# Cognitive Neuroscience
## Agents

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A.A. 2018-2019

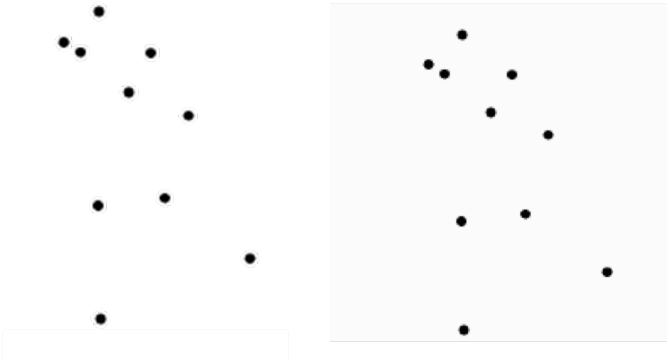
1CFU

# Core knowledge

# Agents

- From a physical causality to a psychological causality:
  - Within the module referring to physical objects we have seen that physical entities are inanimate and, if in motion, this is due to collision events
  - Within the module of agents, we will see that self-propulsion, among other features, defines agents, i.e., special physical entities carachterized by internal states (motivations, intentions, and so forth), forces that can explain motion in agents

# Agents

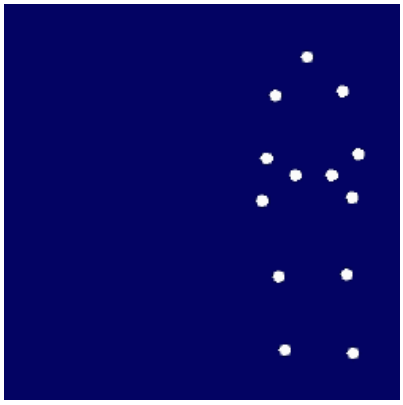


# Agents

1. The biological motion (Johansson, 1973)

- it is a semi-rigid pattern of movement
- it canalizes the attention toward the most probably interesting stimuli
- it is part of the mechanisms that support the perception of basic social signals
- it seems to be compromised in infants with autistic syndrome

# Agents

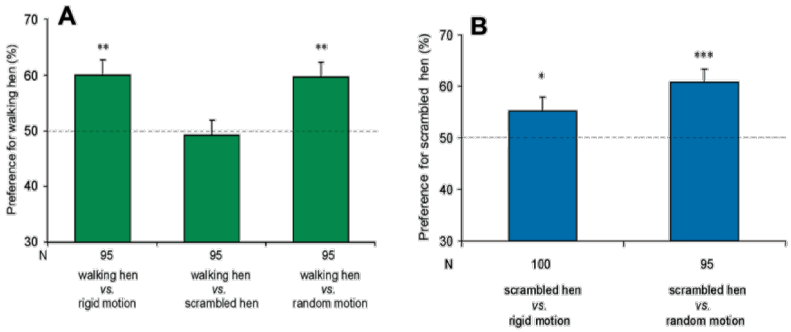


- in 200 ms we recongnise the movement of a human body
- in 400 ms the peculiar activity in which he/she is engaged
- we discriminate the gender, the emotional state, the degree of familiarity, the weight that is lifted up and several complex motor acts
- different animal species

# Agents

- It is so automatic
  - that we can expect it to be an innate mechanism (as Johansson hypothesized)
  - domestic chicks are the most suitable animal model to investigate this issue
    - precocial
    - rapid sensory-motor development
    - tested in the absence of previous visual esperience

# Agents



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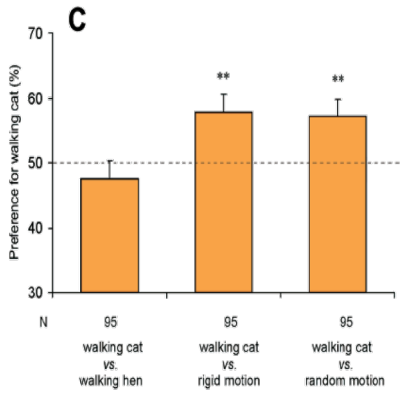



# Agents

- There seems to exist a spontaneous preference for the patterns of biological motion of a vertebrate
  - this is a first mechanism to direct attention toward the most appropriate class of objects that very likely will be the mum or at least the conspecifics
  - such preference seems to be extended to the general movement, common to other vertebrates (raw mechanism)
  - a second mechanism would make the learning possible – of peculiar features of a specific object

# Agents

- infants show a preference for biological motion at about 4–6 months of age
- you could argue that, at that age, they could have had already massive experience of such kind of motion

# Agents

**A predisposition for biological motion in the newborn baby**

Francesca Simion*†, Lucia Regolin‡, and Hermann Bulf*

*Dipartimento di Psicologia dello Sviluppo e della Socializzazione and ‡Dipartimento di Psicologia Generale, Università di Padova, Via Venezia 8, 35131 Padua, Italy

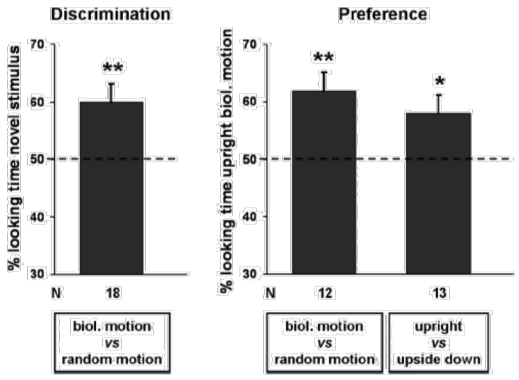
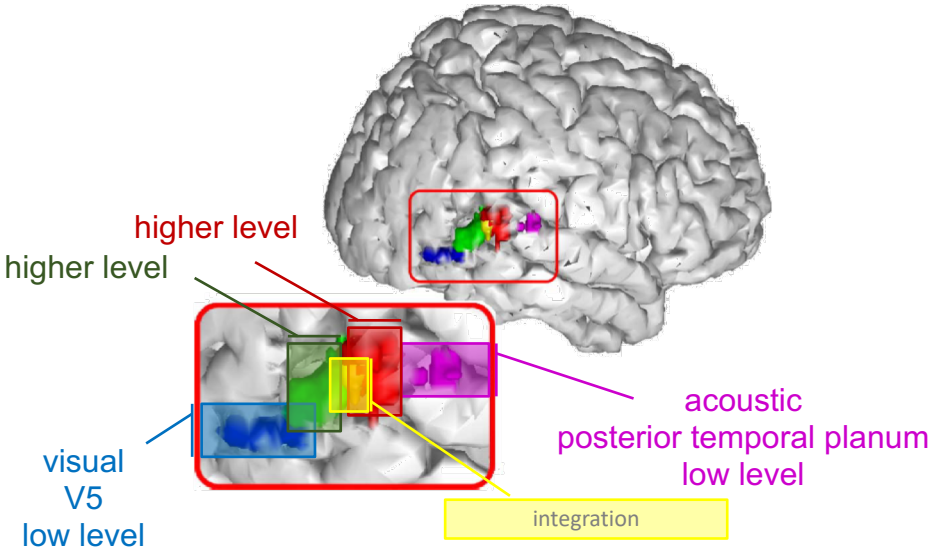



Fig. 2. Results of the three experiments, expressed as the percentage of time (mean ± SEM) spent looking at the biological motion stimulus. Dashed lines indicate chance level. *, $P < 0.05$; **, $P < 0.01$.

- we can test infants immediately after birth (max within the first 48h)
- by using the very same stimuli adoped with chicks (hence not species-specific)
  - infants prefer to attend biological motion stimuli, even if there is a walking hen and not a walking human-being

# Agents

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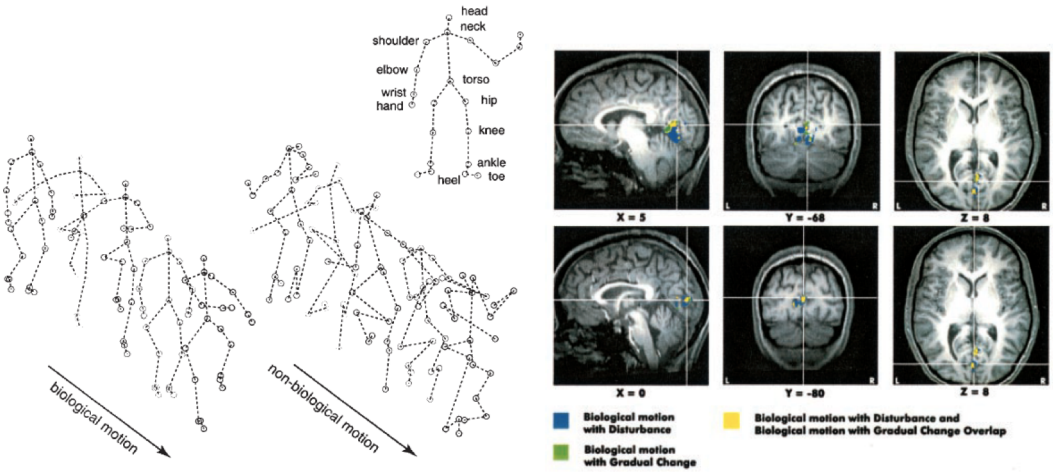

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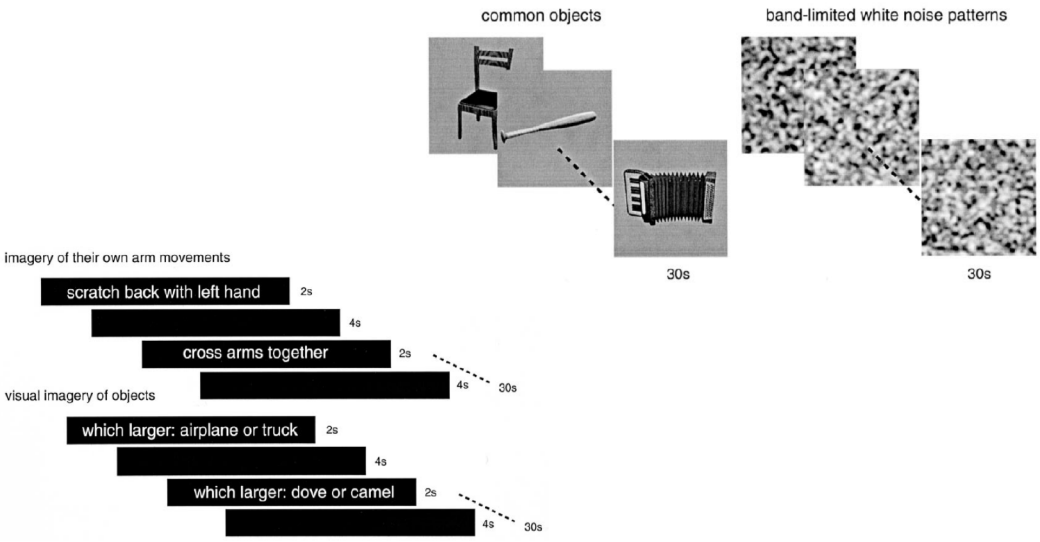


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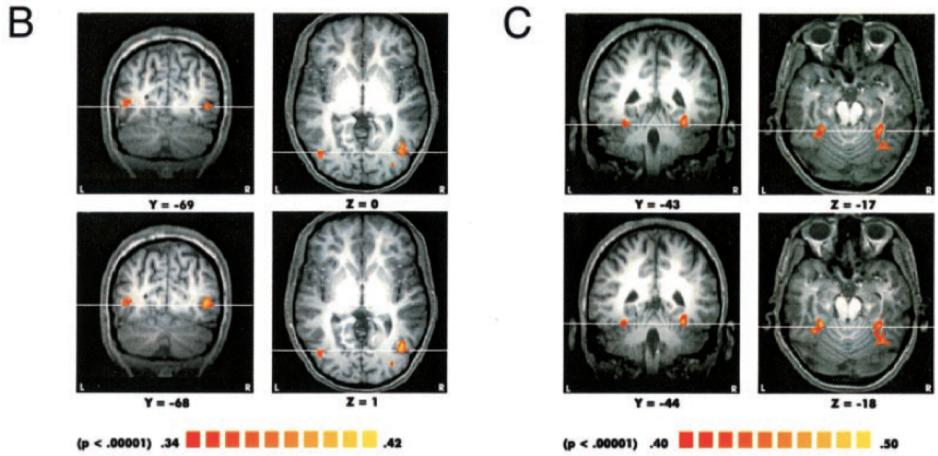

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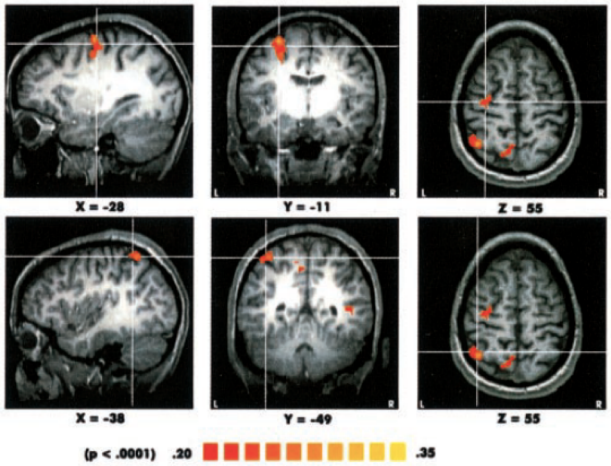
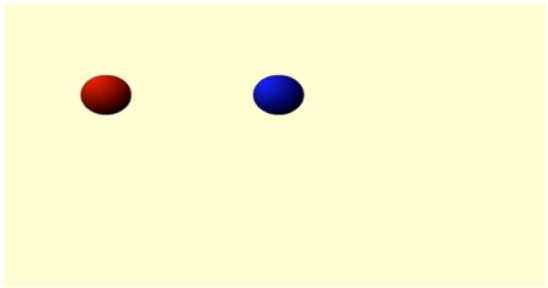



# Agents

**MICHOTTE**



**HEIDER & SIMMEL**

# Agents

2. Animacy
   Spontaneous motion (endogenous)

- It does not require that the stimuli resemble organisms or part of an organism in order to obtain such impression of **psychological causality**
  - The causality depends only on spatiotemporal features specific of the kinematics of the event

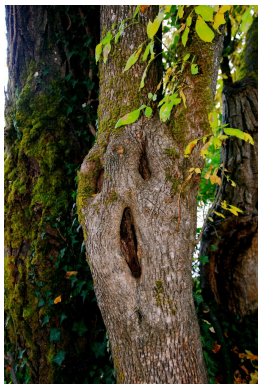
# Agents

- The perceived causality depends uniquely on spatial and temporal variables of the event kinematics

- There is a sort of hypersensitivity to intentional signals, especially for those conveyed by movement (think about 'cloudspotting' and how you refer to the movement of the clouds or the sun or other simple natural events)
  - Changes in direction (especially in front of another object) => intentional agency
  - Changes in speed (especially the acceleration)
  - Self-propulsion
  - Arrest + motion

# Agents

There is a further hyperactive mechanism:
3. the face-detector



# Agents

- In evolutionary terms, the ability to detect, even with just a few essential cues, that in close proximity there potentially is another organism is fundamental:
  - If it is a predator, one can escape
  - If it is a prey, one can approach
- Being hyperactive, it subserves agent recognition also when the visibility is reduced or when only a limited number of cues are available:
  - Take the instance in which preys and predators are partially occluded by a bush
- By studying and understanding these universal and basic mechanisms we can explain the reason why people sometimes refer about magical manifestations...

# Agents

- Pareidolia
  - Jesus's face on the toast or on an Ikea door

# Agents

- Faces are special:
  - Universally important
  - Provide infos about gender, age, health state…
  - and emotions

# Agents

# Primary emotions

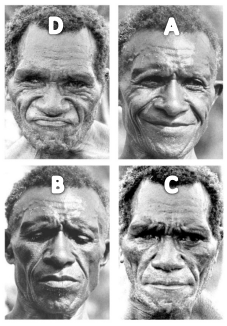
- Ekman & Friesen (1967) asked to the members of a tribal population of Papua New Guinea to show a feeling with the facial mimic
- How would you expresss

A) The arrival of a friend and you are happy

B) Your baby has died

C) You are angry and ready to fight

D) You see a died pig (long since)



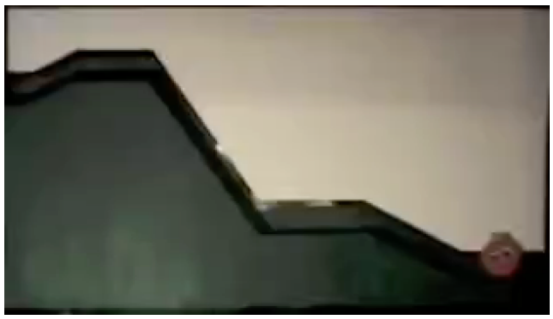
# Agents

- Faces are special:
  - Universally important
  - Provide infos about gender, age, health state
  - And emotions (whether to initiate a social interaction or not)

  - Allow the visual identification of conspecifics
  - Eyes: direct the attention toward specific parts of the environment
  - Mouth: understanding of the verbal message

# Agents

- Agents' actions are efficiently directed toward goals
- Agents interact with other agents, contingently and reciprocally
- Agents need not to have faces/eyes (see Heider & Simmel), but these cues are useful



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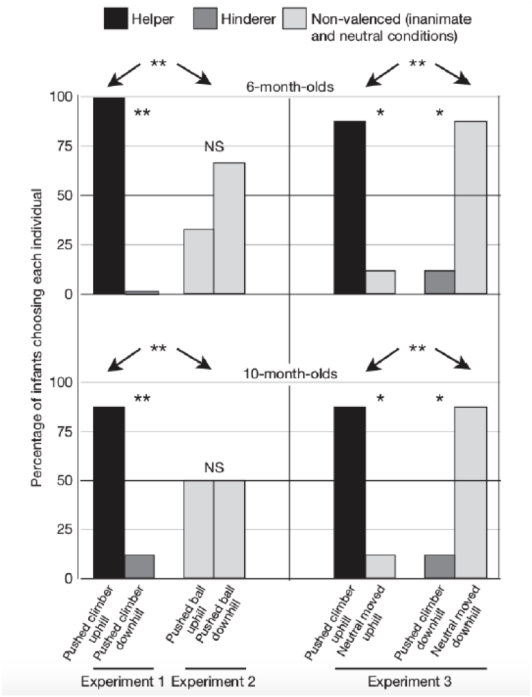
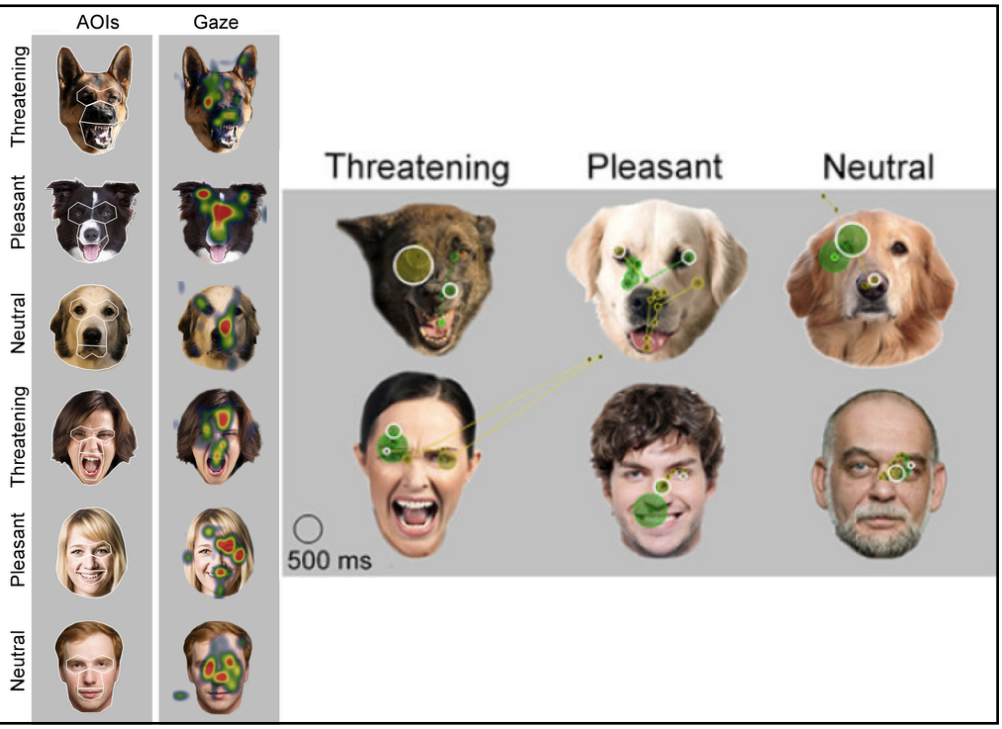



# Agents

- Eye gaze:


# Agents




# Agents

Johnson, Dziurawiec, Ellis, & Morton (1991)

# Agents

- According to the core knowledge hypothesis, core systems would be available at birth. This is, of course, difficult to prove in humans. Human newborns are very immature at birth; hence, developmental studies suffer from the unavoidable limitation of a lack of precise control on the effect of early experience.
- Are mechanisms that preferentially orient neonates' attention to human faces inborn? It is virtually impossible to provide a complete absence of face stimulation even in neonates studied a few hours after birth.
- Note, however, that similar limitations are also apparent with altricial non-human species.

# Agents

- Sugita (2008) reared infant Japanese monkeys (*Macaca fuscata*) with no exposure to any face for 6–24 months
- Results:
  - Before being allowed to see a face, the monkeys
    - showed a preference for human and monkey faces in photographs,
    - discriminated human faces as well as monkey faces.

# Agents

- After the deprivation period, the monkeys were exposed to either human or monkey faces for a month
  - soon after, the monkeys selectively discriminated the exposed species of face
  - showed a marked difficulty in regaining the ability to discriminate the other nonexposed species of face.
- These results indicate the existence of an experience-independent ability for face processing
- An apparent sensitive period during which a broad but flexible face prototype develops into a concrete one for efficient processing of familiar faces

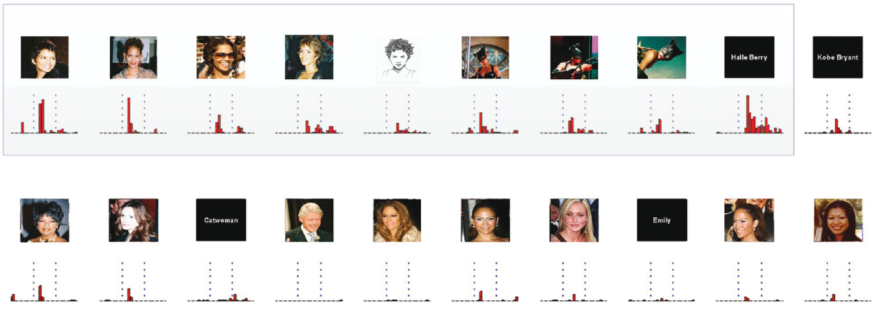
# Agents

- However, monkeys still had a few hours of experience with their mother after birth, making any strong claim for an experience-independent ability for face processing untenable
- Besides, it could be argued that monkeys maintained for several months without exposure to faces would show an abnormal pattern of psychological development. On the contrary, testing monkeys soon after birth would prove unfeasible because of their relative immaturity.

# Agents

- an unlearned representation (CONSPEC), shared among vertebrates, that directs the animal's attention toward stimuli whose internal features are arranged according to a triangular face-like configuration
- starting from this template, one can encode and memorize specific features of a specific individual (CONLERN)

# GrandMa Cells? Halle Barry neuron…

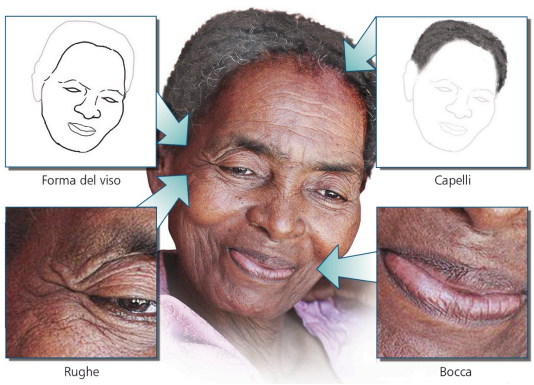


# GrandMa Cells? Halle Barry neuron…

- Some concerns:
  - Single-unit recording does not provide a global view of the brain activity
    - A larger sample of stimuli could activate the same neurons
    - A larger number of neurons could be involved
  - The cells are not uniquely visual

  - Three order level of problems:
  1. One percept = one neuron -> errors and, in case of cell death, the percept is lost
  2. It depends on experience -> how do we perceive unusual objects?
  3. How is it possible to recognise an individual despite his/her continuous changes?

# GrandMa Cells?

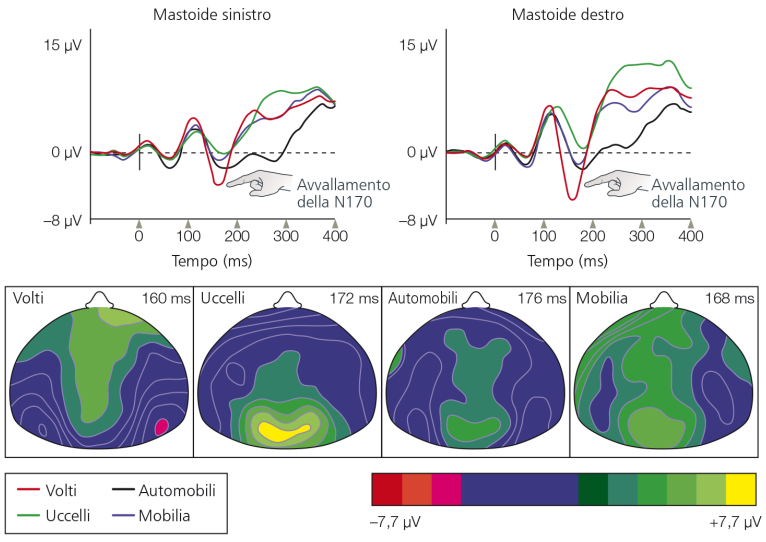



- More likely, several features, making unique an object, are activated together (neuronal ensemble)
- This would explain mistakes with similar objects -> same neurons are activated by both objects
- When a few cells are lost, other neurons can still support the encoding and retrieval of an object
- These neurons would support unusual objects recognition -> in virtue of the analogies with known objects

# Are faces special? Neuropsychology

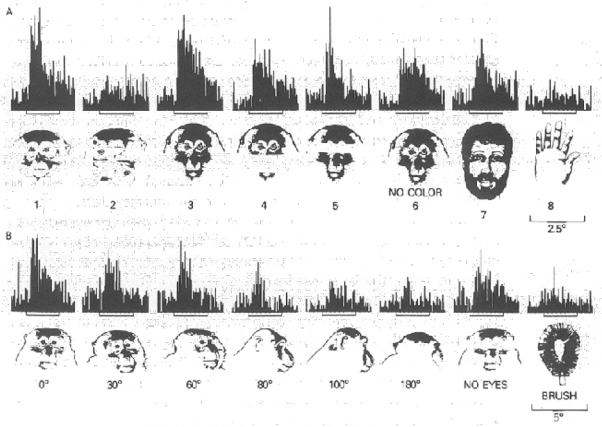
- PROSOPOAGNOSIA (face blindness)
  - limited to the inability to recognise faces
  - bilateral lesions or unilateral right lesion
  - ...but temporal, occipital, parietal...

# Are faces special? EEG recordings



# Are faces special? Single-unit recording

- Face cells have been recorded in the macaque brain

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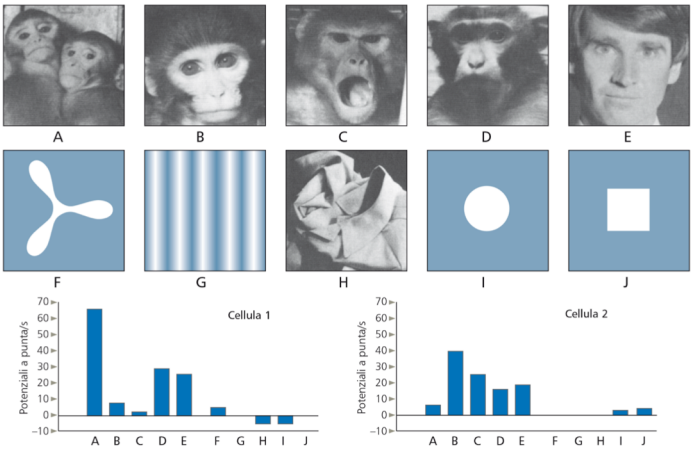
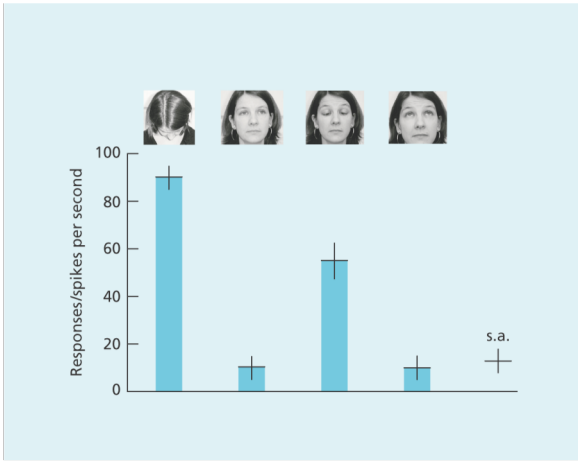
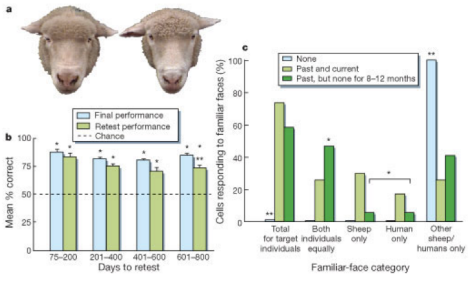


# Are faces special? Single-unit recording




# Are faces special? Single-unit recording

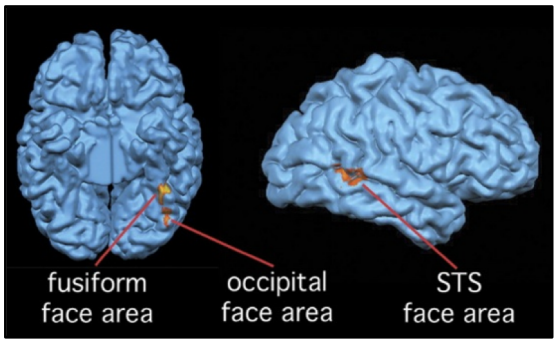



- Sheeps recognize up tp 50 different faces of conspecifics
- With the 80% of accuracy
- And remember them for more than 2 years

# Are faces special? Single-unit recording

- Face cells have been recorded in the macaque brain as well as in the sheep brain
- Their specificity:
  - for the face of the sheep
  - for the face of the sheep of the same breed
  - for the human face
  - for the direction of the gaze
  - for the rotation of the head
  - there are also horn-sensitive cells

# Are faces special? fMRI




- Fusiform gyrus
- Other areas are involved in the face processing:
  - Temporal superior sulcus
- The FFA seems to encode invariant features, the STS dynamic features

# FFA: faces vs competence

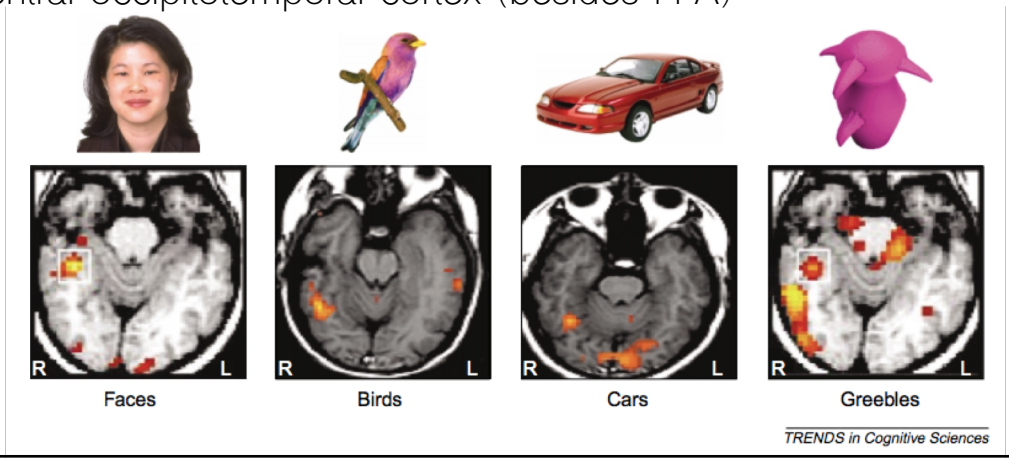
- Whether the FFA is domain specific for the faces, is not yet completely clarified
- One alternative hypothesis concerns the possibility that it is activated whenever the individual has to make a perceptual discrimination between well-known stimuli -> **level of competence**
  - Faces vs Flowers
    - We are all face experts, only a few are experts about roses; we see the FFA more often enrolled for faces because they are important for interactions and survival

# FFA: faces vs competence

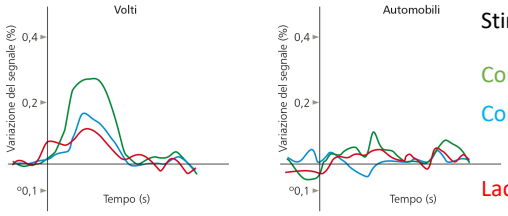
- Car experts show higher FFA activation for cars than birds (Gauthier et al., 2000)
- People trained extensively to discriminate item of a specific category, FFA activation is higher for the trained category (Gauthier et al., 1999)

# FFA: faces vs competence

Experts' categorization entails larger cerebral area (i.e., the ventral occipitotemporal cortex (besides FFA)




# FFA: faces vs competence

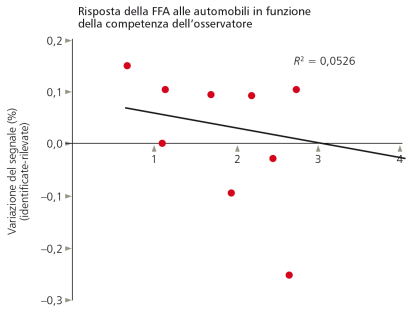



Stimuli presented for less than 50 ms

Correct identification of a specific face or car

Correct identification of the category but not the individual

Lack identification category



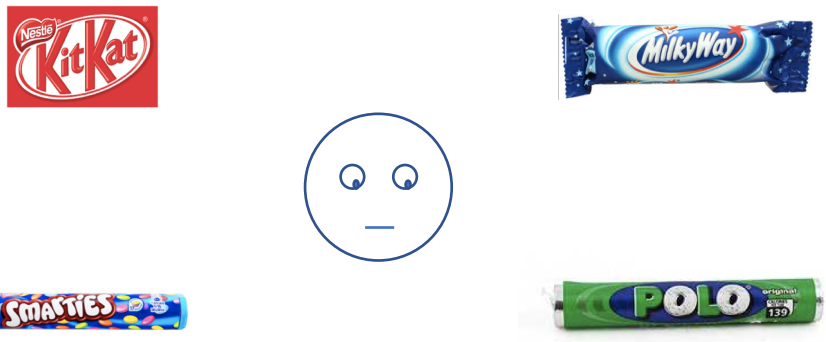

May be both hp have some correct element

# Atypical development

- Those that we have just seen are behaviors that unfortunately show deficits in infants with an atypical development, as for instance in the case of autistic spectrum disorder
  - These children show deficit in social interactions that are often compromised because
    - There is insufficient eye-contact
    - They hardly understand the facial expressions
    - They are unable to follow the gaze by others

# Gaze – autism

- Baron-Cohen et al. 1995, the four-sweets task
  - What will Charlie go for?



# Biological motion – autism

- In school-age children with autism, perception of biological motion is impaired
- By that age, there could be already compensatory coping strategies. How are those children during critical developmental periods?

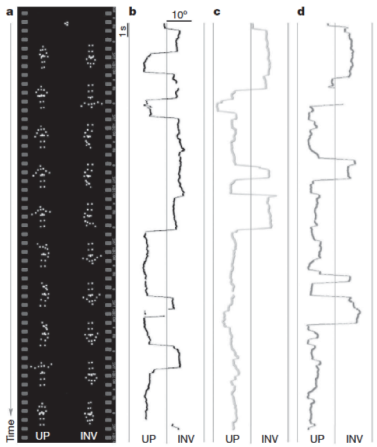
# Biological motion – autis

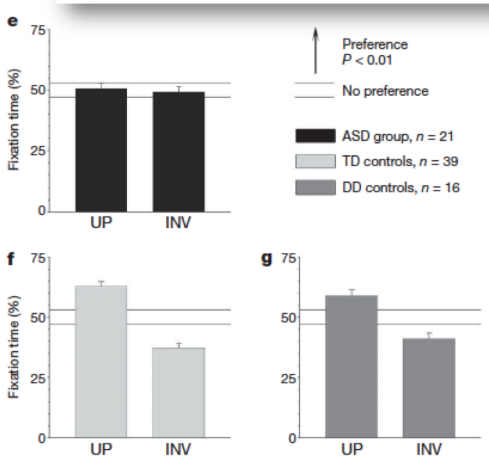
Vol 459|14 May 2009|doi:10.1038/nature07868 nature

LETTERS

**Two-year-olds with autism orient to non-social contingencies rather than biological motion**

Ami Klin[1], David J. Lin[1]†, Phillip Gorrindo[1]†, Gordon Ramsay[1,2] & Warren Jones[1,3]



# Eye movements – autism

- by comparing children with typical vs atypical development, the same authors showed that
  - The visual search of the scene is compromised already at a young age
  - As well as of the faces
  - It is also compromised the perception of the biological motion
  - In other situations, the perception is comparable to that of typically developing children (Klin et al., 2009; Blake et al., 2003)
- Autistic people seem to be captured by local contingencies, they seem to loose the possibility to give a global meaning to the scene. Where we usually perceive also an emotion from a point-light display, unfortunately these children cannot (Nackaerts et al., 2012)

# Eye movements – autism

- Within a face, while speaking, the point in which there is the higher audio-visual contingency is the mouth (as in the clapping of the hands of the previous movie)
- Less attention to the eyes which are the most significant part
- At 2 years, they seem already onto a different developmental trajectory: they have already learnt that the coincidence of light and sounds is more salient than other social info
- Eye fixation correlates with the level of social disability
  - The lesser the eye fixation, the higher the disability (Jones et al., 2008)

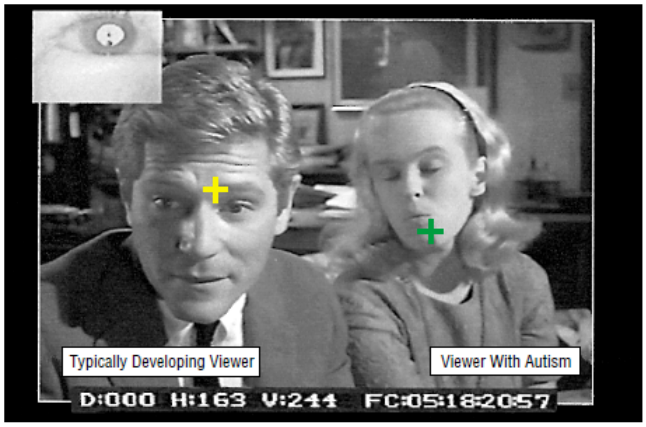
# Reading the mind in the eyes

- the *reading the mind in the eyes* is a test in which adults identify a complex mental state by only presenting the eyes: «compassionate» o «thoughtful» (Baron-Cohen et al., 2001)
- It's a preliminary attribution of a mental state
  - That does not include other contents (e.g., being compassionate to the sight of a suffering animal) but that is part (or maybe its at the basis) of the ToM

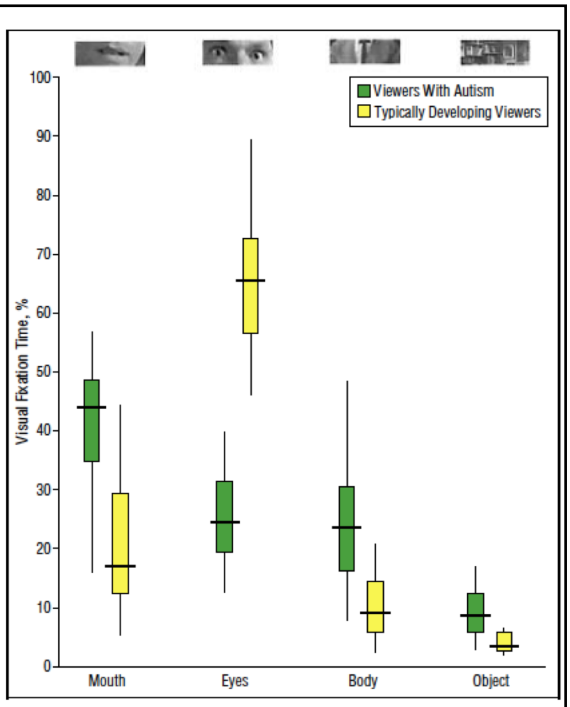
# Who's Afraid of Virginia Woolf ?

- A beautiful movie, 1966
- We are completely engaged in the dynamics of the complex interactions and we try to understand the emotional reactions in the eyes/on the faces of the other characters (not speaking)
- In 2002, Ami Klin et al. used this movie to investigate how participants with autism explore the scenes whilst watching the movie
- They found that in socially relevant moments, the participants looked at secondary detail in the scene, completely unrelated to the meaning of the speech. As if the eyes and the face has not much meaning

# Agents




*Klin et al., 2002*




# Agents

**Developmental Science**

Developmental Science 11:1 (2008), pp 40–46 DOI: 10.1111/j.1467-7687.2007.00608.x

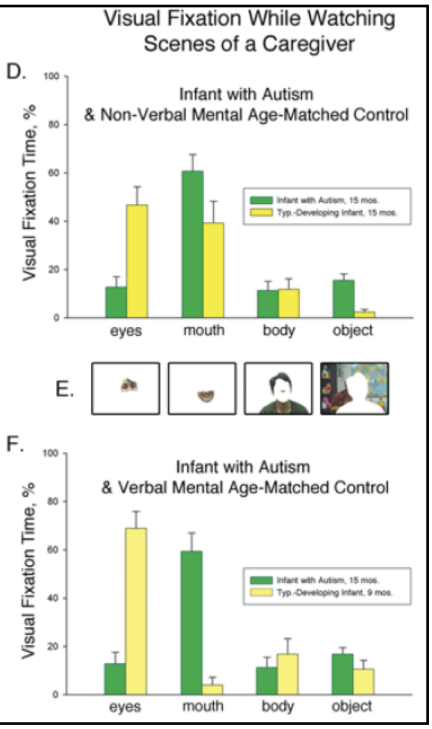
REPORT

**Altered face scanning and impaired recognition of biological motion in a 15-month-old infant with autism**

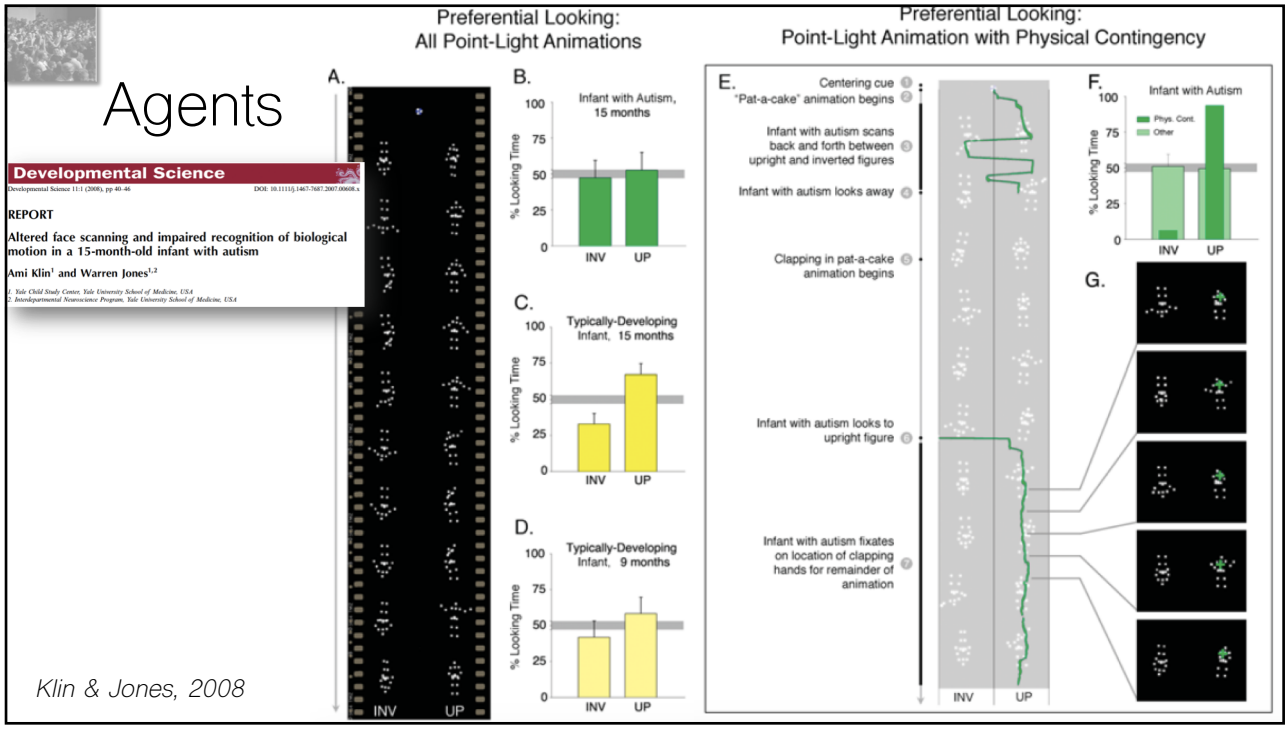
Ami Klin[1] and Warren Jones[1,2]

*1. Yale Child Study Center, Yale University School of Medicine, USA*
*2. Interdepartmental Neuroscience Program, Yale University School of Medicine, USA*

*Klin & Jones, 2008*

# Agents




Developmental Science

Developmental Science 11:1 (2008), pp 40–46 DOI: 10.1111/j.1467-7687.2007.00608.x

REPORT

**Altered face scanning and impaired recognition of biological motion in a 15-month-old infant with autism**

Ami Klin[1] and Warren Jones[1,2]

1. Yale Child Study Center, Yale University School of Medicine, USA
2. Interdepartmental Neuroscience Program, Yale University School of Medicine, USA

*Klin & Jones, 2008*

# Eye movements

- Earlier interventions with more precocious indicators?

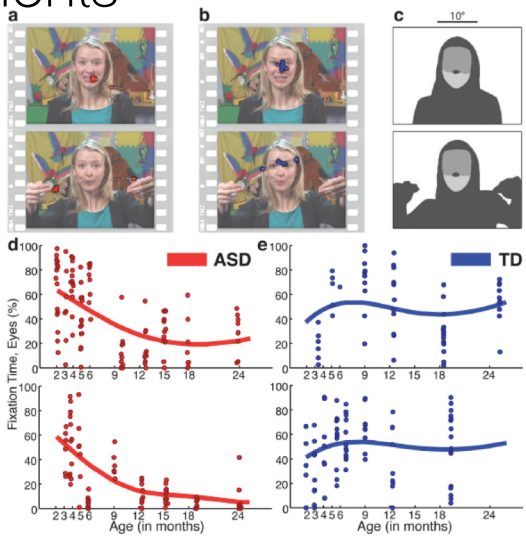
LETTER

doi:10.1038/nature12715

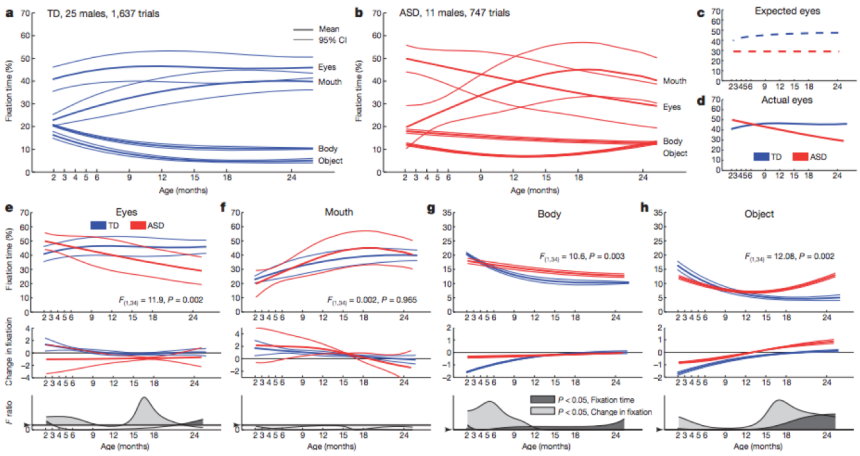
**Attention to eyes is present but in decline in 2–6-month-old infants later diagnosed with autism**

Warren Jones[1,2,3] & Ami Klin[1,2,3]

# Eye movements




# Eye movements



# Eye movements

- It is confirmed the importance of ocular movement detection
- This is the most precocious indicator available

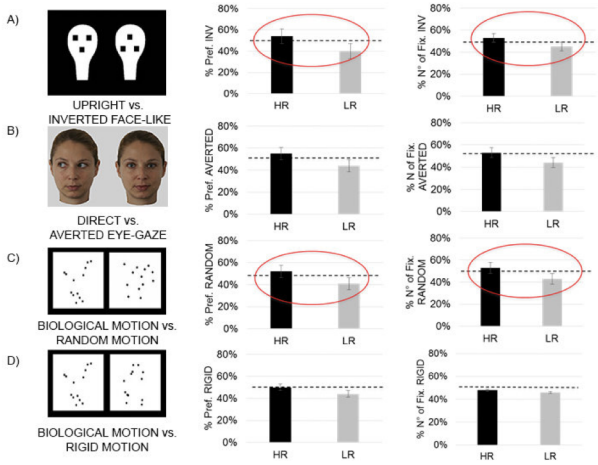
- Previous hypothesis falsified: during the first months of life, the basic mechanism (precursor) is not diminished in infants that later are diagnosed with ASD, rather it appears at average levels and only later it declines in its functioning
  - A short temporal window showing both the precocious compromission of the underliying process
  - And an opportunity to allow a precocious treatment based on apparent initial preserved attention to gaze and eyes region

# Eye movements

- Some researchers tested newborns with high risk of familiar autism (sisters/brothers of autistic children) on

  - Face-like stimuli
  - Gaze orientation
  - Biological motion

# Eye movements




Di Giorgio et al., 2016

# Eye movements

- The results show that
  - Both the % of looking
  - And the number of fixations
  - Is higher for the version of the stimuli that are not attractive to typically developing children (Di Giorgio et al., 2016)
- This is a first demonstration that deficits in orienting mechanisms toward socially relevant stimuli can be found very early in children at high risk of autism

# Core knowledge

The criteria hypothesized by Spelke (2000) seem to be satisfied as for the system of knowledge that support our reasoning on the behaviour of agents:

- Given at birth
- Independent from experience and formal culture/acculturation
- Largely shared between species
- At the basis of learning processes