Magnifying graphomotor output to highlight intention in aging: A closer look at performance using a digitized clock drawing test

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Background

- The NIA and Alzheimer's Association have advocated for research focused on 'pre-clinical' phases of pathological aging.
- This highlights the need for more sensitive cognitive measures of risk.
- Capitalizing on data acquired during a digitized Clock Drawing Test (dCDT) we identified preparatory strokes of graphomotor output or intention called 'hooklets' not previously visible to the naked eye.
- We introduce these measures and explore their structural and functional brain associations in community-dwelling healthy older adults (OA).

Methods

PARTICIPANTS. Healthy adults 60 years and older were recruited via community outreach and screened based on the following criteria:

- INCLUSION:
  - -Absence of SCID symptoms / disorder
  - -Hamilton Depression Rating Scale (HDRS) score ≤8
- EXCLUSION:
  - -Any SCID disorder
  - -HDRS score ≥15
  - -Brain injury or disorder
  - -Presence of metallic implant
  - -Unstable medical illness
  - -Past or current substance abuse
- All subjects had a Mini-Mental State Exam (MMSE) score ≥ 24

DIGITIZED CLOCK DRAWING TEST.

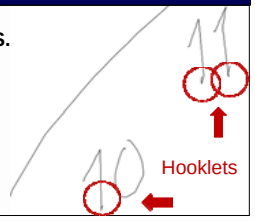
Participants drew a clock with all the numbers setting the hands to ten after eleven; a copy condition was also administered.

A computer scoring program is used interactively to classify performance.

Hooklets

HOOKLET VARIABLES.

- Total number
- Average speed
- Percent length of digit stroke length



Results

Group Demographics	OA (n=36)
Age	66.5±4.5
Sex (M:F)	13:23
Degree Years of Education	15.9±3.2
MMSE Score	29.1±1.1
WTAR Predicted Full Scale IQ Score	110.0±12.5
Stroke Risk Factor Prediction Score	10.3±4.0

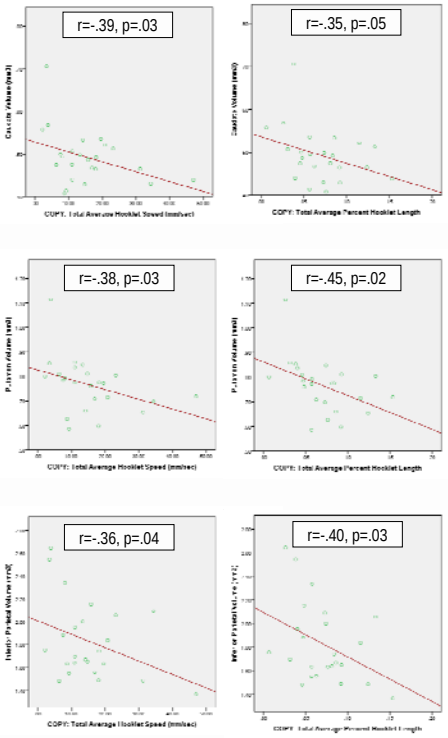
Composite z-scores	Cronbach's Alpha
Learning & Memory (L&M) California Verbal Learning Test-II, WMS-III (Logical Memory/ Visual Reproduction)	0.648
Attention & Information Processing Stroop (Word/ Color), Trail Making Test (Part A/ Motor), WAIS-III (Digit Symbol Coding)	0.838
Executive Functioning (EF) Verbal Fluency (Fruits/Furniture), Trail Making Test (Part B), Stroop (Interference), Self-Ordered Pointing Test, WAIS-III (Digit Span Backwards)	0.703
Language Verbal Fluency (Animals)-detailed scoring	0.810

FREE SURFER DERIVED BRAIN REGIONS.

- Anterior cingulate cortex (dorsal/ rostral)
- Entorhinal
- Inferior parietal
- Orbital frontal cortex (lateral/ medial)
- Parahippocampal gyrus
- Hippocampus
- Caudate
- Putamen
- Cerebral white matter

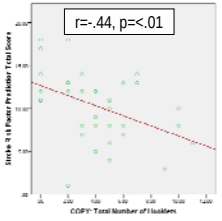
Results

BRAIN VOLUME ASSOCIATIONS



These regions consistently correlated with speed and percent length hooklet measures

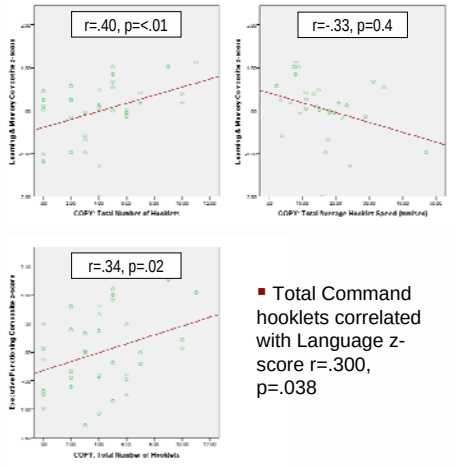
STROKE RISK FACTOR ASSOCIATIONS



- More highly correlated to the number of hooklets than any composite cognitive score.
- Also correlated with Copy condition: **average speed** r=.318, p=.046 **percent length** r=.337, p=.037.

Results

COGNITIVE ASSOCIATIONS



- Total Command hooklets correlated with Language z-score r=.300, p=.038

Conclusions

- In aging, hooklet production during the dCDT Copy condition is associated with better EF and L&M as well as lower vascular burden.
- Shorter hooklets produced quickly may reflect basal ganglia integrity.
- An easily administered clinical tool that measures previously undetected graphomotor intention may provide biomarkers to help identify 'pre-clinical' risk in older adults.

References/Acknowledgements

MIT Clock Sketch, Lahey Clinic

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