Learning Visual Attention to Identify People with Autism Spectrum Disorder

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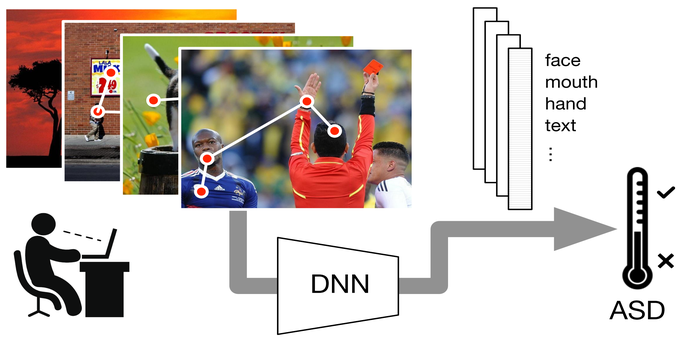
Introduction

Autism Spectrum Disorder (ASD) affects one in 68 people in the US. We propose a quantitative and objective ASD diagnostic tool based on eye tracking and deep neural networks (DNNs). The diagnostic process is completely data-driven and assumption-free.

Subjects freely observe a selection of natural-scene images, with eye movements recorded. Discriminative features are extracted from a deep neural network of visual attention and integrated to predict the subjects' ASD risk.



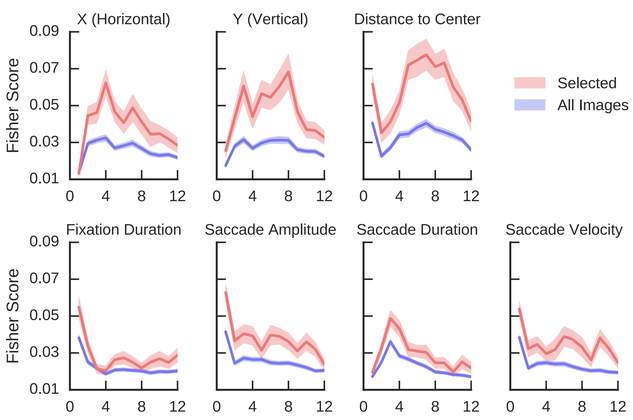
- **Subjects:** 20 high-functioning adults with ASD and 19 healthy controls.
- **Stimuli:** 700 natural-scene images.
- **Task:** passive image viewing for 3 seconds.

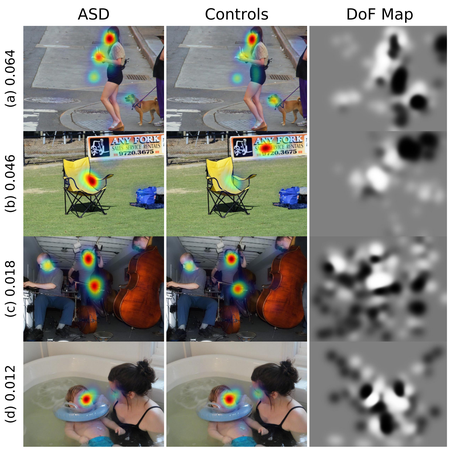
Contributions

- The first DNN-based model for ASD diagnosis, demonstrating superior performance.
- Generalizable to other neurodevelopmental disorders.
- Reducing the amount of data and time required.
- Enriching understanding of the atypical attention in ASD.

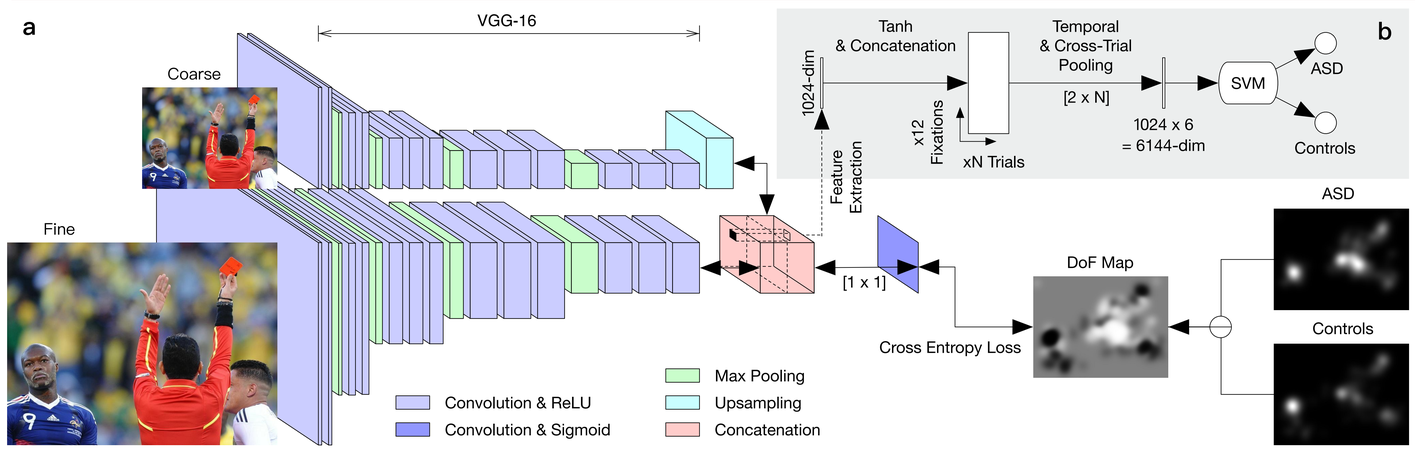
Image Selection

- Select the most discriminative images based on the Fisher scores of gaze features.
- Compute a DoF map to indicate the difference of eye fixations between subjects with ASD and controls.





Feature Learning and Classification



- Discriminative image features are learned to predict the difference of fixation maps.
- For each subject, features at fixated pixels are extracted and integrated across trials.
- The features are then classified with a linear SVM.

Results

	No. of Images	Acc.	Sen.	Spe.	AUC
Gaze	700	0.81	0.83	0.79	0.85
	100	0.86	**0.93**	0.79	0.88
VGG-16	700	0.85	0.83	0.87	0.89
	100	0.83	0.83	0.84	0.85
VGG-16 (fine-tuned)	700	0.85	0.83	0.87	0.89
	100	**0.92**	**0.93**	**0.92**	**0.92**

Article	Tool	Acc.	Sen.	Spe.	AUC
Falkmer *et al.* [12]	CARS	0.81	0.82	0.80	—
	ADOS	0.82	0.87	0.78	—
	ASD-DC	0.84	0.88	0.81	—
Liu *et al.* [22]	ET	0.89	**0.93**	0.86	0.89
Ours	ET	**0.92**	**0.93**	**0.92**	**0.92**