Awareness of Driving Ability in Senior Drivers With Neurological Conditions

Lynnette G. Kay, Anita C. Bundy, Lindy Clemson

OBJECTIVE. We sought to determine the agreement between rating of awareness based on scores on the Driving Awareness Questionnaire (DriveAware) and global judgments of awareness awarded after on-road assessment, thereby establishing the possibility of measuring drivers’ awareness.

METHOD. A prospective cohort study of 60 senior drivers with neurological conditions who were referred for driving assessment. Awareness was rated as intact, partial, or absent on the basis of the discrepancy score between participants’ and clinicians’ responses to DriveAware. A second clinician (masked to these results) rated awareness on the same scale at the completion of the on-road assessment. Agreement of categorical ratings was adjusted for chance using the kappa statistic.

RESULTS. Results yielded a kappa of .69 ($SE = .08$), indicating agreement substantially beyond chance.

CONCLUSION. Results indicate that awareness of driving ability may be measured with substantial accuracy using DriveAware in senior drivers with neurological impairments. The psychometric properties of DriveAware require further research.


As increasing numbers of older people seek to continue driving to maintain their independence and social participation, driving assessment has become increasingly important in occupational therapy. Clearly, it is important to ensure that drivers are safe, and self-awareness has been identified as an important factor in minimizing unsafe driving (Coleman Bryer, Rapport, & Hanks, 2006).

Older drivers may be affected by the visual, physical, and cognitive changes associated with aging. Awareness plays an important role in adapting to these changes by facilitating the adoption of compensatory strategies. Holland (2001) suggested that older drivers commonly adopt two levels of compensatory behavior, namely avoidance of complex or difficult situations and coping strategies to reduce the mental load or stress of driving (e.g., reducing speed, using a copilot). Most, but not all, older drivers avoid situations they find challenging such as driving at night or in bad weather, in high traffic periods, on major highways, and in unfamiliar areas (Charlton et al., 2003; Holland, 2001). If drivers are unaware of their deficits, however, they are unlikely to recognize the need to modify their driving behavior.

The same picture emerges in studies of older drivers with particular medical conditions. Decreased driving exposure has been associated with lower levels of cognitive and visual function generally (Ball et al., 1998; Stutts, 1998) and cognitive impairment associated with Alzheimer’s disease specifically (Cotrell & Wild, 1999). In each of these studies, however, a small group of drivers with cognitive impairment did not limit their driving to avoid challenging situations. Although these authors...
postulated that this group failed to recognize their impairments and thus the need for avoidance, the design of the studies precluded drawing this conclusion (Ball et al., 1998). These studies used self-reports about driving avoidance; however, in the only study to examine actual driving performance and awareness, healthy older drivers were able to predict their driving skills accurately, taking into account their age-related deficits, in contrast to those drivers with Alzheimer’s disease who did not accurately predict their driving skills (Wild & Cotrell, 2003). Interestingly, a small number of those with Alzheimer’s disease had good awareness of their cognitive impairments but poor awareness of the impact of these impairments on their driving skills. Furthermore, in a large retrospective study, cognitive impairment coupled with absence of awareness was associated with failure on the road (Kay, Bundy, & Clemson, 2008). In this study, we assessed awareness during the on-road assessment, raising the question of whether it is possible to measure awareness as part of an off-road assessment.

Awareness is a complex and multidimensional construct involving both knowledge of deficits and judgment about the impact these deficits may have on function (Marková, Clare, Wang, Romero, & Kenny, 2005). Given its complexity, it is not surprising that measuring awareness is difficult. Recent comprehensive reviews of assessments of awareness have revealed that awareness is most commonly defined as a discrepancy between an individual’s responses and an agreed-on standard (Clare, Marková, Verhey, & Kenny, 2005). The standard may consist of a relative or clinician’s opinion, the individual’s objective performance on a test, or both (Clare et al., 2005). All of these methods have limitations. Measurements of awareness based on the subjective opinions of another are influenced by factors associated with the other’s understanding, interpretation, and experience. However, assessment based on comparison of self-report with test performance can be limited by lack of test validity.

To our knowledge, only one study has been published that included a specific measure of driving awareness for senior drivers (Wild & Cotrell, 2003). This measure relied on comparing drivers’ and informants’ ratings. However, our clinical experience has revealed that many senior drivers presenting for a driving assessment do not have a caregiver who can act as an informant. Therefore, we developed the Driving Awareness Questionnaire (DriveAware) to measure awareness as part of an off-road assessment by comparing drivers’ answers to specific questions reflecting driving awareness with clinicians’ ratings. The purpose of this exploratory study was to determine the agreement between the ratings of awareness (based on scores on DriveAware) before the on-road assessment and the global rating made after an on-road assessment by a separate clinician.

**Method**

**Design**

We used a prospective cohort design to determine the agreement between one clinician’s rating of awareness of driving ability using DriveAware before the on-road assessment and a second clinician’s rating of awareness after an on-road driving assessment.

**Participants**

We recruited 60 participants with a neurological condition, ≥60 years old, referred for a driving assessment, from two major driving rehabilitation centers in Sydney, New South Wales, Australia. Only those clients with a diagnosis known to be associated with impaired awareness were eligible for the study. The sample included participants with mild cognitive impairment (42%), dementia (35%), cerebrovascular accident (12%), Parkinson’s disease (5%), and other conditions (6%). The majority (72%) of the sample was male. The age range was 61 to 86 years ($M = 76.6\text{ years, } SD = 6.3$).

**Measures**

*DriveAware.* DriveAware was developed in consultation with clinicians experienced in driving rehabilitation using the Awareness of Disease States standardized assessment as an exemplar (Anderson & Tranel, 1989). DriveAware consists of five questions (see the Appendix for the full assessment form):

1. Why have you been referred for a driving assessment?
2. Are you having trouble remembering or organizing things?
3. Do you have any concerns about your driving?
4. How would you rate your driving performance now, compared with 10 years ago?
5. How do you think you performed on the Visual Recognition Slide Test (USyd) today?

We compared participants’ responses with clinicians’ responses to the same questions using specified marking criteria (provided in the Appendix). For example, participants received a score of 3 on the first question if they did not report the primary reason for the assessment as indicated on their referral; a score of 2 if they initially did not report the primary reason but later mentioned it; and a score of 1 if they reported the primary reason for the assessment. The clinician’s rating for this question is always 1 because the participant has been referred for a driving assessment as a result of concerns about his or her driving because of a medical condition. All “correct” answers were based on information on the referral and observation of performance on tests during the off-road assessment. We calculated a
discrepancy score by subtracting the clinicians’ scores from the participants’ scores on each question and then rated awareness of driving according to the discrepancy score:

- A discrepancy score of 0 or 1 indicates intact awareness, or awareness of the impact of cognitive deficits on driving;
- A discrepancy score of 2, 3, or 4 indicates partial awareness, or some awareness of the impact of deficits on driving; and
- A discrepancy score of 5 to 10 indicates absent awareness, or no awareness of the impact of cognitive deficits on driving.

**On-Road Assessment.** We conducted the on-road assessments on a standardized route commencing in light traffic and progressing to more complex traffic, including controlled and uncontrolled intersections, rotaries, yield and stop signs, varying speed zones, high pedestrian areas, and driving on multilane roads, including lane changes. To ensure safety, a vehicle with automatic transmission and dual controls was used for all assessments. The driving instructor, sitting in the passenger seat, was responsible for giving instructions and maintaining safety, and the occupational therapist, sitting in a rear seat, was responsible for recording driving performance and any driving instructor interventions. After 20 min, the occupational therapist gave the participant feedback about his or her performance. The assessments continued for a further 30 min during which time the therapist observed whether the participant modified his or her driving performance after feedback. Most assessments were conducted between 10:00 a.m. and 3:00 p.m. The on-road rating of awareness of driving ability was made by the occupational therapist at the conclusion of the assessment on the basis of the participant’s response to feedback.

We used the following operational definitions:
- **Intact awareness:** accepts feedback about driving performance and attempts to implement suggested changes in driving behavior;
- **Partial awareness:** accepts some but not all feedback about driving performance and does not attempt to implement suggested changes in behavior; and
- **Absent awareness:** no overt indication of awareness of driving errors or does not accept feedback about driving performance and makes excuses (e.g., driving instructor acted too quickly, unfamiliar vehicle or unfamiliar route) and does not attempt to implement suggested changes.

**Procedures**

The study was approved by the ethics committees of both centers. Potential participants were provided with a detailed explanation of the study purpose and procedures before providing written informed consent. To ensure that there was no coercion of clients with limited awareness, we also obtained the signature of a witness, either a relative or an independent staff member.

Each participant underwent an occupational therapy driving assessment. One occupational therapist conducted the off-road assessment. This included an interview concerning medical history, such as primary diagnosis and other medical history and medication, and driving history, such as driving frequency, vehicle usually driven, and record of violations and accidents. A standard physical and vision screening assessment was conducted. In accordance with standard clinical practice in Australia, the Visual Recognition Slide Test (Kay et al., 2008) was used to measure awareness of the driving environment together with written and image-based tests (projected on a wall) of applied road law knowledge. The occupational therapist then completed DriveAware, calculated the discrepancy score, and qualified the participant’s awareness of driving ability as intact, partial, or absent. A second occupational therapist, masked to the participant’s off-road assessment results, conducted the on-road assessment with a qualified driving instructor. Because many of the participants were at risk of unsafe driving, the first occupational therapist provided feedback to the driving instructor about the participant’s deficits to ensure safety during the on-road assessment. At the conclusion of the on-road assessment, the second occupational therapist qualified the participant’s awareness of driving ability as intact, partial, or absent. All occupational therapists involved in the study (N = 5) had completed postgraduate training and at least 3 years of clinical experience in driving rehabilitation. The same occupational therapist completed the off-road assessment, including DriveAware, for all participants. All occupational therapists who conducted the on-road assessments underwent additional training in rating awareness of driving ability after the on-road assessment.

**Statistical Analysis**

The awareness score (intact, partial, or absent) derived from DriveAware during the off-road assessment and the awareness score based on the on-road assessment was the unit of analysis. The agreement between the off- and on-road ratings of driving awareness was corrected for chance using the kappa statistic (Portney & Watkins, 2000). Kappa examines both the proportion of observed agreements and the proportion of agreements expected by chance and calculates the proportion of agreements that can be attributed to reliable measurement. We used the Statistical Package for Social Sciences (SPSS) for Windows 15.0 (SPSS, Inc., Chicago) to analyze the results by cross-tabulating the off- and on-road ratings of driving awareness and applying the kappa statistic. Values of kappa above 80% represent almost perfect agreement; from 60% to
Results

The cross-tabulation of the occupational therapists’ off- and on-road ratings of driving awareness are reported in Table 1. These results yielded a kappa of .69 (SE = .08), indicating substantial agreement beyond chance. There were no errors of agreement between the off- and on-road ratings of awareness when awareness was deemed to be intact or absent. All errors were related to the rating of either off-road or on-road awareness as partial.

Discussion

The results of this study indicated substantial agreement between the rating of awareness of driving ability using DriveAware before the on-road assessment and the rating of awareness after the off-road assessment. Awareness of driving ability has previously been identified as an important factor for safe driving performance both clinically (Kay et al., 2008) and theoretically (Anstey, Wood, Lord, & Walker, 2005). It now appears possible to use DriveAware to rate with substantial accuracy awareness of driving ability without observing actual driving performance. This exploratory study indicates that DriveAware may potentially be a useful addition to the driving assessment process. However, further extensive research is required to examine DriveAware’s psychometric properties, which was beyond the scope of this exploratory study. In its current, untested form, DriveAware is not ready for widespread use and should not be incorporated into clinical practice until more research has been completed.

The errors of agreement in this study indicated that clinicians using DriveAware could most accurately identify participants at either end of the spectrum of awareness. Although awareness is a continuous construct (Pachana & Petriwskyj, 2006), it is not surprising that it is easier to identify those with intact or absent awareness. However, precisely because awareness deteriorates with the progression of many neurological conditions, such as dementia, Parkinson’s disease, and multiple sclerosis, it is a useful construct to measure (Pachana & Petriwskyj, 2006). When using DriveAware, the level of awareness (intact, partial, or absent) was determined by the magnitude of a discrepancy score. Because DriveAware is a new tool, there was no previous research concerning the size of the discrepancy score that was indicative of the level of awareness. We used clinical judgment in defining the categories for this study, and the errors in rating partial awareness both off and on road indicate that the cutoff scores for each level of awareness may need to be adjusted. A larger study is under way to provide statistical evidence for the precise cutoff scores for each level of awareness.

Use of DriveAware in conjunction with other tests in the off-road assessment may improve the predictive accuracy of the off-road assessment. The large retrospective study by Kay et al. (2008) revealed that clients with cognitive impairment who also had deficits in awareness were unsafe on the road. If it is possible to identify these drivers with an off-road assessment, it may not be necessary to proceed with the expensive and potentially dangerous on-road assessment. This possibility is being investigated in a prospective study currently under way.

Limitations of the Study

Several limitations contribute to the need for caution in generalizing the results of this study. First, the sample size was small; therefore, the study needs to be replicated with a larger sample to verify the results. Second, we included in this study participants with a variety of diagnoses known to impair awareness. Thus, participants were diagnosed with a neurological condition, different forms of dementia, or mild cognitive impairment. However, including participants with a variety of diagnoses means that the study mirrored the population seen in most driving rehabilitation centers. Additionally, any measurement tool needs to be applicable to a range of client groups. Because details about the severity of dementia were not available for all participants, it was not possible to examine any association between awareness and severity of dementia. Future research could investigate this relationship.

Conclusion

DriveAware scores predicted with substantial accuracy the rating of awareness of driving ability assigned by occupational therapists after on-road assessment in a sample of senior drivers with neurological conditions. DriveAware shows promise as a useful tool to measure awareness of driving ability. Further research is required to examine its psychometric properties before it can be included in the battery of tests used by clinicians. ▲
Acknowledgments
We thank the clinicians at Driver Rehabilitation and Fleet Safety Services and Calvary Rehabilitation and Geriatric Services for their support in collecting data and discussing clinical observations and Liz Barnes for her statistical advice.

References

Appendix. Scoring Criteria for DriveAware

<table>
<thead>
<tr>
<th>Participant’s Report</th>
<th>Clinician’s Rating</th>
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</thead>
<tbody>
<tr>
<td>1. Awareness of reason for driving assessment referral</td>
<td>1. Referral based on concern about driving because of medical condition.</td>
</tr>
<tr>
<td>Why have you been referred for a driving assessment?</td>
<td></td>
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<tr>
<td>3. Does not report primary reason for assessment.</td>
<td></td>
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<tr>
<td>2. Does not initially report reason for assessment, but later mentions this.</td>
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</tr>
<tr>
<td>1. Reports primary reason for assessment.</td>
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<tr>
<td>2. Awareness of cognitive deficits</td>
<td></td>
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<tr>
<td>Are you having trouble remembering or organizing things?</td>
<td></td>
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<tr>
<td>3. Does not report any change in memory or cognitive skills.</td>
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<tr>
<td>2. Reports some difficulty with memory or planning but does not affect daily life/driving.</td>
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</tr>
<tr>
<td>1. Reports problems with cognitive abilities that do affect driving (gets lost, becomes confused).</td>
<td></td>
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<tr>
<td>2. Assessment of impact of deficits on driving</td>
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<tr>
<td>Do you have any concerns about your driving?</td>
<td></td>
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<tr>
<td>3. No family or medical concern about driving performance.</td>
<td></td>
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<tr>
<td>2. Family or medical uncertainty, want to check that driving is safe.</td>
<td></td>
</tr>
<tr>
<td>1. Family or medical concern about driving.</td>
<td></td>
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<tr>
<td>2. Reports mild/possible problems with driving.</td>
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<tr>
<td>1. Reports significant problems or concerns about driving.</td>
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<tr>
<td>4. Awareness of changes in driving over the past 10 years</td>
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<tr>
<td>How would you rate your driving performance now compared with 10 years ago?</td>
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<tr>
<td>3. Documented improvement in driving performance.</td>
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<tr>
<td>2. No documented deterioration.</td>
<td></td>
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<tr>
<td>1. Verified or reported incidents/near misses.</td>
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<tr>
<td>2. Reports driving is about the same.</td>
<td></td>
</tr>
<tr>
<td>1. Reports driving is probably worse because of aging.</td>
<td></td>
</tr>
<tr>
<td>5. Awareness of performance on tests</td>
<td></td>
</tr>
<tr>
<td>How do you think you performed on the Visual Recognition Slide Test today?</td>
<td></td>
</tr>
<tr>
<td>3. Scored 100/140 or better.</td>
<td></td>
</tr>
<tr>
<td>2. Scored 80–100/140.</td>
<td></td>
</tr>
<tr>
<td>1. Scored below 80/140.</td>
<td></td>
</tr>
</tbody>
</table>

Note: Scoring: Add the participant’s report score and the clinician’s rating score separately. Calculate the discrepancy score using the formula Discrepancy Score = Participant’s Report score – Clinician’s Rating score. Discrepancy score of 0–1 = intact awareness; 2–4 = partial awareness; 5–10 = absent awareness.

150 March/April 2009, Volume 63, Number 2