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Clinical Application of Measurement of Eyeball Movement for Diagnose of Autism

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Abstract : This paper shows developing an objectivity index using the measurement of subtle eyeball movement to diagnose autism. The developmentally disabled assessment varies, and the diagnosis depends on the subjective judgment of professionals. Therefore, a supplementary inspection method that will enable anyone to obtain the same quantitative judgment is needed. The diagnosis are made based on a comparison of the time of gazing an object in the conventional autistic study, but the results do not match. First, we divided the pupil into four parts from the center using measurements of subtle eyeball movement and comparing the number of pixels in the overlapping parts based on an afterimage. Then we developed the objective evaluation indicator to judge non-autistic and autistic people more clearly than conventional methods by analyzing the differences of subtle eyeball movements between the right and left eyes. Even when a person gazes at one point and his/her eyeballs always stay fixed at that point, their eyes perform subtle fixating movements (ie. tremors, drifting, microsaccades) to keep the retinal image clear. Particularly, the microsaccades link with nerves and reflect the mechanism that process the sight in a brain. We converted the differences between these movements into numbers. The process of the conversion is as followed: 1) Select the pixel indicating the subject's pupil from images of captured frames. 2) Set up a reference image, known as an afterimage, from the pixel indicating the subject's pupil. 3) Divide the pupil of the subject into four from the center in the acquired frame image. 4) Select the pixel in each divided part and count the number of the pixels of the overlapping part with the present pixel based on the afterimage. 5) Process the images with precision in 24 - 30fps from a camera and convert the amount of change in the pixels of the subtle movements of the right and left eyeballs in to numbers. The difference in the area of the amount of change occurs by measuring the difference between the afterimage in consecutive frames and the present frame. We set the amount of change to the quantity of the subtle eyeball movements. This method made it possible to detect a change of the eyeball vibration in numerical value. By comparing the numerical value between the right and left eyes, we found that there is a difference in how much they move. We compared the difference in these movements between non-autistc and autistic people and analyzed the result. Our research subjects consists of 8 children and 10 adults with autism, and 6 children and 18 adults with no disability. We measured the values through pasuit movements and fixations. We converted the difference in subtle movements between the right and left eyes into a graph and define it in multidimensional measure. Then we set the identification border with density function of the distribution, cumulative frequency function, and ROC curve. With this, we established an objective index to determine autism, normal, false positive, and false negative.

Keywords : subtle eyeball movement, autism, microsaccade, pursuit eye movements, ROC curve
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