Using fNIRS (functional near-infrared spectroscopy) to investigate the prefrontal cortex control of oropharyngeal swallow in a healthy female: A case study

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Background: This study explores cortical activity patterns during swallowing tasks using functional near-infrared spectroscopy (fNIRS), focusing on both actual and imagery of swallowing under different texture conditions (saliva, water, pudding, and rice noodles). Precise coordination between sensory-motor and prefrontal regions is essential for normal swallowing, such as the dorsolateral prefrontal cortex (DLPFC) and orbitofrontal cortex (OFC). Growing evidence from neuroimaging suggests that both motor execution (ME) and motor imagery (MI) activate overlapping but distinct neural networks, offering insights for neurorehabilitation in dysphagia.

Methodology: One healthy young female participant completed a series of swallowing and imagery tasks using four food textures corresponding to IDDSI Levels 0, 2, 4, and 7. The study implemented strict controls to minimize motion artifacts, including specific delivery methods for food intake and environmental restrictions. The fNIRS device monitored hemodynamic changes during each task block, and data were analyzed with a time-series correlation approach rather than traditional statistical tests. This method enabled the assessment of similarity in cortical activity patterns between actual and imagery of swallowing, with a particular focus on the DLPFC and OFC.

Results: Strong correlations in brain activities across regions during actual swallowing, while such correlations decreased during imagery tasks, suggesting altered network integration during mental imagery. The study's use of solid and semi-solid food items enhanced ecological validity, though it also introduced challenges related to motion artifacts and task timing. A major methodological innovation of this study involved using both sequential and reverse task orders to probe priming effects in cortical activity, potentially offering an alternative approach to understanding the neural mechanisms of swallowing.

Conclusion: Despite its strengths—innovative design and rigorous control measures—the study was limited by a single-subject sample and the sensitivity of the correlation-based analysis to variability in swallowing duration. Future research should adopt functional connectivity analyses, larger participant samples, and a hybrid approach that integrates conventional statistical methods with time-series modeling. This will increase generalizability and yield a more comprehensive understanding of the neurophysiology of swallowing. Our findings may provide insights for investigating the network dynamics of swallowing, which may help advance dysphagia rehabilitation.

References

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