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Predictive validity and clinical relevance of DriveSafe DriveAware as a cognitive assessment of fitness to drive in medically at-risk drivers

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Abstract

Objective: To evaluate the predictive validity and potential clinical relevance of the DriveSafe DriveAware assessment for predicting on-road driving outcomes in medically at-risk drivers.

Design: Prospective cohort study.

Setting: Fitness-to-drive assessment pathway involving a driver licensing authority, medical review clinic, and occupational therapy driver assessors in the Australian Capital Territory, Australia.

Participants: A convenience sample of 138 drivers referred for occupational therapy driving assessment because of medical fitness-to-drive concerns.

Methods: Participants completed the DriveSafe DriveAware, comprising DriveSafe and DriveAware subtests, before an on-road driving assessment. On-road outcomes were dichotomised as pass (unrestricted licence) or fail (conditional licence, reassessment, or licence cancellation). Receiver operating characteristic analyses, Youden's Index, and classification accuracy metrics were calculated.

Results: DriveSafe DriveAware demonstrated strong classification performance, with 86% sensitivity, 100% specificity, 100% positive predictive value, and 93% overall accuracy. Eighty-seven percent of participants were classified as *Likely to Pass* or *Likely to Fail*, with 13% classified as *Further Testing*. No participants classified as *Further Testing* achieved an unconditional pass. DriveSafe and DriveAware subtests showed excellent discrimination (area under the curve = 0.96 and 0.95, respectively). Optimal cut-offs were broadly consistent with previously proposed thresholds. Drivers who failed the on-road assessment were older and had lower DriveSafe and DriveAware subtest scores than those who passed.

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Conclusion: DriveSafe DriveAware showed strong predictive validity in this sample and may support triage and clinical decision-making within fitness-to-drive assessment pathways.

Keywords
Cognitive fitness to drive, older drivers, medically at-risk drivers, occupational therapy, predictive validity, driving assessment

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Introduction

Assessing medical fitness to drive is a high-stakes clinical task with important implications for community safety, autonomy, and community mobility.[1,2] This is particularly relevant for older adults and people with medical or neurological conditions that may affect driving capacity.[1,3] Although road trauma has declined overall in Australia,[4] unsafe driving among medically at-risk drivers remains a concern, creating a need for timely, evidence-based approaches to identifying individuals who may require further assessment or support with driving reduction or cessation.[3,5–7]

Driver licensing authorities make final decisions about licence status, but these decisions rely heavily on clinical input from health professionals, particularly general practitioners, who are often required to identify fitness-to-drive concerns, make recommendations, and initiate referral for further assessment.[1,3,7,8] Although Austroads provides national medical standards, assessment pathways may vary across jurisdictions, and clinicians report uncertainty about the adequacy of available decision-making tools.[1,3,7] Clinicians must therefore balance safety with independence when making recommendations that can substantially affect mobility and quality of life.[2,5,6]

Individuals undergoing fitness-to-drive assessment must meet relevant visual, physical, and cognitive standards.[1] Cognitive assessment commonly relies on brief screening tools, including the Trail Making Test,[9] Montreal Cognitive Assessment,[10] Mini-Mental State Examination,[11] and Clock Drawing Test.[12] However, these instruments have shown inconsistent and often limited ability to predict on-road driving outcomes.[13–15] Assessments intended to support fitness-to-drive decision-making should demonstrate strong predictive validity, including acceptable sensitivity, specificity, and predictive values.[13,16–19] They should also be brief, practical, feasible for clinical use, minimally affected by education,[20] and suitable for people with communication difficulties such as dysphasia.

DriveSafe DriveAware (DSDA) is a standardised cognitive fitness-to-drive assessment developed within a functional cognition framework to address some of these limitations.[14,21,22] It combines assessment of driving-environment awareness with insight into driving-related performance. Earlier computer-administered versions demonstrated good-to-excellent predictive validity for on-road driving outcomes.[23–25] Cheal et al.[14] reported strong predictive validity for the iPad-based touchscreen version in medically at-risk drivers; however, this remains the only published evaluation of that version, using data collected in 2014. Replication in a different cohort, jurisdiction, referral pathway, and time period is therefore needed to assess generalisability.

The aim of this study was to evaluate the predictive validity and clinical relevance of DSDA in a cohort of drivers referred for fitness-to-drive assessment. Specifically, the study aimed to assess its ability to predict on-road driving outcomes, examine optimal cut-off scores in relation to previously published thresholds, and consider the implications of these findings for fitness-to-drive assessment in an independent clinical setting.

Methods

Study design and setting

This prospective cohort study was conducted in the Australian Capital Territory, Australia, within a fitness-to-drive assessment pathway involving the Driver Licensing Authority (DLA), the Fitness to Drive Medical Clinic, and occupational therapy driver assessors.

In the Australian Capital Territory, individuals considered at risk of unsafe driving due to age or medical condition may be referred to the DLA by healthcare professionals, law enforcement, or other concerned parties. Referrals are triaged through a multidisciplinary process involving the DLA, Fitness to Drive Medical Clinic, and occupational therapy driver assessors, and directed to specialist medical review, occupational therapy driving assessment, or both. The occupational therapy driving assessment includes both a clinical and an on-road component.

Outcomes of medical review may include clearance to drive, licence restrictions, licence cancellation, or referral for occupational therapy driving assessment. Occupational therapy driving assessments may result in similar licence recommendations, with final licensing decisions made by the DLA.

Recruitment and data collection occurred between August 2022 and June 2024. Ethical approval was obtained from the Australian Capital Territory Health Human Research Ethics Committee (2022.ETH.00046), and all participants provided written informed consent prior to participation.

Participants

Participants were a convenience sample of adults referred for occupational therapy driving assessment either directly by the DLA or following medical review at the Fitness to Drive Medical Clinic. Eligible participants were aged 18 years or older, held an active or recently suspended driver's licence, and had been referred due to concerns regarding medical fitness-to-drive.

Participants met one of the following criteria: (i) aged ≥70 years without a neurological diagnosis; (ii) aged ≥70 years with a neurological diagnosis; or (iii) aged <70 years with a neurological diagnosis. The age threshold reflects Australian Capital Territory requirements for medical fitness-to-drive review (≥70 years for commercial drivers; ≥75 years for private drivers).[26] Individuals with communication difficulties, including dysphasia, were included.

Exclusion criteria were diagnosed psychiatric or substance-use disorders, failure to meet visual acuity standards for driving,[1] and insufficient English proficiency, as DSDA has not been empirically validated for use with non-English speakers. Cases were also excluded where the on-road fail outcome was attributable primarily to physical rather than cognitive impairment. This was determined by reviewing occupational therapy driver assessor on-road assessment reports for participants who failed and excluding cases where the fail was due to physical limitations affecting vehicle control, rather than cognitive errors such as impaired observation, judgement, attention, planning, or traffic negotiation. This criterion was applied because DSDA assesses cognitive and perceptual aspects of driving awareness rather than physical capacity to operate vehicle controls.

Measures

DSDA

DSDA is a standardised, iPad-based assessment of cognitive fitness-to-drive comprising two subtests: DriveSafe and DriveAware. The DriveSafe subtest presents 10 four-way intersection scenes requiring identification of hazards (maximum score 84), while the DriveAware subtest comprises two self-rated and five clinician-rated items assessing awareness (score range 0–17). Scores are classified using predefined cut-offs: DriveSafe (*Safe* ≥72; *Further Testing* 58–71; *Unsafe* ≤57) and DriveAware (*Intact* ≥13; *Further Testing* 11–12; *Impaired* ≤10). These classifications are combined using a predefined DSDA decision matrix to generate an overall classification of likely performance on an on-road driving assessment: *Likely to Pass*, *Further Testing*, or *Likely to Fail*. Figure 1 provides a schematic representation of the matrix-based classification logic. Both continuous scores and categorical classifications were analysed. Because the overall DSDA matrix classification is categorical and DSDA does not generate a validated combined numerical total score, DriveSafe and DriveAware continuous scores were analysed separately for receiver operating characteristic analysis. The assessment was administered by the occupational therapy driver assessor as part of the occupational therapy clinical assessment on a 10.2-inch iPad in accordance with the DSDA manual.[21] The DriveSafe Intersection Rules subtest was excluded because of its previously reported limited predictive value.[25]

On-road driving assessment

The reference standard was performance on an occupational therapy on-road driving assessment. This assessment was used as the clinical reference standard because it provides direct observation of functional driving performance in real traffic conditions and is used within the Australian Capital Territory fitness-to-drive pathway to inform licensing recommendations. However, it should be regarded as a clinical reference standard rather than an error-free gold standard, as outcomes may be influenced by route characteristics, traffic conditions, assessor judgement, and performance on a single assessment occasion.[1,6,27]

This assessment was undertaken in a dual-control automatic vehicle over ∼60 minutes and used a checklist based on the Australian Competency Standards for Occupational Therapy Driver Assessors,[28] targeting the skills required for an unrestricted or Open Area Licence across varied driving conditions. A driving instructor provided directions and intervened if required for safety, while the occupational therapy driver assessor assessed performance from the rear passenger-side seat. Driving errors, including speed control, lane positioning, safety checks, and response to feedback, were recorded. A critical error resulted in an automatic fail recommendation. Outcomes were classified as ‘pass’, ‘pass with conditions’, ‘fail – reassess after lessons’, or ‘fail’. For analysis, outcomes were dichotomised as ‘pass’ or ‘fail’. ‘Pass’ indicated that the driver met criteria for an unrestricted licence. ‘Fail’ included ‘pass with conditions’, ‘fail – reassess after lessons’, and ‘fail’, because these outcomes indicated that the driver did not meet criteria for unrestricted driving. This dichotomisation was used because the study aimed to evaluate whether DSDA could identify drivers who met the standard for unconditional driving.

Covariates

Additional variables included age, sex, years of education, number of reported non-neurological comorbidities, and reason for referral (age-related concerns, neurological diagnosis ≥70 years, neurological diagnosis <70 years). These variables were examined descriptively because of their potential relevance to both DSDA performance and on-road outcomes.

Procedure

Following referral and consent, participants completed the occupational therapy off-road clinical assessment. DSDA was administered by the occupational therapy driver assessor as part of this assessment, in accordance with the standardised DSDA protocol. The DriveSafe and DriveAware subtests were completed in the fixed sequence specified by the application, with the clinician supporting administration and entering responses or ratings as required. In all cases, DSDA preceded the on-road driving assessment, which was usually conducted on a separate day. The on-road assessment was then conducted as described above, with the occupational therapy driver assessor recording the recommended licensing outcome. Research data were extracted from the DSDA report, the occupational therapy clinical assessment record, and the on-road assessment report.

Bias and study size

Participants who did not complete the on-road driving assessment, including those who surrendered their licence, became unwell, died, or were lost to follow-up, were excluded, which may have introduced selection bias. Blinding was not feasible because DSDA formed part of the clinical assessment process, and the occupational therapy driver assessor was aware of DSDA results during the on-road assessment, creating potential assessor expectation bias. Participation bias may also have occurred if consenting individuals differed from non-participants.

No formal sample size calculation was undertaken because this pragmatic prospective cohort study included all eligible referrals during the recruitment period, reflecting real-world practice

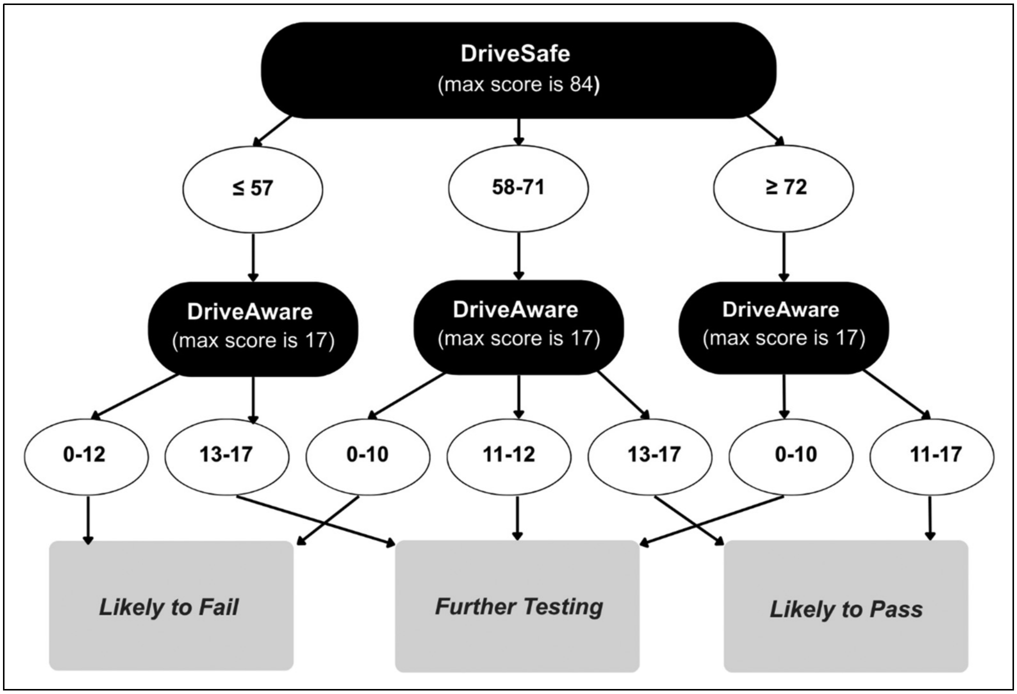

Figure 1. Schematic representation of the matrix-based classification logic for DriveSafe DriveAware (DSDA) using recommended cut-off scores. DriveSafe: ≤57 = *Unsafe*; 58–71 = *Further Testing*; ≥72 = *Safe*. DriveAware: 0–10 = *Impaired*; 11–12 = *Further Testing*; 13–17 = *Intact*. Based on Cheal.[25]

within the Australian Capital Territory fitness-to-drive pathway. Precision of classification accuracy estimates was therefore evaluated using 95% confidence intervals.

Statistical analysis

Continuous variables were summarised as means and standard deviations, and categorical variables as counts and percentages. Group differences by on-road outcome were examined using analysis of variance for continuous variables and chi-square tests for categorical variables. Effect sizes were calculated using η^2 for analysis of variance and φ for chi-square tests.

Receiver operating characteristic analyses were conducted separately for the DriveSafe and DriveAware continuous subtest scores against dichotomised on-road outcomes. Area under the curve values with 95% confidence intervals were calculated. Youden's Index was used to identify data-derived cut-off scores, which were considered alongside published DSDA thresholds.

Classification accuracy was evaluated using 2×2 cross-tabulations, with on-road fail treated as the positive outcome. Sensitivity, specificity, positive predictive value, negative predictive value, and accuracy were calculated for the predefined DSDA matrix classification and subtest classifications. *Further Testing* classifications were treated as indeterminate and excluded from the primary analysis, consistent with recommendations to avoid forcing uncertain cases near decision thresholds into binary classifications.[29,30] An additional analysis combined *Further Testing* with *Likely to Fail* to examine the effect of this classification approach. Ninety-five percent confidence intervals were calculated using exact binomial methods.

Additional descriptive analyses examined false negative classifications, *Further Testing* cases, and participants with communication difficulties. Analyses used available data; missing values were not replaced. Analyses were performed using SPSS version 30, with statistical significance set at $p < .05$. Multivariable modelling was not undertaken because the primary aim was to evaluate predictive validity rather than independent predictors of on-road outcome.

Results

Participant recruitment and characteristics

Between August 2022 and June 2024, 174 drivers referred for occupational therapy driving assessment were screened: 141 were referred directly by the DLA and 33 following Fitness to Drive Medical Clinic assessment. Thirty-six drivers were excluded because no on-road assessment was conducted ($n = 18$); the on-road fail outcome was primarily attributable to physical limitations ($n = 12$); a psychiatric or substance-use disorder was present ($n = 3$); or DSDA was not attempted or could not be completed ($n = 3$). The final sample comprised 138 participants; 62% were male, mean age was 77 years, and 77% had a neurological diagnosis, most commonly stroke, dementia, or mild cognitive impairment (Table 1).

Table 1. Participant demographics ($N = 138$).

Category	Detail
Sex, male, *n* (%)	85 (62%)
Age, years – mean (*SD*) [range]	77.0 (12) [33–97]
Years of education – mean (*SD*) [range]	12.8 (4) [2–25]
Reason for inclusion (*n*, %)	
Neurological condition <70 years	27 (20%)
Neurological condition ≥70 years	78 (56%)
Age-related driving concerns ≥70 years	33 (24%)
Neurological diagnosis present (*n*, %)	
Stroke	20 (15%)
Dementia, unspecified type	19 (14%)
Mild cognitive impairment	17 (12%)
Unspecified cognitive impairment	13 (9%)
Alzheimer's disease	12 (9%)
Parkinson's disease	9 (7%)
Vascular dementia	5 (4%)
Traumatic brain injury	4 (3%)
Brain tumour	3 (2%)
Multiple sclerosis	2 (1%)
Other	2 (1%)
Total with neurological diagnosis (*n*, %)	106 (77%)

Note. Percentages are calculated using the total sample ($N = 138$). Neurological diagnosis categories were mutually exclusive and based on the primary diagnosis documented in the clinical record. SD: standard deviation.

Participant characteristics and test scores by on-road outcome

Drivers who passed the on-road assessment were younger and had higher DriveSafe and DriveAware scores than those who failed (Table 2). Sex also differed between groups, with a higher proportion of males in the on-road pass group. In contrast, years of education and number of non-neurological comorbidities did not differ by outcome. Group differences were large for DriveSafe, DriveAware, and age, and negligible for education and comorbidities. All participants with identified communication difficulties ($n = 5$) were classified as *Likely to Pass* and subsequently passed the on-road assessment.

Discriminative ability and optimal cut-off scores

Receiver operating characteristic analyses demonstrated excellent discrimination for both DriveSafe (area under the curve = 0.96, 95% confidence interval 0.93–0.99) and DriveAware (area under the curve = 0.95, 95% confidence interval 0.92–0.99) in predicting on-road outcome (Figure 2). Youden's Index supported data-derived DriveSafe thresholds of ≥71 for *Safe* performance and ≤67 for *Unsafe* performance. For DriveAware, data-derived thresholds were ≥13 for *Intact* awareness and ≤11 for *Impaired* awareness. These data-derived thresholds were considered alongside the published DSDA cut-offs.

Classification accuracy and classification outcomes

Overall DSDA classification accuracy is presented in Table 3, with DriveSafe and DriveAware subtest performance presented in Table 4. In the primary DSDA classification analysis, sensitivity was 86%, specificity was 100%, positive predictive value was 100%, negative predictive value was 87%, and overall accuracy was 93%. No false positives were observed.

Table 2. Participant characteristics and test scores by on-road driving assessment outcome ($N = 138$).

Variable	Pass ($n = 58$)	Fail ($n = 80$)	Test statistic	p-value	Effect size
Age, years	70.2 (13.8)	81.6 (7.5)	$F(1136) = 38.81$	<.001	$\eta^2 = .22$
Years of education	13.1 (4.2)	12.6 (4.1)	$F(1121) = 0.32$	.57	$\eta^2 = .00$
Number of comorbidities[a]	1.9 (1.0)	1.7 (1.0)	$F(1122) = 0.75$	.39	$\eta^2 = .01$
DriveSafe score	75.8 (4.3)	60.1 (9.5)	$F(1136) = 135.97$	<.001	$\eta^2 = .50$
DriveAware score	14.2 (1.5)	9.3 (2.8)	$F(1136) = 142.64$	<.001	$\eta^2 = .51$
Sex, male, n (%)	42 (72%)	43 (54%)	$\chi^2(1) = 4.95$	.026	$\varphi = .19$

Note: Pass: met criteria for an unconditional licence on the occupational therapy on-road driving assessment; Fail: did not meet criteria for an unconditional licence, including conditional licence, reassessment, or licence cancellation. Data are presented as mean (SD) for continuous variables and n (%) for categorical variables. F statistics are from ANOVA for continuous variables; χ^2 is from Pearson chi-square test for sex. η^2: eta squared; φ: phi coefficient.
[a]Comorbidities exclude neurological diagnoses.

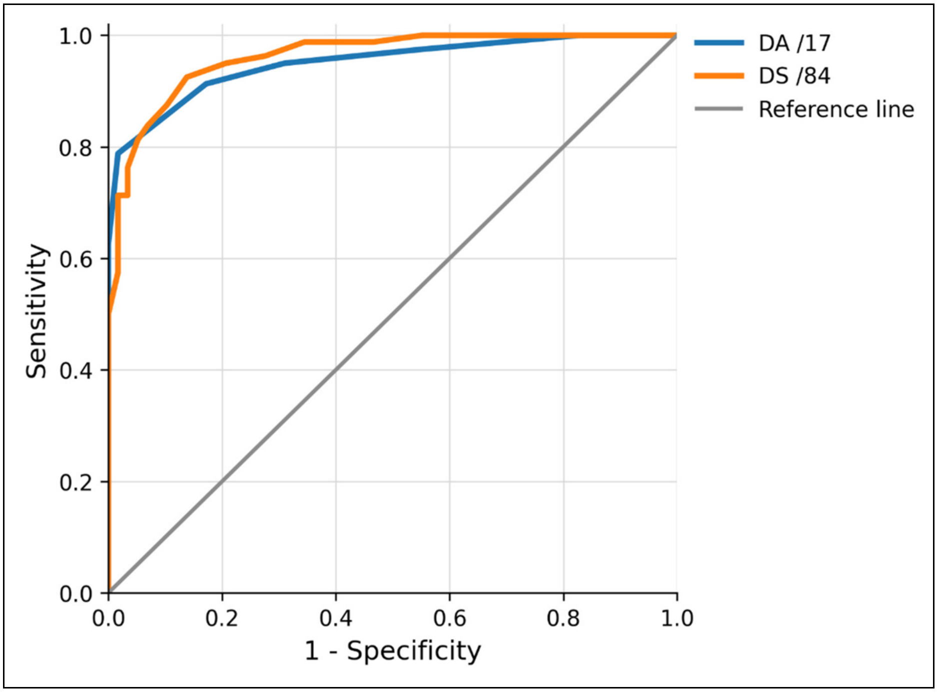

Figure 2. Receiver operating characteristic curves for DriveSafe and DriveAware subtest scores in predicting on-road outcome.

When *Further Testing* classifications were combined with *Likely to Fail*, classification accuracy changed minimally, with sensitivity of 89%, specificity of 100%, and accuracy of 94%. The DriveSafe and DriveAware subtests also showed strong classification accuracy. DriveSafe demonstrated sensitivity of 83%, specificity of 100%, and overall accuracy of 93%, while DriveAware demonstrated sensitivity of 88%, specificity of 100%, and overall accuracy of 93%.

Among participants classified as *Likely to Fail*, approximately half were recommended conditional licences and the remainder received licence cancellation. Nine participants were classified as *Likely to Pass* but failed the on-road assessment. Most had DriveSafe subtest scores close to the *Safe* threshold

Table 3. Classification accuracy of the overall DriveSafe DriveAware matrix for on-road outcome.

A. Classification of on-road outcome by DriveSafe DriveAware category

Analysis	Classification	Fail, *n* (%)	Pass, *n* (%)	Total, *n* (%)
Primary analysis	*Likely to Fail*	53 (38)	0 (0)	53 (38)
	Further Testing	18 (13)	0 (0)	18 (13)
	Likely to Pass	9 (7)	58 (42)	67 (49)
Additional analysis	*Likely to Fail + Further Testing*	71 (51)	0 (0)	71 (51)
	Likely to Pass	9 (7)	58 (42)	67 (49)

B. Classification accuracy estimates

Analysis	Test-positive classification	Participants included, *n*	Sensitivity % (95% CI)	Specificity % (95% CI)	PPV % (95% CI)	NPV % (95% CI)	Accuracy % (95% CI)
Primary analysis	*Likely to Fail*	120	86 (74–93)	100 (94–100)	100 (93–100)	87 (76–94)	93 (86–97)
Additional analysis	*Likely to Fail + Further Testing*	138	89 (80–95)	100 (94–100)	100 (95–100)	87 (76–94)	94 (88–97)

Note. In the primary analysis, *Further Testing* classifications were treated as indeterminate and excluded from classification accuracy calculations. In an additional analysis, *Further Testing* classifications were combined with *Likely to Fail*. On-road fail was treated as the positive reference outcome and was defined as being unable to meet the standard for an unrestricted licence. PPV: positive predictive value; NPV: negative predictive value; CI: confidence interval.

Table 4. Classification accuracy of DriveSafe and DriveAware subtests for on-road outcome.

A. Classification of on-road outcome by subtest category

Subtest	Classification	Fail, *n* (%)	Pass, *n* (%)	Total, *n* (%)
DriveSafe	*Unsafe*	29 (21)	0 (0)	29 (21)
	Further Testing	45 (33)	8 (6)	53 (38)
	Safe	6 (4)	50 (36)	56 (41)
DriveAware	*Impaired*	50 (36)	0 (0)	50 (36)
	Further Testing	23 (17)	9 (6)	32 (23)
	Intact	7 (5)	49 (36)	56 (41)

B. Classification accuracy estimates

Subtest	Test-positive classification	Participants included, *n*	Sensitivity % (95% CI)	Specificity % (95% CI)	PPV % (95% CI)	NPV % (95% CI)	Accuracy % (95% CI)
DriveSafe	*Unsafe*	85	83 (66–93)	100 (93–100)	100 (88–100)	89 (78–96)	93 (85–97)
DriveAware	*Impaired*	106	88 (76–95)	100 (93–100)	100 (93–100)	88 (76–95)	93 (87–97)

Note. Further Testing classifications were treated as indeterminate and excluded from classification accuracy calculations. On-road fail was treated as the positive reference outcome and was defined as being unable to meet the standard for an unrestricted licence. PPV: positive predictive value; NPV: negative predictive value; CI: confidence interval.

of ≥72 rather than clearly high scores, and most had DriveAware subtest scores in the *Intact* range. No participant classified as *Further Testing* achieved an unconditional pass; most were recommended conditional licences, with a smaller proportion recommended licence cancellation.

Discussion

This study evaluated the predictive validity and clinical relevance of DSDA for predicting on-road pass/fail outcomes in older drivers and drivers with neurological conditions referred for fitness-to-drive assessment, providing an independent evaluation of the iPad-based version in a different setting. DSDA demonstrated strong discrimination, high specificity, and clinically meaningful cut-offs. Using the predefined matrix classification, it achieved high accuracy (93%), with 86% sensitivity and 100% specificity. Most participants were classified as *Likely to Pass* or *Likely to Fail*, with only 13% classified as *Further Testing*. This supports its potential triage role while maintaining a conservative approach for uncertain cases. The *Further Testing* category also appeared clinically meaningful, as no participant in this group achieved an unconditional on-road pass, although most were granted conditional licences.

Years of education were not associated with on-road outcome or DSDA performance, suggesting that predictive validity was not explained by educational differences. This is reassuring, as some cognitive screening tools favour individuals with higher education.[20] Because participants with insufficient English proficiency were excluded, findings cannot be assumed to generalise to non-English-speaking populations. The five participants with communication difficulties, including dysphasia, were classified as *Likely to Pass* and passed the on-road assessment, suggesting possible feasibility in this subgroup; however, the small number precludes conclusions.

The findings were broadly consistent with Cheal et al.,[14] despite the older cohort and different setting. The association between age and on-road outcome was also consistent with literature linking older age with changes in driving performance.[31] All key metrics exceeded the proposed 80% benchmark for clinically useful screening tools.[18,19] Although the optimal *Unsafe* DriveSafe threshold in this cohort was higher than the previously proposed score of 57, its lower sensitivity supported retaining the more conservative cut-off proposed by Cheal et al.[14] All participants scoring below 57 on DriveSafe or below 10 on DriveAware failed the on-road assessment, further supporting the clinical relevance of these lower thresholds.

The high positive predictive value observed reflects the clinically referred nature of the sample and should be interpreted within this context.[32] Nevertheless, a positive predictive value of 100% is clinically notable because all drivers classified as *Likely to Fail* failed the on-road assessment. While the confidence intervals indicate some uncertainty around the exact magnitude of specificity and positive predictive value, the absence of false positives supports the clinical relevance of the *Likely to Fail* classification. In contrast, the negative predictive value of 87% shows that a *Likely to Pass* classification did not completely exclude on-road failure. Nine drivers, representing 13% of those classified as *Likely to Pass*, subsequently failed the on-road assessment, reinforcing the need to interpret DSDA results alongside clinical judgement and contextual information. The small number of false negatives suggests that uncertainty was concentrated in near-threshold rather than clearly impaired cases. Only one driver misclassified as *Likely to Pass* had their licence cancelled; most received conditional licences or further driving instruction. False negatives clustered among drivers with DriveSafe scores below 75, particularly near the *Likely to Pass* cut-off of 72, suggesting that scores in this range, or observations of impulsivity or unusual test behaviour may warrant closer scrutiny and possible on-road referral. DSDA may therefore help prioritise on-road assessment resources, although this requires prospective evaluation before pathway incorporation.

Examination of the DriveSafe and DriveAware subtests provided further insight into the DSDA framework. DriveSafe showed strong, relatively balanced classification performance, supporting its usefulness for identifying drivers who did not meet the standard for an unrestricted licence while remaining cautious when classifying drivers as *Likely to Pass*. DriveAware also showed excellent overall discrimination, but its performance at the predefined cut-off scores was more variable: the lower cut-off had strong specificity and moderate sensitivity for identifying drivers who did not meet the unrestricted licence standard, whereas the higher cut-off was less effective for identifying those who did. No participant scoring in the DriveAware *Impaired* range passed the on-road assessment, supporting the importance of insight and awareness in predicting real-world driving outcomes.[33–35] Together, these findings suggest that DriveSafe provided more stable cut-off-based classification, while DriveAware contributed complementary information about insight and awareness. This supports interpreting the DSDA matrix as an integrated tool rather than two interchangeable subtests. Future research should examine whether matrix refinement could improve classification of drivers with near-threshold DriveSafe scores and high DriveAware scores.

The pattern of licensing outcomes suggests that contextual and environmental factors may influence how cognitive impairment is managed in practice. In this relatively low-traffic jurisdiction, where alternative transport may be more limited than in larger metropolitan settings, conditional licences may allow some drivers who do not meet criteria for an unconditional licence to continue driving within restricted parameters while planning for driving reduction or cessation.[6,36] This interpretation should be viewed cautiously, as the study was conducted in a single jurisdiction and did not compare licensing practices across settings. Previous research supports early, supported discussions about driving cessation involving patients, families, and support networks.[2,5] Within this context, DSDA may support triage and discussions about driving reduction or cessation.

Excluding participants who did not complete the on-road assessment may have introduced selection bias. The highly selected sample of English-speaking, medically at-risk drivers referred through the DLA, Fitness to Drive Medical Clinic, and/or occupational therapy driver assessor limits generalisability to lower-risk community samples, non-English-speaking populations, and settings with different referral pathways, licensing systems, or driving environments. Exclusion of cases where on-road failure was primarily physical means findings apply to cognitively focused fitness-to-drive assessment rather than physical capacity to operate vehicle controls. Assessor blinding was not feasible because DSDA formed part of the clinical pathway and the assessor was aware of the results during on-road assessment, which may have introduced expectation bias. This risk was partly mitigated by use of a structured on-road assessment, with licence recommendations based on observed driving performance rather than DSDA results alone. Although predictive validity estimates were strong, replication in other settings is needed to confirm the generalisability of these findings. Future research should examine DSDA in other populations, including individuals with limited English proficiency. Prospective studies should also evaluate its role in identifying drivers who require on-road assessment, particularly those with uncertain or near-threshold results. Where feasible, future validation studies should use blinded on-road assessors and examine implementation in clinical workflows, including general practice or other primary care settings. Nevertheless, DSDA showed strong predictive validity and clinical relevance in this setting, and its high specificity, positive predictive value, and triage performance suggest that it may have a role within clinical pathways.

Clinical messages

- DSDA showed strong predictive validity for identifying drivers at risk of failing an on-road driving assessment, with high specificity.
- A *Likely to Fail* result was highly reliable in this sample, with no false positives observed.
- DSDA may support clinical decision-making by helping identify drivers unlikely to pass and those requiring further on-road assessment.
- Clinical judgement remains essential, particularly when DriveSafe subtest scores are close to the *Safe* cut-off of 72 or behavioural concerns are present.

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Author contributions

All listed authors have substantially contributed to the work. BJJ, JMO, VP and LM conceptualised the work. BJJ collected the data and analysed the data under supervision from LM and VP, and all authors reviewed the data. BJJ drafted the manuscript, and all authors critically reviewed and edited the manuscript and approved the final version.

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Declaration of conflicting interests

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Data availability statement

The data underlying this study are not publicly available because of ethical and privacy restrictions and the conditions of participant consent.

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