Self-Reported Importance and Difficulty of Driving in a Low-Vision Clinic Population

Robert W. Massof, James T. Deremeik, William L. Park, and Lori L. Grover

Purpose. To validate estimates of self-perceived driving ability from difficulty ratings of driving tasks and to determine the association of the importance and difficulty of driving with the magnitude of visual impairments.

Methods. A consecutive series of 851 patients at a low-vision clinic rated the importance of driving on a four-point scale. Those who gave nonzero importance ratings then rated driving difficulty on a five-point scale. Those who gave nonzero difficulty ratings then rated the difficulty of each of 21 driving tasks on a five-point scale. Visual acuity was measured with the Early Treatment of Diabetic Retinopathy Study (ETDRS) chart, and contrast sensitivity was measured with the Pelli-Robson chart. Rasch analysis was used to test the validity and reliability of self-perceived driving ability estimates from difficulty ratings of tasks.

Results. Patients who rated driving as not important (41%) had worse visual acuity (logMAR = 0.88) and worse contrast sensitivity (log CS = 0.83) than did those who rated driving as extremely important (55%; logMAR = 0.62; log CS =1.03; multivariate analysis of variance [MANOVA]; $P = 0.003$). Self-perceived driving ability correlated negatively with the overall rating of driving difficulty ($r = -0.69$; $P < 0.001$) and with logMAR ($r = -0.28$; $P < 0.001$), and correlated positively with log CS ($r = 0.35$; $P < 0.001$). The most difficult driving tasks were navigating in parking ramps, parking in the correct space, seeing lane markings, and reading signs. The least-difficult driving tasks were seeing traffic and reading the speedometer. Rasch analysis confirmed instrument validity and reliability.

Conclusions. Low-vision patients appeared to devalue the goal of driving when visual impairments were more severe. Valid measures of self-perceived driving ability can be estimated from difficulty ratings of specific driving tasks. (*Invest Ophthalmol Vis Sci.* 2007;48:4955–4962) DOI:10.1167/iovs.06-0566

The automobile is the dominant form of transportation in the United States.[1] Driving is a significant contributor to quality of life.[2] Loss of ability to drive and driving privileges, especially by older people can lead to dependence on others, isolation, and depression.[3,4] Visual impairment is a common reason for older people to lose their driving privileges or to give up driving, even if they still are eligible to drive.[2,5–7]

Findings in most studies concur that self-reported driving difficulty increases with reductions in visual acuity and losses of contrast sensitivity,[8] and that visually impaired drivers sometimes self-limit or abandon driving because of perceived safety issues.[9] Most such studies focus on populations that are elderly and have normal or near-normal vision. Visual impairments within the study populations usually are mild and are associated with cataract or uncorrected refractive errors.[10,11]

In a recent study, DeCarlo et al.[2] looked at the driving behavior of 126 patients with AMD who sought services at a low-vision clinic. They observed that 24% of the low-vision patient sample was still driving and three fourths of those drivers did not meet the state vision requirements for a driver's license. However, the low-vision drivers limited their driving to less than 10% of the miles driven per year by the normally sighted population in the same age group. The average visual acuity of the drivers in the low-vision sample was 20/109 (range, 20/30–20/600); the nondrivers in the sample had worse acuity (average, 20/214; range, 20/30–20/3500). Eighty-five percent of those who did not drive reported that they had stopped because of their impaired vision. The drivers in the sample scored higher on the NEI VFQ (Visual Function Questionnaire)-25 than did the nondrivers, even after correcting for visual acuity differences. But the life space (area traveled from the home) was the same for drivers and nondrivers among the low-vision patients, indicating that the nondrivers were able to compensate with other transportation strategies.

In the present study, we further explored self-reported perceptions of driving-related issues in a low-vision clinic sample. We asked how important driving was to the low-vision patients and what the relation was between perceived driving ability and visual impairments.

Methods

All low-vision patients scheduled for a first visit appointment at the Wilmer Low Vision Rehabilitation Service are recruited to serve as subjects in an umbrella research project on the measurement of vision disability. Subjects sign a Health Insurance Portability and Accountability Act (HIPAA) waiver and a consent form that is read to them. Recruitment procedures and all study methods conform with the tenets of the Declaration of Helsinki and have been approved by the Johns Hopkins Institutional Review Board (IRB) for human subjects research. For the present study, data were obtained from 851 consecutively recruited low-vision subjects. Subjects ranged in age from 18 to 101 years, with a median age of 75 years. Fifty-seven percent of the subjects were women. Binocular visual acuity with habitual correction measured on the rear-illuminated Early Treatment of Diabetic Retinopathy Study (ETDRS) chart[12] ranged from 20/15 to light perception, with a median of 20/60 (mean = 0.54 logMAR; SD = 0.45 logMAR for the 99% of patients with measurable acuities), and binocular log contrast sensitivity measured on the Pelli-Robson chart[13] ranged from 1.95 to 0.00 (among the 81% of patients with measurable contrast sensitivity) with a mean of 0.78 and an SD of 0.56. The distribution of visual system disorders in the sample was 42% age-related macular degeneration, <1% other macular disorders, 11% diabetic retinopathy, 3% other retinal vascular diseases, 5% retinal degeneration, 3% retinal detachment, 4% other retinal disorders, 12% glaucoma, 6% optic atro-

From the Lions Vision Research and Rehabilitation Center, Wilmer Ophthalmological Institute, Johns Hopkins University School of Medicine, Baltimore, Maryland.

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Corresponding author: Robert W. Massof, Lions Vision Center, 6th floor, 550 N. Broadway, Baltimore, MD 21205; rmassof@lions.med.jhu.edu.

phy, <1% amblyopia, <1% progressive myopia, 2% refractive errors, 4% cerebral vascular accidents (CVA) and brain disorders, and 4% other disorders. Because of HIPAA regulations, we have no information about patients who did not agree to join the study.

Subjects were mailed an intake questionnaire to be completed at home and sent back to the investigators. They were contacted by telephone to schedule an appointment for a telephone interview. During that call, the intake questionnaire was administered by telephone if the subject did not have assistance available. The questionnaire included three questions about driving that were used in the present study: (1) Are you licensed to drive? (2) Do you drive now? (3) If you do not drive, when did you last drive? (<6 months ago, 6–12 months ago, 1–2 years ago, >2 years ago, or never).

A trained interviewer called the subject at the appointed time before the first visit to the clinic and administered the Activity Inventory (AI).[14,15] The AI used for the present study consisted of 50 goal-level items that describe general activities. For each goal, the subject was asked to rate how important it is to perform the activity independently. One of the goals is driving. The ordered rating categories are "not important," "slightly important," "moderately important," and "extremely important." If the subject responded "not important," the interviewer moved on to the next goal, otherwise the subject was asked to rate the difficulty of performing the activity independently. The ordered difficulty rating categories were "not difficult," "slightly difficult," "moderately difficult," "very difficult," and "impossible." If the subject responded "not difficult," the interviewer moved on to the next goal; otherwise the subject was asked to rate the difficulty of a series of tasks related to the goal. The ordered difficulty rating categories for the tasks were the same as those used for the goals, or the subject could respond "not applicable." The tasks listed under the driving goal are shown in Table 3.

Data analysis was limited to the three driving questions on the intake questionnaire, the importance and difficulty ratings of the driving goal, and the difficulty ratings of the driving tasks. Rasch analysis[16,17] with the Andrich rating scale model[18] was used to estimate an interval-scaled perceived driving ability variable for each subject and an interval-scaled perceived required driving ability variable for each task based on driving task difficulty ratings (WINSTEPS ver. 3.16[19]). Person and item measure fit statistics and reliability coefficients[20] also were estimated to evaluate the accuracy and precision of the perceived driving ability scale.

Results

Importance and Difficulty Ratings of the Driving Goal

Low-vision subjects effectively dichotomized the importance of driving ratings. As summarized in Table 1, 41% of the 851 low-vision subjects rated driving as not important and 55% rated it as extremely important. Only 1% of responses fell in the slightly important category and 3% in the moderately important category.

Of those 349 subjects who rated driving as not important, 29% had a driver's license, but only 2% still drove. Of those 468 subjects who rated driving as extremely important, 77% had a driver's license and 49% still drove. Among the 602 nondrivers, 17% had given up driving within the previous 6 months, and only 9% of them rated driving as not important. Compared to this group, the OR of responding that driving is not important increased with increased reported time since the patient stopped driving. However, as shown in Table 2, only the ORs for the group of patients who stopped driving more than 2 years earlier and for the group of patients who never drove are significantly greater than 1 (statistical criterion of $\alpha = 0.05$).

Those subjects who rated driving as not important had lower visual acuity (mean logMAR = 0.88; SD = 0.69) and lower contrast sensitivity (mean log CS = 0.83; SD = 0.45)

Table 1. Distributions of Visual Impairment Measures and Driving History for Different Ratings of the Importance of Driving

Importance Rating	Number of Subjects	Percent of Subjects	Mean LogMAR	SD LogMAR	Mean LogCS	SD LogCS	Has DL	Currently Drives	Number of Nondrivers	Percent of Nondrivers Who Last Drove				
										<6 mo	6 mo–1 y	1–2 y	>2 y	Never
0	350	41%	0.88	0.69	0.83	0.45	29%	2%	343	9%	7%	7%	46%	31%
1	11	1%	0.66	0.57	1.08	0.65	78%	30%	8	33%	17%	0%	50%	0%
2	26	3%	0.59	0.40	1.19	0.26	75%	42%	15	31%	23%	8%	23%	15%
3	464	55%	0.62	0.60	1.03	0.43	77%	49%	236	28%	19%	17%	28%	7%

0, not important; 1, slightly important; 2, moderately important; 3, extremely important; DL, driver license.

TABLE 2. ORs for Different Time Periods Reported by Patients since They Last Drove Relative to the Group of Patients Who Reported That They Had Stopped Driving Less Than 6 Months Earlier

Patient Response	<6 mo	6–12 mo	1–2 y	>2 y	Never
Not important	OR	1.3	1.49	5.39*	13.53*
	95% CI	0.64–2.67	0.77–3.10	3.06–9.49	6.67–27.44
Impossible	OR	1.13	1.23	1.30	1.40
	95% CI	0.60–2.15	0.67–2.26	0.76–2.43	0.79–2.49

The column labeled "Never" is the group of patients who reported that they have never driven. The first set of ORs is based on odds that patients would respond that being able to drive is not important to them. The second set of odds ratios is based on odds that patients who respond that driving is at least somewhat important also would respond that driving is impossible to do.

* Significantly greater than 1 ($P < 0.0001$).

than did those subjects who rated driving as extremely important (mean logMAR = 0.62; SD = 0.60; mean log CS = 1.03; SD = 0.43). Because there are multiple independent (rating categories) and dependent (visual impairment measures) variables and logMAR visual acuity correlates with log CS for this sample of low-vision patients ($r = -0.55$, $P < 0.0001$), we used multivariate analysis of variance (MANOVA) to sort out the separate effects. As illustrated in Figure 1, we found that corrected differences in visual acuity and in CS between groups of patients with different importance ratings were significant ($P = 0.003$), but the only pairings with significant differences were between the extreme response categories for both visual acuity and for CS (Bonferroni post hoc analyses; $P < 0.0001$).

Driving difficulty ratings were obtained from the 501 subjects who rated driving as slightly, moderately, or extremely important (59% of all subjects). As summarized in Table 3, within this group, 19% rated driving as not difficult, 18% as slightly difficult, 15% as moderately difficult, 11% as very difficult, and 37% as impossible.

Ninety-eight percent of 97 subjects who responded that driving was not difficult had a driver's license, and 84% still drove. Fifty percent of the 186 subjects who responded that driving was impossible had a driver's license, but only 1% reported that they still drove. Of the 15 nondrivers who responded that driving is not difficult, 57% had stopped driving within the previous 6 months, and 7% had stopped more than 2 years earlier. Of the 184 nondrivers who responded that driving was impossible, 25% had stopped driving within the previous 6 months and 30% had stopped driving more than 2 years earlier. As shown in Table 2, relative to those who reported that they had stopped driving within the previous 6 months (and for whom driving held at least some importance), the OR of responding that driving was impossible was not significantly different from 1 for any reported length of time since the patient had stopped driving.

Subjects who responded that driving was not difficult had better visual acuity (mean logMAR = 0.37; SD = 0.49) than did subjects who responded that driving was impossible to do (mean logMAR = 0.83; SD = 0.62). As illustrated by the adjusted means in Figure 2A, logMAR paralleled the difficulty rating (MANOVA $P < 0.0001$). Subjects who responded that driving was not difficult had better CS (mean = 1.23 log CS; SD = 0.29 log CS) than did subjects who responded that driving was impossible (mean = 0.87 log CS; SD = 0.50 log CS). Similarly, as shown in Figure 2B, log CS paralleled the difficulty rating (MANOVA, $P < 0.0001$).

Difficulty Rating of Driving Tasks and Questionnaire Validation

Only those subjects who reported that driving was slightly difficult, moderately difficult, very difficult, or impossible were asked to rate the difficulty of the 21 driving tasks ($N = 405$) to

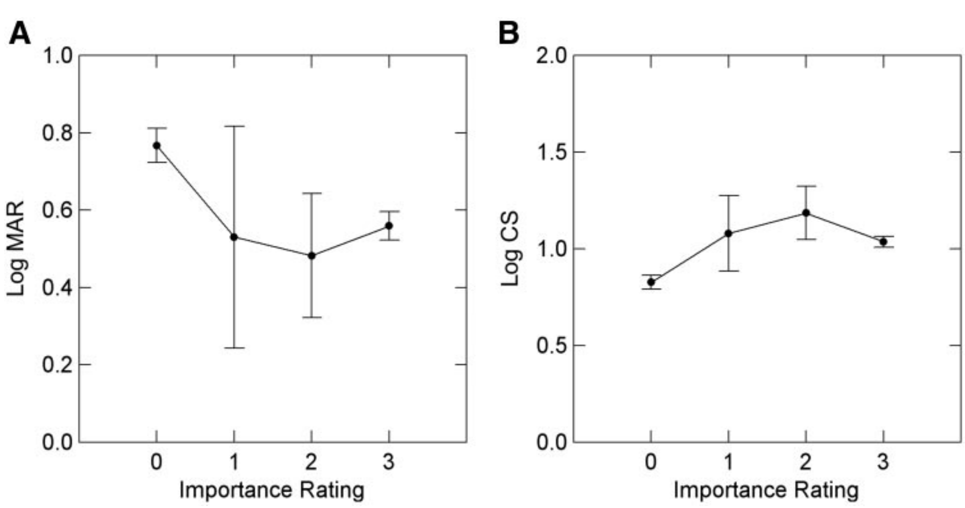

FIGURE 1. (**A**) Adjusted visual acuity, expressed as logMAR, versus the importance of being able to drive rating. The only significant difference in logMAR is between importance ratings of 0 and 3 (MANOVA, $P = 0.003$). Error bars are ±1 SE. 0, not important; 1, slightly important; 2, moderately important; 3, extremely important. (**B**) Adjusted log contrast sensitivity versus the importance of being able to drive rating. The only significant difference in log CS is between importance ratings of 0 and 3 (MANOVA, $P = 0.003$). Error bars are ±1 SE. The scale is as in (**A**).

Table 3. Distributions of Visual Impairment Measures and Driving History for Different Ratings of the Difficulty of Driving among Those Subjects Who Rated the Importance of Driving at Greater Than Zero

Difficulty Rating	Number of Subjects	Percent of Subjects	Mean Log MAR	SD Log MAR	Mean Log CS	SD Log CS	Has DL	Currently Drives	Number of Nondrivers	Percent of Nondrivers Who Last Drove				
										<6 mo	6 mo–1 y	1–2 y	>2 y	Never
0	97	19%	0.37	0.49	1.23	0.29	98%	84%	15	57%	14%	14%	7%	7%
1	88	18%	0.40	0.43	1.20	0.26	95%	90%	9	50%	13%	13%	25%	0%
2	75	15%	0.55	0.68	1.16	0.37	93%	75%	19	24%	41%	12%	18%	6%
3	54	11%	0.71	0.52	0.89	0.42	78%	35%	35	57%	14%	14%	7%	7%
4	186	37%	0.83	0.62	0.87	0.50	50%	1%	184	25%	20%	16%	30%	8%

0, not difficult; 1, slightly difficult; 2, moderately difficult; 3, very difficult; 4, impossible; DL, driver license.

estimate their perceived driving ability. The tasks in Table 4 are ordered according to the estimated interval-scaled Rasch item measure, which ranged from 1.19 for the task that was perceived to be most difficult (i.e., requires the most ability), to −0.75 for the task that was perceived to be least difficult (i.e., requires the least ability). The SE of the item measure estimates ranged from 0.05 to 0.07 logits. The item measure separation reliability (i.e., an estimate of the fraction of the variance in item measures that can be attributed to true differences in the item measures), is 0.98 (i.e., 2% of item measure variance can be attributed to estimation error).

To test the validity of the estimated item measures, we employed the item measure information weighted (infit) mean square, which is a χ^2 statistic weighted by the average expected variance. The expected value of the infit mean square is 1.0. Values greater than 1.0 indicate that the average response error to the item across subjects (relative to the expectations of the measurement model) is greater than would be expected by the overall variability in the responses. Values less than 1.0 indicate that the average response error across subjects for the item is less than expected from the overall distribution of response errors.[21]

To facilitate the evaluation of the fit of responses to the expectations of the measurement model, we transformed the infit mean squares to normal deviates (*z*-scores) by using the Wilson-Hilferty transformation.[22] This transformed infit mean square is equivalent to a *t*-statistic.[23] The expected mean of the distribution of transformed infit mean squares is 0.0 and the expected SD is 1.0. From the data in Table 4, it can be seen that the most misfitting items are parking in the appropriate parking space (6.1 SD from the expected value), seeing lane markings (6.7 SD from the expected value), and seeing traffic on interstate (5.4 SDs from the expected value). Considering the multiple comparisons, when a Bonferroni correction is applied, only these three items have significantly greater average response errors ($P < 0.002$ for an α of 0.05) than expected (i.e., the responses are less predictable than expected from the overall variability). At the other extreme, the average error for merge into traffic is significantly less than the expected value ($P < 0.002$ for an α of 0.05)—that is, the responses are more predictable than expected from the overall variability. The responses to the other 17 items are consistent with the expectations of the measurement model, which confirms the validity of those item measures.

Figure 3 illustrates the density of estimated perceived driving ability measures on an interval scale for each subject who rated the difficulty of driving tasks. The mean of the distribution is 0.42 logits and the SD is 1.08 logits. The row of tick marks above the abscissa in Figure 3 illustrates the driving ability perceived to be required by each of the 21 driving tasks (i.e., item measures in Table 4). The distribution of item measures is well centered on the person measure distribution; however, the range of person measures is nearly four times larger than the range of item measures. Thus, the rating scale is doing most of the work in discriminating persons of different abilities in the tails of the person measure distribution. The SE of the person measure estimate ranges from 0.17 to 1.83 logits. The person measure separation reliability is 0.87, indicating that 13% of the variance in the person measure distribution can be attributed to estimation error.

Relationship of Perceived Driving Ability with Visual Function and Driving Status

Figure 4 illustrates that subjects who reported that they currently drove had greater perceived driving ability (mean = 1.15 logits; SD = 0.73 logits) than did those subjects who reported that they no longer drove (mean = 0.25 logits; SD = 0.87

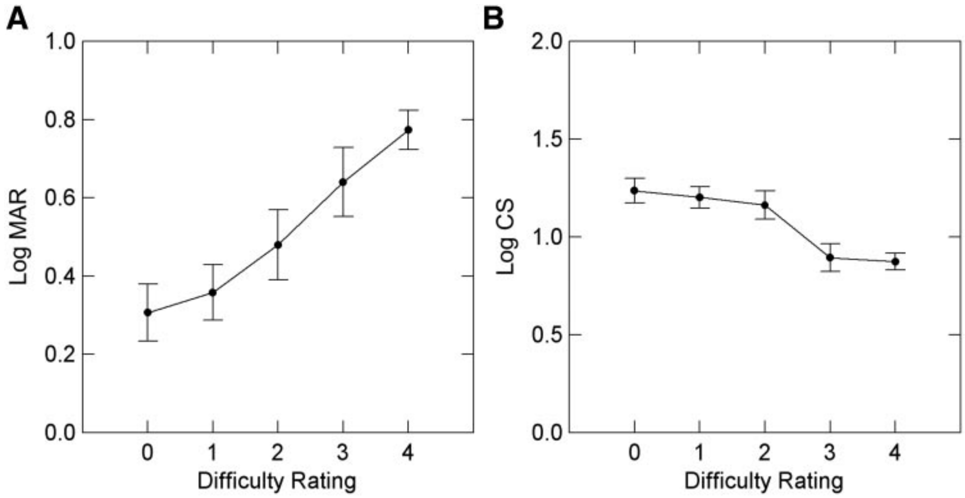

FIGURE 2. (**A**) Adjusted visual acuity, expressed as logMAR, versus the difficulty of driving rating. The differences in logMAR versus difficulty ratings are significant (MANOVA, $P = 0.0001$). Error bars are ±1 SE. 0, not difficult; 1, slightly difficult; 2, moderately difficult; 3, very difficult; 4, impossible. (**B**) Adjusted log contrast sensitivity versus the difficulty of driving rating. The differences in log CS versus difficulty ratings are significant (MANOVA, $P = 0.0001$). Error bars are ±1 SE. Scale is as in (**A**).

logits). The difference between these two groups in perceived driving ability is significant (*t*-test, $P < 0.001$). Figure 5 demonstrates that the means of the distributions of perceived driving ability estimated from task difficulty ratings do not vary with importance ratings (one-way ANOVA, $P = 0.336$), but they do decrease with the difficulty rating the subjects assigned to the overall goal of driving (one-way ANOVA, $P < 0.0001$; $P < 0.005$ for all pairs of ratings with Bonferroni post hoc analysis; Spearman correlation = −0.69 between overall driving difficulty rating and perceived driving ability, $P < 0.001$). No task difficulty ratings were obtained from subjects who responded that driving is not difficult.

Difficulty ratings of driving tasks by current drivers appeared to provide a more accurate estimate of perceived driving ability than did difficulty ratings of driving tasks by nondrivers. As illustrated in Figure 6, the transformed infit mean squares exceeded the expected value by more than 2 SD in 7.5% of the subjects and were less than the expected value by

TABLE 4. Results of Rasch Analysis on Difficulty Ratings of Driving Tasks by Subjects Who Rated Both the Importance and Difficulty of Driving at Greater Than Zero

Items	Count	Average Rating	Item Measure	Error	Infit MNSQ	Infit ZSTD
Navigate in parking lots with ramps	199	2.48	1.19	0.07	1	0
Park in the appropriate parking space	347	2.16	0.67	0.05	1.51	6.1
See lane markings	356	2.13	0.63	0.05	1.56	6.7
Read road signs	317	1.56	0.27	0.05	0.91	−1.2
Read road maps	306	1.54	0.27	0.05	0.98	−0.2
Merge into traffic	331	1.53	0.20	0.05	0.72	−4.1
Read instrument panel	313	1.31	0.07	0.05	0.82	−2.4
Change lanes	344	1.35	0.03	0.05	0.82	−2.6
Read gas gauge	346	1.33	0.00	0.05	1.08	1.1
Maintain appropriate distance from the car in front of you	320	1.24	−0.02	0.05	0.95	−0.6
Identify traffic signals	357	1.22	−0.12	0.05	1.1	1.2
See merging cars	357	1.20	−0.14	0.05	0.72	−4
Distinguish when a car is stopped on the shoulder of the highway or interstate	361	1.22	−0.16	0.05	0.88	−1.6
See traffic on interstate	368	1.17	−0.21	0.05	1.49	5.4
Stay in the lane	373	1.16	−0.22	0.05	1.1	1.3
Drive at night	359	1.14	−0.23	0.05	1.11	1.4
See pedestrians	373	1.09	−0.30	0.05	0.81	−2.6
Stop at right place at an intersection	346	0.95	−0.34	0.05	0.9	−1.2
See traffic on city streets	375	0.99	−0.41	0.05	0.95	−0.6
See traffic on rural roads	372	0.97	−0.43	0.05	0.9	−1.2
Read speedometer	362	0.67	−0.75	0.06	0.91	−1

Count refers to the number of subjects who rated the difficulty of the item (one possible response was "not applicable" which is scored as missing data). The Average Rating is the mean rank score of the difficulty rating (0–3) across subjects. The Item Measure is the estimate of item difficulty on an interval scale from the Andrich rating scale model (mean item measure is 0) and Error is the standard error of the estimate of the item measure. The Infit MNSQ is the mean square residual (difference between the subject's response to the item and the response expected by the Andrich model) weighted by the expected average variance. The infit mean square is distributed as χ^2 and Infit ZSTD is the value corresponding to the Wilson-Hilferty transformation of the infit mean square distribution to a standard normal distribution.

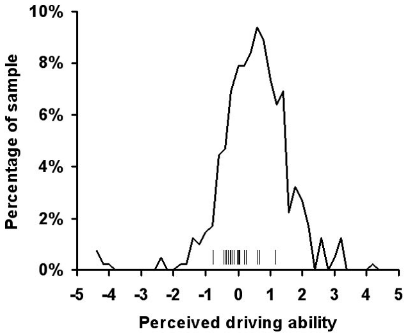

FIGURE 3. Locations of item measures for required driving ability (tick marks above the abscissa) and relative frequency distribution of person measures for perceived driving ability estimated from difficulty ratings of driving tasks by subjects who rated driving importance and difficulty greater than zero. Driving ability values on the abscissa are person and item measures estimated from Rasch analysis and are in logit units.

more than 2 SD in 16% of the subjects (to be compared to 2.5% in each tail of the normal distribution). Figure 7 demonstrates that the subjects who reported that they currently drove formed a tight distribution of transformed infit mean squares around the expected value, whereas most of the outliers in both tails of the distribution can be attributed to those subjects who reported that they were not driving.

The analysis of the fit statistics summarized in Figure 7 suggest that the responses of nondrivers, when combined with the responses of drivers, may distort estimates of perceived driving ability measures. To test this possibility, we repeated the Rasch analysis, first using only the responses of drivers and a second time using only the responses of nondrivers. Item measures estimated from drivers' responses were in strong agreement with item measures estimated from the responses of all subjects (intraclass correlation, $\rho = 0.9997$). Item measures estimated from nondrivers' responses were in moderate agreement with item measures estimated from the responses of all subjects ($\rho = 0.736$). Comparing person measure estimates from driver responses alone to estimates from the responses of all subjects, showed strong agreement ($\rho = 0.99996$). The agreement between person measure estimates based on nondriver responses and estimates based on responses of all subjects also was strong ($\rho = 0.979$). These results indicate that despite disagreements in item measures for the nondrivers, the analysis of responses of all subjects did not distort the estimates of perceived driving ability (person measure).

Perceived driving ability is related to visual acuity and CS. Figure 8A illustrates a scatter plot of perceived driving ability in logits versus visual acuity in logMAR units. The Pearson product moment correlation is $r = -0.28$ ($P < 0.001$). The regression line has a slope of -0.49 and an intercept of 0.81. This linear trend is shallower than the regression line fit to person measures estimated from NEI VFQ responses versus logMAR acuity for low-vision patients in another study.[24] Figure 8B illustrates a scatterplot of perceived driving ability versus log CS. The Pearson correlation is $r = 0.35$ ($P < 0.001$). The regression line has a slope of 0.83 and an intercept of -0.26.

DISCUSSION

Twenty-nine percent of the low-vision patients in our sample were still driving. This percentage is similar to the observations of DeCarlo et al. (24%).[2] Of the patients who were driving, 39% reported that it was at least moderately difficult to do so. More than half of all the patients in our sample considered driving to be extremely important, but only 49% of those patients were still driving. The median visual acuity for our low-vision patient sample was 20/60. As estimated from state licensing requirements,[25] half of the patients in our sample would be eligible for a driver's license in 41 states and the District of Columbia on the basis of visual acuity; one state would provide nonrestricted licensure, 40 states would automatically restrict licensure and specify categories of restriction that include, but are not limited to driving in the daytime only, limits on driving distance and/or speed, requirement for an annual examination, requirement for minimum visual field, documentation by report from an eye specialist, and comprehensive road testing. In addition, of the states that currently provide a path-to-driver licensure with the use of a prescribed spectacle-mounted bioptic telescopic system, at 20/60 acuity, one state would mandate bioptic driving licensure, and in the other states licensure would either be recommended or required[25] based on documentation by the eye specialist and requirements of the state licensing agency. These results, reinforced with earlier independent observations by DeCarlo et al.,[2] strongly suggest that a comprehensive approach to the issue of driving should be a formal component of a comprehensive outpatient low-vision rehabilitation program. Such an approach would include documentation of vision impairment and residual visual function, early identification of candidates for specialized licensure options, educating the patient on licensure standards and his/her eligibility, provision of appropriate patient counseling, and referral for driver education and training.

Of those low-vision patients who considered driving not important, 31% reported never having driven. Of the patients who drove at one time but considered driving unimportant, two thirds stopped driving more than 2 years ago. In the case of nondrivers who considered driving extremely important, 70% had stopped driving less than 2 years ago. Although alternative explanations could be entertained, the pattern of odds ratios in Table 3 suggests that for most low-vision patients, it appears to take more than 2 years postdriving before driving loses its importance. DeCarlo et al.[2] reported that nondrivers in their sample compensated with a variety of alternative transportation strategies. Generalizing those results to our sample, it appears that it took more than 2 years for most patients to develop reliable alternatives to driving. It is likely that this adaptation could be accelerated with targeted patient education, the development of an individualized transportation plan, and advocacy of driving alternatives as part of the rehabilitation process, in addition to increased early referral for low-vision rehabilitation care.

As would be expected from previous correlations reported in the literature,[8] Figure 8 illustrates a trend toward a monotonic relationship between perceived driving ability at the driving task level and the severity of visual impairments. The

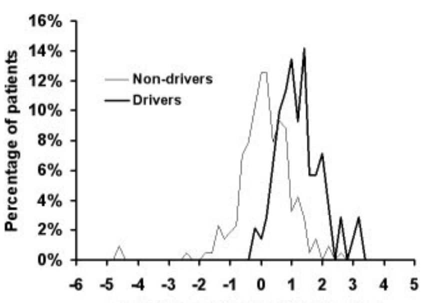

FIGURE 4. Relative frequency distributions of person measures for perceived driving ability estimated from difficulty ratings of driving tasks by nondriving and driving subjects who rated driving importance and difficulty greater than 0. Driving ability values on the abscissa are person measures estimated from Rasch analysis and are in logit units.

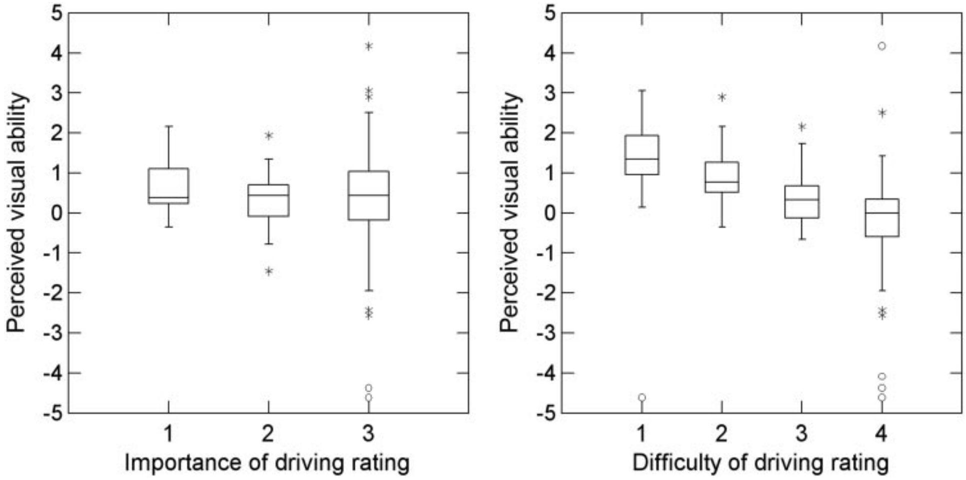

FIGURE 5. Distributions of interval measures of perceived driving ability estimated from difficulty ratings of driving tasks for different ordinal importance of driving ratings (*left*) and different ordinal overall difficulty of driving ratings (*right*) by subjects who reported that both driving importance and difficulty were greater than 0. *Horizontal line* in the center of each box is the median, the *box hinges* define the first and third quantiles, the *whiskers* define the range of values extending 1.5 times the midrange beyond the boundaries of the box, the *asterisks* are outliers, and the *circles* are far outliers.

trend is the same for both drivers and nondrivers. This trend is similar, but shallower, to trends estimated for non–driving-oriented measures of perceived functional ability in other low-vision patient samples.[24,26,27] However, the correlation is weaker than that seen in the other studies and there is wide variability about the trend line. This spread in the data indicates that other variables besides visual acuity and CS factor into perceived driving ability. Those variables may be modifiable with clinical treatment (e.g., bioptic telescopic systems) and driver rehabilitation training. If so, the lack of a tight relationship between perceived driving ability and visual impairment measures offers hope that rehabilitation programs that target driving could be successful in low-vision patients. On the other hand, some of the departure from the trend line could be attributable to comorbidities and other factors that are not amenable to rehabilitation.

From a measurement perspective, the mean square fit statistics, as illustrated in Figure 7, lead to the conclusion that low-vision drivers are more accurate in estimating the difficulty of driving tasks than are nondrivers. One could imagine a plethora of explanations for this result, which we did not explore. Lack of accuracy indicates the presence of other factors that confound the measurement. Those factors, such as cognitive or physical disorders, might also contribute to the patient's driving status. In this study we have not attempted to sort out the effects of comorbidities, which are ubiquitous in the older population, but Figure 4 clearly illustrates that nondrivers have lower perceived driving ability than do drivers. Other studies have concluded that the lack of confidence in driving ability leads to self-imposed limitations on driving or giving up driving altogether.[9] Developing confidence in driving ability is a major goal of most low-vision driver training programs.[28]

In conclusion, more than half of patients of an outpatient low-vision clinic in a large urban academic medical center potentially were eligible to drive in 80% of the states. More than a quarter of the patients were driving at the time of their clinic appointment. However, 40% of those patients reported that driving was difficult. Driving was rated as an extremely important goal by more than half of the low-vision patients. The data suggest that it takes more than 2 years after patients stop driving before they adapt to that loss of function and driving ceases to be important to them. The results of this

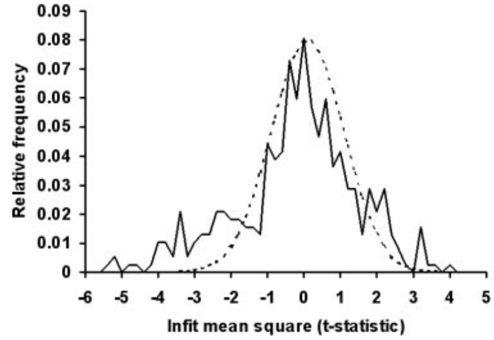

FIGURE 6. Relative frequency distribution of transformed infit mean squares for person measures of perceived driving ability (*solid line*) compared to the expected distribution (*dashed line*). Positive transformed infit mean squares correspond to greater errors in responses to the items compared with the expected responses (misfit to the measurement model), and negative transformed mean squares correspond to smaller response errors than expected (responses are too predictable relative to the overall response variance).

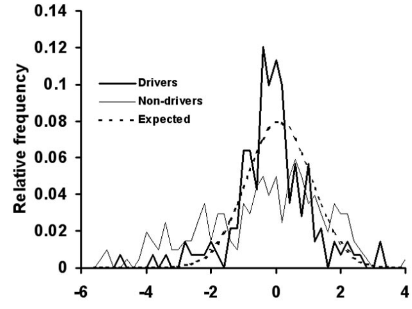

FIGURE 7. Same as Figure 6, except that the person measure infit mean square distributions for drivers and nondrivers are plotted separately. The distribution for drivers agrees with expectations, whereas the distribution for nondrivers is broader than the expected distribution.

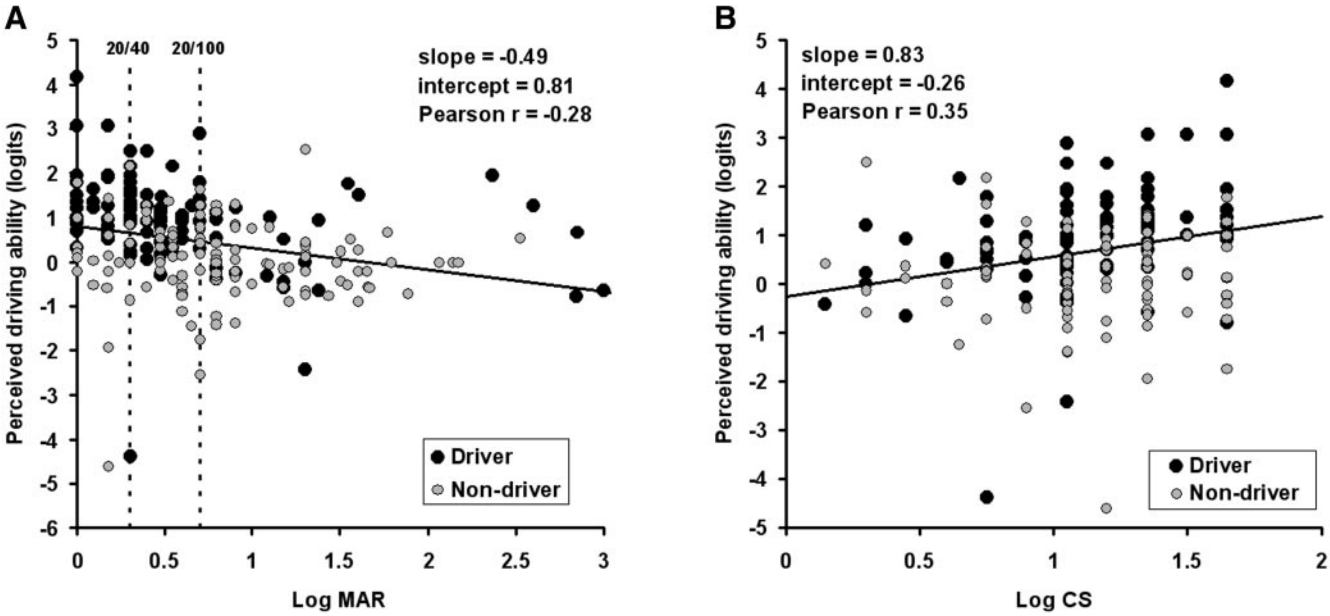

Figure 8. (**A**) Scatterplot of person measures of perceived driving ability versus logMAR binocular visual acuity. *Two vertical lines*: visual acuity interval over which most states will grant a restricted license to drive. (**B**) Scatterplot of person measures of perceived driving ability versus log binocular CS.

study, combined with similar results of earlier studies, lead us to conclude that driver evaluation and training should be a major component of comprehensive low-vision rehabilitation programs.

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