Differentiating Patients (ADHD, FASD, Parkinson's Disease) from Controls by Gazing Patterns

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Introduction

Eye movements and certain complex visual functions are influenced by diseases such as Attention Deficit Hyper-activity Disorder (ADHD) and Fetal Alcohol Spectrum Disorders (FASD)

Here we examine how bottom-up (stimulus-driven) attention selection mechanisms may differ between patient and control populations, and we take the advantage of the differences to develop classifiers to differentiate patients from controls.

Neurobehavioral Disorder

Attention Hyperactivity Disorder (ADHD)
Persistent patterns of inattention and/or hyperactivity, poor impulsive control, etc.

Fetal Alcohol Spectrum Disorders (FASD)
Complex patterns of behavioral or cognitive abnormali-ties in attention, impulsive control, memory, etc.

FASD is often misdiagnosed as **ADHD** because of similar symptoms. However, their causes and treatments are different

Parkinson's Disease (PD)
Slow reaction time, different allocation of attention, difficulties in impulsive control, short-term memory loss, etc.

Experiments

Exp. 1 (Children populations)
21 **ADHD** (11.2 ± 1.8 yr) v.s.
13 **FASD** (12.3 ± 2.1 yr) v.s.
18 **Control Children** (10.7 ± 1.8 yr)

Exp. 2 (Elderly populations)
14 **PD** (67.4 ± 6.6 yr) v.s.
24 **Control Elderly** (70.3 ± 7.5 yr)

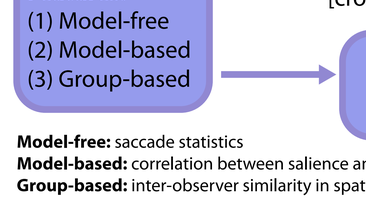
Aims:
(1) Classifying individuals based on their eye movements during free-viewing of natural scenes.
(2) Identifying the most discriminative features that can be used to differentiate populations.

Methods

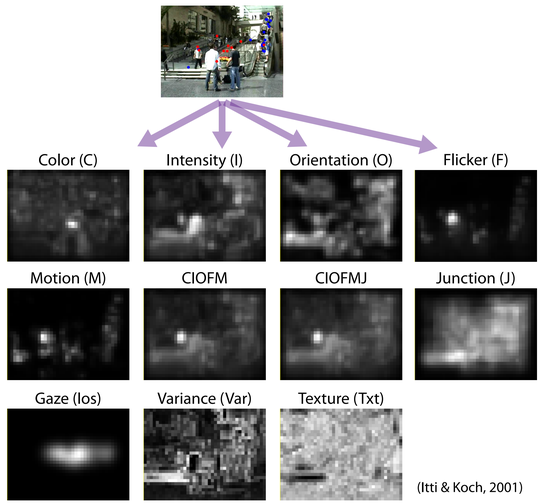
Record Eye Movements

Stimuli: Natural scene MTV-style videos (20 minutes - 40 videos, ~30 sec. each). MTV-style video is a continuous video whose scene changes every 2-4 seconds.

Instruction:
"Watch and enjoy the clips"

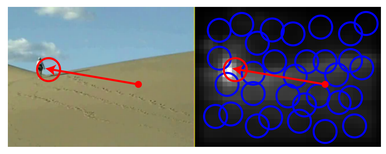


Compute Saliency Maps

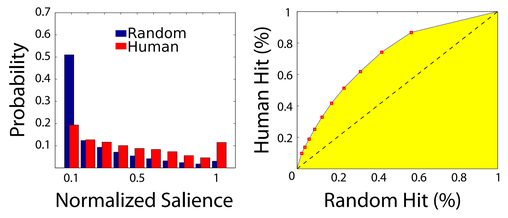


Correlation between Salience & Gaze

Compare the saliency value at saccade endpoint (red) to randomly sampled values (blue) from the saliency map



Quantifying the correlation by ordinal dominance analysis

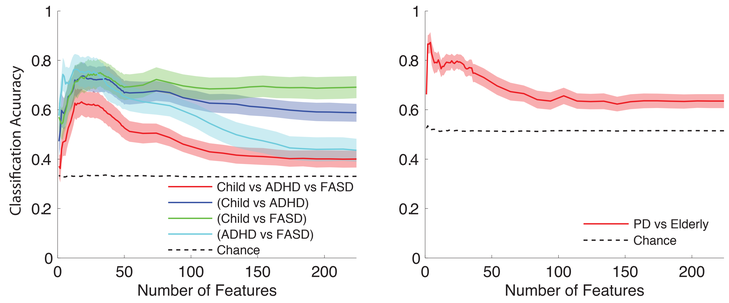


Classification

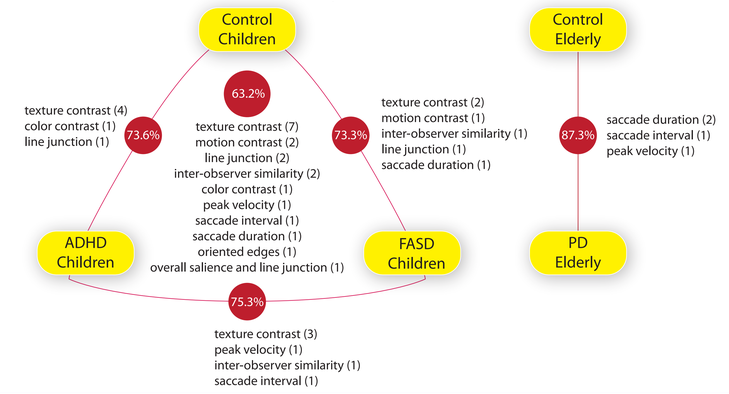
Model-free: saccade statistics
Model-based: correlation between salience and gaze
Group-based: inter-observer similarity in spatiotemporal distribution of gaze

Results

Classification accuracy as a function of number of selected features during the process of feature elemination (MSVM-RFE).



Summary of classification accuracy (in red circles) and the most discriminative fatures among populations. The numbers in parenthe-ses show occurences of the feature that was picked by feature ranking when the classifier has the best performance.



Summary

Discriminative information about the visual behavior of ADHD, FASD and PD can be extracted from 15 minutes of natural-viewing eye traces.

Identification of the most discriminative features for different clinical groups provides new quantitative insights on how specific disorders may affect different aspects of attention and gaze control.

The proposed approach can serve as an easily-deployed, low-cost and high-throughput screening tool for clinical disorders.

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