Differentiating Patients from Controls by Gazing Patterns
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Introduction
Several Studies have shown that eye movements and certain complex visual functions are influenced by diseases such as Attention Deficit Hyperactivity Disorder (ADHD) and Fetal Alcohol Spectrum Disorders (FASD).

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

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

Fetal Alcohol Spectrum Disorders (FASD)
Complex pattern of behavioral or cognitive abnormalities in attention, impulsive control memory, etc.

FASD is often misdiagnosed as ADHD because of similar symptoms. However, their causes & treatment are different.

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

Experiments
Exp. 1 (Children Populations)
22 ADHD (10.9±2.0 yr) vs. 10 FASD (12.4±2.1 yr) vs. 18 Control Children (10.5±2.0 yr)
Exp. 2 (Elderly Populations)
13 (67.4±6.9 yr) PD vs. 23 Control Elderly (70.2±7.7 yr)

Note: 8 ADHD, 5 FASD, 5 Control Children, 2 PD, and 1 Control Elderly were removed from the experiments for less than 5 minutes of valid eye traces. Another 2 ADHD and 2 FASD children were removed due to medication on the day of the experiment.

Classification
Features: (1) Correlations between salience and gaze (2) Saccade statistics
Pre-Processing: (1) Remove features with few saccades (2) Normalize data (Standard score)

Methods

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

Instruction: “Watch and enjoy the clips”

Compute Saliency Map
Feature Extraction
Color
Intensity
Orientation
Flicker
Motion

Feature Integration

Correlation between Salience & Gaze
Compare the saliency value at saccade endpoint to randomly sampled values from the saliency map
Only analyze saccades that are ill-predicted by eye movements of young adults

AUC: 0.71

Random Hit (%)
Normalized Saliency
Probability

Results
Exp. 1 (ADHD vs FASD vs Control Children)

72%
77.5%
85.7%
87.5%

Number of Features

Feature Ranking
1st: 1.494(4.63), E_hox2/sacred5 2nd: 1.494(4.63), E_hox2/sacred5 3rd: 1.494(4.63), E_hox2/sacred5 4th: 1.386(3.28), sa cere_q3/sacred5 5th: 1.386(3.28), hox2/sacred4 6th: 0.626(0.88), pixel_q3/sacred5 7th: 0.626(0.88), pixel_q3/sacred5

Exp. 2: (PD vs Control Elderly)

89%

Number of Features

Feature Ranking
1st: 0.972(5.11), sa cere_q3/sacred5 2nd: 0.508(4.24), sa cere_q3/sacred5 3rd: 0.508(4.24), ampr_g3/sacred2 4th: 0.427(4.91), x_hox2/sacred2 5th: 0.9418.331, Q_tacred5

Summary
Stimulus-driven attentional selection is influenced by diseases (ADHD, FASD, Parkinson) as shown by classification accuracy.

The difference can serve as a possible screening/diagnostic tool for clinical applications

An easier (task-free), cheaper, quicker and more natural method to test patients compared to other tests

(Acknowledgements: This work was supported by the National Science Foundation and the Human Frontier Science Program.)