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Brain-to-brain coupling during handholding is associated with pain reduction

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The mechanisms underlying analgesia related to social touch are not clear. While recent research highlights the role of the empathy of the observer to pain relief in the target, the contribution of social interaction to analgesia is unknown. The current study examines brain-to-brain coupling during pain with interpersonal touch and tests the involvement of interbrain synchrony in pain alleviation. Romantic partners were assigned the roles of target (pain receiver) and observer (pain observer) under pain–no-pain and touch–no-touch conditions concurrent with EEG recording. Brain-to-brain coupling in alpha–mu band (8–12 Hz) was estimated by a three-step multilevel analysis procedure based on running window circular correlation coefficient and post hoc power of the findings was calculated using simulations. Our findings indicate that hand-holding during pain administration increases brain-to-brain coupling in a network that mainly involves the central regions of the pain target and the right hemisphere of the pain observer. Moreover, brain-to-brain coupling in this network was found to correlate with analgesia magnitude and observer's empathic accuracy. These findings indicate that brain-to-brain coupling may be involved in touch-related analgesia.

hyperscanning | social touch | empathy | pain | EEG

Until recently, research on the sense of touch focused mainly on discriminative input to the brain and investigated sensory

derstand someone else's emotional experience or state—plays a key role in social touch (23) and pain reduction (33). There is widespread consensus that empathy for pain recruits brain structures that are also involved in the firsthand experience of the pain for which the empathy is being shown. Indeed, research has repeatedly demonstrated that pain and empathy for pain activate the bilateral anterior insular and anterior midcingulate cortex (34–36), triggering emotional resonance in the observer. In line with this, recent electroencephalogram studies reveal that alpha rhythms particularly over frontocentral underlie both self and other pain (37, 38). These studies imply that shared neural networks are activated in the target and the observer, suggesting that brain-to-brain coupling should occur during empathy for pain.

However, although traditional research on shared pain implies that the target of the pain and the observer undergo simultaneous activation, research to date has been based on a "single-person" approach. This approach involves an artificial environment in which a single isolated human response is simplified and analyzed, but it does not consider the additional element involved in social interaction per se and therefore does not allow testing real-time brain coupling between target and observer (39). Researchers have increasingly acknowledged that pain is affected by multidimensional factors. The biopsychosocial model posits that a physical illness such as pain can be explained by a