.7 years; education = 15.1 ± 0.9 years of school. All participants performed all conditions. The order of presentation was randomly assigned.

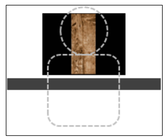
Object Left Down screen displaying a piece of wood placed on the left



Hand Centre Up screen displaying a left hand placed on the centre of the desk, in vertical position, in front of the participant



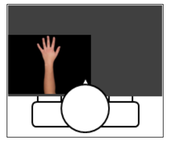
Object Centre Up screen displaying a piece of wood placed on the centre of the desk, in vertical position, in front of the participant



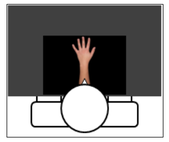
EXP– 2

Participants: 14 healthy right-handed volunteers (9F), age = 24 ± 3.8 years; education = 16.9 ± 2.3 years of school.
All participants performed all conditions. The order of presentation was randomly assigned

Hand Left Down screen displaying a left hand placed on the left

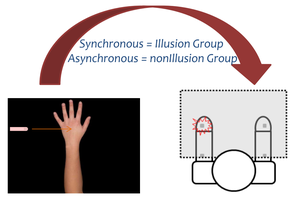


Hand Centre Down screen on the centre of the desk, aligned with participants' body midline

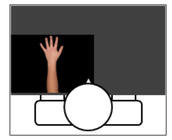


EXP– 3

Participants: 32 healthy right-handed volunteers (22F), age = 24.5 ± 3.7 years; education = 16.7 ± 1.8 years of school
Half participants randomly assigned to Illusion Condition, the other half to the Non Illusion Condition. All participants performed the same spatial task.



Hand Left Down screen displaying a left hand placed on the left, as in experiment 2



Results

EXP– 1

Faster RTs in Object Up Centre condition than in Object Down Left Condition and faster in Object Down Left Condition than in Hand Up Centre Condition (p=0.03371).

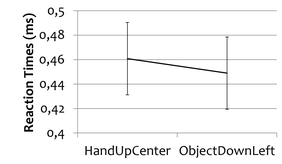


Fig. 4- Screen Position and visual stimulus

EXP– 2

Faster RTs in Hand Left condition than in Hand Centre condition, independently from the side being touched (p = 0.03128).

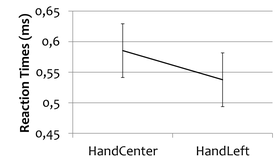


Fig. 3 - Effect of Screen Position

EXP– 1 Vs. EXP– 2

Faster RTs in Object Left Down condition than in Hand Left Down condition (p=0.04504); Faster RTs in Hand Centre Up condition than in Hand Centre Down condition (p=0.00648)

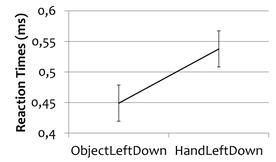


Fig. 5- Screen Position and visual stimulus

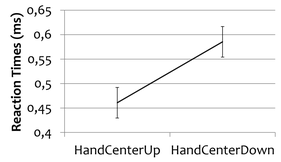


Fig. 6 - Screen Position

EXP– 3

Faster RTs in Touch Condition (finger touching the hand on the screen) than in no Touch Condition (finger just approaching) (p<0.001).
Faster RTs for the tactile perception on the left side of the body than on the right (p<0.005)

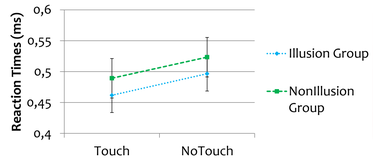


Fig. 1 - Main effect of Touch

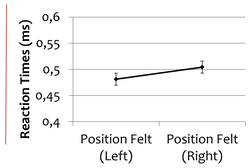


Fig. 2 - Main effect of Position Felt

Conclusions

- ✓ participants responded faster to the tactile stimuli presented on their own arms when they could see on a pc screen the limb of a stranger being touched, as compared to a condition where they could see the same limb being approached but not touched;
- ✓ the effect that we found cannot be fully classifiable as a VET effect (i.e., a body-location specific enhancement of tactile processing caused by the vision of the location of the body where the stimuli are presented). In fact, the participants in our experiment responded faster to tactile stimuli when they could see a 'picture' of a hand being touched rather than when seeing their own body touched (just like in the classic VET paradigm; see Longo et al., 2008).
- ✓ the faster RTs for seeing an object instead of a hand may suggest that seeing a hand recruits higher attentional resources, leading to a slowing down of the RTs; the same can be supposed for the slower RTs in Hand Centre condition than both Hand Left condition and Hand Up Centre condition.

In conclusion, the effects found might be mediated by higher order multisensory mechanisms related to the allocation of attentional resources to the body.

Bibliography
Blakemore, S.-J., Bristow, D., Bird, G., Frith, C., & Ward, J. (2005). Somatosensory activations during the observation of touch and a case of vision-touch synaesthesia. *Brain: a journal of neurology*, *128*, 1571-83.
Botvinick, M., & Cohen, J. (1998). Rubber hands "feel" touch that eyes see. *Nature*, *391*(6669), 756.
Kennett, S, Taylor-Clarke, M., & Haggard, P. (2001a). Noninformative vision improves the spatial resolution of touch in humans. *Current biology: CB*, *11*(15), 1188-91.
Gallace, A., Tan, H.Z., Spence, C., 2007. The body surface as a communication system: the state of art after 50 years of research. Presence: Teleoperators and Virtual Environments 16, 655–676.
Glover, D and Miller, D, Averis, D and Door, V. (2005) The interactive whiteboard: a literature survey. Technology, Pedagogy and Education (14) 2: 155–170.
Longo, M. R., Cardozo, S., & Haggard, P. (2008). Visual enhancement of touch and the bodily self. *Consciousness and Cognition*, *17*(4), 1181-1191. Elsevier Inc.
Moseley, G. L., Olthof, N., Venema, A., Don, S., Wijers, M., Gallace, A., & Spence, C.(2008).Psychologically induced cooling of a specific body part caused by the illusory ownership of an artificial counterpart. *Proceedings of the National Academy of Sciences of the United States of America*,*105*(35),13169-73.
Schaefer, M., Heinze, H.-J., & Rotte, M. (2005). Viewing touch improves tactile sensory threshold. *Neuroreport*, *16*(4), 367-70.