Newborns' face recognition is based on spatial frequencies below 0.5 cycles per degree.

Adélaïde de Heering*, Chiara Turati**, Bruno Rossion*, Hermann Bulf**,

Valérie Goffaux*, & Francesca Simion**

Cognition, in press, 2007

Main findings

* Newborns were able to extract from a face the visual information lying from 0 to1 cpd (Exp. 1), but only a narrower 0 to 0.5 cpd spatial frequency range was successful to accomplish face recognition (Exp. 2).

* These results provide the first empirical support of a low spatial frequency advantage in individual face recognition at birth and suggest that early in life low-level, non-specific perceptual constraints affect the development of the face processing system.

Aim of the study

* Examine how limitations of the visual system during the first days of life may shape subsequent development of face processing abilities.
* By manipulating the bands of spatial frequencies of face images, we investigated what is the nature of the visual information that newborn infants rely on to perform face recognition.

Hypothesis

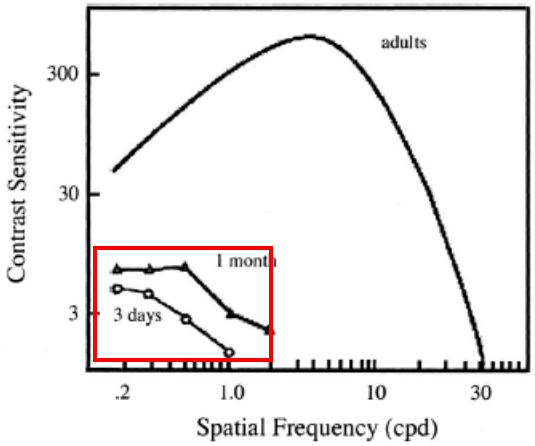


Figure 1

- Greater sensitivity to LSF
- Greater sensitivity to Contrast

EXPERIMENT 1

Participants	28 Newborns

Stimuli

Filtered faces

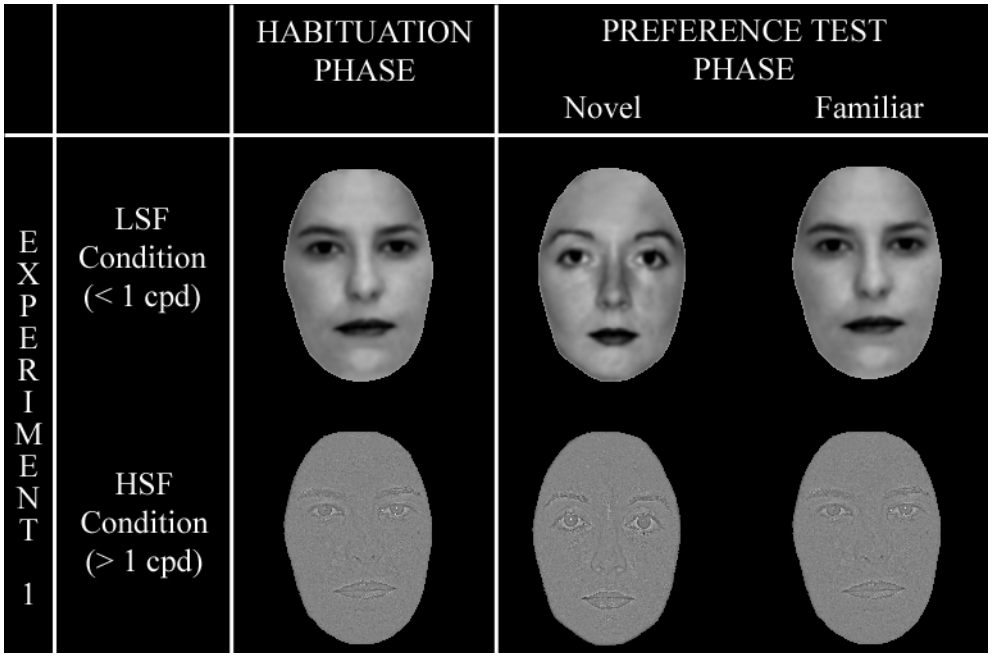


Figure 2

Procedure

Infant-controlled habituation procedure

Experiment 1

Results

* The average total fixation times during the habituation phase in the LSF (70.15 s, *SD* = 27.93) and in the HSF condition (55.1 s, *SD* = 19.65) did not differ significantly, $t(26) = 1.652$, $p = .11$.

* In the LSF condition, the preference score for the novel stimulus retaining all the frequencies below 1 cpd was above chance ($M = 62\%$, $SD = 11$, one-sample $t(13) = 4.15$, $p = .001$), what was not the case in the HSF condition ($M = 49.8\%$, $SD = 17.4$, one-sample $t(13) = .049$, $p = .961$).

* The preference scores obtained in the LSF and HSF conditions were significantly different, $t(26) = 2.276$, $p = .031$.

Discussion

1. Newborns discriminate and recognize images of unfamiliar faces to which they were habituated, but only when the spatial frequency range is comprised between 0 to 1 cpd (LSF condition).

2. Moreover, if considering that HSF provide information related to fine edges of a pattern while LSF support the extraction of coarse cues, outcomes provided indicated that coarse scales play a major role in supplying newborns' visual system with effective information for face recognition.

EXPERIMENT 2

Participants	25 Newborns

Stimuli

Filtered faces

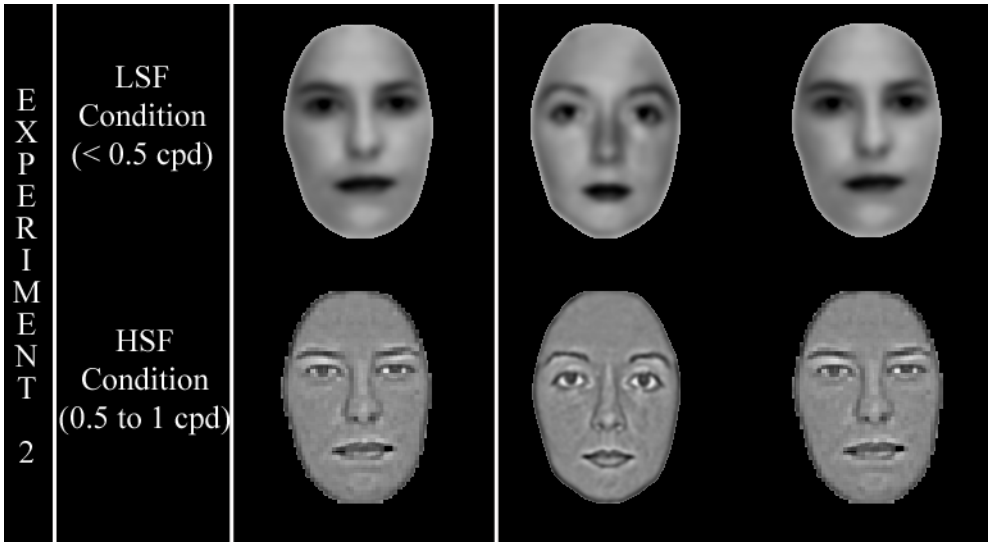


Figure 2

Procedure

Infant-controlled habituation procedure

Results

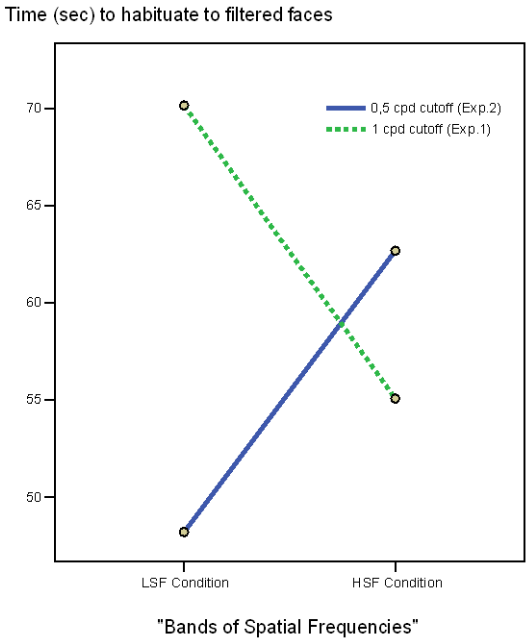
* Total fixation time to reach the habituation criterion was not significantly different in the HSF (*M* = 62.67 s, *SD* = 22.84) and LSF (*M* = 48.2 s, *SD* = 18.52) conditions, $t(23) = 1.731$, $p = .097$.

* A mean novelty preference score significantly higher than the chance level was obtained when newborns had to recognize the LSF face (< 0.5 cpd) (*M* = 63%, *SD* = 11, one-sample $t(11) = 3.995$, $p = .002$). Yet, the *t*-test comparison was not significant in the HSF condition (*M* = 48%, *SD* = 14, one-sample $t(12) = .501$, $p = .626$).

* LSF and HSF preference scores differed significantly, independent samples *t*-test: $t(23) = .706$, $p = .008$.

An ANOVA on infants' total fixation time to reach the habituation criterion was run to compare Experiments 1 and 2 and revealed:

* The absence of main effect for the Cutoff factor (p = .961)
* The absence of main effect for the Band of Spatial Frequencies (p = .256)
* The presence of an interaction between the two factors (p = .022)



Post-hoc t-tests indicated that newborns' total habituation time was significantly longer in the LSF condition with a cutoff of 1 cpd (M = 70.15 s) than in the LSF condition with a cutoff of 0.5 cpd (M = 48.2 s), $t(24)$ = .076, p = .029.

Figure 3

Experiment 2

An ANOVA run on novelty percentage scores obtained in both experiments revealed:

* The presence of a main effect for the Band of Spatial Frequencies (*p* =.001)
* The absence of a main effect for the Cutoff factor (*p* = .906)

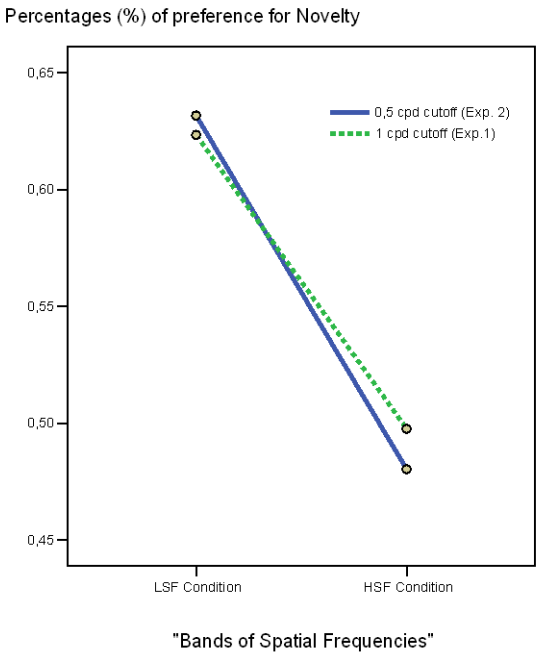


Figure 4

Experiment 2

Discussion

1. Evidence from Exp. 2 demonstrated that individual face recognition depends on the LSF content of the stimuli (0 to 0.5 cpd).

2. Newborns habituated in a significantly longer time to the 0-1 cpd LSF face than to the 0-0.5 cpd LSF face.

=> This is in line with evidence on early visual memory that stipulates that in infancy the time needed to habituate to a visual stimulus increases with the complexity of the pattern (Cohen, 1988; Slater & Morison, 1991).

=> Newborns' longer habituation times in the LSF condition of Exp. 1 corroborates the contention that newborns are able to detect and process the visual information comprised in the SF range between 0.5 and 1 cpd (Macchi Cassia et al., 2002). Nevertheless, novelty preference scores showed that newborns did not take any advantage from this range in the test phase.

Main conclusions

Within the newborns' sensitive spatial frequency bandwidth, only a narrower range lying between 0 and 0.5 cpd appears to be successful to accomplish the recognition of an individual face.

Provided evidence firmly support the idea that non-specific constraints of the newborns' visual system (CSF) combined with peculiar visuo-perceptual characteristics of the face stimuli (LSF) force newborns to process those aspects of a face that deal with large scale variations rather than subtle variations provided by fine details.

Non-specific constraints of the perceptual system interacting with certain systematic variations present in the surrounding environment may thus allow increasing neurocognitive specialization of face processes with development.