The effects of facial NMES on emotion recognition

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Introduction

- According to the facial feedback hypothesis (FFH), engaging facial muscles can influence one's emotional state and affective judgments (Coles, Larsen, & Lench, 2019).
- Numerous methods have been used to examine the impact of facial feedback (posing, holding a pen in the mouth, and Botulinum toxin).
- Facial NMES, a lesser-known approach which utilises electricity to engage facial muscles, has been used to alter one's emotional experience and treat symptoms of depression (Kapadia et al., 2019; Yen-Chin et al., 2017; Zariffa et al., 2014).
- Because the time the muscle can be engaged can be precisely controlled and modified, facial NMES has advantages over other approaches. For example, can be engaged for as little as 100 ms or as long as several minutes.
- Furthermore, it can be activated at various points during the experiment, such as before or during stimulus onset.
- To date, no study has yet investigated facial NMES as a means of modulating one's perception of emotional facial expressions.
- We present preliminary findings from four pilot investigations in which we used face NMES to induce facial feedback effects.

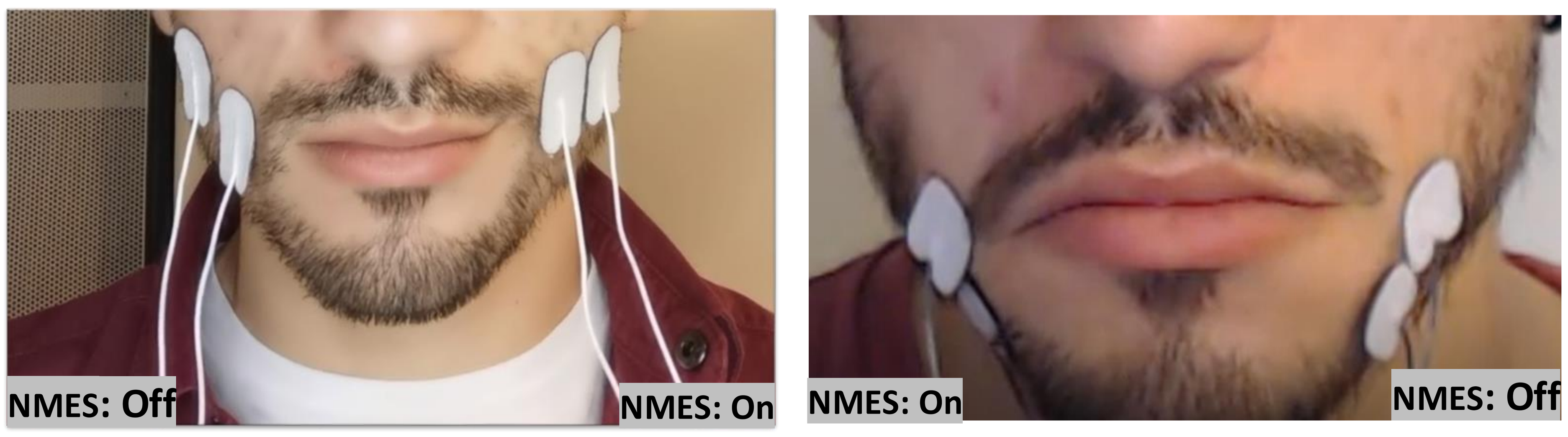

Fig 1. (A) An example of facial NMES with electrodes over the Zygomaticus Major (ZM) with the lip corner pulling up. When the electricity is applied (ON), the muscle contracts and pulls the lip corner. (B) An example facial NMES of the Depressor Anguli Oris (DAO) with the lip corner pulling down.

Methods

• Participants completed a 2-Alternatives-Forced-Choice Task in which they categorised emotional facial expressions as happy or sad.

• Across different pilots, facial NMES was delivered either to the Zygomaticus Major (ZM) or Depressor Anguli Oris muscles (DAO).

•The muscle was stimulated for 500 ms at 70 Hz biphasic square pulse with a pulse delay of 14 us, pulse width of 100 ms. The intensity was adjusted for each participant to maximise comfort.

•NMES was either before or during visual stimulus onset.

•Across pilots, we varied the stimulation intensity. In some cases, NMES was delivered at 50% of motor threshold (MT/2).

A summary of each pilot

•In pilot 1 the ZM was at 50% of MT before stimulus onset (n = 10, M age = 27.4, SD = 7.02).
•In pilot 2, the ZM was at 50% of MT during stimulus onset (n = 9, M age = 25.9, SD = 4.01).
• In pilot 3, we stimulated the DAO muscle at 100% of MT before and during stimulus onset (n = 18, M = 22.4, SD = 4.06). Additionally, EEG data was recorded using eegoSports (ANT Neuro, The Netherlands) from 64 scalp electrodes at a sample rate of 512 Hz.
• In pilot 4, the ZM was stimulated before and during visual stimulus onset at 50 and 100% of MT (n = 22, M = 22.2, SD = 3.32).

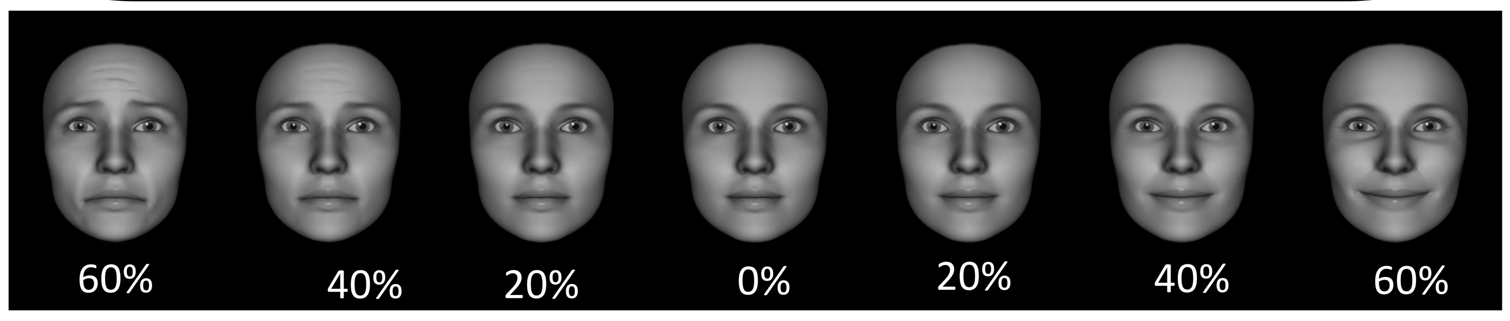

Fig 2. A single avatar conveying sadness and happiness in steps of 20%, progressing from 60% (sad) to 60% (happy), with the intermediate (4th) image neutral (0 percent).

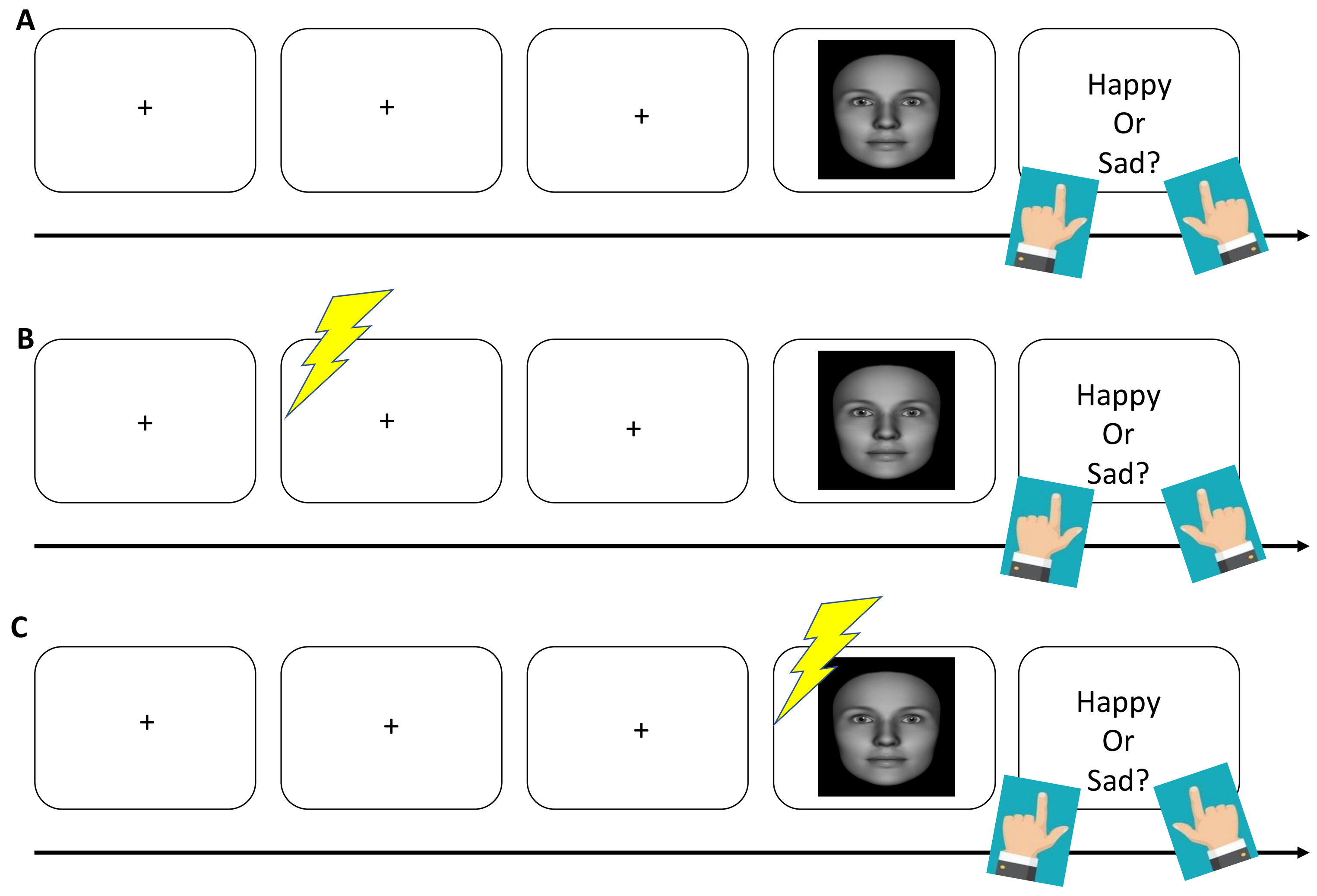

Fig 3. The task layout is as follows: (A) the first row depicts the NMES off condition, (B) the second row depicts the NMES before condition, and (C) the last row depicts the NMES during condition.

Results

- Each pilot was analysed separately using Generalised Linear Mixed-Effects binomial model (GLMM), using the glmer function of the lme4 package in R. The model included participants' choice. The stimulus emotion was centered and entered as a continuous variable, while NMES was entered as a factor (reference: off). Formula: with the formula (choice ~ NMES * emotion + (1 | participant).
- There was no significant effect of NMES on emotion categorisation were found in pilot 1 and 2. With the odds of participants categorising the face as happy or sad being equally likely. However, in pilot 2 (in which the DAO was stimulated) we see the odds of choosing happy at 100% of MT decreasing compared to pilot 3 (in which the ZM was stimulated).
- There was an effect of NMES on early visual processing in the EEG data for pilot 2 (see Fig 5). Specifically, when a frown is elicited by applying facial NMES to the DAO, we find a reduced response of the N170 component toward neutral faces (0% in Fig. 2).
- In pilot 3 we find a significant main effect of NMES-during and a marginally significant effect of NMES-before. Raw and modelled data are shown in figure 6.

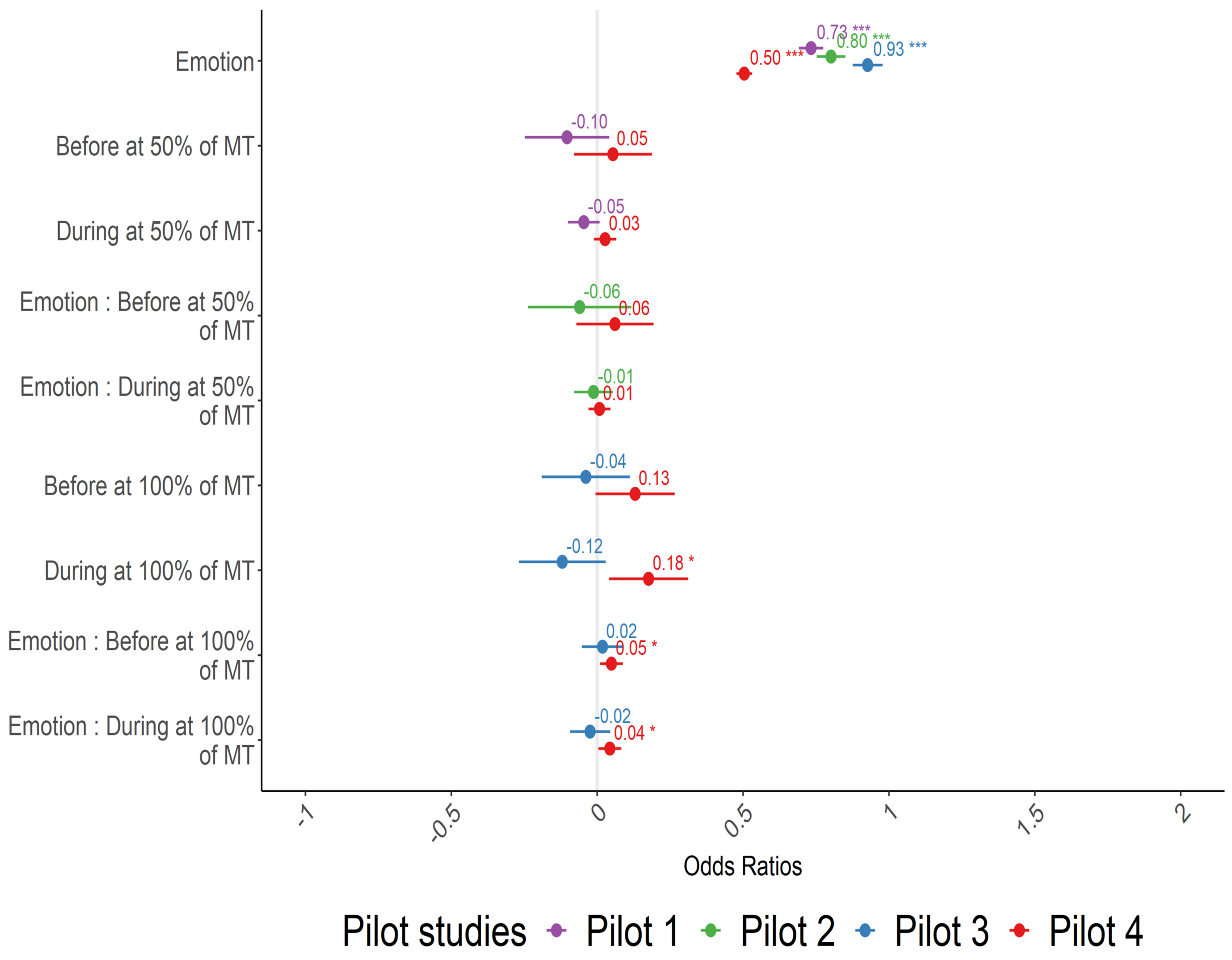

Fig 4. Model summaries for each pilot. Presented are the odds of the participant categorising the face as happy compared to sad. * = p < .05; ** = p < .01; *** = p < .001

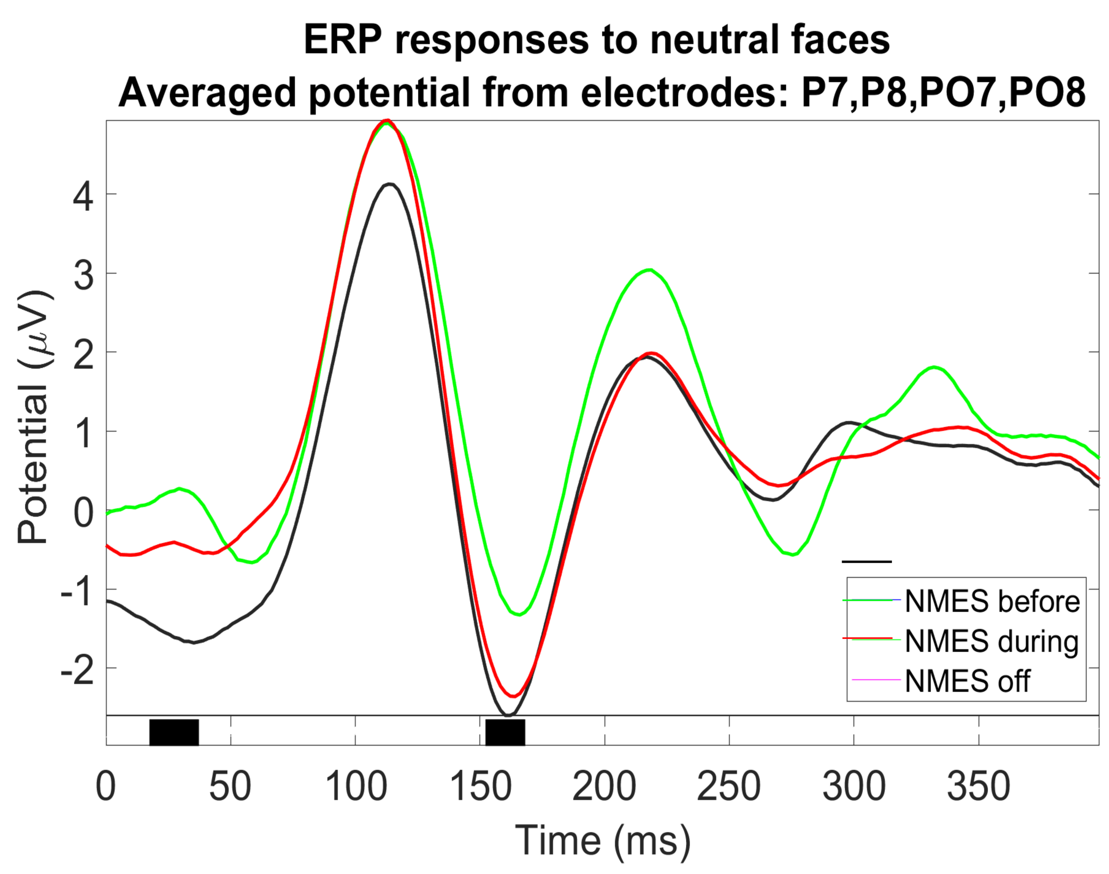

Fig 5. The ERP results are from Pilot 2, in which the DAO was activated. Occipital-temporal electrodes from the left hemisphere are plotted between 0 (visual stimulus onset) and 400 ms. Permutation statistics were conducted, and a Holms' correction was applied to correct for multiple comparisons. Black bars indicate p < .05.

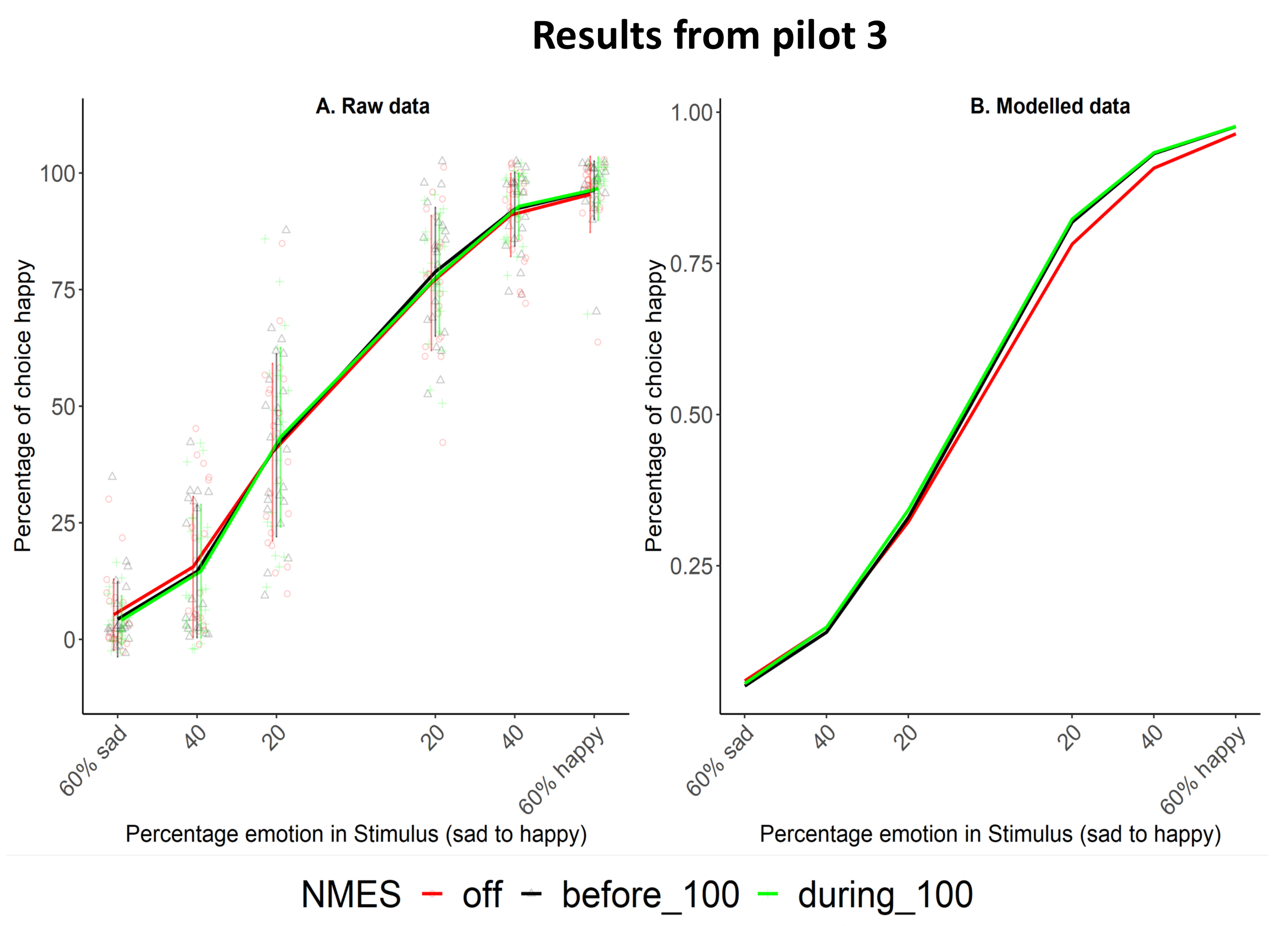

Fig 6. (A) Lines represent the average percentage of trials categorised as happy,
by emotional expression and NMES condition. Raw data (jittered to improve visibility) is shown with, green crosses (NMES during) blue triangles (NMES before) and red circles (NMES off). (B) Marginal means of the GLMM fitted to the data.

Conclusions

- The behavioural results of pilots 1 and 2, did not show the expected facial feedback effects. However, this may be due to the task design which displayed the face for a long period of time (1 – 1.5 sec). Task difficulty was increased in pilot 3.
- However, in pilot 2 in which EEG was recorded, we see a significant differences between the conditions for the N170 components. However, this is preliminary, and we intend to follow up in future studies by comparing DAO and ZM stimulation on the N170 ERP.
- Finally, in Pilot 3, we discovered a behavioural effect of facial NMES given to the ZM at 100% MT. Specifically, the odds of classifying a face as happy vs sad were higher.
- A replication in a greater sample is now under way.

References:

• Kapadia, et al. (2019). *BioMedical Engineering OnLine*, *18*(1), 109.
• Yen-Chin, et al. (2017). *Proceedings of the Eleventh International Conference on Tangible, Embedded, and Embodied Interaction*, 579–582.
• Zariffa, et al. (2014). *Neuromodulation: Technology at the Neural Interface*, *17*(1), 85–92.