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LETTER

Commentary on "Working Memory Load-Dependent Cortical Mechanism of Distraction Analgesia in Healthy Individuals: An fNIRS Study" [Letter]

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Dear editor

We read with great interest the recent article by Du et al,[1] entitled "Working Memory Load-Dependent Cortical Mechanism of Distraction Analgesia in Healthy Individuals: An fNIRS Study", published in the Journal of Pain Research. The authors elegantly examined how increasing working-memory (WM) load during a cognitive task modulates pain perception and cortical hemodynamic responses measured by functional near-infrared spectroscopy (fNIRS). Their study provides valuable insights into the cortical mechanisms underlying distraction analgesia. We commend the authors for integrating behavioral and neuroimaging data in this field. However, several methodological, interpretational, and translational issues merit further discussion to enhance the robustness and clinical relevance of these findings.

Methodological Considerations in fNIRS Analysis

In Du et al's study, the sample consisted of 35 healthy university students aged 21–26 years. While this homogeneous sample helps control variability, it limits the generalizability of the findings. Cognitive load, attention control, and pain sensitivity are known to vary substantially with age, sex, and chronic pain conditions. Future research should consider more diverse populations, especially clinical cohorts, where cognitive modulation of pain may differ from that of healthy young adults. As Du et al also acknowledged in their limitations section, the restricted age range and the use of healthy participants constrain the generalizability of their results. Our intention is to further emphasize that these factors remain important considerations for future research, particularly when extending cognitive–pain modulation findings to clinical populations.

Furthermore, Du et al analyzed task-related oxyhemoglobin (HbO) changes and simple bivariate correlations between cortical regions. Although this approach captures local activation patterns, it may be confounded by systemic physiological noise and global signal fluctuations. The absence of short-channel regression or global signal correction can lead to inflated connectivity estimates. Employing advanced analytical techniques—such as partial correlation, coherence, or Granger causality—could improve the specificity of the observed cortical networks. It would also be beneficial if future reports provided detailed descriptions of preprocessing steps (motion correction, baseline drift removal, and filtering), as these factors substantially affect HbO variability in fNIRS studies involving pain tasks.

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Interpretational Issues Regarding the Directionality of Effects

Du et al interpreted their results as evidence that a higher WM load reduces pain perception. While this interpretation aligns with attentional control theories, it presupposes a unidirectional causal link from cognitive load to pain reduction. However, pain itself can disrupt working-memory performance, leading to apparent changes in cortical activation.[2,3] The possibility of bidirectional or reciprocal interactions between pain and cognitive effort warrants further consideration. Applying mediation or cross-lagged analytical frameworks could help disentangle whether WM load genuinely modulates pain processing or whether increased pain disrupts cognitive control circuits.

In addition, the authors focused primarily on prefrontal activation but did not address how other pain-relevant regions —such as the somatosensory cortex, insula, or anterior cingulate cortex—might contribute to the observed modulation. While fNIRS has limited depth sensitivity, future multimodal studies (eg, combining fNIRS with EEG or fMRI) may provide a more comprehensive understanding of the cortical and subcortical dynamics underlying distraction analgesia.

Translational and Conceptual Implications

Du et al further proposed that their findings could serve as a foundation for developing "cognitive-based analgesia interventions". While this translational perspective is appealing, extrapolating from an acute experimental pain model in healthy individuals to clinical applications requires caution. Chronic pain patients often exhibit altered prefrontal–limbic coupling, impaired executive function, and emotional dysregulation, all of which may attenuate the analgesic effects of cognitive load.[4–6] In these populations, distraction tasks may even increase stress-related arousal, thereby diminishing pain relief. Future studies should therefore incorporate patient cohorts, longitudinal designs, or ecological pain paradigms to validate the potential clinical relevance of distraction-based cognitive modulation.

Conclusion and Future Directions

In conclusion, Du et al have made an important contribution to the understanding of cortical mechanisms involved in distraction analgesia using fNIRS. Their study highlights the importance of cognitive control in modulating pain perception. Addressing methodological limitations in fNIRS preprocessing, expanding sample diversity, and clarifying the directionality of WM–pain interactions will further strengthen the interpretability and translational value of this line of research. We appreciate the authors' efforts to advance this promising area and hope our comments will stimulate continued discussion and refinement of experimental designs for future pain neuroimaging studies.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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