VISION AND DRIVING IN MULTIPLE SCLEROSIS

Maria T. Schultheis, PhD, Kevin Manning, MS, Valerie Weisser, MS, Alison Blasco, BS, Jocelyn Ang, BA, Mark E. Wilkinson, OD


Objective: To examine the relationship between measures of visual dysfunction and driving performance in persons with multiple sclerosis (MS).

Design: Between-group comparison.

Setting: All data were collected in an outpatient research setting.

Participants: Persons (N=66) with MS of the relapsing remitting type (26 self-reporting visual difficulties; 40 self-reporting no visual difficulties) and 26 age- and sex-matched healthy controls.

Interventions: Not applicable.

Main Outcome Measures: Measures of vision included visual acuity, depth perception, and color perception. Driving was measured using documented accident/violation rate and self-reported driving behaviors.

Results: Quantitative analysis only revealed that MS persons with self-reported visual difficulties performed significantly worse than healthy controls on color perception (Kruskal-Wallis; $\chi^2=8.89$, $P=.01$). There were no group differences on driving behaviors, and correlational analysis revealed a lack of relationship between the selected visual (visual acuity, depth perception, color perception) and driving performance measures (documented accident/violation rate and self-limiting driving behaviors).

Conclusions: Persons with MS who self-reported difficulties with vision had acceptable visual acuity, despite demonstrating impairment in color perception. The fact that visual acuity remains the most common measure for visual fitness to drive remains problematic. There is a need to further define measures of visual dysfunction relevant to driving among this clinical population.

Key Words: Automobile driving; Multiple sclerosis; Rehabilitation; Visual acuity.

© 2010 by the American Congress of Rehabilitation Medicine

MULTIPLE SCLEROSIS IS A chronic, inflammatory, and neurodegenerative disorder of the central nervous system. Visual changes are the first symptom of illness in approximately 50% of persons with MS, and up to 90% of persons with MS will have illness-related vision impairment. These symptoms vary both in type and severity, can be difficult to characterize, and may be present in persons with nominal visual acuity (ie, 20/20, or the ability to see clearly at 20 feet what should normally be seen at that distance). Vision is essential to safe driving. Current procedures to determine visual fitness to drive predominantly focus on assessment of visual acuity, and 38% of all states in the United States rely solely on this measure. This is true despite the dearth of evidence for a relationship between visual acuity and unsafe driving in the general population. Among drivers with MS, factors such as cognitive and physical impairment have been related to driving difficulties, but no study has directly examined the impact of visual difficulties. The current study examined the relationship between measures of visual impairment and driving performance among persons with MS. Furthermore, based on the evidence that self-reported visual impairment in MS is not entirely captured by measures of visual acuity, additional self-report and objective measures of vision performance were examined.

METHODS

Participants included 66 persons (age range, 21–56y) with a diagnosis of clinically definite MS (61% relapsing remitting) who had not experienced an exacerbation of symptoms within 1 month prior to the onset of the study. Participants with MS were divided into 2 groups based on a single question: 26 participants self-reporting visual difficulties and 40 who did not self-report visual difficulties. Twenty-six HC matched on age and sex who did not report visual difficulties were also included. Participants with a history of other neurologic disease, major psychiatric illness, or substance abuse were ineligible. All participants were community-dwelling experienced drivers and held a valid driver’s license in the state of New Jersey or Pennsylvania. All met the minimum visual requirements established by the DMV in their respective state and were classified as active drivers (a minimum of 1 driving occasion during the previous 1-month period). All participants were given written informed consent approved by the institutional review board.

Measures

Vision. Objective measures of visual acuity, depth perception, and color perception were obtained using the Optec 2500 Visual Examiner. Acuity was recorded in Snellen format; not surprisingly, given the visual requirement for licensure, over half of the sample had 20/20 or close to 20/20 vision. Therefore, this variable was dichotomized into 20/20 vision and vision greater than or equal to 20/30. Color perception was tested using the Ishihara method, and because color misper-
Inadequate performance was infrequent, performance was classified as normal (no errors on this measure) or abnormal (presence of errors). For depth perception, participants were shown images of 4 floating rings and asked, “Which ring is floating toward you?” Scores ranged from 0 (low) to 9 (high) accuracy.

**Driving**. State-issued driver abstracts from the DMV provided a history of accidents and violations from the previous 5 years. Given the rarity of these events, analyses focused on the presence or absence of accidents/violations. The second measure of driving performance included self-reported behaviors of limiting their driving (eg, not driving in bad weather). A 2-class decision (yes/no limit driving) from the response was calculated as the self-limiting driving behavior variable.

**RESULTS**

**Descriptive Observations Between the Groups**

Descriptive characteristics and visual measures of the cohorts are presented in **table 1**. Qualitative analysis of the 3 groups (MS with self-reported visual difficulty, MS with no self-reported visual difficulty, and HC) revealed different patterns in several variables of interest. This included reported self-limiting driving behaviors, with 50% of the MS participants with self-reported visual difficulty reporting they limited their driving behaviors, compared with 41% of the MS with no self-reported visual difficulty and 41% of the HC Participants who self-reported visual difficulties were less likely to have 20/20 visual acuity performance but still met the licensure criteria. Specifically, 35% of the MS with self-reported visual difficulty group had 20/20 acuity compared with 63% of the MS with no self-reported visual difficulty group and 62% of the HC group.

**Quantitative Between-Group Analyses**

There were no differences in limiting driving behavior or documented accidents and violations between the 3 groups (MS with self-reported visual difficulty, MS with no self-reported visual difficulty, and HC). Kruskal-Wallis tests revealed the visual performance of the 3 groups significantly differed on measures of color perception (Kruskal-Wallis; \( \chi^2 = 8.89, P = .01 \)) but not visual acuity (Kruskal-Wallis; \( \chi^2 = 5.63, P = .06 \)), or depth perception (Kruskal-Wallis; \( \chi^2 = 2.36, P = .11 \)). Mann-Whitney U tests with Bonferroni correction \( (P = .0167) \) were used to follow up. Results indicated that the MS with self-reported visual difficulty group made more errors of color perception than the MS with no self-reported visual difficulty and HC groups. No difference on color perception between the MS with no self-reported visual difficulty and HC groups were found.

Correlational analyses were used to examine relations between vision and driving variables using only MS participants. The decision to self-limit driving was not related to performance on a test of depth perception \( (r = -.17, P = .19) \), visual acuity \( (\chi^2 = 3.45, P = .06) \), or color perception \( (\chi^2 = 1.17, P = .28) \). Likewise, the presence of accidents and violations was not associated with depth perception \( (r = -.12, P = .33) \), visual acuity \( (\chi^2 = .48, P = .48) \), or color perception \( (\chi^2 = .74, P = .39) \).

**DISCUSSION**

This is the first study to directly examine the relationship between visual difficulties and driving in MS. The study examined 3 aspects of vision: visual acuity, color perception, and depth perception in a sample of licensed drivers with MS and without self-reported visual difficulties. The findings indicate that persons with MS who self-report visual difficulty perform worse than both HC and persons with MS who do not self-report visual difficulty on an objective measure of color perception, but not on depth perception or visual acuity. No significant relations were found between the 3 visual measures and measures of driving performance, specifically documented accident/violation rate and self-limited driving behaviors.

It is remarkable that despite the difference in self-report of visual difficulties, there was little difference in the objective measures of vision, with the exception of color perception. Because acquired color vision changes can be indicative of optic nerve changes, our data may suggest persons with MS who perceive a change in their color perception are likely sensitive to the early subtle changes in visual functioning that come with illness-related optic neuritis. Although color perception did not correlate with driving behavior in our study, previous work has provided some evidence about the potential contribution of this visual domain to safe driving.

**Study Limitations**

While the current study attempted to examine the critical relationship between driving and vision in persons with MS, the selected visual and driving measures were limited. Most notably, the study relied on measures of visual quantity (ie, acuity and depth perception) and did not include adequate measures of visual quality (eg, contrast sensitivity). Furthermore, the range of visual acuity was restricted by DMV visual requirements. Likewise, driving was examined using gross measures of driving performance (eg, accident involvement) and did not directly evaluate aspects of driving directly related to vision (eg, nighttime driving). Indeed, using reported accidents/violations may underestimate other minor accidents and “near-misses.” Future studies should include a broader range of visual measures and more specific measures of driving performance and emphasize less dependence on visual acuity alone. Finally, the sample used represented a high-functioning group with minimal influence of illness based on Extended Disability Status Scale scores and performance on an extensive neuropsychologic battery. Given the progressive nature of MS, the need to examine this relationship at varying stages of severity is clear.
CONCLUSIONS

Despite these limitations, the findings highlight an important clinical issue. The fact that visual acuity remains the most common measure for visual fitness to drive remains problematic. Driving is a complex and dynamic activity that requires the integration of motor, cognitive, and sensory information. Defining the contribution of the subtle and not-so-subtle visual difficulties faced by persons with MS is critical to ensuring the safety of MS drivers and others.

References

Supplier