



Commentary: Mechanical Pain Thresholds and the Rubber Hand Illusion

Matteo Martini*

School of Psychology, University of East London, London, United Kingdom

Keywords: pain, body ownership, rubber hand illusion, virtual hand illusion, embodiment

A Commentary on

Mechanical Pain Thresholds and the Rubber Hand Illusion

by Bauer, A., Hagenburger, J., Plank, T., Busch, V., and Greenlee, M. W. (2018). *Front. Psychol.* 9:712. doi: 10.3389/fpsyg.2018.00712

Investigations into the relationship between bodily illusions and pain perception are representing a relatively modern trend in cognitive science. Recently, Bauer et al. (2018) published a work with the aim to determine if the vision of a potentially painful stimulus threatening the rubber hand can modify the mechanical pain threshold (MPT). They state that MPT remains relatively stable during the induction of the rubber hand illusion (RHI), yet it can be significantly decreased by the vision of an artificial threat to the RH. The purpose of the present commentary is to provide alternative explanations to Bauer's results, which have not been discussed in their article. This process would help promote additional reflection on this topic and hopefully foster further advances in this field.

The analgesic effects linked to the vision of the own body ("visual analgesia") were initially described by Longo et al. (2009). Although there is not full consensus (Mohan et al., 2012; Torta et al., 2015), such effect has been consistently reported by many other studies (see Martini, 2016 for a review). For a neurophysiological explanation to this phenomenon please see the review written by Haggard et al. (2013). Discussing their main finding and supported by control experiments, Bauer and colleagues argue that their results stand in contrast to Longo's "visual analgesia" and they suggest that this apparent discrepancy might be due to the different material used in their experiments. I agree with the authors on the fact that the vision of a threatening stimulus can increase pain sensation (Arntz and Claassens, 2004; Höfle et al., 2012; Martini et al., 2013). While Bauer and colleagues threatened the rubber hand with a knife, clear threatening stimuli were not used in Longo's et al. study. However, there might be something else. In a recent virtual hand illusion (VHI) study, Nierula et al. (2017) set out to verify whether the distance between the real and the fake limb, typically present in RHI studies, could dampen visual analgesia. What they found was a significant decrease in heat pain thresholds when the virtual hand was far from the real hand compared to when they were perfectly co-located. So, visual analgesia is hindered if the real and the fake hand are not in the same place. The lack of analgesic effect due to the vision of "one's own" body in Bauer's study could be then due to the distance (20 cm) between the real and the rubber hand. If this is true it might explain why, during the vision of the rubber hand being simply touched by the knife handle, there was no analgesic effect revealed by a higher MPT linked to the vision of "one's own" body. Additionally, given the type of visual stimuli (knife point = threat vs. knife handle = no-threat) and the paradigm (RHI) used in their study, I think they should have discussed their findings also in the light of the latest findings on skin conductance response (SCR). Indeed, recent evidence

OPEN ACCESS

Edited by:

Jack Tsao,
University of Tennessee, Knoxville,
United States

Reviewed by:

Mark W. Greenlee,
University of Regensburg, Germany

*Correspondence:

Matteo Martini
m.martini@uel.ac.uk

Specialty section:

This article was submitted to
Perception Science,
a section of the journal
Frontiers in Psychology

Received: 19 July 2018

Accepted: 24 August 2018

Published: 18 October 2018

Citation:

Martini M (2018) Commentary:
Mechanical Pain Thresholds and the
Rubber Hand Illusion.
Front. Psychol. 9:1715.
doi: 10.3389/fpsyg.2018.01715

point at an increase in the arousal response during the vision of stimuli approaching the owned rubber hand, regardless of the affective valence of the stimulus (Ma and Hommel, 2013; Johnson et al., 2016). So, the choice of a knife handle as a control stimulus could not be entirely appropriate.

In their third control condition Bauer and colleagues asked their participants to close their eyes before the measurement of MPT, so they did not see any stimuli approaching the RH. During this condition a modulation of proprioceptive drift was reported and a high level of ownership was found, but no pain modulation was documented. The authors thus state that “the induction of the RHI alone did not change the MPT values significantly” and that this would be in contrast with Martini et al. (2014). However, in the mentioned study all conditions envisaged constant visual feedback (i.e., no eyes closed) and the main finding was interpreted in favor of the transfer of the visual analgesia to virtual bodies, never mentioning a possible analgesic effect of the VHI “alone.” What precisely is this effect they refer to has to be clarified. Maybe the authors refer to another possible analgesic effect related to “disownership” of the real hand, which they state it did not take place. Unfortunately the phenomenon of disownership, likely overlapping the “loss of own hand” phenomenon (Longo et al., 2008), has not been directly measured by the authors. A future investigation specifically targeting the real contribution of the “disownership” phenomenon in pain studies with bodily illusion is therefore needed.

Another point worth discussing might be the type of pain chosen to measure the participants’ pain threshold: the majority of studies about visual analgesia during RHI/VHI paradigms

made use of thermal or electrical stimuli. In Bauer’s experiment mechanical stimuli were chosen. The authors explain their preference stating that “MPT is assumed to be closer to clinical pain than thresholds measured with thermal stimuli,” but unfortunately no explanations nor any references were provided to support their assertion. Mechanical, electrical and heat pain threshold have been shown to have some level of independence and can react differently to different modulators (for ex. Tong et al., 2007; Okkerse et al., 2017). Furthermore, drawing on previous neurophysiological studies reporting a differential contribution of myelinated A- δ and unmyelinated C-fibers in different types of pain, Lötsch et al. (2016) have shown how electrical, thermal, and pinprick mechanical stimuli belong to three separate clusters of pain measures, and these stimuli seem to be processed differently in the brain (Murrell et al., 2007). Thus, the choice of the type of pain to gauge, as well as of other components of the experimental design (for ex. the choice of the control conditions), can make the difference in this type of experiments (Martini et al., 2015).

As a final point, given the high inter-subject variability and the complexity of the “embodiment” phenomenon (Longo et al., 2008), it might be always worthy reporting *qualitative* data too. What is a praxis for clinical research with patients could be extended to healthy participants as well, to boost interpretability of data and comparability among studies.

AUTHOR CONTRIBUTIONS

The author confirms being the sole contributor of this work and has approved it for publication.

REFERENCES

- Arntz, A., and Claessens, L. (2004). The meaning of pain influences its experienced intensity. *Pain* 109, 20–25. doi: 10.1016/j.pain.2003.12.030
- Bauer, A., Hagenburger, J., Plank, T., Busch, V., and Greenlee, M. W. (2018). Mechanical pain thresholds and the rubber hand illusion. *Front. Psychol.* 9:712. doi: 10.3389/fpsyg.2018.00712
- Haggard, P., Iannetti, G. D., and Longo, M. R. (2013). Spatial sensory organization and body representation in pain perception. *Curr. Biol.* 23, R164–R176. doi: 10.1016/j.cub.2013.01.047
- Höfle, M., Hauck, M., Engel, A. K., and Senkowski, D. (2012). Viewing a needle pricking a hand that you perceive as yours enhances unpleasantness of pain. *Pain* 153, 1074–1081. doi: 10.1016/j.pain.2012.02.010
- Johnson, M. I., Smith, E., Yellow, S., and Mulvey, M. R. (2016). A preliminary investigation into psychophysiological effects of threatening a perceptually embodied rubber hand in healthy human participants. *Scand. J. Pain* 11, 1–8. doi: 10.1016/j.sjpain.2015.10.004
- Longo, M. R., Betti, V., Aglioti, S. M., and Haggard, P. (2009). Visually induced analgesia: seeing the body reduces pain. *J. Neurosci.* 29, 12125–12130. doi: 10.1523/JNEUROSCI.3072-09.2009
- Longo, M. R., Schüür, F., Kammers, M. P., Tsakiris, M., and Haggard, P. (2008). What is embodiment? A psychometric approach. *Cognition* 107, 978–998. doi: 10.1016/j.cognition.2007.12.004
- Lötsch, J., Dimova, V., Ullsch, A., Lieb, I., Zimmermann, M., Geisslinger, G., et al. (2016). A small yet comprehensive subset of human experimental pain models emerging from correlation analysis with a clinical quantitative sensory testing protocol in healthy subjects. *Eur. J. Pain* 20, 777–789. doi: 10.1002/ejp.803
- Ma, K., and Hommel, B. (2013). The virtual-hand illusion: effects of impact and threat on perceived ownership and affective resonance. *Front. Psychol.* 4:604. doi: 10.3389/fpsyg.2013.00604
- Martini, M. (2016). Real, rubber or virtual: the vision of “one’s own” body as a means for pain modulation. A narrative review. *Conscious. Cogn.* 43, 143–151. doi: 10.1016/j.concog.2016.06.005
- Martini, M., Perez-Marcos, D., and Sanchez-Vives, M. V. (2013). What Color is My Arm? Changes in skin color of an embodied virtual arm modulates pain threshold. *Front. Hum. Neurosci.* 7:438. doi: 10.3389/fnhum.2013.00438
- Martini, M., Perez-Marcos, D., and Sanchez-Vives, M. V. (2014). Modulation of pain threshold by virtual body ownership. *Eur. J. Pain.* 18, 1040–1048. doi: 10.1002/j.1532-2149.2014.00451.x
- Martini, M., Perez-Marcos, D., and Sanchez-Vives, M. V. (2015). Author’s reply to the commentary by Gilpin et al. *Eur. J. Pain* 19, 143–144. doi: 10.1002/ejp.606
- Mohan, R., Jensen, K. B., Petkova, V. I., Dey, A., Barnsley, N., Ingvar, M., et al. (2012). No pain relief with the rubber hand illusion. *PLoS ONE* 7:e52400. doi: 10.1371/journal.pone.0052400
- Murrell, J. C., Mitchinson, S. L., Waters, D., and Johnson, C. B. (2007). Comparative effect of thermal, mechanical, and electrical noxious stimuli on the electroencephalogram of the rat. *Br. J. Anaesth.* 98, 366–371. doi: 10.1093/bja/ael377
- Nierula, B., Martini, M., Matamala-Gomez, M., Slater, M., and Sanchez-Vives, M. V. (2017). Seeing an embodied virtual hand is analgesic contingent on colocation. *J. Pain* 18, 645–655. doi: 10.1016/j.jpain.2017.01.003
- Okkerse, P., van Amerongen, G., de Kam, M. L., Stevens, J., Butt, R. P., Gurrell, R., et al. (2017). The use of a battery of pain models to detect analgesic properties

- of compounds: a two-part four-way crossover study. *Br. J. Clin. Pharmacol.* 83, 976–990. doi: 10.1111/bcp.13183
- Tong, K. C., Lo, S. K., and Cheing, G. L. (2007). Alternating frequencies of transcutaneous electric nerve stimulation: does it produce greater analgesic effects on mechanical and thermal pain thresholds? *Arch. Phys. Med. Rehabil.* 88, 1344–1349. doi: 10.1016/j.apmr.2007.07.017
- Torta, D. M., Legrain, V., and Mouraux, A. (2015). Looking at the hand modulates the brain responses to nociceptive and non-nociceptive somatosensory stimuli but does not necessarily modulate their perception. *Psychophysiology* 52, 1010–1018. doi: 10.1111/psyp.12439

Conflict of Interest Statement: The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2018 Martini. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) and the copyright owner(s) are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.