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Utility of the MOCA as a cognitive predictor for fitness to drive.

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## COVER PAGE

Title: Utility of the MOCA as a cognitive predictor for fitness to drive

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## BACKGROUND

Determining fitness to drive is a major concern affecting aging and disabled populations, particularly concerning reduced cognitive functioning, functional limitations and reduced vision [1, 2]. The Royal Society for Prevention of Accidents encourages aging drivers to maintain their licence (for independence, mobility and quality of life), emphasising that prematurely removing someone's driving licence negatively affects their quality of life - the consequences of which outweigh the chance of being involved in a collision, for both the driver and the remainder of society [3].

The gold standard test in the United Kingdom (UK) to determine the ability to drive is an on-road driving assessment, and clinicians have the opportunity to refer patients to an independent Mobility Centre (accredited by Driving Mobility) where an assessment will be performed based upon on-road driving experience as judged by a professional driving instructor and occupational therapist[4]. The assessment is resource expensive and only a limited number of individuals are referred. To date no screening test is clinically implemented in the UK which accurately determines fitness to drive[4].

This study sets out to evaluate the potential of the Montreal Cognitive Assessment (MOCA) as a screening tool, for people with concerns regarding cognitive capacity; to determine pass/fail cut-offs for on-road driving assessment.

## METHOD

People referred via various pathways (Driving and Vehicle Licensing Agency, self-referral or health professionals such as General Practitioners, Occupational Therapists, Nurses or Physiotherapists), were assessed between 21<sup>st</sup> of February 2013 and 31<sup>st</sup> of March 2014 at the RDAC in the United Kingdom in the following cities & towns; Birmingham, Hull, Cannock, Oxford, Worcester, Northampton and Leamington. The assessment is not a driving test and only those with an existing driving license (full, provisional or *section 88*) are included. Individuals presenting with self-indicated cognitive problems (18.9% of total assessments carried out), were assessed using the MOCA and analysed to form a sub-sample for analysis.

243 people, were assessed by an experienced multidisciplinary team consisting of occupational therapists and driving instructors. Following a standard assessment route and criteria assessment, outcomes were classified as follows: "Pass" – client was deemed to be able to drive safely; "Fail" – client was not deemed safe to drive; and "Review" – where a decision could not be taken at that point in time and more guidance / practice may be required. This study focussed on those who passed or failed this assessment within largest (e.g.  $n > 5$ ) neurological groups found within the sample assessed during this period.

Cognitive subdomains were assessed via the Montreal Cognitive Assessment (MOCA), whereby total MOCA scores and subdomains were analysed. A score of  $\text{MOCA} \geq 26$  is considered to be normal[5]. Age, condition and on-road assessment outcome were noted.

### Statistical Analysis

Descriptive statistics (mean, standard deviations and range) were used to describe the patient populations within this study. MOCA data was explored by means of an independent  $t$ -test in order to compare those who passed and failed their driving assessment. The Receiver Operating Characteristic (ROC) curve was computed to evaluate the cut offs for passing and failing the driving assessment utilising the MOCA by means of sensitivity (true positive rate) and 1-specificity (false positive rate) whereby a value of 100% was chosen as optimal sensitivity and specificity.

## RESULTS

Five groups with neurological problems were extracted and analysed on those who passed and failed their assessment; Brain Injury (BI,  $n=17$ , aged  $45.4 \pm 18.0$  yrs), Dementia ( $n=50$ , aged  $74.9 \pm 12.7$  yrs), Stroke ( $n=39$ , aged  $67.7 \pm 13.4$  yrs), Parkinson's (PD,  $n=13$ , aged  $66.7 \pm 10.0$  yrs) and Multiple Sclerosis (MS,  $n=16$ , aged  $60.1 \pm 19.3$  yrs).

Total MOCA scoring was explored in those who passed ( $n=81$ ; MOCA 23.8 range 12-30) or failed ( $n=54$ ; MOCA 17.4 range 4-28) their driving assessment, independent of clinical diagnosis. An

independent sample *t*-test found a significant difference ( $p<0.001$ ) in the total MOCA scores in pass and fail groups. Sensitivity was found to be 44% with a specificity of 94% whereby the condition was set as the MOCA classification (normal or MCI; cutoff  $\text{MOCA}\geq 26$  = normal) and the test outcome set as the assessment outcome (pass or fail). Further ROC analysis exploring pass/fail cut offs showed an area under the curve of 0.815 ( $p<0.001$ ) with 95% confidence interval 0.744-0.887 whereby two cut-off points were observed a)  $\text{MOCA}<12$  Very accurate (100%) in picking up fails but not specific to picking up passes (16.7%) and b)  $\text{MOCA}>27$  Not accurate (4.9%) in picking up fails, but specific to picking up passes (100%). A visualisation of the MOCA classification vs condition vs obtained total MOCA score can be found in Figure 1.

FIGURE 1 ABOUT HERE

## DISCUSSION

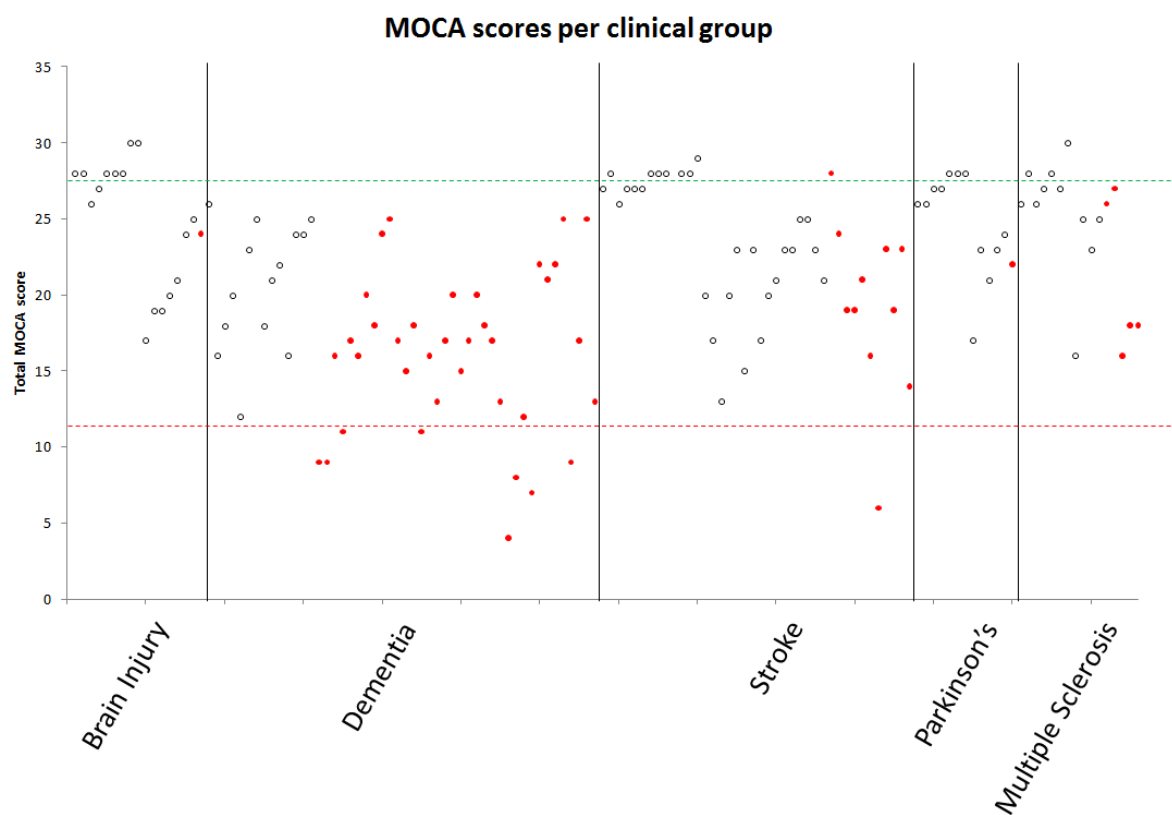
The results of this research suggest that the MOCA could potentially be used as a quick cognitive screen for health practitioners to help with decision making to determine the need for an on-road driving assessment in people self-referring with concerns regarding their cognitive capacity to drive. Our findings give clear cut offs from the MOCA for people who are likely to pass,  $\text{MOCA}>27$ , and people likely to fail,  $\text{MOCA}<12$ , on-road assessments. As such, these individuals would not benefit from an on-road driving assessment. However, individuals scoring between 12 and 27 on the MOCA have a 50/50 change of passing, and thus referring these individuals for on the road driving assessment would appear to make good use of this resource.

Therefore we propose that considering the difficulty of determining global safety to drive, that our findings could have clinical utility for practitioners assessing people with suspected cognitive problems. Additionally we propose the potential utility of using the MOCA to inform clinical decision making and judgement as to the need for referral for on-road driving assessment. Further research should explore the impact of this approach on a larger group of conditions and the impact on costs and safe driving practice.

## REFERENCES

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## Appendix 1: Figure 1



**Figure 1** displaying the total MOCA (vertical axis) scores versus conditions (horizontal axis) whereby the open dots indicate those who passed their on-road fitness to drive test, and those with a red dot indicate a fail.