Stereoscopic vision and emotional face processing: insights from a combined EEG and virtual reality study

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Mind Body Emotion

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Introduction

Facial expressions are configurations of salient landmarks within three-dimensional facial structures.

Stereoptic depth cues can improve face processing, possibly attributed to extra spatial information or to their prevalence in human interactions [3,6].

We investigated potential differences in the neural representation of facial expressions perceived stereoscopically compared to those without stereoscopic information.

Multivariate decoding represents a sensitive approach to investigate traces of face processing in the EEG [5].

Analyses

EEG preprocessing

semi-manual ICA rejection

automated epoch rejection and channel correction (autoreject) [2]

bandpass filter: 0.1 – 40 Hz

baseline subtraction: 200 ms pre-stimulus

Decoding

sliding classifier (10 ms window): logistic regression

repeated (50x) 3-fold cross-validation

features: EEG per channel (avg. across 3 trials)

decoding targets:
- emotional expression (multi-class, binary)
- viewing condition (binary)
- identity (multi-class)

Statistics

cluster-corrected *t*-tests

(one-sided, against theor. chance level)

Methods

Setup

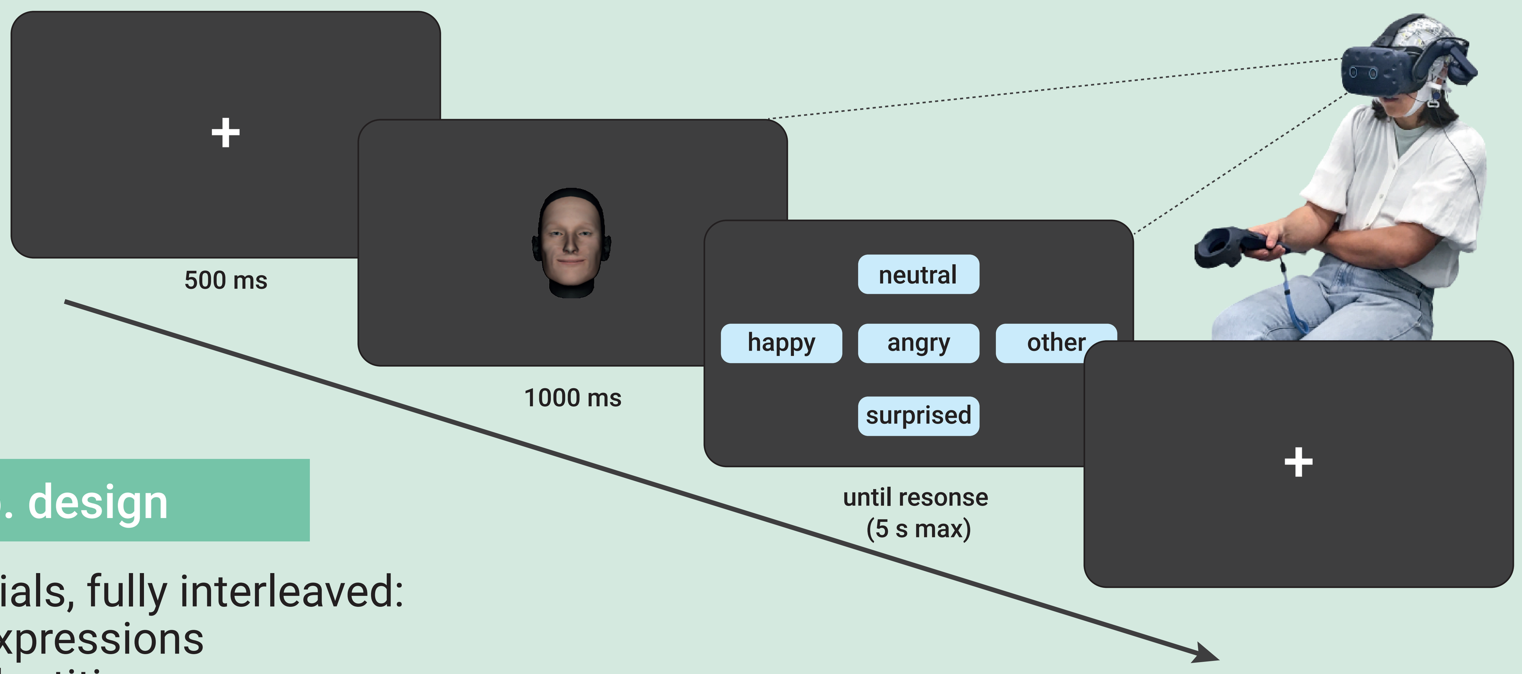
EEG

BrainProducts LiveAmp
60 channels (+ 4 EOG)
500 Hz

VR

HTC Vive Pro Eye
90 Hz refresh rate
eye-tracking (120 Hz)

Participants:
- N = 34 (all female)
- tested for stereopsis



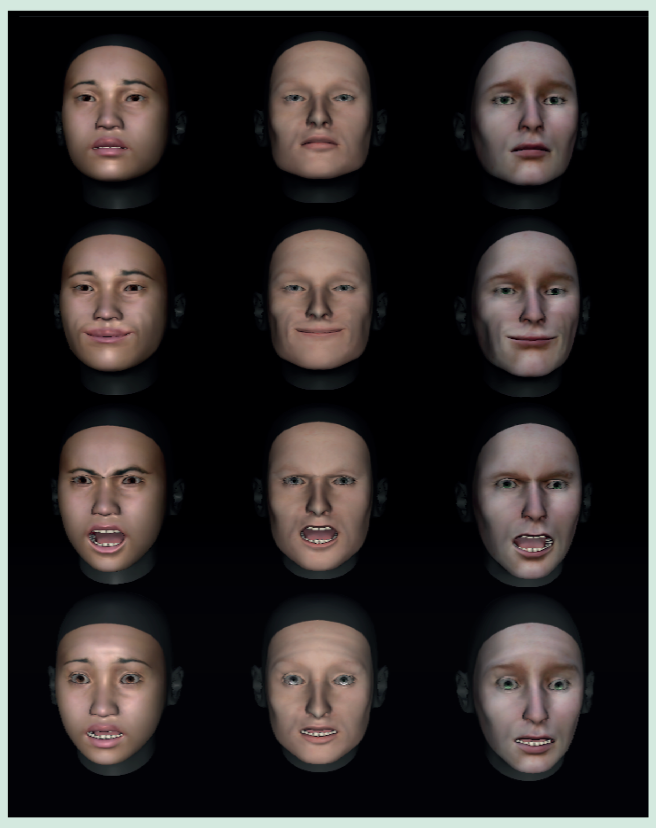
Exp. design

720 trials, fully interleaved:
- 4 expressions
- 3 identities
- 2 viewing conditions

Stimuli

Created with MakeHuman [4] + FACSHuman [1]

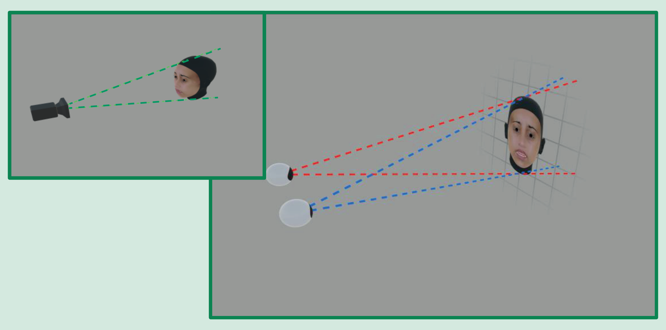
Validated [1] (in 2D and b/w)



Viewing conditions

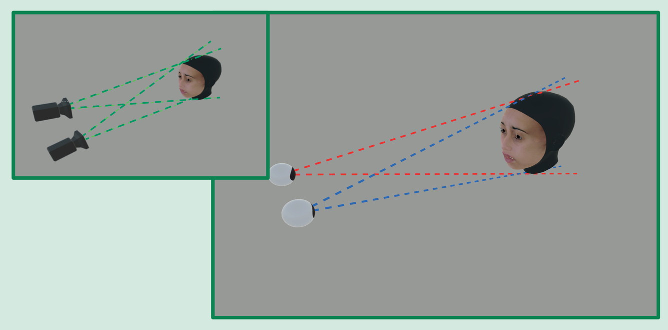
For both viewing conditions, the stimuli were presented as frontal portraits in the VR headset.

Monoscopic



The 3D object is captured with a single (virtual) camera and the resulting 2D image is presented as a plane in the virtual environment (comparable to showing a picture on a screen). The visual input to both eyes is therefore identical.

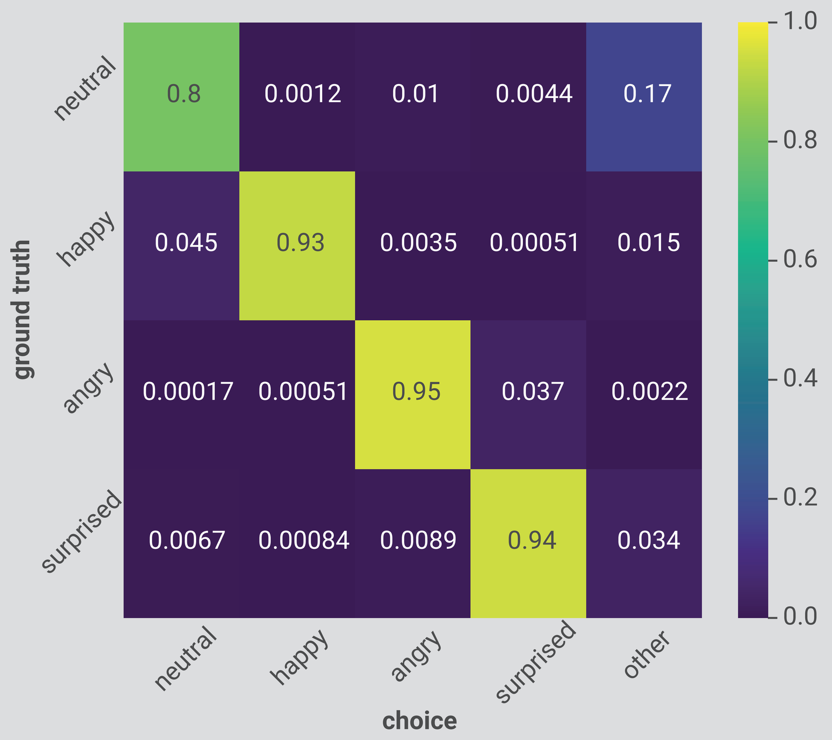
Stereoscopic



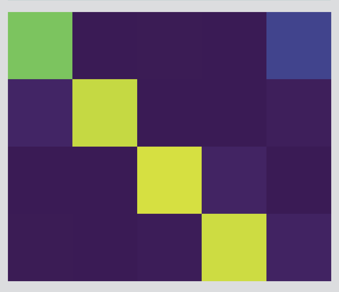
Two (virtual) cameras record a 3D object with slightly different perspectives. The two images are separately rendered to the observers two eyes (here using the two displays in the VR headset). This creates the impression of spatial depth.

Results

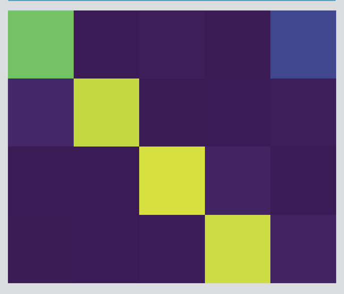
Behavior



monoscopic

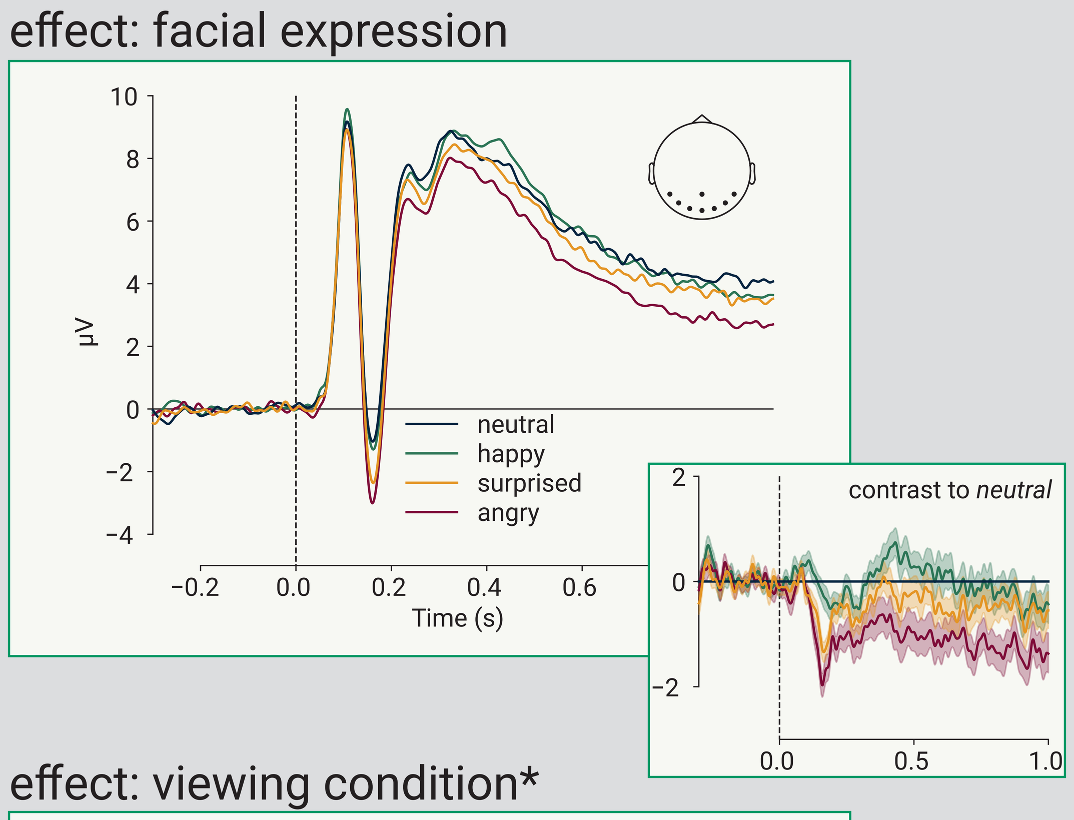


stereoscopic

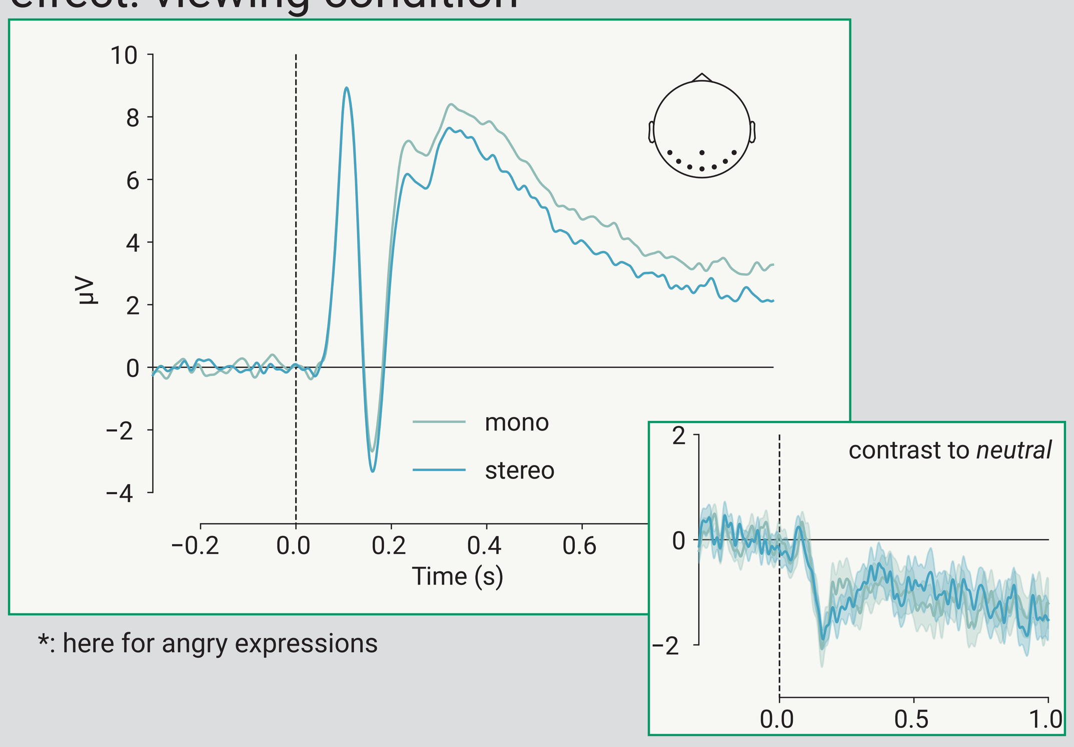


EEG

effect: facial expression



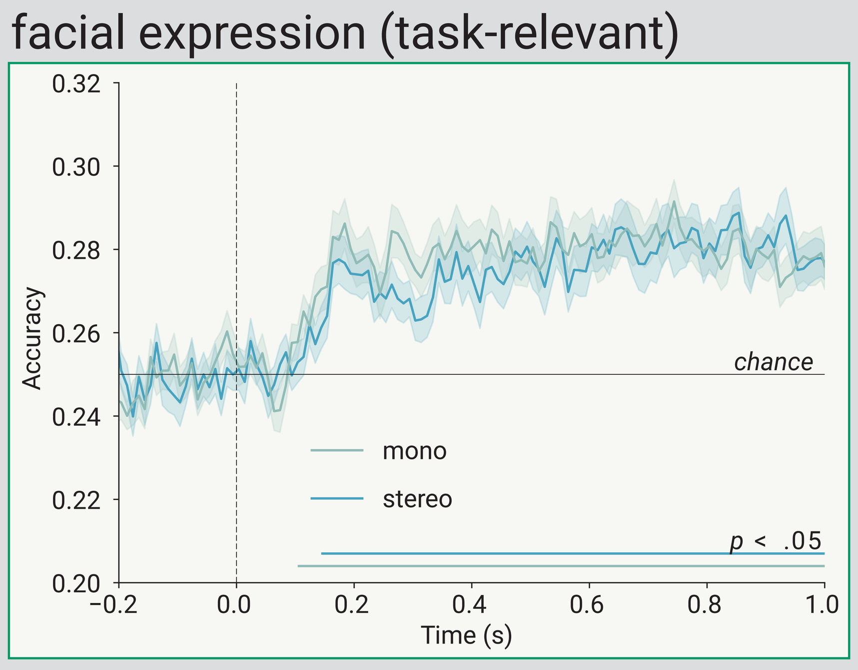
effect: viewing condition*

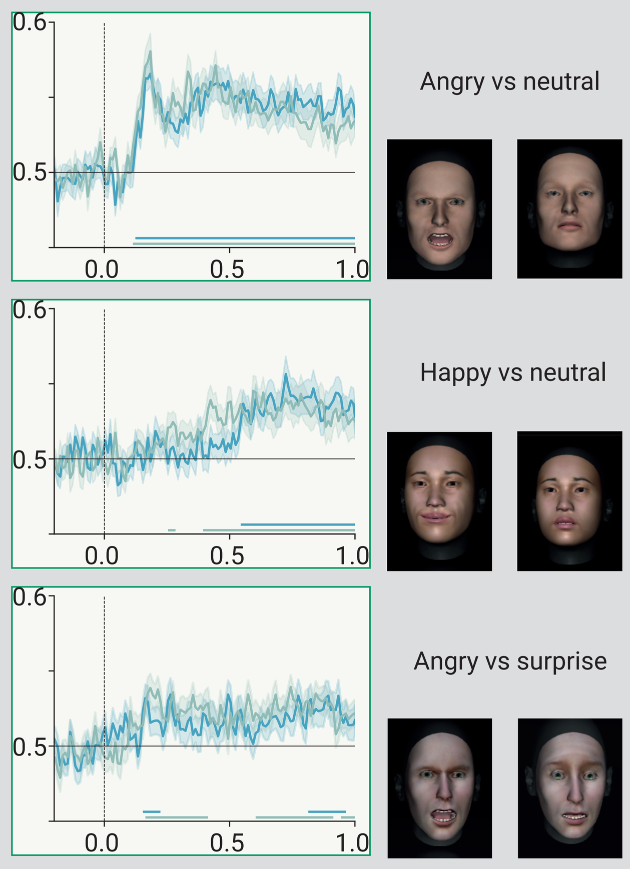


*: here for angry expressions

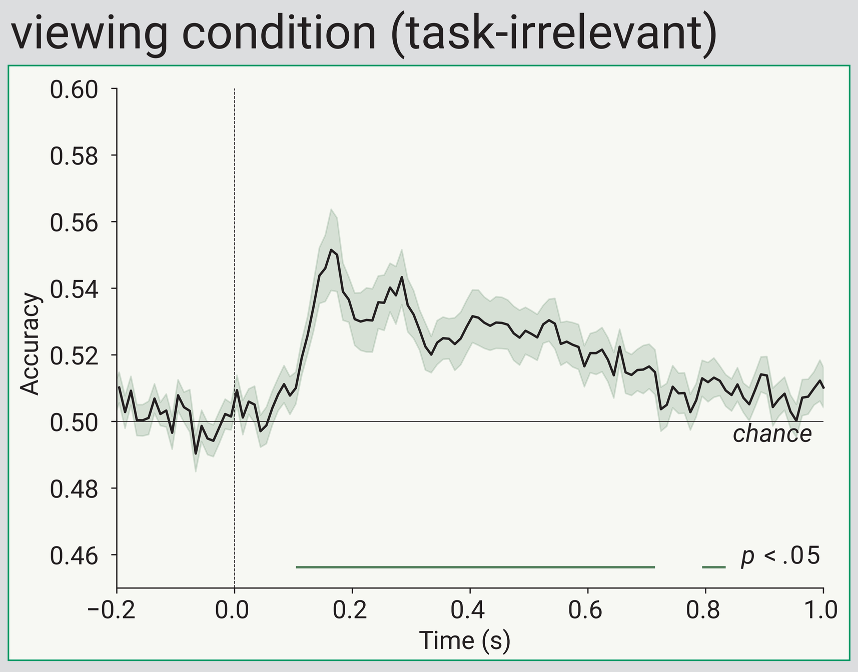
Decoding

facial expression (task-relevant)

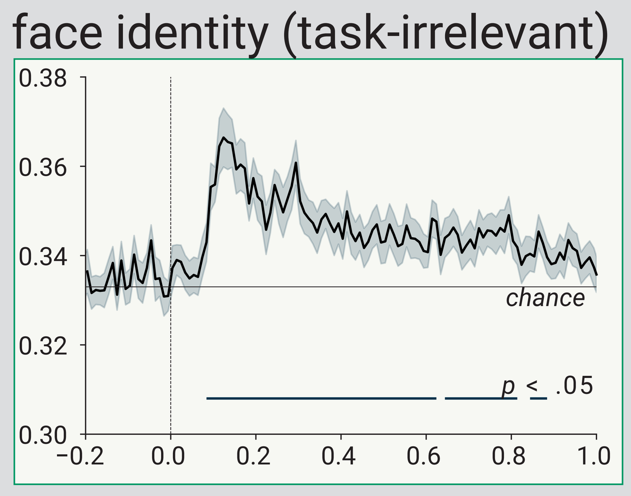




viewing condition (task-irrelevant)



face identity (task-irrelevant)



Discussion

Participants clearly recognized the computer-generated (CG) emotional facial expressions, with no significant difference between the viewing conditions.

The observed facial expression can be decoded from the EEG also when using a VR headset and CG face stimuli. This opens many possibilities for future studies with naturalistic and strictly controlled face stimuli.

No significant differences in decoding performance for the two viewing conditions.

Stereoscopic depth cues do not seem to change how the human brain processes facial expressions. [Limitation: for static frontal portraits]

Stereoscopic depth cues are represented in the brain, but discarded early (like other task-irrelevant stimuli).

References

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