

Cognitive Testing on Mobile & Wearable Devices

CAMBRIDGE
COGNITION

Cognition Kit

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A neuroscience digital health company - Measuring cognition accurately



Validated by over 30 years of neuroscience research



A measure of cognitive function in over 100 indications



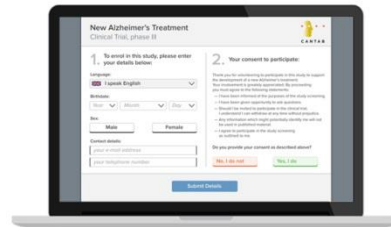
Trusted by the world's top pharmaceutical companies

Technology Platforms for Cognitive Testing



Research tools

Tools for clinical and research trials to detect effects of drugs and environmental changes



At-home testing

Cognitive tests that can be completed by participants at home



High Frequency testing

Frequent monitoring of cognitive ability using wearable devices



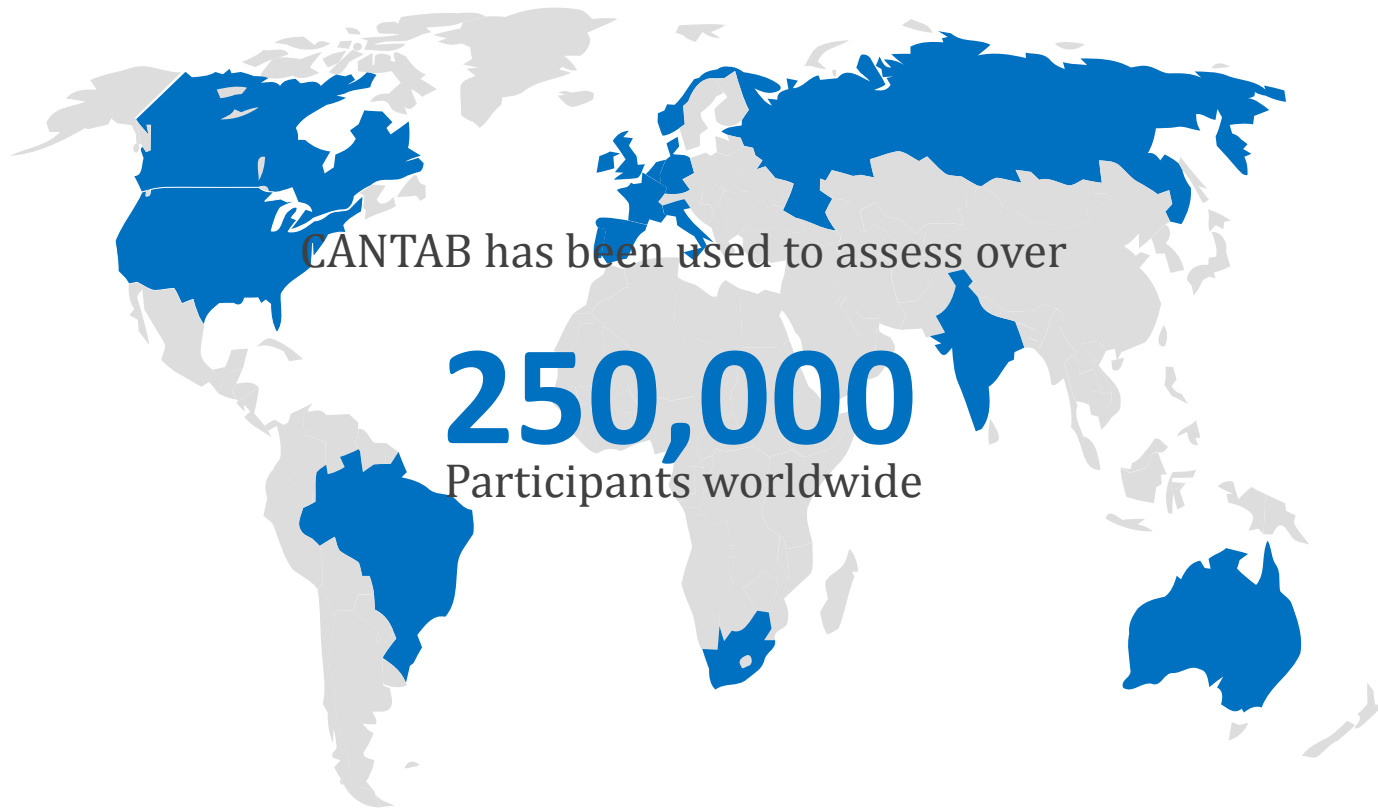
In-clinic tools

Cognitive assessments for clinical use that can identify those who require further investigation

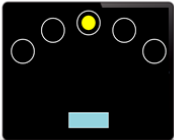

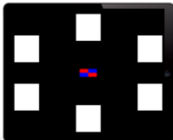
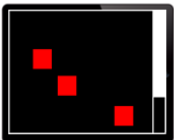

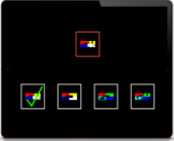
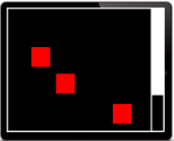
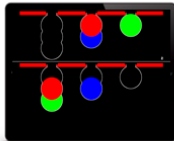
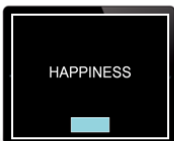



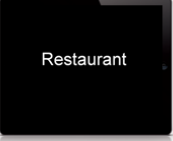

Neuroanalytics Consultancy

We provide expertise in the design, analysis and interpretation of neuropsychological endpoints in cognitive studies and clinical trials with extensive experience using research and analytic approaches.

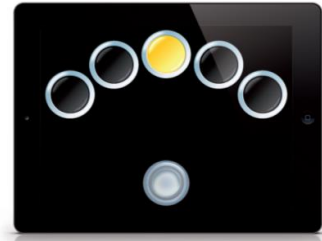
CANTAB COGNITIVE SCIENCE



Specific to Cognitive Domain

Psychomotor speed	Attention	Memory	Executive function	Social cognition	
					
Reaction Time	Rapid Visual Information Processing	Paired Associates Learning	Spatial Working Memory	Emotion Recognition Test	
					
		Delayed Matching to Sample or Spatial Working memory	Stockings of Cambridge	Affective Go/No-go	
					
		Pattern or Spatial Recognition Memory	Attention Switching Task		
					
		Verbal Recall / Recognition Memory	Stop Signal Task		

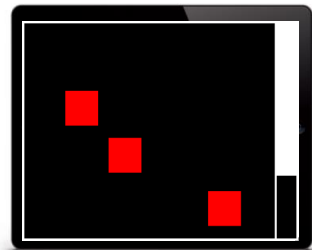
Specific to Neural Mechanisms – Digital Biomarker



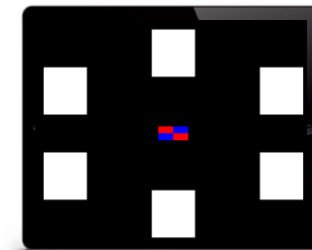
Reaction Time



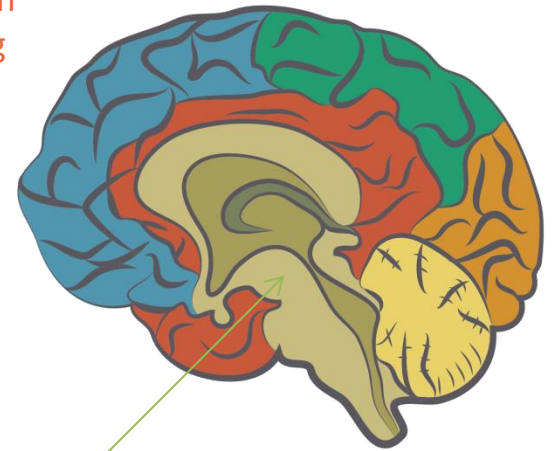
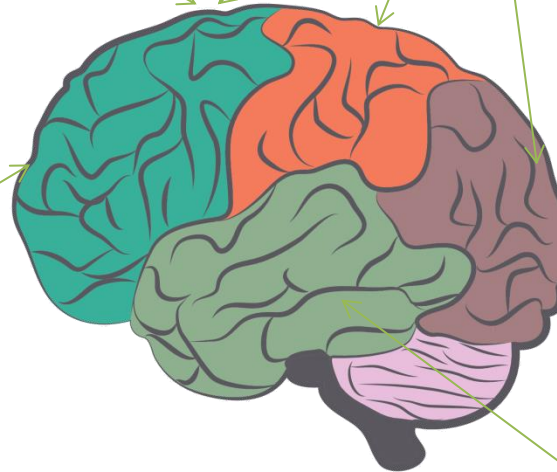
Rapid Visual Information Processing



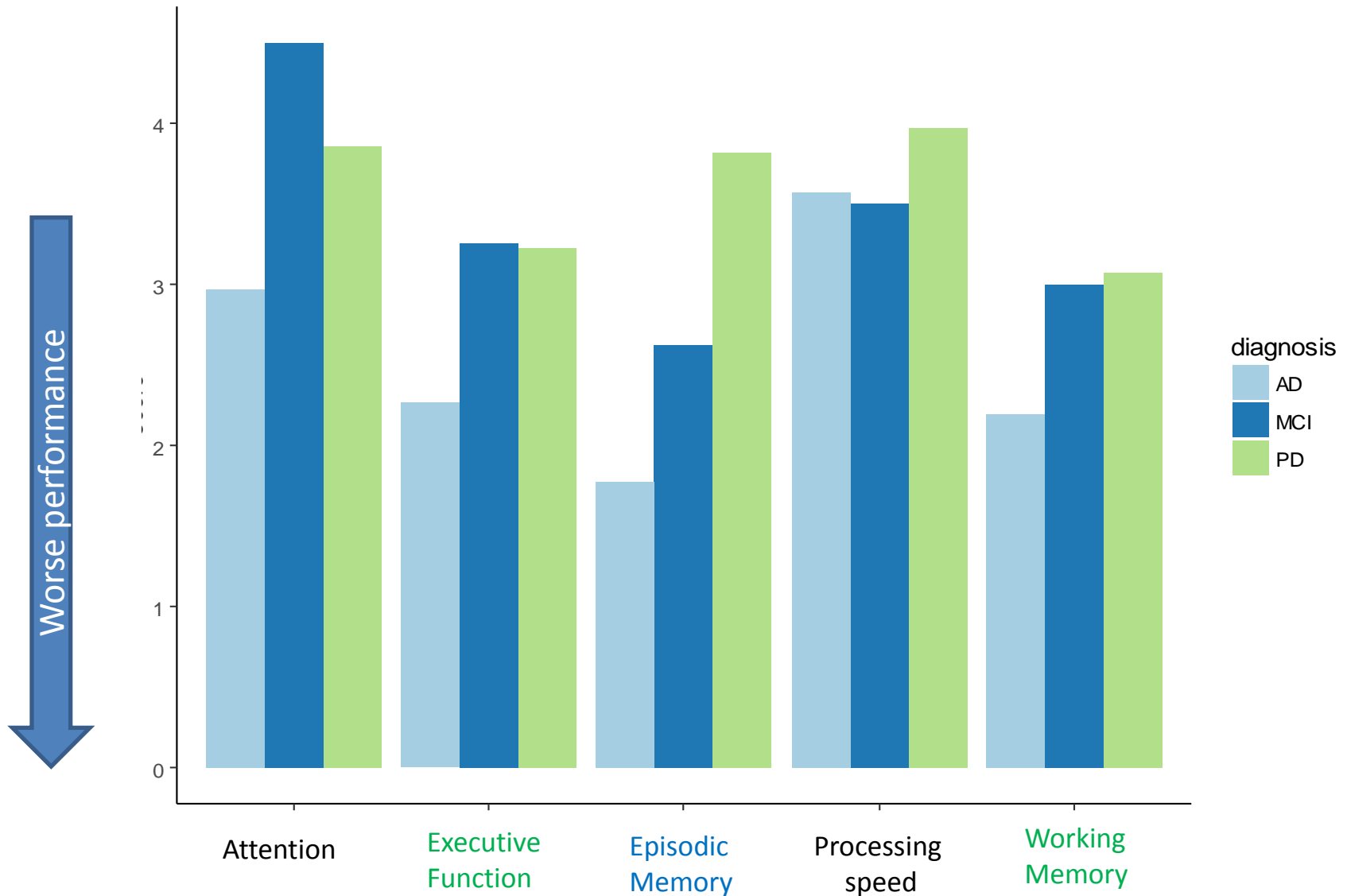
Spatial Working Memory



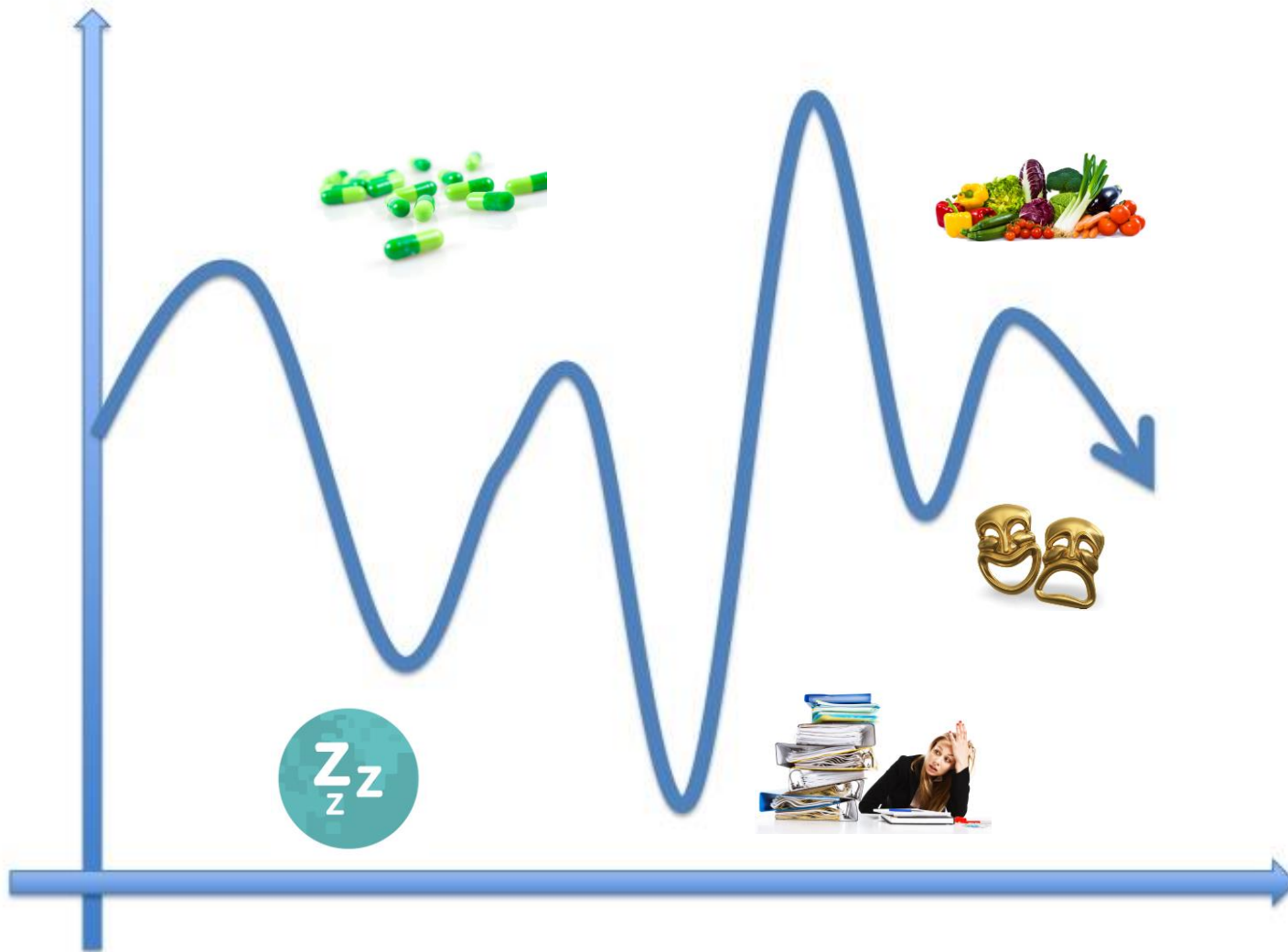
Episodic Memory



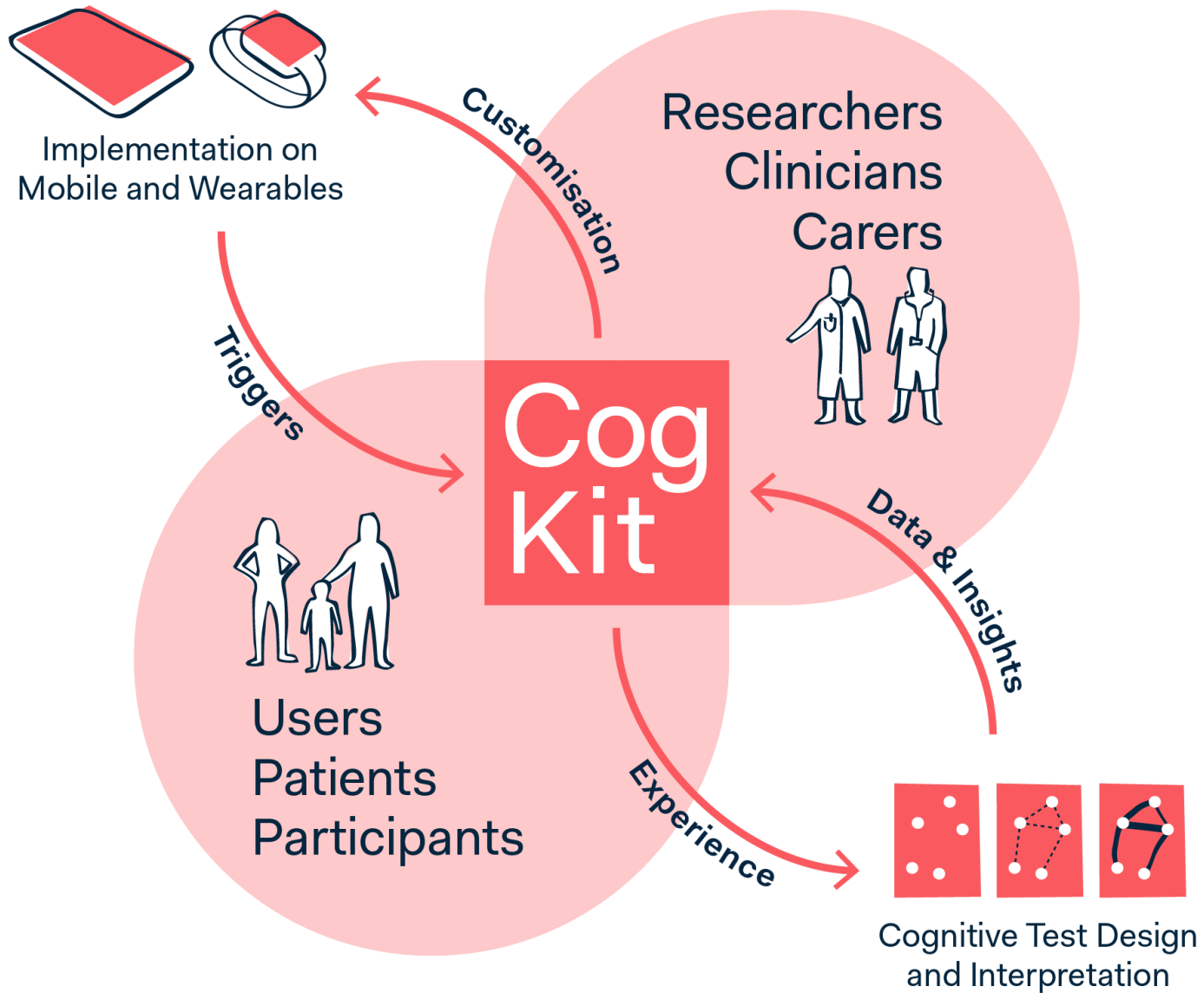
Sensitive to Disease State – Cognitive Signature



Cognition is subject to daily fluctuations



How to measure Cognition in the real world



Daily assessment across platforms and devices

Cognition Kit software enables an individual to complete an assessment on a range of mobile and wearable devices without having to visit a clinic or be helped by a health care professional.

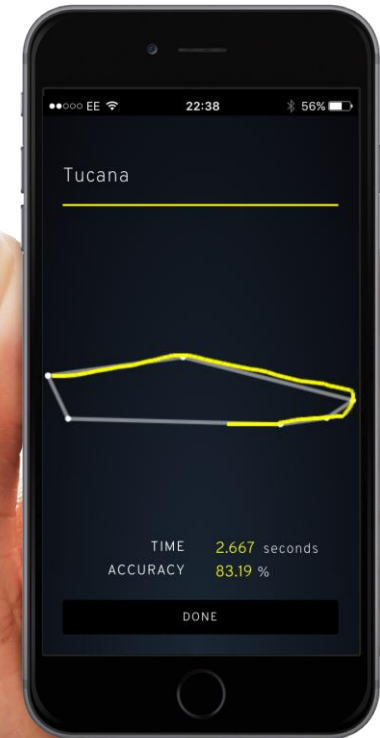
Cog Kit N-back tasks to measure memory and attention.



Cog Kit Emotional recognition tasks to measure social cognition.



Cog Kit Drawing tasks to measure memory and executive function.



Best Practice Approach

Decisions are made with the individual in mind

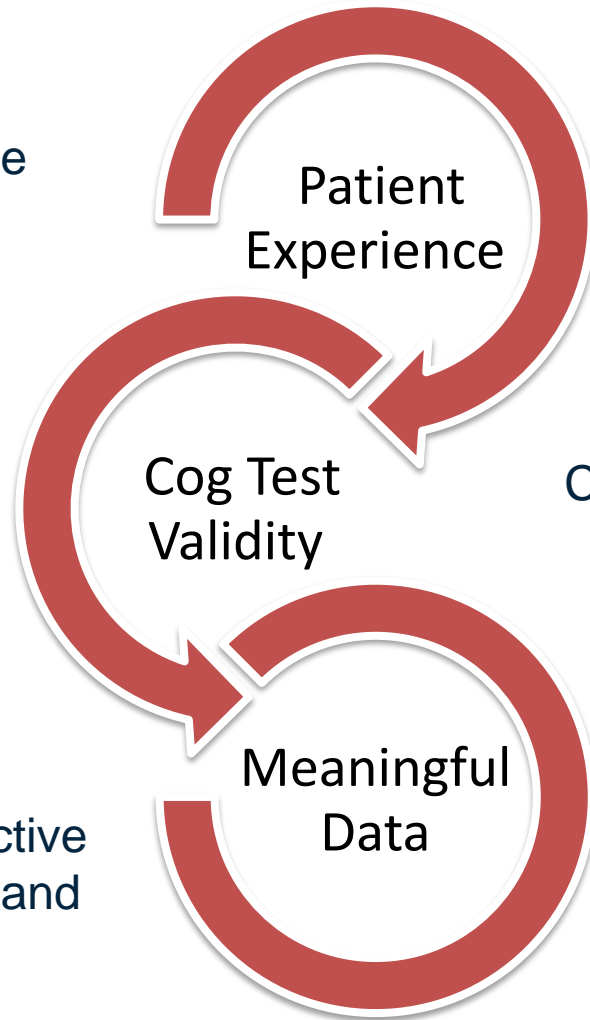
Patient Experience

Cog Test Validity

Cognitive test selection and adaptation designed with scientific rigor

Meaningful Data

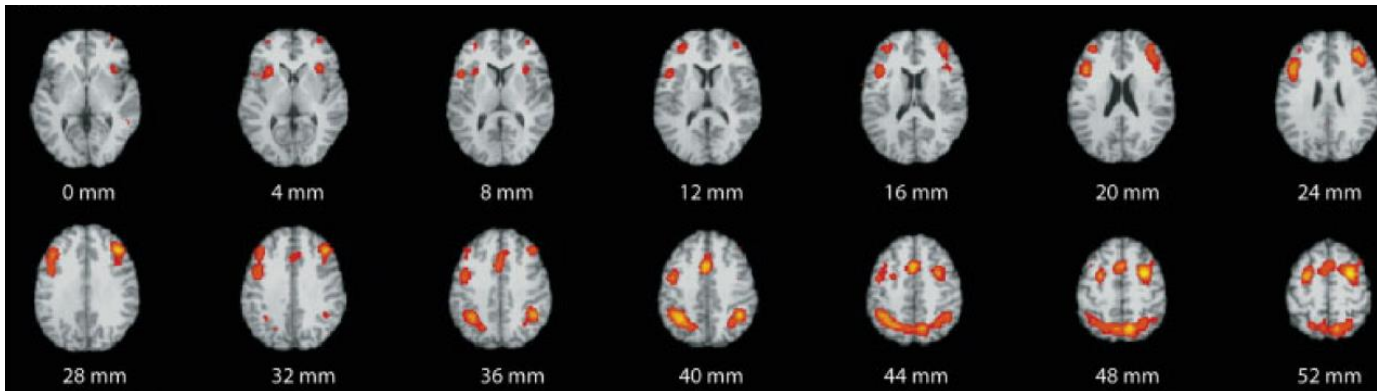
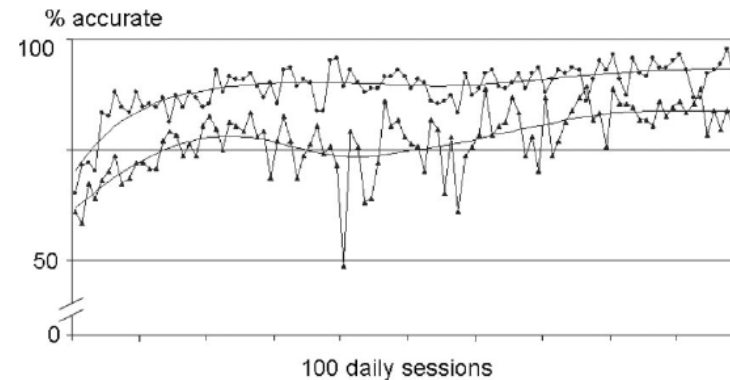
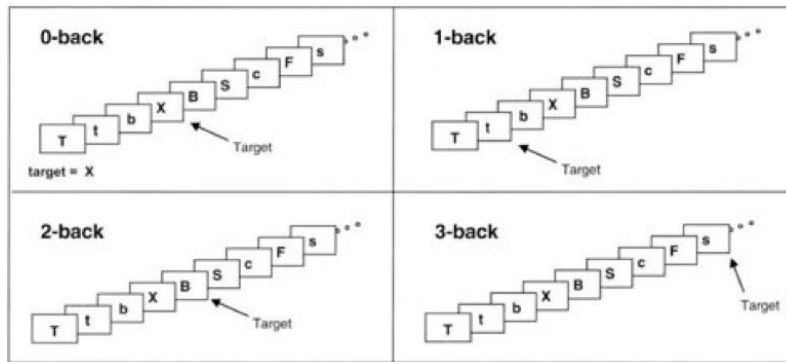
Large Data Sets of objective cognitive measurement and passive data points



Cognition Kit – Validation Process



Developing a cognitive test for high-frequency testing



- N-back task activates a network of areas in the brain including frontal and parietal regions (Owen et al., 2005).
- There is significant variation across and within days on n-back performance, partly linked to mood and motivation (Brose et al., 2012).

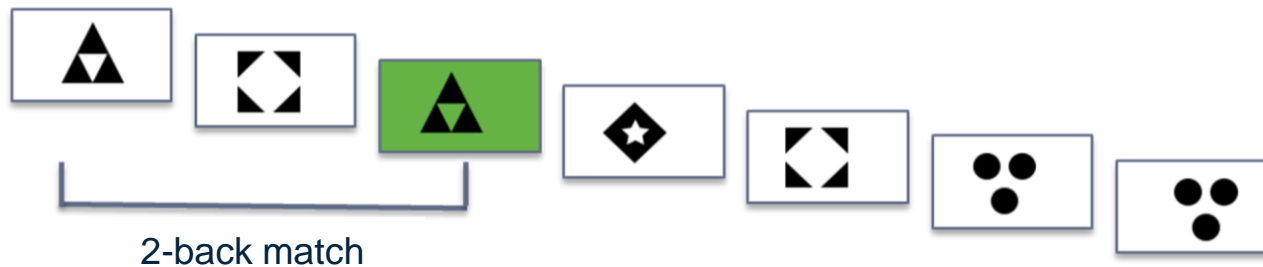
Phase 1: Proof of concept study in healthy volunteers

Study design:

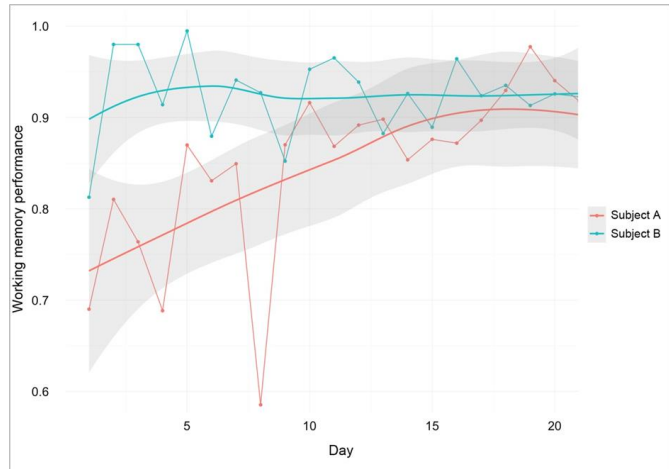
- 10 (4 females) aged 25-55
- Sensor data (heart rate, skin temperature, GSR) measured continuously between 0900-1900
- 4 CANTAB tasks (SWM, RVP, AST, ERT) and the PANAS administered each day after 1700
- Cognitive & mood assessment scheduled hourly



Presentation = 600 ms
ISI = 600 ms

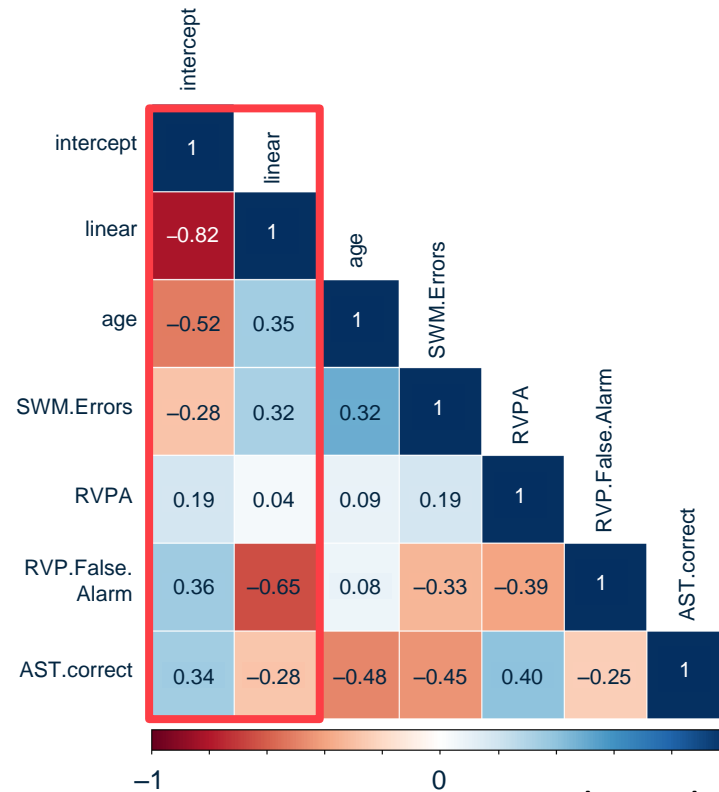
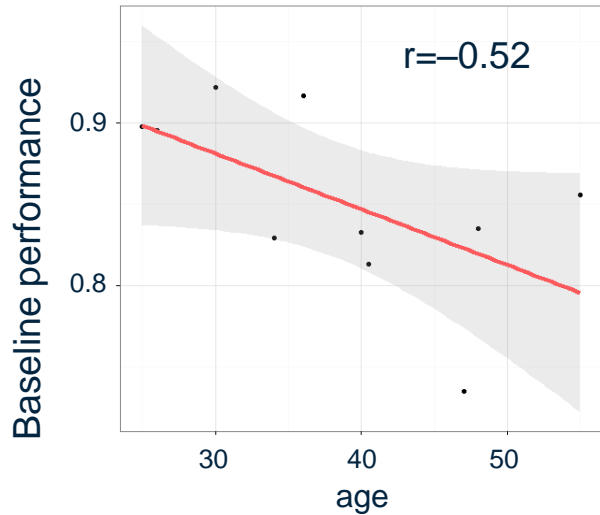


Phase 1: Detailed cognitive data



1-minute micro-tests capture meaningful across-time variation and correlate with gold-standard computerised tests.

Revealed issues with device and dynamic range of the test.



Cormack et al, AAIC 2016

Phase 2: Design refinement using web-based testing

Findings from phase 1:

- A number of participants rapidly reached ceiling
- People were giving symbols names — verbal recording of the stimuli, and familiarity with symbols over time
- Issues with the device used in the proof-of-concept: battery life, limited display, discontinuation

Questions for phase 2:

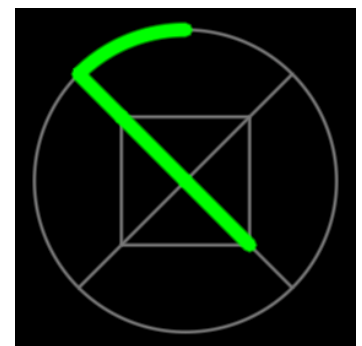
- Change of symbol design and larger bank of symbols to reduce availability of verbal strategies
- Could we titrate the difficulty level without increasing the n: role of symbol complexity, timing parameters, and number of symbols
- Decision to use Apple iWatch

Phase 2: Participant Experience

- Refining task to increase dynamic range
- Converted task for web-based testing with redesigned stimuli
- Crowd-sourced A-B testing using Amazon m-turk
- Series of experiments exploring the impact of task parameters on participant performance using:
 - Presentation time
 - Symbol design
 - Number of unique symbols

n = 994 participants aged 20–64 in total

n = 88 also completed CANTAB Spatial Working memory test and CANTAB PAL (episodic memory)



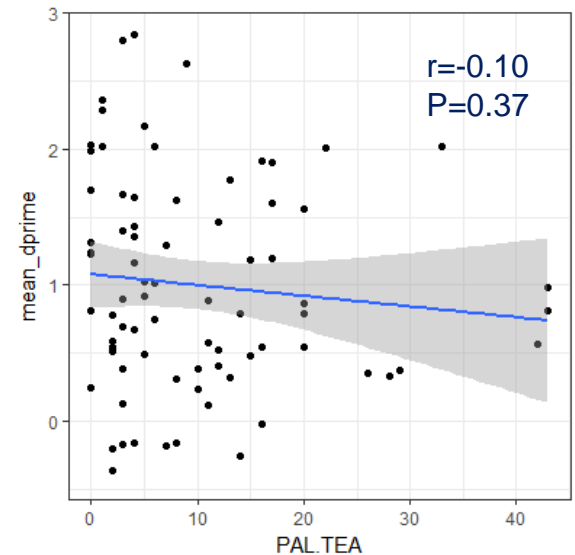
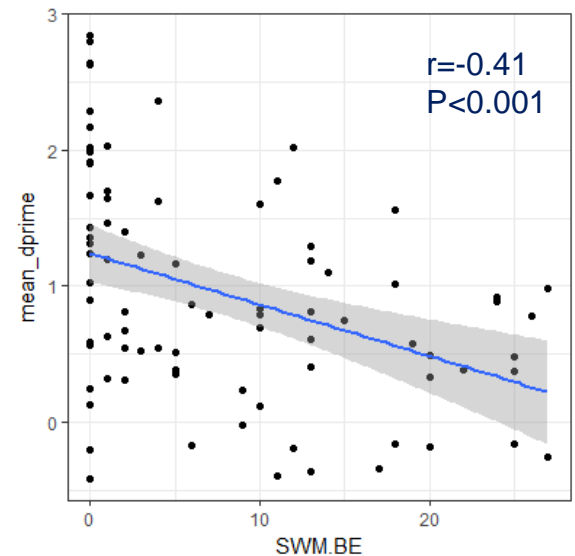
Phase 2: Cognitive Test Validity

Iterative A-B experimentation determined:

- Significant effect of stimulus presentation time on performance
- Significant impact of number of symbols in trial
- Symbol design (e.g. number of segments + arrangement) did not significantly impact performance

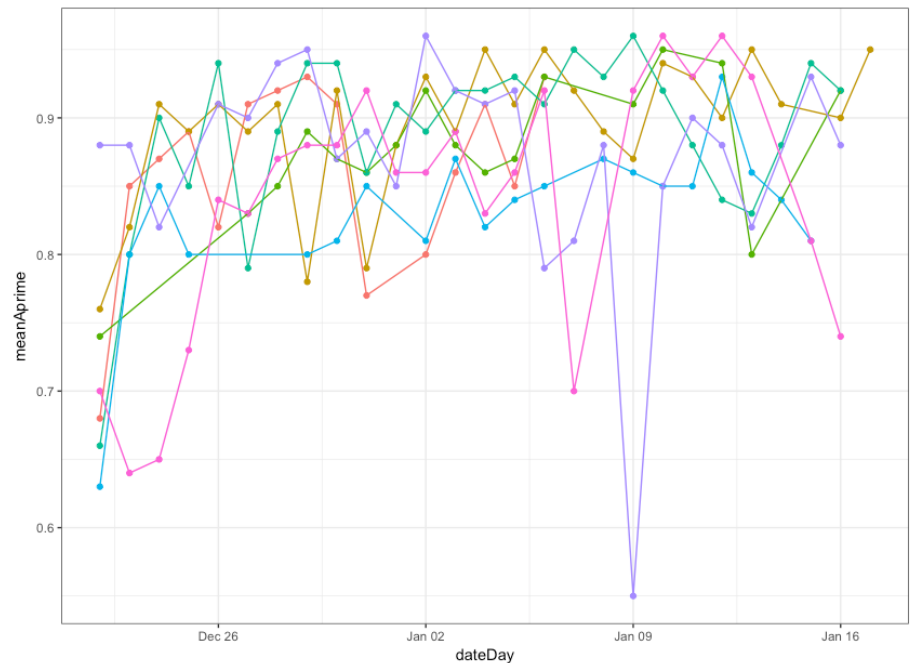
Correlations with CANTAB test — significant association with SWM, but not PAL.

Confirms sensitivity to working memory performance.



Phase 3: In-person testing and iterative design

- Would the same parameters work on the watch?
- How would participants perform over an extended time? Is the paradigm and testing schedule tolerable?
- What are some of the barriers to compliance? How can we make sure that patients understand the app and the tasks?
- N=7 subjects over 3 weeks.
- Apple watch
- N-back testing x3 times a day



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