

Characterizing Misophonia-Related Brain Activity Using fNIRS – A feasibility study

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Abstract: Misophonia is characterized by decreased tolerance to specific sounds that elicit strong negative emotional, physiological, and behavioral responses. While fMRI has explored these mechanisms, loud scanner noise and enclosed environments confound neural measurements and heighten anxiety. We evaluated functional near-infrared spectroscopy (fNIRS), a quiet, portable optical neuroimaging modality, to study misophonia. We recorded fNIRS, Photoplethysmography (PPG), and Electrodermal Activity (EDA) in 10 healthy adults during trigger, unpleasant, and neutral sounds. Unpleasant and trigger sounds elicited greater cortical activation than neutral sounds. Unpleasant sounds also induced heart rate deceleration. This study validated the feasibility of using fNIRS to study misophonia.

Introduction: Misophonia is characterized by decreased tolerance to specific sounds or sound-related stimuli (“triggers”) that elicit strong negative emotional, physiological, and behavioral responses. A prior fMRI study¹ linked trigger sounds to orofacial motor activation, with activation level scaling with misophonic distress.

However, the MRI environment is poorly suited for studying auditory responses in misophonia. The loud (90-120 dB)², enclosed MRI environment contaminates auditory stimuli, alters sound perception, heightens anxiety responses³, and confounds neural measurements². In addition, MRI is costly and non-portable, limiting its potential for future clinical deployment or longitudinal monitoring.

To overcome these limitations, we proposed using functional near-infrared spectroscopy (fNIRS), a quiet and portable optical neuroimaging modality, to assess cortical responses to misophonia trigger sounds in an acoustically isolated environment. To evaluate fNIRS feasibility, we replicated the experimental procedures used in prior fMRI work¹, substituting an fNIRS device to determine whether activation in the orofacial motor area could be detected.

Methods: Participants completed a single 2-hour visit involving consent, demographic and misophonia surveys, fNIRS cap placement, and a bilateral screen to confirm normal hearing status (20 dB HL at octave intervals from 250 Hz to 8000 Hz). Using PsychoPy for precise stimulus delivery and timing, we simultaneously recorded fNIRS, PPG, and EDA to assess neurovascular and physiological responses. During the task, participants heard three categories of sounds: (1) trigger sounds (e.g., chewing); (2) unpleasant sounds (e.g., infant crying); and (3) neutral sounds (e.g., rain). After each 15s sound, participants rated sound annoyance and antisociality. We presented 126 trials (42 per category) across five ~11min sessions.

Results: We collected fNIRS, EDA and PPG data from 10 healthy controls across three experimental conditions. Figure 1 shows the brain activation maps derived from fNIRS data. PPG extracted heart rate decreased significantly during the unpleasant sounds compared to the neutral sounds. There were no differences in EDA related results across three conditions.

Conclusion: Overall, the results indicate greater brain responses during the unpleasant and trigger sound conditions compared to the neutral condition. This study validated the feasibility of using fNIRS to study misophonia. Future studies will utilize this paradigm to collect data on participants with misophonia and conduct comparison analysis with age- and sex- matched controls.

References: 1. S. Kumar et al., “The Motor Basis for Misophonia,” *Journal of Neuroscience* 41(26), 5762–5770, Society for Neuroscience (2021).

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