UNIVERSITÄT LEIPZIG
Experimental Psychology and Methods

The role of Semantic and Emotional Content in Visual Cortex Processing

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Introduction:

Emotional stimuli have the capacity to engage our attention in an involuntary bottom-up manner, overriding top-down control and prioritising their processing due to their high threatening or rewarding potential, reflecting enhanced sensory gain in primary visual regions, conveyed via re-entrant feedback signals from amygdala and higher cortical regions. Nonetheless, the relationship between the semantics versus the emotional content at the visual cortex remains unclear. Therefore, the present study aims to analyse the electrocortical response to neutral and emotional (pleasant & unpleasant) complex visual stimuli with and without semantic meaning in the visual cortex.

Materials & Methods:

Frequency-taggled Steady-State Visual Evoked Potentials (SSVEPs) were EEG recorded and analysed under a passive viewing Rapid Serial Visual Presentation (RSVP) paradigm at 4 Hz, where each image were exposed during 250 ms. RSVP streams were conformed by meaningless images followed by intact neutral or emotional (pleasant & unpleasant) complex scenes taken from the International Affective Picture System (IAPS). Keeping constant the low level features of stimuli, meaningless images consisted on phase-scrambled versions of the intact IAPS pictures. Critically, emotional images differed at valence but not at arousal dimension.
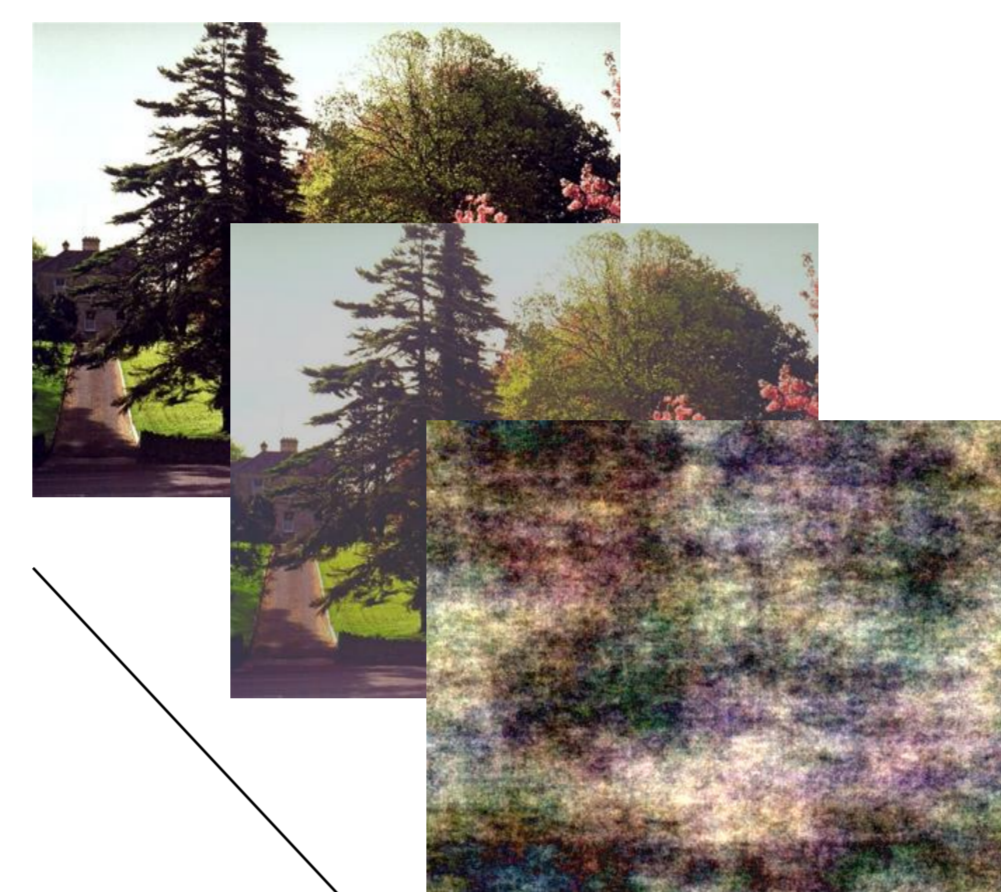
1.a.
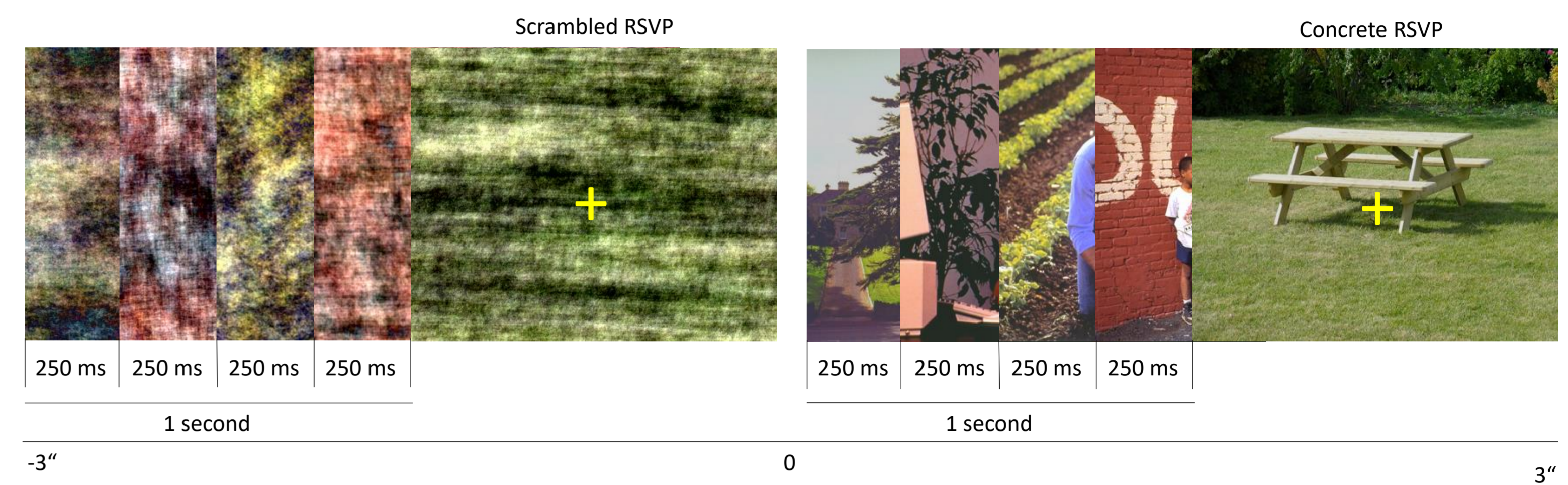
1.b.

Figure 1.a. illustrates the 2 steps image processing to [1st] unify the low level features (brightness & contrast) across images, and [2nd] generate the phase-scrambled meaningless stimuli from the intact complex IAPS scenes. Figure 1.b. exemplifies trial composition, where scrambled images are presented during 3 seconds at 4 Hz (250ms each), followed by intact images exposure during 3 additional seconds in an uninterrupted 4 Hz RSVP stream. Time point 0 represents the change from scrambled to concrete images in the RSVP streams.

Results:

ANOVA II time course analyses revealed significant differences regarding the semantic content ($F_{1,15}= 9.62$; $p< .01$), pointing to greater SSVEP amplitude responses to intact complex scenes compared to its scrambled versions ($t_{1,15}= -3.81$; $p<.01$) (figures 2.c & d). No significant differences were found for the global main effect of emotional category, neither for interaction between both factors. Following post-hoc analyses revealed significant differences between emotional (pleasant ($t_{15}= -3.20$; $p< .01$) & unpleasant ($t_{15}= -3.25$; $p< .01$)) Vs. neutral stimulation during intact image exposure. No significant differences across emotional conditions (pleasant Vs. unpleasant) were found. The analysis of the SAM rating scores (see figures 3.a & b) of the stimuli revealed interaction across conditions for both, valence ($F_{1,15}= 83.32$, $p< .01$) and arousal ($F_{1,15}= 17.22$, $p< .01$). Post-hoc t-tests revealed coherent scores with IAPS ratings. Critically, no significant difference were found across emotional conditions (pleasant & unpleasant) regarding the arousal dimension.
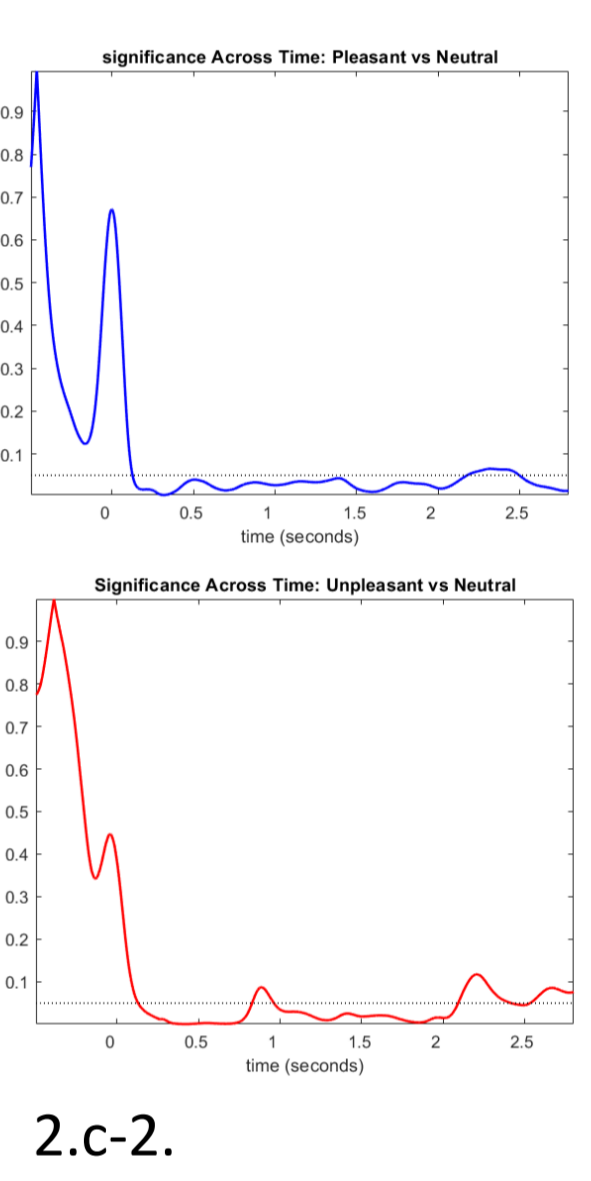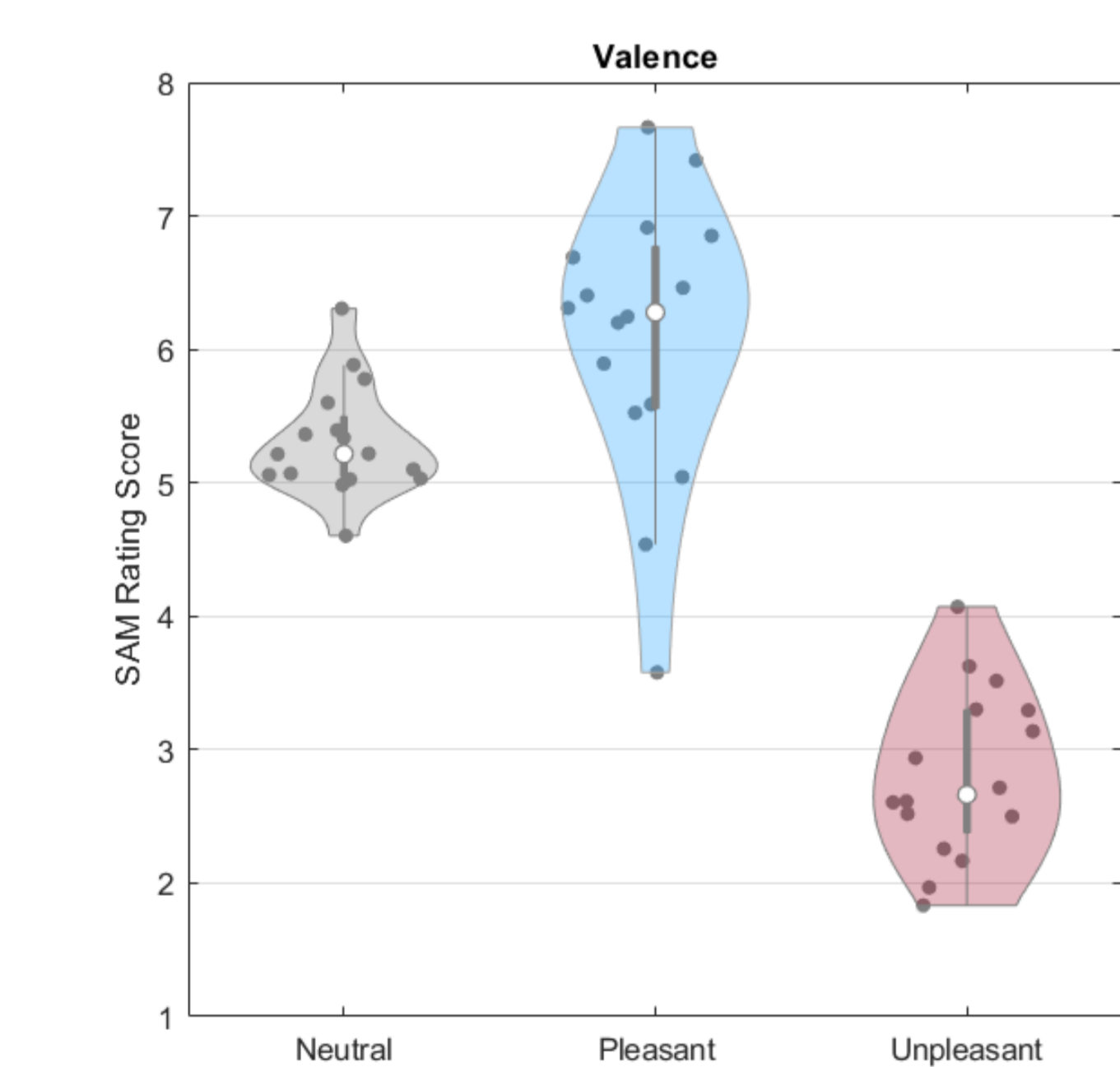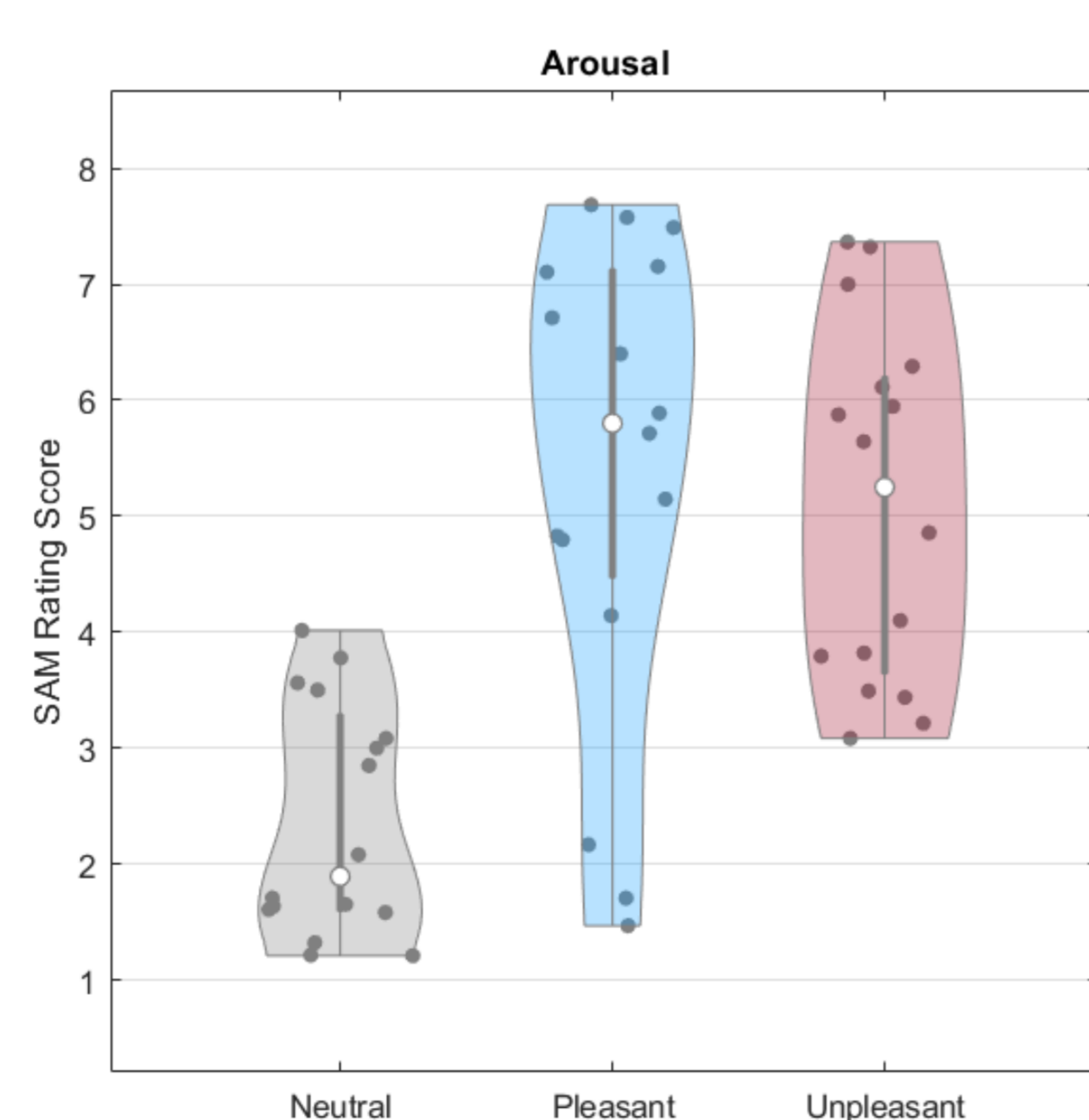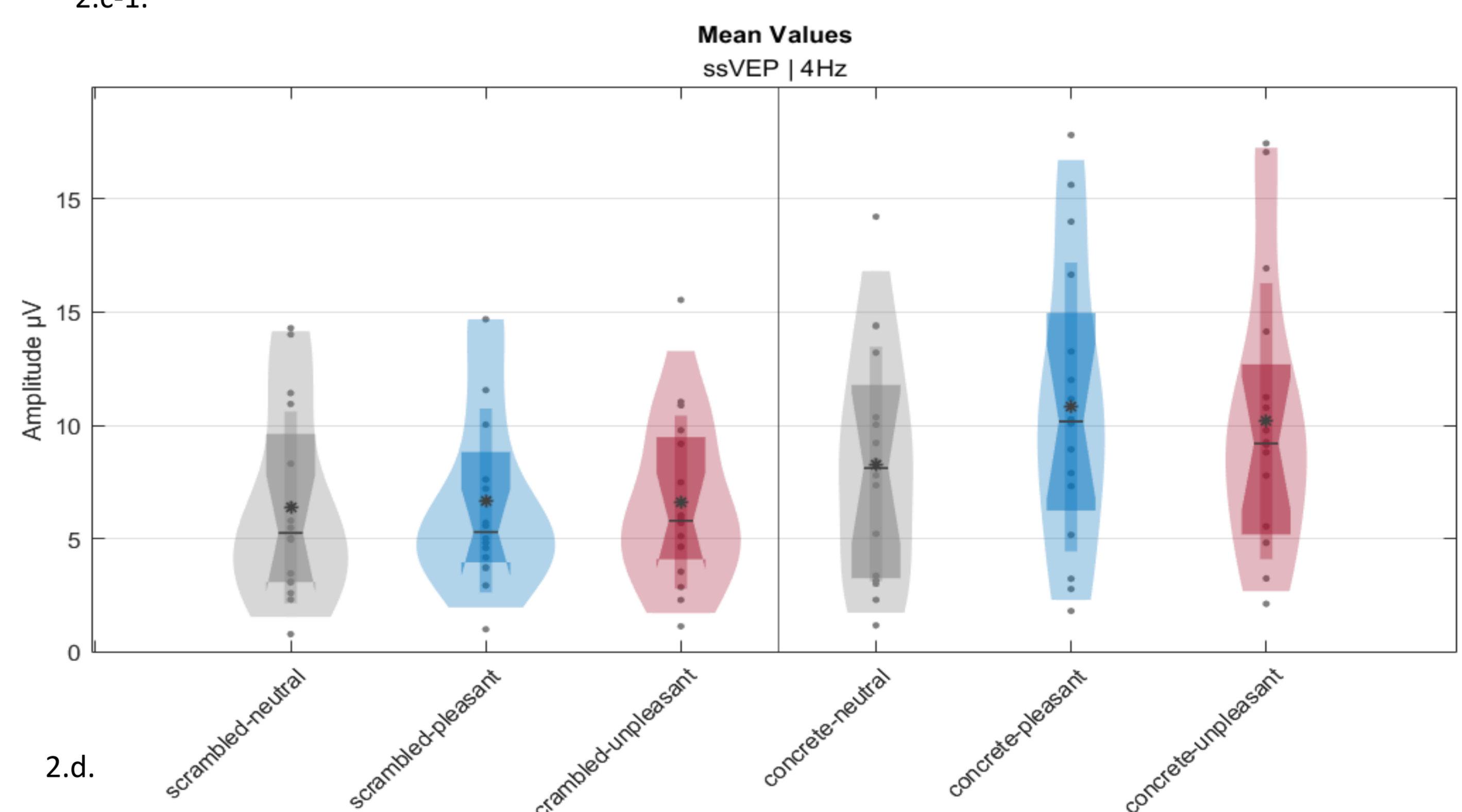
2.c-1.

2.c-2.

2.a.

2.b.
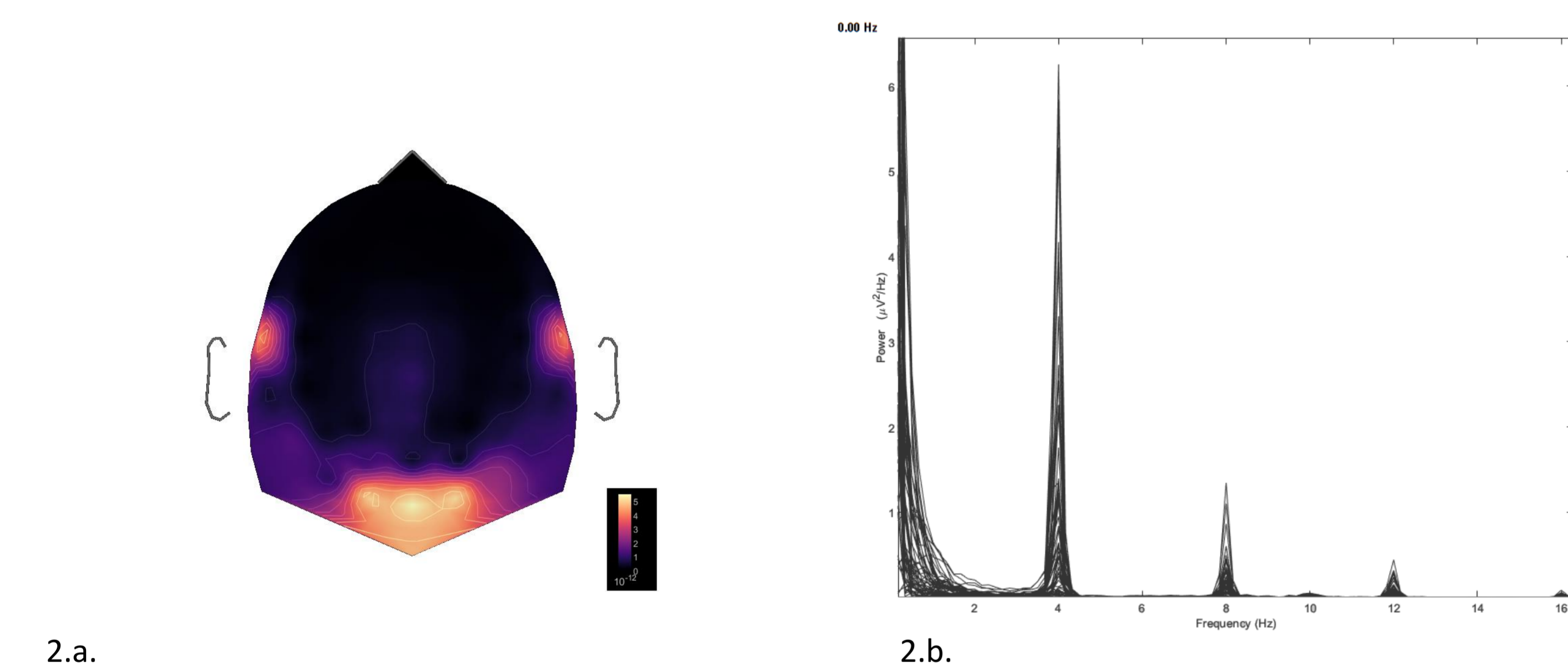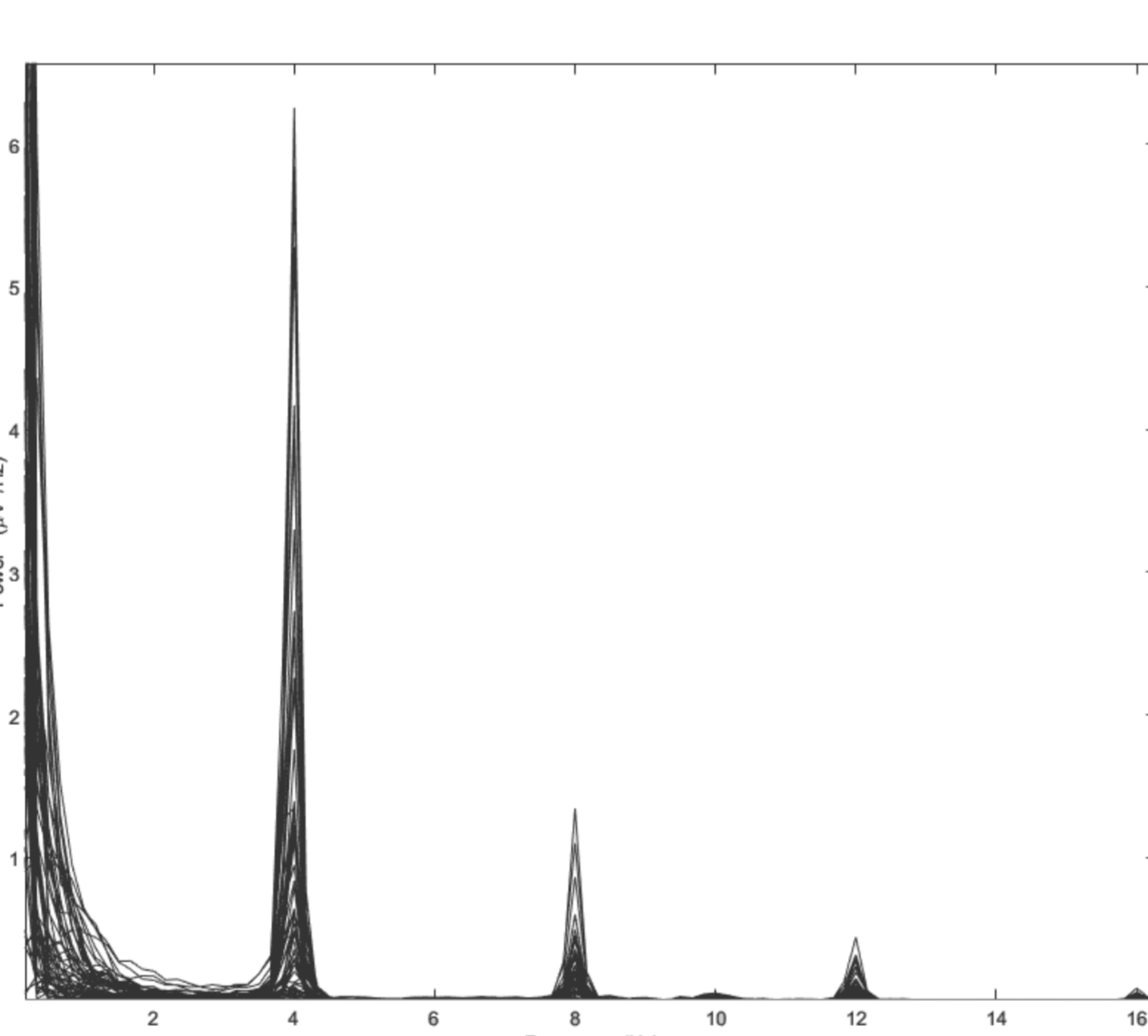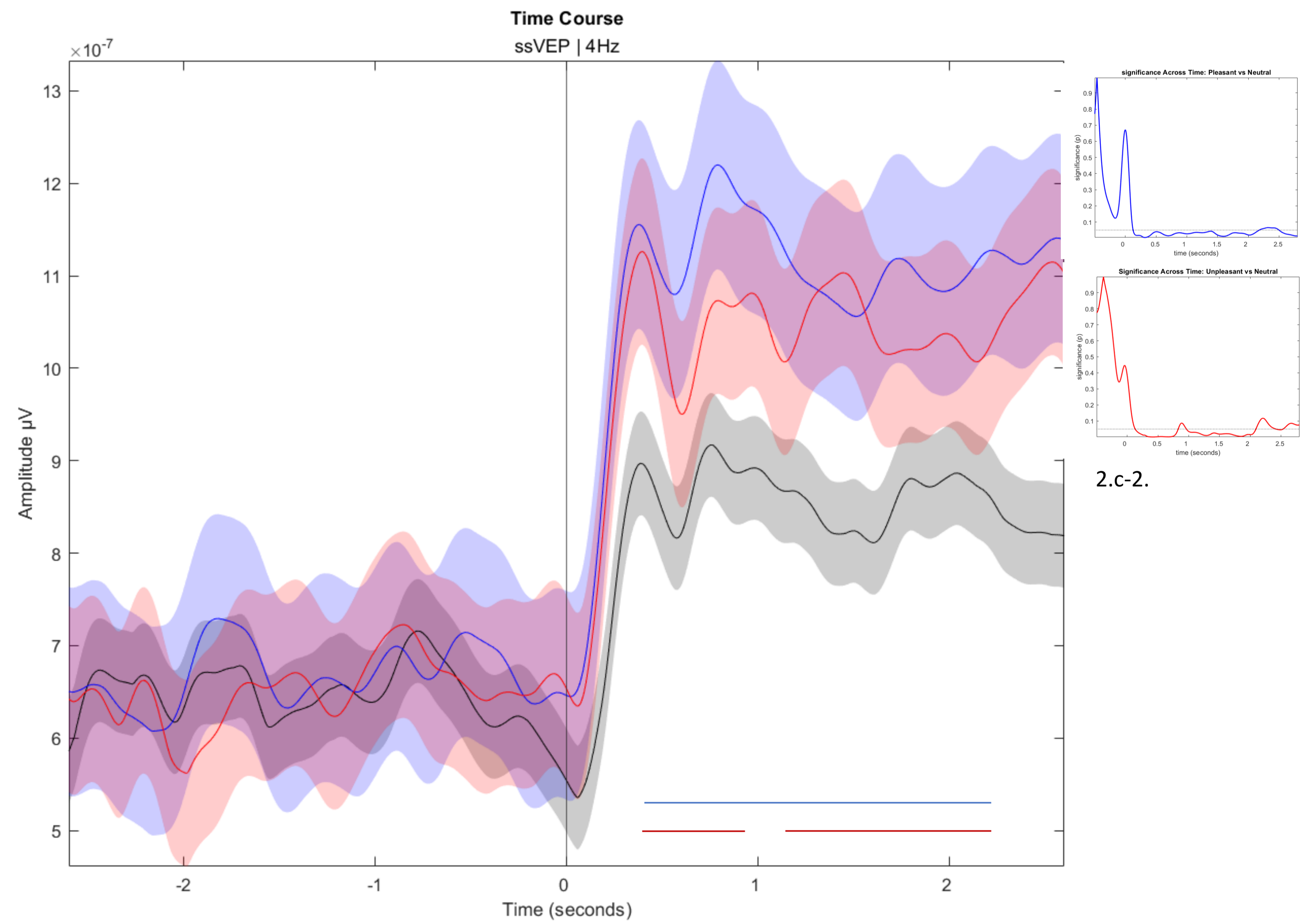
3.a.

3.b.

2.d.

Figure 2.a. shows the topography of the 4 Hz SSVEP response to the 4 Hz RSVP stimulation. Figure 2.b. depicts the *Fast Fourier Transform* (FFT) EEG values of the collapsed conditions, with a main peak at the stimulation frequency (4 Hz) and the subsequent harmonics at 8,12 and 16 Hz. Figure 2.c-1 illustrates the SSVEP time-course of the averaged signal at the frequency of interest (4 Hz), recorded by the relevant electrodes illustrated in figure 2.a. , depicting the change in the amplitude from scrambled-to-concrete change in RSVP streams for each emotional category. Figure 2.c-2 illustrates the significant differences between pleasant & unpleasant Vs. neutral condition during the concrete phase of the RSVP. Figure 2.d. collects the average values of the SSVEP response for each condition during scrambled & concrete phases of RSVP stimulation. Figure 3.a & b illustrate the SAM rating scores for valence & arousal (respectively) for each emotional condition.

Discussion:

Our results suggest that differences in the priority processing of emotionally relevant elements do not depend (solely) on the low-level properties of the images, such as colour or contrast, but on their semantic content. Furthermore, the absence of significant differences in SSVEP amplitudes during emotional stimulation with respect to the valence dimension (Pleasant vs. Unpleasant) suggests that the enhanced sensory gain would be mainly driven by the arousal.

Bibliography:

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