Faces are « spatial » - Holistic face perception is supported by low spatial frequencies

Valérie Goffaux & Bruno Rossion

Journal of Experimental Psychology: Human Perception and Performance, in press
Main findings and conclusions

* Integration of facial features into a holistic representation is supported by low-spatial frequencies of the visual stimulus.

* This is supported here by showing larger whole/part advantages and face composite effects with low spatial frequencies than high spatial frequencies.

* In line with the coarse-to-fine hypothesis of information processing in the visual system, these observations suggest that holistic processing may precede the analysis of local features during the microgenesis of face perception.
Faces are processed holistically

= Facial features are *integrated* rather than being represented and processed independently of one another

Practically, this implies that the recognition of a face feature (e.g. the eyes) is *influenced* by the processing of other the other face parts
Two major paradigms/effects provide evidence for holistic face processing

1. The whole-part advantage

Discriminating two faces differing by one feature is easier/faster than the 2 features presented in isolation

Tanaka & Farah, 1993
Davidoff & Donnelly, 1990
Farah et al., 1998
Sergent, 1984
Homa, Haver & Schwartz, 1976

2. The face composite illusion

Identical top parts of faces look different if they are aligned with different bottom parts

Young et al. 1987
What is the visual information supporting the extraction of a holistic face representation?

Here we test the hypothesis that holistic processing of a face is mostly dependent on low spatial frequencies (LSF) of the visual stimulus rather than high spatial frequencies (HSF).

This hypothesis was first put forward by Sergent (1986) and never tested empirically.
Experiment 1: whole-part advantage with LSF, HSF and full-spectrum faces

Delayed matching task on unfamiliar faces

2 x 3 design

Whole-to-parts vs. Whole-to whole
LSF, HSF, full-spectrum
Larger whole-part advantage for LSF face stimuli
Experiment 2: face composite effect with LSF, HSF and full-spectrum faces

2 x 3 design

Faces aligned vs. misaligned

LSF, HSF, full-spectrum
Larger face composite effect for LSF face stimuli

Note: performance is equal for all conditions when faces are misaligned

Experiment 2
Experiment 3: face composite effect with LSF, HSF and full-spectrum faces presented upside-down

Rationale: if the larger face composite effect for LSF truly reflects holistic face encoding, it should be reduced by inversion

2 x 3 design

Faces aligned vs. misaligned

LSF, HSF, full-spectrum
Compared to experiment 2, larger drop of face composite effect for LSF stimuli with inversion

Note: blurring faces (LSF) + inversion dramatically affects recognition (Collishaw & Hole, 2000).

Experiment 3
Experiment 4: face composite effect with LSF, HSF and full-spectrum faces + middle spatial frequency range (MSF), thought to be particularly important for face recognition

2 x 4 design

Faces aligned vs. misaligned

LSF, HSF, MSF, full-spectrum
Larger face composite effect for LSF face stimuli

Note: performance is equal for all conditions when faces are misaligned

*Experiment 4*
Conclusions

Holistic face perception is rooted in coarse visual cues transmitted by early spatial frequency filters, as first hypothesized by Sergent (1986).

→ Holistic face representations can be built from low resolution face pictures suggesting that holistic processing may help detecting and segmenting the face stimulus by linking internal and external facial features together against the background scene.

→ Neuropsychological and developmental studies also support a critical role of LSF to build holistic 3D individual representations of faces.

Conclusions
SF filtering technique provides a means to reduce, or enhance, holistic processing of faces

The well-documented temporal precedence of LSF processing over HSF processing (e.g. Bredfeldt & Ringach, 2002; Mihaylova, Stomonyakov & Vassilev, 1999; Loftus & Harley, 2004) and the present observations that holistic perception of faces is predominantly supported by LSF, suggest that the extraction of a holistic face representation may be an early stage in face processing. Such initial LSF-derived holistic representation may be based on the earliest visual inputs to high-level visual areas showing a preference for face stimuli (i.e. middle fusiform gyrus).

Conclusions