

# Pupillary Light Reflex and its Implications in Multiple Sclerosis

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Multiple sclerosis (MS) is a chronic autoimmune disorder of the central nervous system and the most common non-traumatic neurological disability in young adults. While its effects on the motor and sensory systems are well recognized, autonomic nervous system (ANS) dysfunction in MS remains underdiagnosed due to the absence of fast, objective, and non-invasive screening tools.

Given the dual innervation of the eye's pupil by parasympathetic and sympathetic pathways, the pupillary light reflex (PLR) offers a valuable, underutilized window into central autonomic function.

This project investigates whether handheld quantitative pupillometry can detect differences in parasympathetic and sympathetic function between healthy individuals and MS patients using tailored light stimuli. We tested 107 patients with MS and 36 healthy volunteers (HVs) using two pupillometry protocols: Protocol 1 (Parasympathetic reflex): A bright light pulse over a dim background elicited a constriction response mediated by the sphincter pupillae and parasympathetic fibers. Protocol 2 (Sympathetic reflex): A dim pulse over a bright background triggered pupil dilation, driven by the dilator pupillae and sympathetic innervation. Pupillary diameter (in mm) was measured pre- and post-stimulus using a standardized pupillometer setup.

Measurements were plotted and compared between MS and HV cohorts. Quantitative results showed clear differences in both initial and end pupil diameters between MS patients and healthy

controls for both reflex types. In Protocol 1, MS patients displayed less constriction and larger post-stimulus pupil diameters compared to HVs, suggesting diminished parasympathetic activity.

In Protocol 2, MS patients showed reduced dilation responses, indicating sympathetic pathway involvement. These changes were consistent across the cohort and visually confirmed in the diameter-time graphs. The observed alterations in PLR dynamics support the presence of autonomic dysfunction in MS, affecting both sympathetic and parasympathetic branches.

Quantitative pupillometry therefore shows promise as a non-invasive, reproducible, and timeefficient diagnostic aid for identifying autonomic changes in neuroimmunological conditions such

as MS. Further work will explore the correlation between pupillometry data and clinical MS metrics

such as lesion location, disease subtype, and disability progression. Expanding testing to other neuroinflammatory conditions may help validate pupillometry as a broader tool for autonomic profiling in neurological disease.