Research Project: **Uncovering the Neural Basis of Authentic Emotion Recognition**

Theoretical background

Understanding whether an expression is genuine or not is an important skill in social context in order to appropriately behave. However, emotions conveyed by emotional faces classically used in the research on emotions are posed (deliberately produced without reflecting the felt emotion). Two recent datasets tried to overcome the absence of an ecological dataset of emotional expressions (Dawel et al., 2017; McLellan et al., 2010). However, both have insurmountable drawbacks that prevent them from drawing conclusions on authenticity perception (they proposed static 2D images instead of dynamic stimuli). The use of dynamic stimuli represents an important feature in reaching a higher ecological validity in laboratory settings. Indeed, research on the brain correlates of the perception of emotional expressions could be potentially flawed as so far only the perception of static posed emotions has been investigated. Thus, it is not clear whether the results reported in the literature really reflect the processing of emotions or rather they reflect the processing of the non-authenticity of the perceived emotions. The identification of how the brain encodes authentic and non-authentic emotional expressions is important for basic affective neuroscience research. Several neurobiological models of emotion processing have been proposed, yet these have been based almost exclusively on functional activation, and so lack a refined understanding of the connectivity between implicated regions. The concertation of processing stages in different brain regions necessary for an understanding of others' emotions is well delineated by a recent theoretical model proposed by Wood (Wood et al., 2016), which considers the recognition of others' emotions as a complex process involving parallel activation of two different systems, one for the visual analysis of faces and facial expressions and a second one for sensorimotor simulation of facial expressions. A crucial aspect of Wood's model is that the brain regions devoted to the simulation mechanism may send information back to visual areas to influence the quality of the representation of facial expressions. However, at the moment there is no direct evidence of this fascinating aspect of Wood's model.

Aims and Hypotheses

The aim of the present project is to shed light on the way the human brain makes humans able to recognize the authenticity of an emotional expression. As the ultimate goal, by improving the functional connectivity of the visuo-motor network, we aim to enhance emotion authenticity recognition abilities. We hypothesize that the functional connectivity between the motor and the visual systems might be the key component essential for the correct discrimination of authentic versus posed emotions.

Methods

Participants: sample size and justification of the sample size

A power analysis based on previous published studies (e.g., Romei et al., 2016) indicates that a sample size of 15 participants is necessary to achieve a statistical power of > 95% (2-tailed = 0.05) (G*Power). Thus, 30 healthy volunteers will be tested in two experiments.

Tools

Participants will be shown short videos depicting authentic and not authentic emotions (happy, fear, and disgust) selected from the PEDFE dataset (Miolla et al., 2023) and they will be asked to judge whether the emotion is authentic or not (forced choice) and to rate its authenticity and intensity (Likert scale from 1 to 9). To boost functional connectivity we will use an innovative TMS protocol called ccPAS, able to induce spike-timing-dependent-plasticity (Romei et al., 2016).

Procedure

Participants will undergo a cccPAS protocol before the authenticity recognition task. The ccPAS is a TMS protocol able to foster the neural pathway between interconnected areas. The directionality of the stimulation pulses will be manipulated across experiments. Participants' performance at the authenticity recognition tasks will be compared before and after the ccPAS administration.

Statistical analyses

Accuracy and reaction times (RTs) will be collected during the emotion authenticity recognition task before and after the ccPAS administration. Analysis of variance (ANOVA) will be used to investigate differences within and between groups. Post-hoc analyses will be conducted with the Newman-Keuls test, and the significance threshold will be set at $p < 0.05$.

Declaration of commitment to request ethical approval

All procedures have been already approved by the Bioethical Committee at UNIBO, Prot. 0335994 del 14/11/2023.

Expected results and Implications

If the functional connectivity between the motor and the visual systems is critical for emotion authenticity recognition, then strengthening their projections should increase performance in the emotional authenticity recognition task, thus making participants more able to correctly discriminate authentic versus posed emotions. No changes in performance are expected after having increased the connectivity of control areas (premotor-motor). The key scientific highlight will be the discovery of the neural network subtending the recognition of emotion authenticity using dynamic stimuli. This knowledge will open the possibility of ameliorating our emotion authenticity discrimination, by our innovative TMS protocol, which is able to boost the functioning of the visuo-motor network. Moreover, the lack of emotion authenticity recognition is a component of a variety of psychiatric conditions and the understanding of its neural dynamics could open the door to understanding how to modify these maladaptive mechanisms.

References

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Wood, A., Rychlowska, M., Korb, S., & Niedenthal, P. (2016). Fashioning the face: Sensorimotor simulation contributes to facial expression recognition. *Trends in Cognitive Sciences*, *20*(3), 227–240. https://doi.org/10.1016/j.tics.2015.12.010

Plan of activities

Research environment: the proposed project will be carried out at the Center for studies and research in Cognitive Neuroscience in Cesena.

Project activities: literature review to acquire relevant theoretical knowledge and to define stimulation parameters and behavioral procedures, recruitment of participants, execution of a pilot study to assess experimental duration and participant's compliance, data collection and analysis, writing of a draft of the main findings to be submitted to a scientific journal and research dissemination at national/international congresses.

Training activities: readings, discussions with the supervisor, direct involvement in lab meetings, attendance of lectures and workshops, revision of manuscripts; activities aimed at acquiring: 1) theoretical knowledge about key models and thematic areas related to cognitive neuroscience of action control; 2) skill for designing and conducting scientific research projects, data analysis and use of non-invasive brain stimulation procedures; 3) writing and oral communication skills for scientific dissemination.

Timing of activities: literature search designing and piloting (Oct 2024 – November 2024); Data collection and analysis (November 2024 – August 2025); Dissemination (May 2025 – November 2025).

Feasibility of the project: the project is highly feasible and involves low risks. The supervisor has acquired extensive expertise in the methods and has already conducted several studies using TMS. Procedures have been already approved by the ethical committee at UNIBO. All the tools and research materials have been already acquired. Based on previous studies we predict mid/large effect sizes; therefore, an adequate sample can be acquired in less than 10 months.