Title: A Novel Eye Movement Biomarker Application for Monitoring Multiple Sclerosis Disease Progression

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Background:

Multiple sclerosis (MS) is characterized by subtle disease progression that is often undetected in clinical practice. Sensitive, accurate tools are needed to assist clinicians in monitoring disease progression. There is a wealth of evidence linking eye movements abnormalities in people with MS (pwMS) to disease severity and cognition. The objective of this study is to determine if a novel eye-tracking tool can accurately predict MS disease severity using eye and gaze movement metrics.

Methods:

PwMS (n=60) were recruited for this cross-sectional study. Eye movements metrics (EMMs) were recorded while performing oculomotor tasks (fixation, pro-saccade, anti-saccade and smooth pursuit) using a tablet running Innodem Neurosciences' patented eye-tracking technology, which only requires the tablet's embedded camera. Of the 350 EMMs automatically extracted, 20 were selected *a priori* for analysis. These were then correlated with clinical outcome measures (Expanded Disability Status Scale (EDSS), Symbol Digit Modalities Test (SDMT), Brief International Cognitive Assessment for MS (BICAMS), and Multiple Sclerosis Functional Composite (MSFC) using the Spearman's ρ correlation coefficient.

Results:

Baseline characteristics on the 60 participants are: mean age 51.0 (SD 10.6; range 26-74), gender (41F/19M), mean EDSS 3.5 (SD 2.1; range 1.0-7.5), and SDMT 49.7 (SD 13.5, range 22-80). Summary of primary EMMs correlations are: A) 9 EMMs correlated with SDMT with absolute correlation coefficient (acc) ≥ 0.3 (range 0.32-0.55; corrected $p<0.05$). B) 5 EMMs correlate with BICAMS with acc ≥ 0.3 (range 0.33-0.54; corrected $p<0.05$). C) 10 EMMs correlate with SDMT with acc ≥ 0.3 (range 0.31-0.53; corrected $p<0.05$) D) EDSS: 9 EMMs correlate with EDSS with acc correlation coefficient ≥ 0.3 (range 0.31-0.52; corrected $p<0.05$). Exploratory analyses showed 114 additional significant correlations between all EMMs and MSFC or BICAMS subtests. The next step will be to determine if machine learning models using these EMMs as inputs can serve as reliable and accurate digital Eye Movement Biomarkers (EMB) for MS progression.

Conclusion:

This cross-sectional study shows promising correlations between individual EMMs and common clinical disease assessment, similar to previously published studies using research-grade eye-trackers. When completed, this trial will demonstrate the reliability of EMBs for the monitoring of MS progression as a non-invasive, accessible and sensitive novel digital biomarker of disease progression.

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