Deficits of saccadic eye-movement control in Parkinson’s and Alzheimer’s disease: new insights from cognitive pupillometry

Characteristics of saccadic eye movements provide a reliable, non-invasive method to evaluate motor and cognitive (dys)function in neurodegenerative disorders such as Parkinson’s disease (PD) and Alzheimer disease (AD). However, saccadic abnormalities alone fail to provide comprehensive insights into the underlying neurocognitive nature of any disease specific deficit. Here, we employed ocular motor assessment combined with Task Evoked Pupillary Responses (TERPs) to investigate the allocation of cognitive resources in PD and AD. To this end, 23 PD patients, 19 AD patients and 24 age-matched controls performed a pro-saccade task and an anti-saccade task. Saccadic latency, amplitude and errors were calculated to evaluate ocular motor control, while pupil size was recorded to assess dynamics of cognitive engagement. Within all three groups, anti- compared to pro-saccade tasks elicited larger and prolonged pupil responses, implying that pupillary parameters are informative of individual cognitive state in both healthy elderly and patients. Furthermore, we found clear between group differences. In the prosaccade task, both PD and AD patients consistently undershot the target. However, while PD pupil parameters were comparable to controls, AD patients showed slower pupil dilation. During the anti-saccade task, PD patients had more direction errors and less precise eye movements compared to controls. Their pupil responses were reduced both in size and duration, indicating that Parkinson pathology may determine inefficient cognitive engagement relative to task demand. AD patients also had an increased direction error rate, and additionally displayed prolonged latencies of correct anti-saccades. Their pupil peak dilation was similar in size but delayed in time compared to controls, suggesting that Alzheimer’s disease causes an overall slowing in allocation of cognitive resources. We conclude that cognitive pupillometry provides new and relevant insights into the nature of information processing deficits in PD and AD.