How the human brain decodes social signals from faces

Nathalie George

Social and Affective Neuroscience Lab. & Centre MEG-EEG
Institut du Cerveau et de la Moelle Epinière, UPMC /CNRS /INSERM

The face

A simple visual stimulus…

... that is unique by the wealth of information that it conveys
The face

social categorisation
(age, gender, group, ...)

kind?

competent?

identity

emotions

mental state

intentions

attention

obj. of

interest

preferences

The face

...personality traits
Visual cognition

The face

Social cognition

⇒ Perception and representation of others and of our relations with others
⇒ Social interaction

Development

✧ Early preference for face-like patterns

Goren et al., 1978
Development

Is Face Processing Species-Specific During the First Year of Life?

Olivier Pascalis,1,2 Michelle de Haan,2 Charles A. Nelson3

We tested discrimination of human and monkey faces by 6-month-olds, 9-month-olds, and adults, using the visual paired-comparison procedure. Only the youngest group showed discrimination between individuals of both species; older infants and adults only showed evidence of discrimination of their own species. These results suggest that the "perceptual narrowing" phenomenon may represent a more general change in neural networks involved in early cognition.

Pascalis et al., 2005

+ Plasticity (critical period?)

Functional brain imaging: Electro- / Magnetoencephalography

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Functional brain imaging: functional Magnetic Resonance Imaging (fMRI)
What have we learnt from this method?
Ventral visual areas (fusiform gyrus) in face perception and recognition

**Perceptual processing**
- Right (52, -60, -24)
- Left (-42, -68, -22)

**Face recognition**
- Right midfusiform (36, -38, -16)

(George et al., 1999)

Ventral visual areas (fusiform gyrus) in face perception and recognition

- Early perception of facial features
  - Inf. Occip. G.
- Invariant aspects (identity)
  - Lat. Fusiform G.
- Person Identity, Name, Biographical info.
  - Anterior Temporal

(Haxby et al., 2000)
Emotions

Diversity and highly dynamic character of the facial expressions of emotions

(from basic to highly social emotions ...)

Amygdala

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Amygdala

(Adolphs et al., 1994, 95)

Amygdala

(Adolphs et al., 1994, 95)

(Breiter et al., 1996)
A more general role of amygdala in emotion and stimulus appraisal

- **Happiness** (Morris et al., 1996; Breiter et al., 1996; Whalen et al., 1998)
- **Disgust** (Anderson et Phelps, 1997, 1998)
- **Anger**: in some brain-lesioned patients (Adolphs et al., 2003; Calder et al., 1996; Sato et al., 2002; Scott et al., 1997)
- **Disgust = fear = happiness = Sadness** (Winston et al., 2003)

=> Stimulus relevance appraisal & Emotional attention

Other brain regions involved

**Limbic system and associated regions**
(Blair et al., 99; George et al., 93; Hornak et al., 96; Krolak-Salmon et al., 03; Morris et al., 98; Philipps et al., 97; Sergent et al., 94; Sprengelmeyer et al., 96)

**Also: somatosensory cortex** (Adolphs et al., 96; Winston et al., 03)
Gaze

Unique morphology of the human eyes

(Kobayashi & Kohshima, 97)

=> The human eyes have become a signal to others

Gaze

(animated Yarbus’ figure (1967) taken from the page of Dr. Albert Fuchs, U. Washington)

(Spezio et al., 2007)
Gaze

Direction of attention of others => joint attention

Which candy ‘Charlie’ prefers?
(Baron-Cohen et al., 1995)

Emotion signification
(Adams et al., 03
Sato et al., 04
Wicker et al., 03)

Mental states
(Baron-Cohen et al., 1999)
“A window to the soul”

Gaze shifts: pSTS and posterior parietal cortex

Intraparietal sulcus
Superior temporal sulcus (pSTS)
Inferior occip. g. & fusiform g.

(Hoffman and Haxby, 2000)
Gaze contact

- Fusiform activation in response to faces with direct gaze

- Amygdala-fusiform coupling under direct gaze only

Gaze & social brain

- Social brain network:

(Calder et Lawrence, 2002; Pelphrey et al., 2004; Wicker et al., 2003)
« Lets’ face it: it’s a network »

Ishai, 2008:

Autistic spectrum disorder

Pierce et al., 2001
Autistic spectrum disorder

The importance of eye fixation

Gaze fixation and the neural circuitry of face processing in autism


* Ocular fixation pattern: NT / ASD

(Spezio et al., 2007)
« Lets’ face it: it’s a network »

Ishai, 2008:

Neural dynamics?

Initial studies: the N170 to faces in EEG

(Bentin et al., 1996; George et al., 1996; George et al., 2005)
Gaze recruits the social & emotional brain early on (150-220 ms)

EEG study:

*Conty et al 2007*

- **Averted gaze motion**
  - Deviated head view
  - Frontal head view

- **Direct gaze motion**
  - Deviated head view
  - Frontal head view

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Early emotional modulation of brain responses to faces

Also, late effects => multiple stage processing

Integration of the various social signals from faces?
Mutimodal information integration from the earliest age

Cues for Early Social Skills: Direct Gaze Modulates Newborns’ Recognition of Talking Faces

Bahia Guellai*, Arlette Sterri
Renss Descartes University, Paris, France; Laboratory for Psychology of Perception, Unité Mixte de Recherche Centre National de la Recherche Scientifique/In St. Centre Biomedical des Saints-Pères, Paris, France

* Correspondence: bguellai@descartes.parc.fr; Tel.: +33-1-56-07-28-87

Figure 2. Mean latencies (in seconds) during the test phase at two familiar and two new faces in both conditions. Error bars represent the standard error (SE).

Parallel, distinct functional routes
A single region may be involved in multiple processing stages + Cortical / subcortical interplay

(Haxby et al., 2002)
Multiple roads to face processing

* Not face-specific…

(cf. Pessoa and Adolphs, 2010)

GENERAL CONCLUSION

- Faces are highly relevant stimuli that convey a wealth of social signals

- Social cues from faces are extracted and integrated very rapidly by highly distributed and dynamic functional brain networks

- Neuroimaging tools reveal the neurodynamics of face and social signal processing
Thank you for your attention

(JR in Kenya, 2010)