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Which Perform Best to Identify ASD and TD: Upright Faces, Inverted Faces, or Their Mix?

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Background:

Social communication deficit is a key symptom for Autism Spectrum Disorder. Much research has demonstrated that human face is a sensitive biomarker for early detection on Autism Spectrum Disorder (ASD), due to its comprising of rich emotional expressions for a successful social interaction. By applying eye-tracking technology, a variety of different paradigms on faces are proposed with focus on subject's gaze behavior and pupillary change.

However, most efforts of ASD related face studies are on upright faces, fewer of them are on inverted faces. There is the conception that the perception and recognition are better of faces presented upright than that of inverted. But no previous study tells which perform better if they are used to identify ASD and Typical Development(TD) children, upright faces or inverted faces. For future application of face paradigm in early detection on ASD, it's necessary to find out the answer.

Objectives: Comparing three experimental paradigms designed on upright faces, inverted faces, and a mix of above two, find out which paradigm is the best in identifying ASD and TD children.

Methods:

47 ASD and 35 TD children of 3-6 years old were recruited, 23 ASD children provided valid data in the experiments, and 22 TD children as control group are matched by age and gender.

The experiments used SMI desktop eye tracking system with sample frequency 120Hz. The basic paradigm was a series of 12 pictures of same size and luminance on human faces of young people with different gender. In Experiment I, 12 face pictures were all upright. In Experiment II, 12 face pictures were all inverted. In Experiment III, the 2nd,5th, 7th, 10th ,12th pictures were inverted faces, while others were upright.

Subject's Fixation time on Area of Interest (AOI) of eyes, mouth, and faces on each picture were collected, as well as pupillary data. Average Fixation time on above AOIs, plus average and maximum changes of pupil diameter on their amplitude, time, and velocity was extracted as features. Further statistical analysis was done by SPSS and Python.

Results:

Three experiments all showed significant difference on features of valid slide numbers and average fixation time on face and eyes, while Experiment II and III showed more on fixation time of mouth and pupil response in maximum diameter change or its changing velocity, referring to attached table.

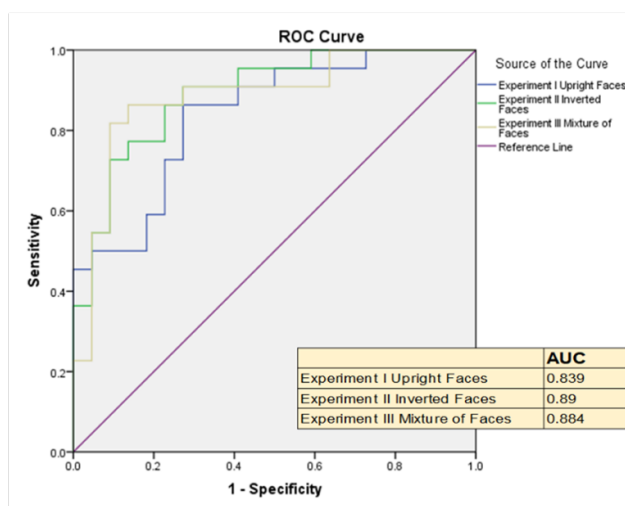
After correlation analysis and Principal Component Analysis, the predicted probability of the regression modes in three experiments are compared by their AUC (Area Under Curve) of ROC curve. Refer to attached Chart, Experiment II and III showed better result of 88.4% and 89% than that of 83.9% in Experiment I.

Conclusions: Although three face paradigms all showed efficiency in identifying ASD and TD, two experiments with inverted faces perform better than upright faces only. But there's no big difference in result for paradigms with inverted faces only or mixture of both faces. These facts support the finding that inverted face can be a better indicator in identifying ASD and TD.

Features w significant difference on ASD &TD

Data Type	No.	Features	Experiment I -- Upright faces	Experiment II -- Inverted faces	Experiment III -- Mixture of faces
Valid Slide Numbers	1	Number of valid slides	0.000 ***	0.001 ***	0.002 **
	2	Average Fixation Time on Faces	0.023 *	0.033 *	0.019 *
AOI	3	Average Fixation Time on Eyes	0.039 *	0.001 ***	0.037 *
	4	Average Fixation Time on Mouth		0.016 *	0.001 ***
Pupil	5	Maximum Amplitude change on Pupil Diameters		0.027 *	
	6	Maximum Velocity on Pupil Diameters Change			0.016 *

* p<0.05, ** p<0.01, *** p<0.001



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