Trail Making Test

trail_making_test.pdf

Computer-aided detection, used in the screening and diagnosing of cognitive impairment, provides an objective, valid, and convenient assessment. Digital sensor technology is a promising detection method.

A study aimed to develop and validate a novel Trail Making Test (TMT) using a combination of paper and electronic devices.

This study included community-dwelling older adult individuals (n=297), who were classified into (1) cognitively healthy controls (HC; n=100 participants), (2) participants diagnosed with mild cognitive impairment (MCI; n=98 participants), and (3) participants with Alzheimer disease (AD; n=99 participants). An electromagnetic tablet was used to record each participant's hand-drawn stroke. A sheet of A4 paper was placed on top of the tablet to maintain the traditional interaction style for participants who were not familiar or comfortable with electronic devices (such as touchscreens). This way, all participants were instructed to perform the TMT-square and circle. Furthermore, we developed an efficient and interpretable cognitive impairment-screening model to automatically analyze cognitive impairment levels dependent on demographic characteristics and time-, pressure-, jerk-, and template-related features. Among these features, novel template-based features were based on a vector quantization algorithm. First, the model identified a candidate trajectory as the standard answer (template) from the HC group. The distance between the recorded trajectories and reference was computed as a critical evaluation index. To verify the effectiveness of our method, we compared the performance of a well-trained machine-learning model using the extracted evaluation index with conventional demographic characteristics and time-related features. The well-trained model was validated using follow-up data (HC group: n=38; MCI group: n=32; and AD group: n=22).

They compared 5 candidates machine learning methods and selected random forest as the ideal model with the best performance (accuracy: 0.726 for HC vs MCI, 0.929 for HC vs AD, and 0.815 for AD vs MCI). Meanwhile, the well-trained classifier achieved better performance than the conventional assessment method, with high stability and accuracy of the follow-up data.

The study demonstrated that a model combining both paper and electronic TMTs increases the accuracy of evaluating participants' cognitive impairment compared to conventional paper-based feature assessment [1)].

1)
Zhang W, Zheng X, Tang Z, Wang H, Li R, Xie Z, Yan J, Zhang X, Yu Q, Wang F, Li Y. Combination of Paper and Electronic Trail Making Tests for Automatic Analysis of Cognitive Impairment: Development and Validation Study. J Med Internet Res. 2023 Jun 9;25:e42637. doi: 10.2196/42637. PMID: 37294606.