Clock drawing errors in young adults and the long-term validity of the MoCA

Alastair D. Smith[1] & Sarah K. Salo[1,2]

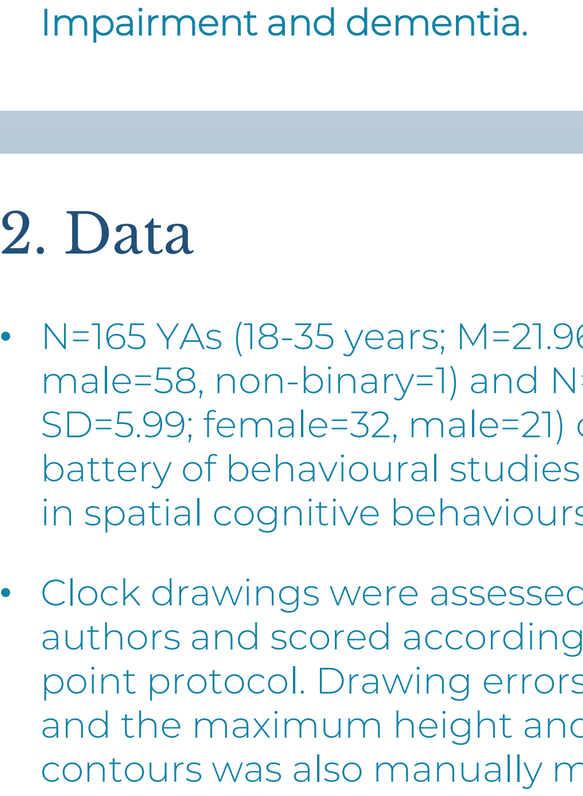
1. University of Plymouth (alastair.smith@plymouth.ac.uk)
2. University of Bristol (sarah.salo@bristol.ac.uk)

1. Introduction

- The **Montreal Cognitive Assessment (MoCA)** is one of the world's most widely used cognitive screens.[1] It probes current orientation in time and space and tests function across a variety of core domains (inc. memory, attention, and language).
- The most strongly-weighted single response is the clock drawing test (CDT). Responses can be awarded up to three points, based on the accuracy of the circular contour, the numbers within it, and the clock hands.
- In isolation, the CDT is thought to be robust to potential confounds such as premorbid IQ, educational attainment, or ethnicity.[2] However, its emphasis in the MoCA means that inaccurate renditions may disproportionately affect the final score, allowing little leeway for additional error before a respondent meets cutoff for impairment.
- We report data collected from a large sample of healthy young adults (YA) adventitiously recruited for an empirical behavioural study. **Over a third of the sample failed to draw an accurate clock, in many cases resulting in a total score that fell below the recommended cutoff for Mild Cognitive Impairment and dementia.**

2. Data

- N=165 YAs (18-35 years; M=21.96, SD=3.65; female=106, male=58, non-binary=1) and N=53 OAs (65-93 years; M=74.77, SD=5.99; female=32, male=21) completed the MoCA within a battery of behavioural studies assessing age-related effects in spatial cognitive behaviours.
- Clock drawings were assessed independently by the authors and scored according to the official MoCA three-point protocol. Drawing errors were further categorised, and the maximum height and width of the circular contours was also manually measured to produce mean size metric.[3]



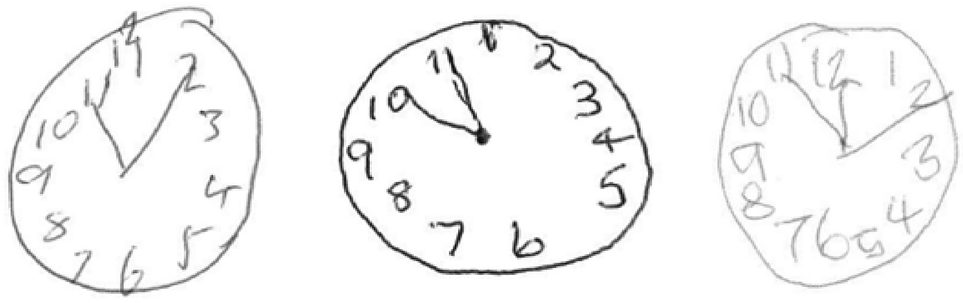
MoCA CDT scoring

1. Contour: the clock face must be a circle
2. Numbers: must all be present, in the correct order, and placed within the correct quadrants
3. Hands: hour and minute hands should be clearly distinguishable, centrally positioned, and pointing to the correct numbers ("ten past eleven")

3. Analysis

YA

OA



- 29.7% (N=49) of YAs failed to meet cutoff (scoring <26), compared to 45.3% (N=24) of OAs. 63.6% (N=105) of YAs achieved the maximum CDT score, with 28.5% receiving two points (N=47) and 7.9% (N=13) scoring one point.
- **Contour**: N=6 of YAs failed to draw any contour, and N=2 produced a misshapen circle.
- **Numbers**: 15% (N=3) of the YAs placed a "1" at the top, and 5% (N=1) placed a "0". 65% (N=13) placed their anchors (i.e. 12, 3, 6, 9) incorrectly and 20% (N=4) of participants did not place twelve numbers on the clock face.
- **Hands**: 28.26% (N=13) of YAs drew them the same length or swapped hour and minute hands. 6.52% (N=3) placed the minute hand at "10", 10.87% (N=5) at "11", 2.17% (N=1) at "12", 17.39% (N=8) at the "1", 4.35% (N=2) at "3", and one participant (2.17%) pointed the minute hand at "4". 17.39% (N=8) pointed the hour hand to "10", and 2.17% (N=1) at "1".

	YA		OA		Difference
MoCA total	17– 30 (M = 26.53, SD = 2.32)		16 – 30 (M = 25.62, SD = 2.83)		p = .050
CDT total	1 – 3 (M = 2.56, SD = .638)		1 – 3 (M = 2.51, SD = .576)		p = .392
Circle size (mm)	15.5 – 47.5 (M = 31.7, SD = 6.35)		17.0 – 49.0 (M = 33.8, SD = 6.27)		p = .037
	Correct	*Incorrect*	*Correct*	*Incorrect*	
Contour	157	8	51	2	p =.745
Number	145	20	49	4	p =.355
Hands	119	46	33	20	p =.174

4. Conclusions

- YA participants most often failed at hand placement, supporting the suggestion that a lack of familiarity with analogue clocks may lead to CDT errors in YAs.[4]
- Reveals lower validity than other sections for detecting age-related differences, despite suggestions that visuospatial components are robust.
- Poor CDT performance means that a respondent may be one point from cutoff for cognitive impairment. CDT performance led to a disproportionate number of failures from the YA cohort - clock drawing assessments may need to be re-evaluated as the present younger generations age.

References

1. O'Driscoll, C., & Shaikh, M. (2017). Cross-cultural applicability of the Montreal Cognitive Assessment (MoCA): a systematic review. *Journal of Alzheimer's disease*, *58(3)*, 789-801.
2. Tuokko, H., et al. (2000). A comparison of alternative approaches to the scoring of clock drawing. *Archives of Clinical Neuropsychology*, *15(2)*, 137-148.
3. Smith, A. D. et al. (2006). Around the clock surveillance: Simple graphic disturbance in hemispatial neglect carries implications for the clock-drawing task. *Journal of Neurology, Neurosurgery and Psychiatry*, 77, 407-409.
4. McDaniel et al. (2024). Clock Drawing Test Performance of Young Adults Based on a One-Shot Case Study. *Archives of Clinical Neuropsychology*, *39(2)*, 175-185.