American Pain Society
RESEARCH
EDUCATION
TREATMENT
ADVOCACY
PUBLISHED BY ELSEVIER

The Journal of Pain, Vol 16, No 6 (June), 2015: pp 499-507
Available online at www.jpain.org and www.sciencedirect.com

Original Reports

Seeing One's Own Painful Hand Positioned in the Contralateral Space Reduces Subjective Reports of Pain and Modulates Laser Evoked Potentials

Elia Valentini,[*,†] Katharina Koch,[*,†] and Salvatore Maria Aglioti[*,†]

**Psychology Department, Sapienza University of Rome, Rome, Italy.*
[†]Santa Lucia Foundation, Scientific Institute for Research, Hospitalization and Health Care, Rome, Italy.

Abstract: Studies report that viewing the body or keeping one's arms crossed while receiving painful stimuli may have an analgesic effect. Interestingly, changes in ratings of pain are accompanied by a reduction of brain metabolism or of laser evoked potentials amplitude. What remains unknown is the link between visual analgesia and crossed-arms related analgesia. Here, we investigated pain perception and laser evoked potentials in 3 visual contexts while participants kept their arms in a crossed or uncrossed position during vision of 1) one's own hand, 2) a neutral object in the same spatial location, and 3) a fixation cross placed in front of the participant. We found that having vision of the affected body part in the crossed-arms position was associated with a significant reduction in pain reports. However, no analgesic effect of having vision of the hand in an uncrossed position or of crossing the arms alone was found. The increase of the late vertex laser evoked potential P2 amplitude indexed a general effect of vision of the hand. Our results hint at a complex interaction between cross-modal input and body representation in different spatial frames of reference and at the same time question the effect of visual analgesia and crossed-arms analgesia alone.

Perspective:* *We found that nociceptive stimuli delivered to the hand in a crossed-arms position evoke less pain than in a canonical anatomic position. Yet we report no significant analgesic effect of vision or crossing the arms on their own. These findings foster the integration of visuospatial and proprioceptive information in rehabilitation protocols.

Key words: *Visual analgesia, crossed-arms analgesia, laser evoked potentials, pain, electroencephalography.*

Simply looking at one's own body can reduce pain ratings and nociceptive evoked potentials,[14] as well as heat pain thresholds,[18] time-frequency oscillations,[17] and functional magnetic resonance imaging bold signal.[15] More specifically, viewing one's own body reduces pain perception, an effect that is paralleled by a decrease of neural activity in somatosensory, insular, cingulate, and extrastriate visual cortices. Scholars propose that visual perception of one's own body induces an increased functional coupling between visual and parietal areas that may subserve multisensory inhibitory mechanisms.[15]

Visual analgesia may seem somewhat counterintuitive as the neural tuning associated with focused and sustained spatial attention[5] should amplify nociceptive processing[12] and therefore heighten pain perception.[7,33] This would be congruent with evidence showing that seeing the hand in an uninformative way enhances tactile acuity and discrimination[11] and somatosensory event-related potentials (ERPs).[1,31]

Although visual feedback (in particular the mirror illusion[23]) has been used for the treatment of pain,[20,29] thus far only 2 experimental studies have assessed the role of manipulating the correct spatial localization of nociceptive stimuli as a method to reduce pain in healthy volunteers.[6,32] These studies reported a reduced

Received October 2, 2014; Revised December 17, 2014; Accepted February 4, 2015.

S.M.A. is supported by EU Information and Communication Technologies Grant (VERE project, FP7-ICT-2009-5, Prot. Num. 257695) and the Italian Ministry of Health (and RF-2010-2312912).

The authors report no conflict of interest.

Address reprint requests to Elia Valentini, PhD, Department of Psychology, Sapienza University of Rome, via dei Marsi 78, 00195 Roma, Italy. E-mail: elia.valentini@uniroma1.it

1526-5900/$36.00

http://dx.doi.org/10.1016/j.jpain.2015.02.003

sensation of pain in volunteers while the arms were in a crossed position and the affected limb was placed in the contralateral side of space, rather than in its canonical anatomic position (ie, uncrossed-limbs position). In addition, crossing the stimulated hand over the sagittal body midline produced a reduction in late laser evoked potential (LEP) amplitude.[6] It is worth noting that in the arm-crossing experimental setup, vision of one's own body was prevented, suggesting that the sole distortion of spatial localization of nociceptive stimulation can affect the experience of pain. Unfortunately, the size of both visual and crossed-arms analgesia alone is too small to have significant relevance in the clinical setting.

Here, we wondered if the 2 phenomena could interact and therefore summate their analgesic effects when combined. No study to date has explored whether the 2 phenomena might interact in affecting perception and brain activity. To investigate this issue, we combined vision of one's own right hand receiving nociceptive painful stimuli in both an ipsilateral and a contralateral position in the peripersonal space. We collected single-trial verbal ratings of pain induced by nociceptive laser stimuli and recorded LEPs using a procedure similar to the one used in our previous study.[14] Participants were tested in 3 observational conditions, namely, while watching 1) one's own hand, 2) a neutral object in the same spatial location, and 3) a fixation cross placed in front of them. Crucially, for each of the 3 conditions, participants kept their arms in an uncrossed or crossed position. Our design allowed us to test whether the visual analgesia contingent upon viewing the painful hand was different when the arms were kept in a crossed or uncrossed position. We hypothesized that any hypoalgesic effect of watching the hand would be higher in a crossed- than in an uncrossed-arms position.

Methods

Participants

Eighteen right-handed healthy participants (10 women) between 21 and 34 years of age (mean $\pm$ standard deviation [SD] = 27.2 $\pm$ 3.6) participated in the study.

All had normal or corrected-to-normal vision and were naïve as to the purpose of the experiment. None of the participants had a history of neurologic or psychiatric illnesses or conditions that could potentially interfere with pain sensitivity (eg, drug intake or skin diseases). Participants gave written informed consent and were debriefed at the end of the experiment. All experimental procedures were approved by the Fondazione Santa Lucia ethics committee and were in accordance with the standards of the Declaration of Helsinki.

Nociceptive Stimulation

The nociceptive heat stimuli were pulses generated by an infrared neodymium yttrium aluminium perovskite (Nd:YAP) laser with a wavelength of 1.34 μm (Electronic Engineering [El.En.], Florence, Italy). Duration of the laser pulses was 5 milliseconds. These pulses selectively and directly activate the Aδ- and C-fiber nociceptive terminals located in the superficial layers of the skin.[2] The laser beam was transmitted via an optic fiber, and its diameter was set at approximately 7 mm ($\approx$38 mm^2) by focusing lenses. Laser pulses were delivered in a square area (5 $\times$ 5 cm) defined on the right hand dorsum prior to the beginning of the experimental session. To prevent increases in baseline skin temperature and fatigue or sensitization of the nociceptors, the position of the laser beam was changed after each pulse using an iron arm that kept the laser handpiece steady and held it at a constant height with respect to the hand dorsum. A thermometer (precision of $\pm$.3°C) was used to measure the temperature of the stimulated skin area.

During a familiarization and calibration procedure to check the quality of the sensation associated with radiant heat stimuli, participants were instructed to define the level of pain using a numerical rating scale (NRS) in which 0 corresponded to "no pain" and 100 to "the worst pain imaginable." The energy of the stimulus was adjusted using a staircase procedure. The procedure required 1 increase (increasing) series and 1 decrease (decreasing) series in intervals of .5 J, followed by 1 increase (increasing) series in intervals of .25 J until the target intensity of the nociceptive sensation was reported (ie, pricking/burning sensation). Lastly, energies that were .5 J below and above the energy level that elicited the pricking/burning pain sensation were delivered to test the reliability of the intensity ratings. Once nociceptive intensity was calibrated, participants underwent a brief test block of 10 stimuli. If a significant discrepancy was noticed between NRS ratings during this block and the ratings of pain assigned to the test energy chosen for the experiment during the calibration procedure, then the calibration procedure was repeated.

Electroencephalographic (EEG) Recording

EEG recordings were obtained from 60 electrodes placed according to the positions of the 10-20 International System (Fp1, Fp2, Fpz, AF3, AF4, AF7, AF8, F1, F2, F3, F4, F5, F6, F7, F8, FC1, FC2, FC3, FC4, FC5, FC6, FT7, FT8, Cz, FCz, Fz, Oz, POz, Pz, C3, C4, C5, C6, T7, T8, TP7, TP8, CP1, CP2, CP3, CP4, CP5, CP6, CPz, P1, P2, P3, P4, P5, P6, P7, P8, PO3, PO4, PO7, PO8, O1, O2). Three surface electrodes were positioned for the vertical, horizontal electro-oculography recording below the right eye and at the right ocular canthus and the electromyography recording at the left mastoid. The nose was used as a reference channel and channel AFz was used as ground. Electrode impedance was kept below 5 kΩ. The EEG signal was amplified and digitized at 1,000 Hz.

Experimental Setup, Design, and Procedure

We investigated the intensity of the sensations and the brain activity of each participant in 2 separate sessions (on 2 different days, same time of day). In the first session, we collected ratings of pain only, whereas in the second session we recorded EEG activity in the same participant without asking for any overt rating of pain.