Spatial Frequency Utilization During the Recognition of Static, Dynamic and Dynamic Random Facial Expressions

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Context

Previous studies have revealed that dynamic facial expressions (DFE) are better recognized than static facial expressions (SFE; Ambadar et al., 2005). We have recently demonstrated that DFE can be recognized while fixating less on the features, and relying more on lower spatial frequencies (SF), than with SFE (Saumure et al., VSS2016).

Some studies suggesting that biological motion could be processed in extrafoveal vision (Gurnsey et al., 2008), the information provided by the motion in DFE may decrease the need to fixate the features and extract higher SF. This hypothesis suggests that the alteration of the biological movement should generate a response similar to what was observed with the SFE.

Method

In order to test this hypothesis we've created dynamic-random facial expressions (D-RFE) by randomizing the frames of the original DFE. Biological motion being altered, we would expect the D-RFE to be processed similarly to SFE.

In this experiment

- Spatial frequency utilization of 27 participants was measured with SFE, DFE and D-RFE.
- Spatial frequency bubbles method (Willenbockel et al., 2010) was used (Figure 1).
- Participants categorized pictures and videos (block design) of the six basic facial expressions and neutrality.
- Presented for duration of 450 ms.
- SF tunings were obtained by conducting a multiple regression analysis on the SF filters and accuracies across trials. Statistical thresholds were found with the Pixel test from the Stat4Ci toolbox (Chauvin et al., 2005).

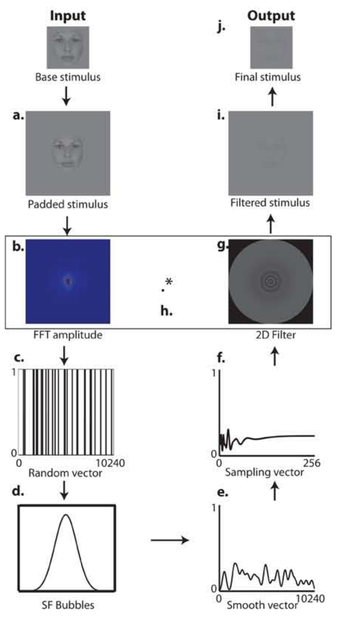

Figure 1 – Example of a stimulus created with the SF Bubbles method.

Results

An average performance of 66.82% (SD=4.5%), 72.14% (SD=4.5%) and 64.91% (SD=4.6%) was found with SFE, DFE and D-RFE respectively.

As illustrated in Figure 2, SF bands peaking at 16.6 cycles per face (cpf), 14 cpf, and 15.6 cpf were found with SFE, DFE and D-RFE, respectively (Z_{Crit}=2.84, p<0.05).

Low SFs (3.2 to 4.2 cpf) were significantly more utilized with D-RFE than with SFE; and mid-to-high SFs (>18.6; 18.9 to 36.8 cpf) were significantly more utilized with SFE than with D-RFE and DFE respectively (Z_{Crit}=3.09, p<0.025). A marginal trend also indicated a higher utilization of low SF with DFE than with SFE ($Z_{dynamic\text{-}static}$=2.57).

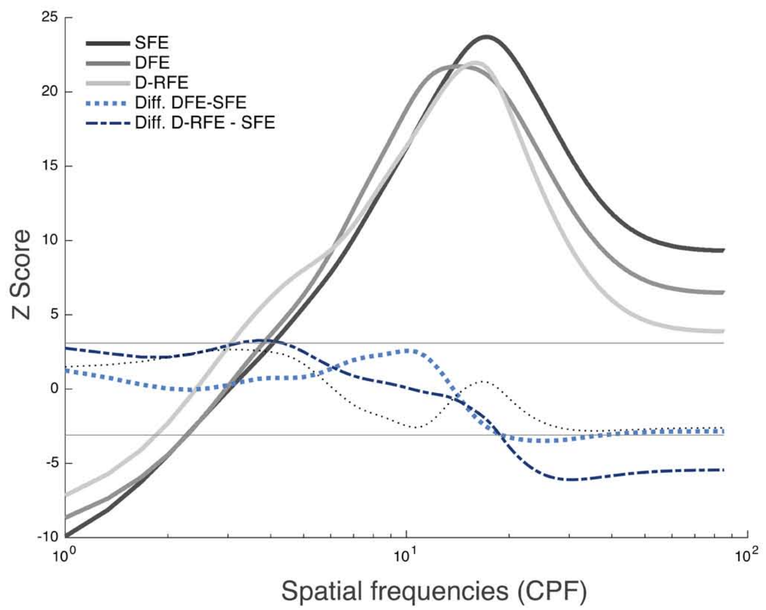

Figure 2 – Spatial frequency utilization while processing SFE, DFE and D-RFE and utilization differences.

Discussion and Conclusion

First of all, these results suggest an impact of motion, being biological (DFE) or not (D-REF) on how facial expressions are processed in an identification task. This difference lies in a greater use of the low SF in presence of movement (DFE, D-RFE) in comparison to processing in absence of movement (SFE).

Secondly, the fact that the performance with D-RFE (64.91%) was significantly weaker than performance obtained with DFE (72.14%) [$t(26) = 5.39$, $p<0.001$] do not support the hypothesis suggesting that movement would improve discrimination of facial expressions by providing a denser sample of facial expressions. This interpretation is consistent with previous research (Ambadar et al., 2005).

However, these results do not give us clear indications on the implication of biological movement in the processing of facial expressions and thus requires the exploration of different sources of explanation. Two hypotheses which suggests that motion would improve recognition of dynamic facial expressions by (a) providing additional kinetic information or (b) driving attention to features of interest by increasing their salience will be examined in future experiments.

References

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