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# The Rookwood Driving Battery: Normative older adult performance

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**Objectives.** The current study aimed to obtain older adult normative data on a neuropsychological battery in relation to functions underlying driving ability. The effect of age on performance on the battery was previously unknown; normative data revision was necessary to enable more appropriate use of the battery with older clients.

**Design.** Cross-sectional cohort study.

**Methods.** Volunteers were sought from healthy older people living independently in the community to complete the Rookwood Driving Battery. A group of 202 volunteers above the age of 70 were recruited from local social groups to complete the battery. Of these, 184 completed a screening test of cognitive integrity (Mini Mental State Examination, MMSE). The age ranged from 70 to 96 (mean age = 81 years, *SD* = 5.438). In the total sample, 155 (77%) were females.

**Results.** Results of the MMSE indicated that 161 (87.5%) of the group fell above a cut-off (25/30) typically used in epidemiological studies to identify age-related cognitive decline. Of these cognitively intact volunteers, performance was marked by higher battery error scores (mean = 5.12, *SD* = 3.75) than those observed in an earlier normative study using younger volunteers below 70 years of age (mean = 1.14, *SD* = 1.87). The two age groups differed significantly on all 10 battery subtests; in all cases the level of significance was .002 or less; for nine subtests, significance fell below .001. In the 'intact' older group, battery performance was observed to be closely related to score on the MMSE, a test of general cognitive integrity ($r = .558$, $p = .01$).

**Conclusions.** Performance on the Rookwood Battery differs for the over 70s and under 70s. The authors suggest essential modifications in its use with older people.

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The assessment of risk in a range of daily living activities, including driving, is one of the major issues faced by clinicians working with older adults (Clark *et al.*, 2001). Assessment and advice regarding driving competency reflect clinicians' multiple responsibilities: to advise clients of their obligation to inform licensing agencies of possible impairments; to manage a client's anxieties about possible driving cessation; and a responsibility to the licensing agencies to provide evidence-based assessment of driving-relevant cognitive skills. The latter responsibility is usually discharged by referral to a Driving Assessment Centre (DAC).

For people with dementia, however, there may be good reasons to undertake neuropsychological screening prior to referral to a DAC to avoid unnecessary referrals (British Psychological Society Advisory document, *Fitness to Drive and Cognition*, 2001). There are potentially very large number of people with dementia who might be referred to DACs of which a significant proportion are likely to fail the on-road test owing to gross impairments in relevant abilities. McKenna and Bell (2007) reported that over the past 6 years at the South Wales Driving Assessment Centre (Rookwood Hospital), 77% of people referred with a diagnosis of dementia failed the on-road test. In marked contrast, the majority of clients referred with a diagnosis of stroke or traumatic brain injury (TBI) passed the on-road assessment. Thus, many people with severe dementia could be spared the humiliation of a 'sure failure' experience if advised against driving following screening with a reliable neuropsychological battery. Duchek *et al.* (2003) recently demonstrated that some people with mild and very mild dementia continue to pass repeated on-road assessments.

There is a growing evidence of the usefulness of neuropsychological assessment as an integral part of the evaluation process (Clark *et al.*, 2001; Meyers *et al.*, 1999; Radford & Lincoln, 2004). Reger *et al.* (2004) undertook a meta-analysis of studies that had included participants with dementia, and reported a clear relationship between neuropsychological test results and on-road driving ability. Attention, concentration, and visuospatial skills were the greatest predictors of on-road performance. In contrast, simple mental status tests such as the Mini Mental State Examination (MMSE, Folstein *et al.*, 1978) and carer report were shown to yield little useful predictive information on their own.

For similar reasons, a comprehensive approach is recommended by the 2001 British Psychological Society advisory document which suggests a three-stage evaluation process, with neuropsychological assessment fulfilling a key role to screen out those who would be clearly predicted to pass or fail an on-road assessment. The Rookwood Driving Battery (McKenna, 1998; McKenna, Jeffries, Dobson, & Frude, 2004; McKenna *et al.*, 2005) was developed as a reliable neuropsychological assessment battery, designed to fulfil this role within a multidisciplinary driving assessment service. For those clients whose performance on neuropsychological testing is equivocal, or for those who resist advice that their driving is compromised, referral to the DAC could then be recommended.

Within the locality of the South Wales Driving Assessment Centre at Rookwood Hospital, a number of clinical psychologists use the Rookwood Battery when issues of driving safety are raised. When referred to the DAC, these clients' on-road performance provide useful information regarding the predictive value of the battery, and such data is included in the most recent report of validation of the battery submitted for publication (McKenna & Bell, 2007).

More generally, the battery has been validated by an initial study of 200 volunteers, clients undergoing assessment at the South Wales DAC (McKenna *et al.*, 2004), and a larger cohort study looking at its predictive value in terms of screening clients with neuropathology (McKenna & Bell, 2007). A major finding of these studies was that older clients' on-road abilities differed significantly from the rest of the client population. Results indicated that older DAC clients above the age of 70 failed on road significantly more often than younger clients, even when they passed the cognitive battery, regardless of diagnosis. This was thought to represent a difference both in cognitive resource and driving style.

A difficulty with the existing normative database of 200 participants was that it had been obtained with a younger group, only five of them were older than 70 (McKenna *et al.*, 2004). To address this issue, the current paper reports on a further validation study establishing normative results for the independently living healthy volunteers aged 70 and above. In order to ensure that volunteers were representative of a healthy ageing population, one consideration was the identification of cognitive impairment over and above the normal ageing process.

### *Participants*

Ethical approval was granted by local Research Ethics Committees. Around 20 social clubs for older people in South-east Wales were identified through voluntary and church organizations and social services' lists of pensioners' groups. They consisted of church, luncheon, retirement or social groups, and were located across a wide geographical area representing the full socio-economic range of communities. The researchers approached club organizers for permission to make a presentation to a group meeting on the nature and purpose of the study. The presentation included a description of the rationale for obtaining normative data for older adults on existing neuropsychological tests, and described the research as involving an hour of paper-and-pencil tests of thinking, concentration, attention, and problem solving, to be completed at a time and venue of the volunteers' own choice. Groups varied in size from around 20 to 50 but occasionally could be as small as 12. People were asked to volunteer if they did not suffer significant hearing or visual loss, neurological conditions such as Stroke or Parkinson's disease, and if they lived independently rather than in a care setting. Exclusion criteria were applied by self-selection in the first instance, but medical history was revisited in the screening assessment for each volunteer, as described in the Protocol. It was not necessary to select only drivers, as the design was a cohort study looking at older adult performance, not older drivers' performance. At this stage, names and contact details were taken and the volunteers contacted after at least one week to confirm their continued interest and to arrange the venue for the testing session. A group of 202 people over the age of 70 years volunteered their participation – approximately 40% of group members who attended the presentations.

The age range was 70–96, with a mean age of 81 years ($SD = 5.438$). Table 1 displays the numbers in each 5-year cohort. Women made up 77% of the total sample (155). Table 1 also displays the socio-economic distribution of the group according to employment, which demonstrates a small bias towards skilled and higher occupations. At the time of the study, 36% were driving (with equal numbers of men and women) and 24% were drivers previously, who had given up. A total of 40% of the sample had never driven, however, and this group was mainly made up of women (96%).

**Table 1.** Age range and socio-economic status

| Age range | *N* | % |
|---|---|---|
| 70–74 | 29 | 14.4 |
| 75–79 | 54 | 26.7 |
| 80–84 | 67 | 33.2 |
| 85–89 | 41 | 20.3 |
| 90–100 | 10 | 5.0 |
| Missing | 1 | 0.5 |
| Total | 202 | 100 |
| *Socio-economic status* | | |
| Higher managerial and professional | 30 | 14.9 |
| Lower managerial and professional | 22 | 10.9 |
| Intermediate occupations | 50 | 24.8 |
| Small employers and own account workers | 16 | 7.9 |
| Lower supervisory, craft, and related occupations | 16 | 7.9 |
| Semi-routine occupations | 43 | 21.3 |
| Routine occupations | 18 | 8.9 |
| Never worked and long-term unemployed | 4 | 2.0 |
| Missing | 3 | 1.5 |
| Total | 202 | 100 |

### *Test protocol*

Assessments were completed at the volunteers' location of choice – their own home, a clinical setting, or their social centre. In practice, most volunteers chose to be tested at home. Information was gathered regarding medical and occupational histories, as well as general level of IQ (as measured by the NART). No assumptions were made about the cause of any lowered scoring on cognitive screening as the clinical diagnosis of dementia requires a greater depth of diagnostic investigation than the present study allowed. Where a poor cognitive score was considered significant for the well-being of that individual, appropriate action was taken according to agreed ethical guidelines. Two people were excluded on this basis.

### *Background older adult screening tests*

Initial reporting of interim results for this study analysed an earlier smaller group without consideration of global cognitive status (McKenna *et al.*, 2005). The known prevalence of dementia would indicate a need to identify volunteers whose scores on cognitive screening suggest the presence of cognitive deterioration as the study sought a representative sample of cognitively healthy older adults. Thus, two additional tests were administered in order to screen for cognitive impairment. These were the MMSE (Folstein, Folstein, & McHugh, 1975) and Clock Face Drawing (Schulman, Gold, Cohen, & Zucchero, 1993). These tests were chosen as those most widely used for this purpose in the field, although they are unsuitable to identify dementia if unsupported by further information, such as clinical history of decline in real-life functioning and self-care skills (Tombaugh & McIntyre, 1992). The MMSE is a widely recognized brief measure of a number of higher mental functions, including short-term memory, calculation, attention, orientation, drawing, writing, and naming. It is insensitive to mild cognitive impairment and subject to education and socio-economic effects. For this reason, occupational history was also noted.

The trail making test was also added (Lezak, Howieson, & Loring, 2004) as a commonly used clinical tool in older adult mental health services when assessing dimensions of executive and attentional skills, and its inclusion was to identify its usefulness as a supplementary task in the battery when assessing older people. Speed and number of errors were recorded for each part (A and B) of the test.

### *Test Battery: The Rookwood Driving Battery*

The Rookwood Driving Battery has been described in detail by McKenna *et al.* (2004). Visual perception abilities were assessed using subtests from the Visual Object and Space Perception Battery (VOSP; Warrington & James, 1991). The VOSP subtests included in the Rookwood Battery tested shape interpretation ('Incomplete Letters') and spatial awareness ('Position Discrimination' and 'Cube Analysis'). Spatial attention and visual search were assessed with a visual attention task based on letter cancellation (Lezak *et al.*, 2004). Praxis skills were tested by asking the participant to copy hand movements, to produce common named gestures, and to mime object use, as well as rule dependant movement in a tapping task, and learning a short sequence of hand movements (derived from Luria, 1973). The latter two praxis tests are also tests of executive function. Further executive function tests included three subtests of the Behavioural Assessment of Dysexecutive Syndrome (BADS; Wilson, Alderman, Burgess, Emslie, & Evans, 1996). These tested reasoning ('Action Programme' and 'Key Search') as well as self-monitoring and response switching ('Rule Shift Cards'). Additionally, executive function and set-shifting were tested with a quantitative adaptation of the Weigl sorting task (Goldstein & Sheerer, 1941). Divided attention was tested using a task involving simultaneous letter cancellation whilst listening to a taped story and noting a specific word each time when it is uttered. This was derived from the Banstead Driving Centre within FORUM (a national association of accredited Mobility Assessment Centres). Normative data have not yet been published; thus it was used as a qualitative measure in this study. Comprehension was assessed using eight items from the Modified Token Test (Coughlan & Warrington, 1978).

The Battery gives a pass/borderline/fail categorization for each subtest – failure determined by 5th percentile cut-offs previously obtained from the younger sample of adults (McKenna *et al.*, 2005). This scoring also enables a composite Rookwood Battery total error score to be derived (error score range 0–22).

The revised National Adult Reading Test (NART, Nelson & Willison, 1991) was used to obtain an estimated measure of pre-morbid IQ.

## Results

### *General ability and cognitive status*

Mean IQ for the sample was 104 ($SD = 12.1$). Using Pearson correlations, there was no significant relation between age and general level of ability measured by NART ($-.027$, $p = .7$). However, there was a small but significant inverse correlation between age and MMSE score ($-.197$, $p = .01$) indicating a slight trend for decline in MMSE score with advancing age.

***Was the sample cognitively intact?***
Individuals' performances on the MMSE and Clock Drawing showed variable overlap. Using MMSE, 23 people met the criterion for impairment (using a score of 24 or less), while using the Clock Face, 29 people met the impaired criterion, and only 7 people met the 'impaired' criterion on both MMSE and Clock face. Thus, it was decided to use only MMSE scores to establish the cognitive status of the group as it offered a wider evaluation of cognition than Clock Drawing. In choosing a cut-off to define cognitive integrity, a score of 25 and above was taken in agreement with that used in a large British epidemiological study (Brayne, Gill, Paykel, Huppert, & O'Connor, 1995; Rait *et al.*, 2005).

MMSE data was available for 184 participants. The majority of the sample (161, 87.5%) scored 25 or above on MMSE; 23 participants (12.5%) scored below 25. These two groups were therefore given the identifiers: Cognitively Intact (CIN; MMSE 25 and above) and cognitively Impaired (CIM; MMSE 24 and below). There was no significant difference between the groups' socio-economic status ($t = 1.68$, $p = .105$) or age ($t = 0.99$, $p = .33$) when tested by Independent Samples $t$ tests. The two groups differed in estimated intellectual ability ($t = -3.34$, $p = .002$), with the CIM group demonstrating a lower NART IQ (mean = 96.65; $SD = 12.13$) than the CIN group (mean = 105.68; $SD = 11.89$).

The difference between these two subgroups was then examined using the composite Rookwood Battery total error score (error score range 0–22), and the number of subtests failed. The box plot (Figure 1) illustrates the degree of difference between the two groups on the battery error score. There was a significant difference between the groups on the battery total error score ($t = 3.887$; $p = .001$; CIM mean = 9.22, $SD = 4.29$; CIN mean = 5.53, $SD = 4.01$), and on the number of tests failed ($t = 3.845$, $p = .001$; CIM mean = 3.91, $SD = 2.21$; CIN mean = 2.05, $SD = 1.87$).

*Post hoc* manipulation of various MMSE cut-offs showed that even the most intact volunteers, who obtained MMSE scores of 30, achieved a mean battery error score of 2.69.

***Normative performance (CIN group)***
A significant negative Pearson correlation was observed between MMSE and total error score on the battery ($r = -.558$, $p = .01$).

*Performance and increasing age*
Table 2 shows all scores for two age bands within the cognitively intact sample (70–79 years, and 80 plus years). Using a multiple comparison adjusted $\alpha = .005$, deterioration from one age band to the other was observed for Action Programme ($t = 2.881$, $p = .005$), Divided Attention Speed ($t = -2.984$, $p = .003$), and Divided Attention '3's (auditory target identification in the divided attention task; $t = -3.947$, $p =< .0001$). A trend towards significance was observed for Incomplete Letters ($t = 2.509$, $p = .013$). On nine other subtests, the age bands were not significantly different.

*Comparisons with younger adult norms*
Results from a group of 200 younger volunteers have already been reported in McKenna *et al.* (2004). Five of this earlier group were in fact over 70 and were thus excluded from analysis of the younger cohort for this present study, and were also excluded from the

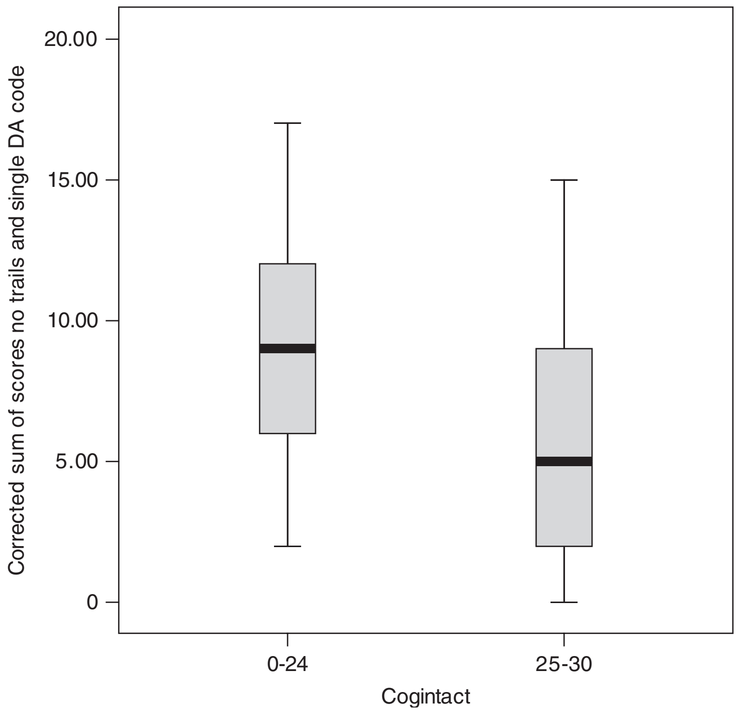


**Figure 1.** Total Driving Battery scores for cognitively impaired and cognitively intact subgroups.

current older sample, as data collection within the younger sample had not included MMSE. Thus, the 161 cognitively intact older volunteers (mean age = 81.06, $SD = 5.54$) were compared with the remaining younger sample ($N = 195$, mean age = 42.46, $SD = 13.80$). The younger volunteers had fewer women (54%) than the older group (77%).

Data for the performances of the two age groups on individual battery subtests are presented in Table 3. There were no significant differences between the age groups on NART measurement of IQ ($t = -1.064$, $p = .288$). Despite this intellectual parity, the groups differed significantly on all other battery tests, with younger adults consistently outperforming the older volunteers. In all cases the level of significance was .002 or less.

Collection of normative data for the younger volunteers pre-dated inclusion of the Visual Attention and Divided Attention tests in the battery; thus younger normative data is available for only 10 subtests, giving a possible total error score of 20. To allow a simple comparison of total battery scores between the older and the younger samples, it was therefore necessary to recalculate the battery score for the older sample excluding Visual Attention and Divided Attention scores to give an exact comparison. The younger people scored a mean battery error score of 1.41 ($SD = 1.87$) and cognitively intact older adults (CIN group) obtained a mean battery error score of 5.12 ($SD = 3.75$).

### *Normative data for Visual Attention and Divided Attention*

As described above, these two tests do not have pre-existing normative data from younger adults. For Visual Attention, two scores were obtained: speed (number of targets scanned during 100 seconds, 86 being the total obtainable) and errors (number of omissions

**Table 2.** CIN age progression above 70 years

| Test | Age group | *N* | Mean | *SD* | *t* | *p* |
|---|---|---|---|---|---|---|
| Weigl | 70–79 | 63 | 3.73 | 0.70 | 0.258 | .797 |
| | 80+ | 97 | 3.70 | 0.70 | | |
| Key search | 70–79 | 63 | 11.25 | 3.53 | 1.721 | .087 |
| | 80+ | 97 | 10.22 | 4.01 | | |
| Action programme | 70–79 | 63 | 4.62 | 0.71 | 2.881 | **.005** |
| | 80+ | 96 | 4.23 | 1.00 | | |
| Rule shift cards | 70–79 | 63 | 18.16 | 3.15 | 1.066 | .288 |
| | 80+ | 97 | 17.63 | 2.94 | | |
| Tapping and sequencing | 70–79 | 63 | 14.10 | 1.68 | 1.496 | .137 |
| | 80+ | 96 | 13.67 | 1.89 | | |
| Cube analysis | 70–79 | 63 | 9.49 | 1.37 | 2.005 | .047 |
| | 80+ | 97 | 9.07 | 1.18 | | |
| Position discrimination | 70–79 | 63 | 19.17 | 1.81 | −0.002 | .998 |
| | 80+ | 97 | 19.18 | 1.38 | | |
| Incomplete letters | 70–79 | 63 | 19.38 | 0.77 | 2.509 | .013 |
| | 80+ | 97 | 18.95 | 1.40 | | |
| Visual neglect speed | 70–79 | 63 | 69.71 | 14.28 | −1.697 | .092 |
| | 80+ | 97 | 65.87 | 13.61 | | |
| Visual neglect errors | 70–79 | 63 | 2.71 | 3.42 | 1.567 | .119 |
| | 80+ | 97 | 3.97 | 6.72 | | |
| Divided attention speed | 70–79 | 62 | 66.63 | 14.31 | 138.130 | **.003** |
| | 80+ | 93 | 59.38 | 15.56 | | |
| Divided attention errors | 70–79 | 62 | 4.52 | 5.82 | 147.698 | .300 |
| | 80+ | 93 | 5.62 | 7.26 | | |
| Divided attention '3's | 70–79 | 62 | 8.56 | 0.880 | 152.793 | < **.0005** |
| | 80+ | 93 | 7.85 | 1.375 | | |
| Praxis | 70–79 | 63 | 15.27 | 1.14 | 0.934 | .352 |
| | 80+ | 97 | 15.10 | 1.05 | | |
| Comprehension | 70–79 | 63 | 6.97 | 1.36 | 2.041 | .043 |
| | 80+ | 97 | 6.53 | 1.32 | | |
| NART IQ | 70–79 | 63 | 105.02 | 12.07 | −0.591 | .556 |
| | 80+ | 93 | 106.17 | 11.87 | | |

NB: *p* values in bold denote significance at adjusted $\alpha =< .005$. All *t* tests are two-tailed comparisons.

expressed as a percentage of total targets scanned). For Divided Attention, three scores were obtained: speed (number of targets scanned during 100 seconds whilst listening to an auditory task, 0–86); errors (number of omissions expressed as a percentage of total targets scanned); and total number of target words responded to from the auditory task (maximum 9). Table 4 shows the scores on these measures which correspond to the 5% frequency obtained by the cognitively intact group, and the frequency of scores below these thresholds obtained by the cognitively impaired group also.

## Discussion

The present study aimed to establish normative performance of older adults aged 70 or above on the tests used within the Rookwood battery in order to improve the evidence

**Table 3.** Means and two-tailed independent sample *t* test comparisons for the two age groups

| Test | Age group | *N* | Mean | *SD* | *t* | *p* |
|---|---|---|---|---|---|---|
| Age | Younger | 195 | 42.46 | 13.80 | – | – |
| | Older | 160 | 81.06 | 5.54 | | |
| Weigl | Younger | 195 | 4.00 | 0.00 | 5.231 | < .001 |
| | Older | 161 | 3.71 | 0.69 | | |
| Key search | Younger | 195 | 12.50 | 3.68 | 4.703 | < .001 |
| | Older | 161 | 10.61 | 3.84 | | |
| Action programme | Younger | 195 | 4.71 | 0.84 | 3.582 | < .001 |
| | Older | 160 | 4.38 | 0.92 | | |
| Rule shift cards | Younger | 195 | 19.62 | 1.26 | 7.057 | < .001 |
| | Older | 161 | 17.80 | 3.07 | | |
| Tapping and sequencing | Younger | 195 | 14.50 | 1.05 | 4.078 | < .001 |
| | Older | 160 | 13.84 | 1.81 | | |
| Cube analysis | Younger | 195 | 9.60 | 0.83 | 3.190 | < .002 |
| | Older | 161 | 9.23 | 1.27 | | |
| Position discrimination | Younger | 195 | 19.70 | 0.86 | 3.777 | < .001 |
| | Older | 161 | 19.18 | 1.55 | | |
| Incomplete letters | Younger | 195 | 19.66 | 0.61 | 5.226 | < .001 |
| | Older | 161 | 19.11 | 1.22 | | |
| Praxis | Younger | 195 | 15.91 | 0.75 | 7.291 | < .001 |
| | Older | 161 | 15.17 | 1.08 | | |
| Comprehension | Younger | 194 | 7.73 | 0.65 | 8.912 | < .001 |
| | Older | 161 | 6.70 | 1.34 | | |
| NART IQ | Younger | 193 | 104.38 | 10.66 | − 1.064 | .288 |
| | Older | 157 | 105.68 | 11.89 | | |

base on which advice is given. The group proved to have representation across the age range, IQ, and socio-economic status of adults above 70 years of age, with the following proviso: volunteers from the lower socio-economic range are a little less well represented in this sample, and it was noteworthy that the social clubs in the more disadvantaged areas of Cardiff and Newport and the surrounding areas had the least uptake of volunteers. This is a typical characteristic and may contribute to the slightly elevated mean IQ as measured by the NART (mean = 104, *SD* = 12.1, compared with theoretical mean = 100, *SD* = 15).

**Table 4.** Older adults' normative performance on Visual Attention and Divided Attention

| | Mean | *SD* | 5th Percentile cut-off derived from CIN group | Percentage of CIM group scoring below cut-off |
|---|---|---|---|---|
| Visual Attention | | | | |
| Speed | 67.47 | 13.96 | 42 and fewer targets | 8.7 |
| Errors | 3.48 | 5.66 | 12.5% errors and above | 17.4 |
| Divided Attention | | | | |
| Speed | 62.43 | 15.51 | 36 and fewer targets | 17.4 |
| Errors | 5.18 | 6.70 | 21.6% and above | 21.7 |
| Number of target words | 8.14 | 1.28 | 5 and fewer | 13 |

Two characteristics emerged which indicated that adopting a cut-off at age 70 was an appropriate demarcation to distinguish younger and older adults. First, when comparing the results with norms for younger volunteers, there were highly significant differences on overall and individual battery scores between the two groups, with the older adults scoring less well on almost all the tests. This difference was far more marked than the differences within the older adult group (those aged below and above 80 years). Only one task of executive function and the Divided Attention task showed a clearly significant decline across the older age divide. This data thus provided good evidence to consider adults aged 70 plus as a distinct group from younger adults and as a homogenous group for the purposes of the battery norms.

Epidemiological studies have established that between 5.9% and 7.3% of over 65-year-olds, and between 19.6% and 27.5% of over 85-year-olds suffer from dementia (Brayne *et al.*, 1995; MRC Cognitive Function and Ageing Study, 1998). Thus, in establishing norms on the Rookwood battery, it was considered important to detect any features of decline over and above the subtle but normal characteristics of decline evident in the group data. Indeed, strong evidence did emerge for a small subset of people who had more specific cognitive impairment in keeping with the concept of 'mild cognitive impairment'. Using a cut-off of 25 on the MMSE, one in eight (12.5%) of the sample fell below the screening threshold for intact cognitive status, and there was a significant difference between the performance of the cognitively intact (CIN) and the cognitively impaired (CIM) older volunteers on the Rookwood Battery.

The identification of the presence of age-related cognitive frailty was still evident in the CIN group's battery scores association with MMSE scores, highlighting the tenuous concept of 'normal cognitive ageing' as age progresses, even though small numbers of the oldest participants in epidemiological studies remain unimpaired (Brayne *et al.*, 1995; MRC Cognitive Function and Ageing Study, 1998). It is clear that both the normal continuum model (Brayne *et al.*, 1995) and the pathology model of ageing (Peterson, 2003) have their benefits, although the problem of designating a cut-off for identifying cognitive impairment beyond the norm remains. In this study, a compromise was reached by selecting out those older adults who demonstrated mild cognitive impairment, using the MMSE cut-off most commonly used in local clinical practice.

The current study aimed to provide normative data for older adults on well-established published neuropsychological tests which are used as part of the Rookwood Battery to assess fitness to drive. Additionally, two tests which have been proved to be powerful in the study of clients at the DAC did not previously have norms for either older or younger adults. These were Visual Attention and Divided Attention. The present study is the first report of norms for these tests with older people.

As expected, there was no significant correlation between NART and age in the full sample. However, NART scores for the CIM group were significantly lower than for the CIN group. As the groups do not differ in socio-economic status, the discrepancy is not likely to be attributable to prior educational attainment. Rather it may reflect previous findings that performance on the NART can indeed be affected by organic cognitive decline (Cockburn, Keene, Hope, & Smith, 2000).

Even with the exclusion of the 'mild cognitive impairment' group, comparison with younger volunteers suggests that performance on the Rookwood Battery deteriorates after the age of 70. Thus, even an objectively independent group of older people living in the community without services or in need of aid demonstrate performance on the battery which is less robust than that of younger participants. Furthermore, even with the exclusion of the CIM group, the relationship of the MMSE scores with age persists, highlighting real but subtle age-related decline in cognitive functioning. This has a serious implication for setting the appropriate error cut-off to identify those who require referral on to the Rookwood Driving Assessment Centre.

Current practice at the driving centre is to use an error score of 10 out of a possible total error score of 22 as a cut-off to predict on-road failure as this produced the most powerful value for predicting a fail on road (PPV .92, McKenna *et al.*, 2005). In the current study, the sample of younger adult controls had obtained a lower mean error score than the cognitively intact older sample. Additionally, *post hoc* identification of the most intact older adults (MMSE of 30) still resulted in poorer battery error scores. Thus, even a small drop below intact cognition has a significant consequence on performance on the battery, and age itself results in compromised battery performance even for seemingly cognitively intact older volunteers.

An additional finding from clients undertaking both the battery and the on-road assessment at Rookwood Driving Assessment Centre was that older adults above 70 years of age perform more poorly on the on-road component than younger clients, regardless of diagnosis (McKenna & Bell, 2007). Using a cut-off of 10, they found that for DAC clients over 70 years of age, 87% of those who failed the battery also failed on road, but that 51% of those who passed the battery also failed on road. Taken in conjunction with the current normative study of older adults, these client data would suggest that the battery cut-off needs to be more stringent than for younger people. This was a counter-intuitive finding and resulted in our re-evaluation of the expectation of a normative older adult group which could perform comparably with younger people on the battery.

The present study suggests that age has a major influence on the cognitive functions assessed on the battery, even allowing for exclusion of the frankly impaired volunteers (low MMSE scorers). Taken independently, one would conclude that the group aged over 70 years performed consistently worse on the battery than younger people. Using this rationale, the cut-off would need to be readjusted to the normative data obtained here, so failure on the battery should require a higher mean error score. Outcome data from the DAC on-road test show that older clients fail on road at a high rate even after passing the battery (McKenna & Bell, 2007), so applying this formula would result in even more older adults failing on road when passing the battery. Cognition may be normal for the age group but inadequate for an on-road pass. Instead, the data would indicate applying a much *lower* error score than 10 as criterion for predicting a fail on road, if the present route is considered to be the correct standard for all comers regardless of age. Alternatively, the route could be altered to match the differing standards of driving evident in the two age groups.

In acknowledgement of these results, and their implication for appropriate assessment of the older adult, the on-road course at the Wales Driving Assessment Centre has recently been revised. The course for the older adult now avoids urban high-density traffic which exerts high demand on speedy multi-tasking (e.g. multiple-lane roundabouts and right-hand turns into heavy fast traffic). Instead, the new route demands high skill in handling tortuous rural roads with intermittent but fast on-coming cars. Both routes conform to the standard test as applied locally for novice drivers. However, the second route conforms more to the style of driving for the older adult in that it avoids very heavy traffic at peak times and in dense urban areas. Monitoring the status of pass/fail rates following this change will provide us with clarification as to the suitability of this new route.

## Conclusion

Scores of cognitively intact older adults (aged over 70) on the Rookwood battery are significantly poorer than those of younger adults (aged less than 70). The outcome of this study suggests that using the pass/fail scoring system derived from the younger normative sample would give cognitively intact older people a higher baseline error score on the battery. As older adults also fail the on-road driving test at a higher rate than younger adults regardless of diagnosis, a better predictive value would require a much smaller error score on the cognitive battery. Thus, half the older adults who scored below 10 still failed on road. For the moment, therefore, it seems evident that a clear fail on the battery (error score of 10 or more) in a clinical evaluation predicts a high fail rate on road, and confirms the battery's usefulness to screen fitness to drive and possibly to avoid referral for an on-road assessment.

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