Facial kinematics of genuine and simulated fear

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Introduction

Past research investigating emotional displays has mainly focused on the facial muscle activation using manual coding approaches, such as the Facial Action Coding System (FACS; Ekman & Friesen, 1978). Although this is the most widely used method to categorize emotion expressions, its primary drawback is that it analyzes each facial movement independently from other movements. The true move towards an objective analysis of emotional function is the synergetic 3-D tracking of facial expressions. Notably, temporal, spatial, and speed parameters might reveal the **inner syntax** of emotional displays such as fear.

Methods

Twenty naïve participants were requested to watch scary videos that triggered **genuine expressions** (GE) of fear. In the control condition, they were asked to deliberately reproduce the same expressions while simply looking at a static picture of fear (simulated expression, SE).

Kinematic profiles of facial movements were recorded by means of six infra-red cameras using a 3-D motion analysis system. Twenty-two reflective hemispherical markers (3 mm in diameter) were recorded by means of six infra-red cameras (Figure 1a-b). Then, we identified the most informative markers by means of principal component analysis and we developed a new framework: the **3-D Sandglass Model** (Figure 1c).

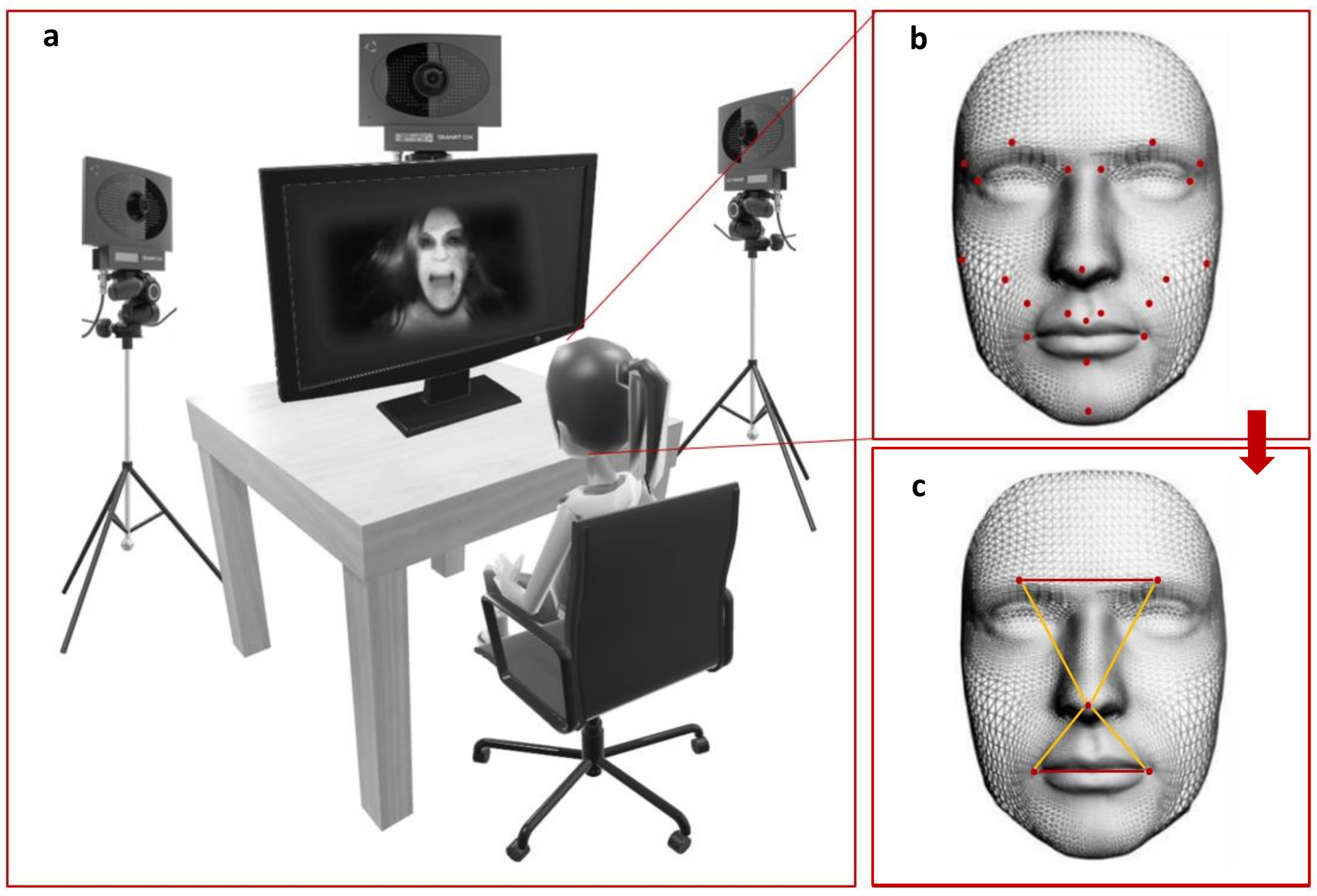
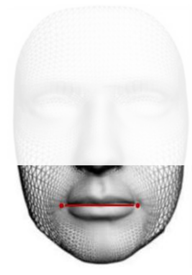


Figure 1. a) Experimental Setup and example of stimulus. **b)** Location of the key points for the expression emotions: 2 middle eyebrows – right and left, 2 nasions – right and left, 2 frontotemporal – right and left, 2 exocanthion – right and left, 2 mandibular joints – right and left, 1 nose tip, 2 zygomaticus – right and left, 2 nasogenian – right and left, 2 crista philtra – right and left, 2 cheilion – right and left, 2 lip midpoint – upper and lower, 1 chin. **c)** 3-D Sandglass Model: the red dots represent the key point for the expression of emotions and the line segments refer to the six facial distances. Red lines refer to distances in the lower and upper parts of the face, whereas yellow lines indicate distances across the vertical axe (i.e., left and right sides of the face).

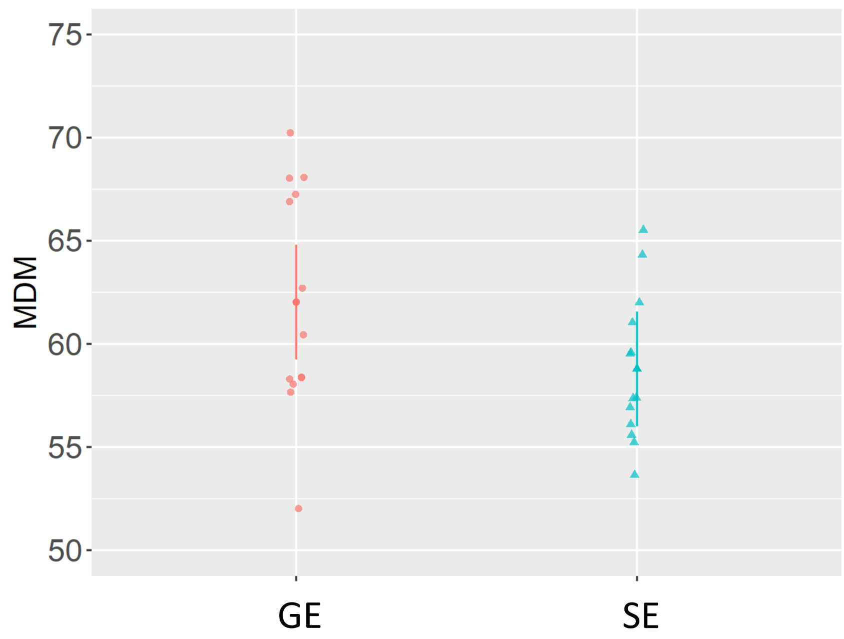
Preliminary Results

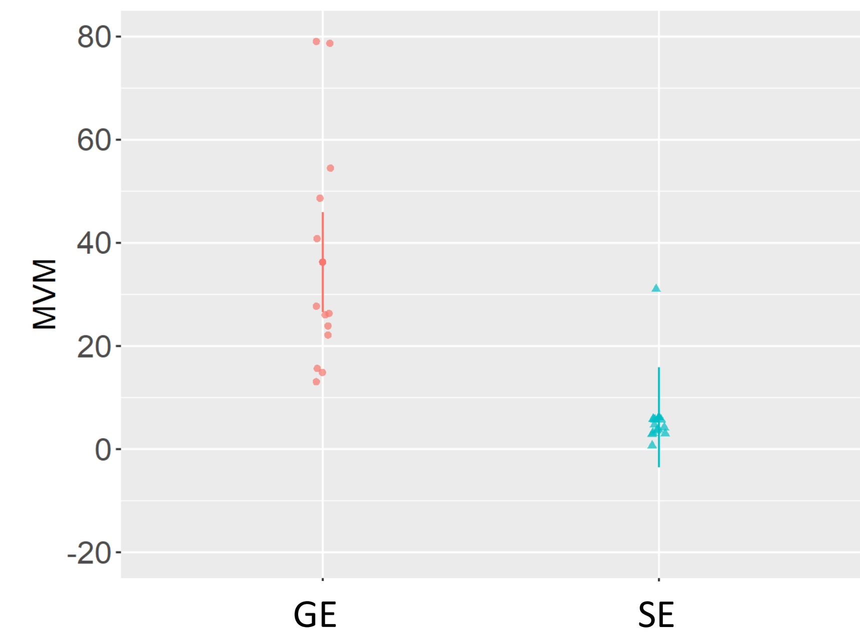
Linear Mixer Models on the factor Condition (GE, SE) for the lower part of the face (right and left cheilion) revealed an increase both in the Maximum Distance (MDM; $F_{(1,12)} = 17.723$; $p < 0.001$) and Maximum Velocity (MVM; $F_{(1,12)} = 20.505$; $p < 0.001$) reached by the corners of the Mouth when the participants were genuinely scared, compared to when they were doing a simulated expression of fear.

Maximum Distance reached by the corners of the Mouth (MDM)
measure unit = mm



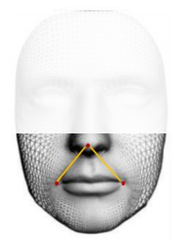
Maximum Velocity reached by the corners of the Mouth (MVM)
measure unit = mm/s



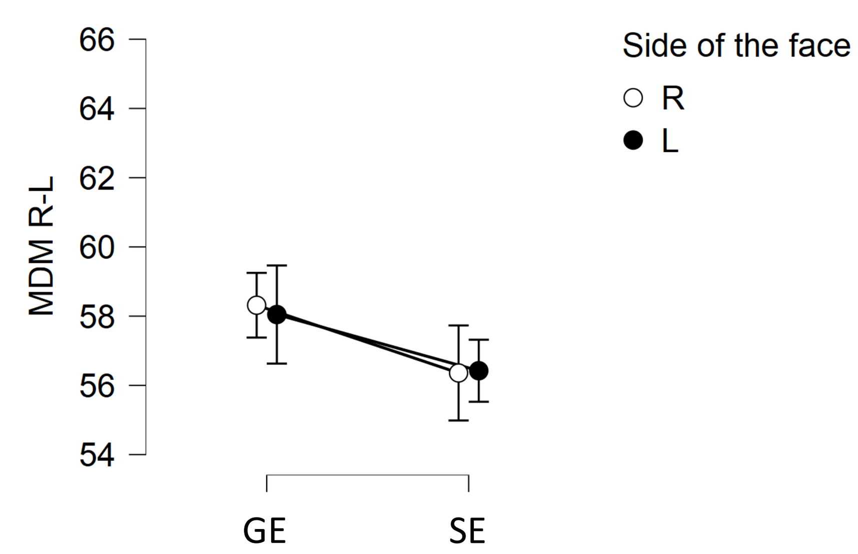


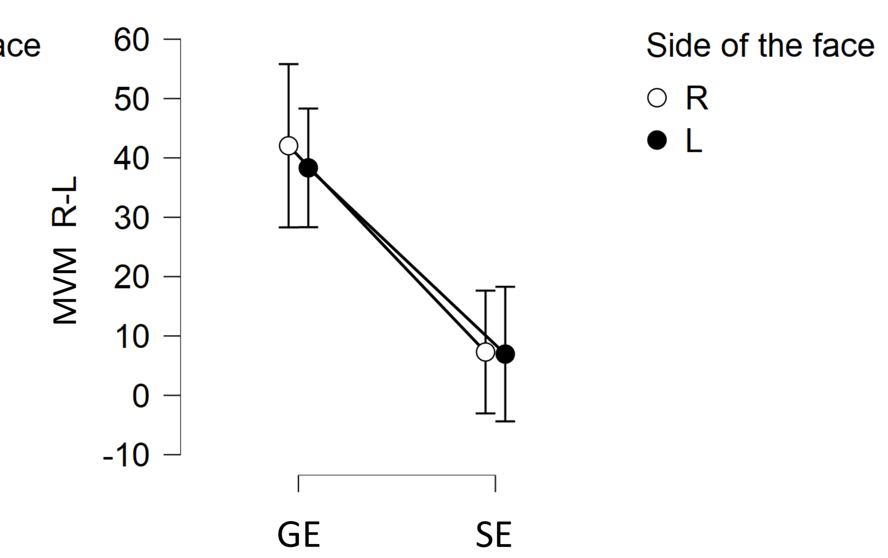
We then added the factor Side (Left, Right) by considering also the maximum distances and velocities of the corners of the mouth with respect to the nose tip. Repeated measures ANOVA confirmed a significant main effect of the Condition (MDM R-L: Condition: $F_{(1, 12)} = 9.014$; $p < 0.05$; $\eta^2_p = 0.429$; MVM R-L: Condition: $F_{(1, 12)} = 14.787$; $p < 0.002$; $\eta^2_p = 0.522$), whereas the interaction between Condition and Side of the face was not significant ($p > 0.05$).

Maximum Distance reached by the corners of the Mouth (MDM)
measure unit = mm



Maximum Velocity reached by the corners of the Mouth (MVM)
measure unit = mm/s





We did not find significant differences in the upper part of the face ($p > 0.05$). Bilaterally innervated eyebrows might be less informative to detect genuine from simulated expressions.

Conclusions

These findings indicate that genuine expressions of fear are characterized by greater amplitude and higher velocity peaks of the mouth's corner with respect to simulated expressions. In practical terms, these results will provide a decisive step forward for the detection of facial deceptive cues and the creation of a well-established database of GEs and SEs for multidisciplinary future studies.

Notably, the development of a gold-standard and user-friendly 3-D model will allow investigations throughout life span – from childhood to old age – as well as in clinical population.

References

Ekman, P. & Friesen, W. (1978). The facial action coding system. Palo Alto: Consulting PsychologistsPress.