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## **Evolution of Oculo-Pupillometric Biomarkers from Childhood to Adulthood in ASD**

Camille Ricou, Yassine Mofid, Emmanuelle Houy-Durand, Joëlle Malvy,  
Frédérique Bonnet-Brilhault, Nadia Aguillon-Hernandez, Claire Wardak

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## Context

Face perception plays a crucial role in social interactions, which are impaired in autism spectrum disorders (ASD). Face processing evolves during childhood, based on social experience, and expertise is considered acquired around 8 or 10 years old. This social skill can be indexed by **oculometric** (visual scanning) and **pupillometric** (physiological reactivity) measures. No studies have yet assessed the **evolution** of these measures **from childhood to adulthood**, both in the **neurotypical and autistic populations**. Understanding and characterizing how these measures develop in neurotypicals is essential to identify potentially atypical development in autism.

*How do oculo-pupillometric parameters in response to face evolve from childhood to adulthood in neurotypical and autistic populations?*



## Method

**Participants:** 108 autistic (aged 3 to 34 years old; CARS score=28.85±5.86; DQ=79.93±28.28) and 150 neurotypical participants (aged 3 to 32 years old).  
**Stimuli:** social and non-social stimuli organized along a social salience gradient: 4 static images of objects, 4 images of neutral faces (2 males and 2 females) and 12 dynamic videos ranging from neutral faces to emotional faces expressing happiness and sadness (2 males and 2 females for each condition). Each stimulus lasted 4 seconds and was presented randomly with an interstimulus of 2s, with a constant luminosity of 10 lux.

**Recording:** FaceLab<sup>®</sup> and SMI RED500<sup>®</sup> head-free binocular eye-tracking systems (60Hz).

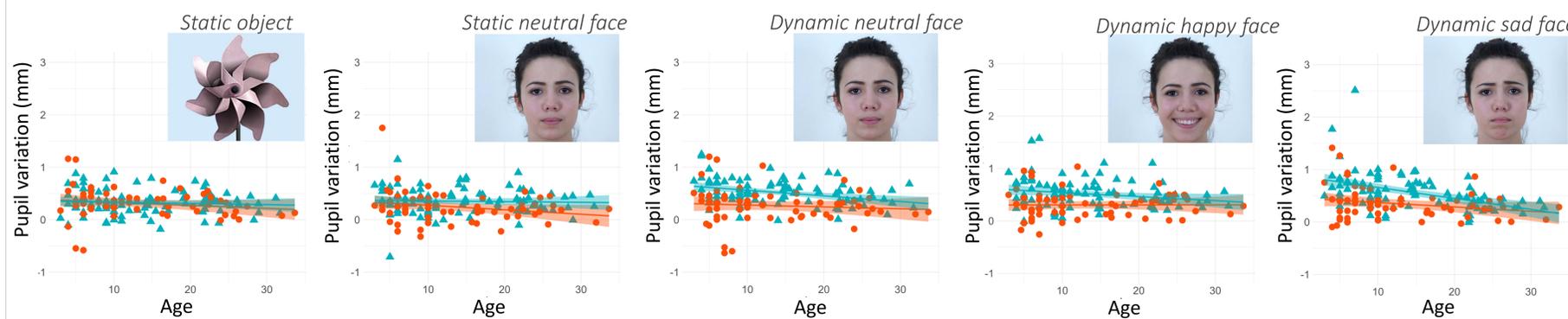
**Measurements:** **oculometric parameters** (proportion of time spent on object and face, and on eyes region) and **pupillometric parameters** (pupil variation calculated as the difference between the raw pupil size and the basal pupil size averaged over the last 200 ms of interstimuli. For our analyses the median of the pupil variation plateau values was used).

**Analysis:** GLM models testing age (continuous predictor) or age ranges (3-7; 8-12; 13-18; 19-33), and group (neurotypical and autistic) for each parameter. These models were corrected by using the Greenhouse-Geiser test and completed by Bonferroni posthoc tests. Finally, ROC analyses were used to describe the discrimination performance between the two groups for each parameter.

## Results

### Pupillometric parameters

#### Age effect on pupillary response to non-social and social stimuli



Neurotypical group: age effect  
Autistic group: no age effect  
*The pupillary response decreases with age for all dynamic faces in neurotypicals*

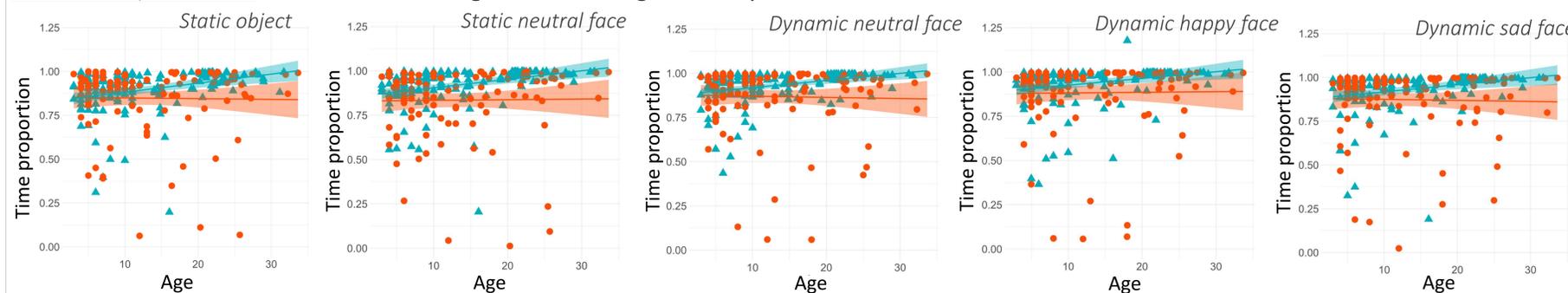
Do the pupillary parameters discriminate between the two groups across all age ranges?

Only in children (3-7 years)

- Higher pupil dilation in neurotypicals than autistics for all dynamic faces stimuli
- ROC analyses revealed good discriminative power (77-78%) with good sensitivity and specificity for all dynamic faces stimuli

### Oculometric parameters

#### Age effect on the gaze time spent on non-social and social stimuli



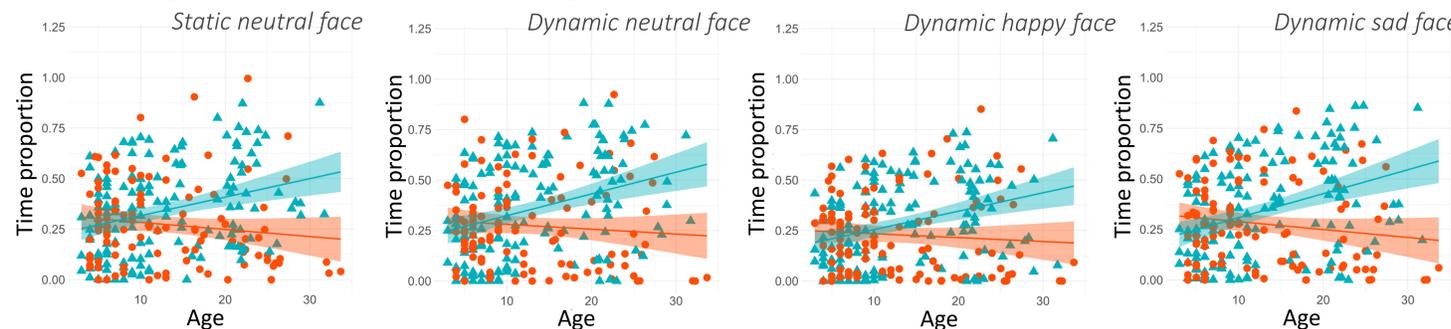
Neurotypical group: age effect  
Autistic group: no age effect  
*The gaze time spent increases with age in neurotypicals*

Do the oculometric parameters discriminate between the two groups across all age ranges?

Only in adults (19-33 years)

- Higher time spent:
  - on the static neutral and dynamic sad face in neurotypicals than autistic
  - on the eyes in neurotypicals than autistics
- ROC analyses revealed good discriminative power:
  - 72-79% with good sensitivity and specificity for the static neutral and dynamic face
  - 71-79% with good sensitivity and specificity for the eyes on all faces stimuli

#### Age effect on the time spent looking at the eyes area of social stimuli



Neurotypical group: age effect  
Autistic group: no age effect  
*The gaze time spent on the eyes in response to social stimuli increases with age in neurotypicals*

## Conclusion

Overall, this continuum study highlights the maturation of oculo-pupillometric parameters during face observation, with the differences between the two groups emerging from divergent maturation processes. Indeed, the pupillary variation in neurotypicals suggests a greater physiological mobilization from an early age that decreases with maturation. On the other hand, the results from the oculometric parameters suggest that neurotypicals focus more on social stimuli during development and that this attentional capture by social stimuli may be affected in ASD. These findings highlight the importance of understanding the maturation of these markers to identify discriminant parameters in ASD. Eye tracking used in a social paradigm appears to be a promising tool that can be used to help for ASD diagnosis, but with specific parameters according to age.

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nadia.aguillon-hernandez@univ-tours.fr  
claire.wardak@inserm.fr  
camille.ricou@inserm.fr