Cognitive Testing on Mobile & Wearable Devices

CAMBRIDGE COGNITION

Cognition Kit

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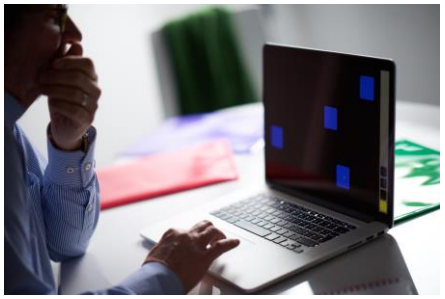
Challenges for cognitive testing on mobile devices

Automated cognitive testing can work even in impaired populations with appropriate adjustments e.g.

- Technological literacy & fiddle factor
- Screen real estate for stimuli & responses
- Intelligent responding & support for queries



Cognitive tests must challenge to be valid;
'challenge' varies between and within individuals

Goal:

Maximise adherence to a valid cognitive assessment protocol

science usable

Scientifically valid cognitive assessment on mobile devices

Opportunities to increase validity

Automated & dynamic

- No ceiling / floor effects, suboptimal dynamic range, human error

Can measure not just what a patient does but how they do it

- More sensitive to disease processes

Real world data

- Ecological validity

High frequency data

- Better fidelity for fluctuations in state

Threats to validity

Unsupervised testing of cognitively impaired users

- Mitigate: automated & human support

Usability issues of the device

- Mitigate: use patient's own / preferred device

" False friends": direct translation to digital may or may not be meaningful

- Mitigate: rigorous scientific validation

Regulatory & GCP compliant development and use

Example development of a cognitive wearable: path to FPFV

Goal: develop a high-frequency cognitive and mood assessment protocol that is acceptable to patients

Feed into protocol

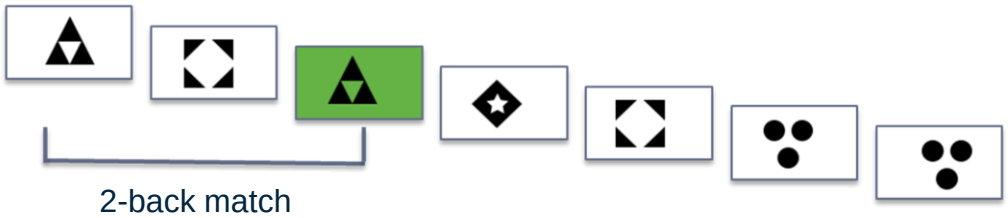
Design & prototyping	Q1 2016
PoC study in n=10	Q2 2016
Design refinement using web-based testing in n=1000	Q3/4 2016
Iterative development/testing in healthy volunteers	Q4 2016- Q1 2017
First patient study n=30	Q1 2017

Proof of concept study in healthy volunteers

Study design:

- 10 healthy volunteers aged 25-55
- Sensor data (heart rate, skin temperature, GSR) measured continuously between 0900-1900
- Cognitive & mood assessment scheduled hourly, with reminders
- 4 CANTAB tasks and a PRO administered each day after 1700

Presentation = 600 ms
ISI = 600 ms

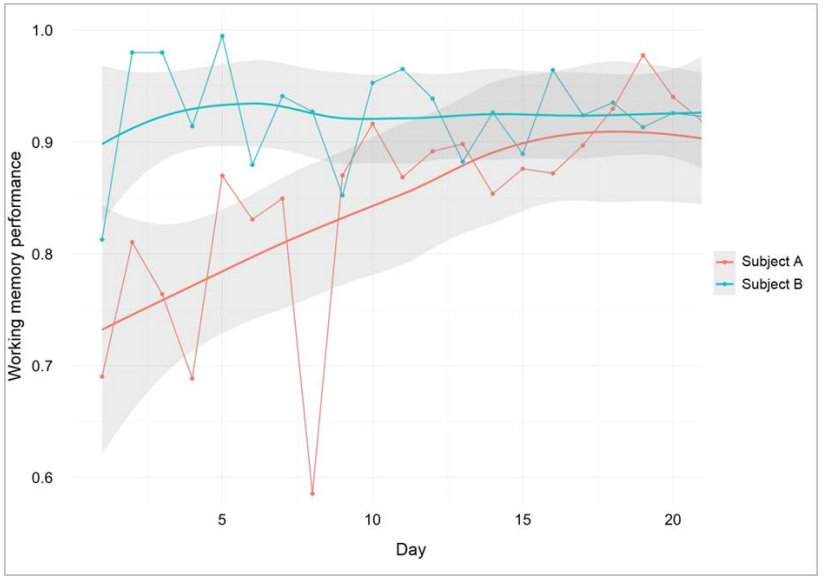


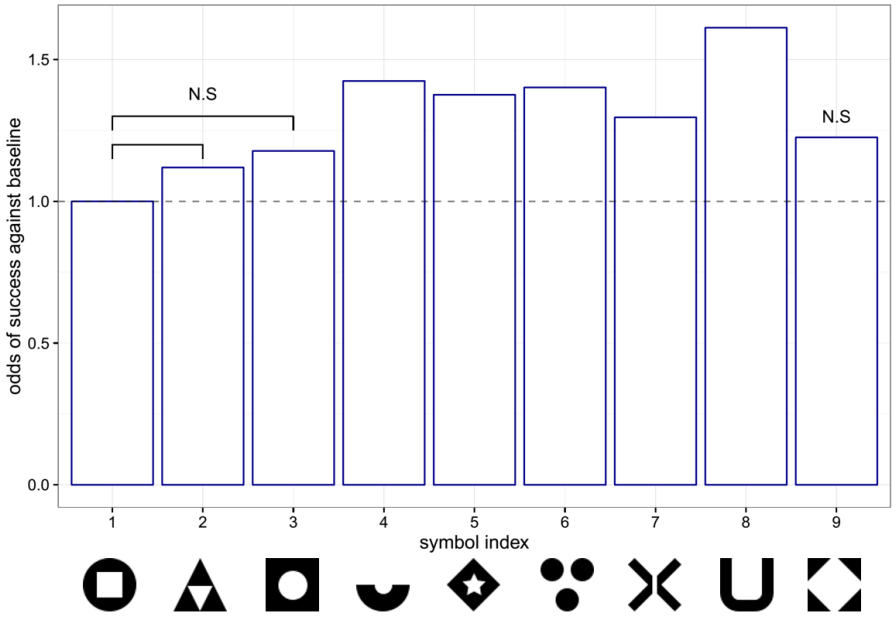
Cormack et al (2016), AAIC poster

Results from POC study

Plausible cognitive results from 1-minute microtests:

- Meaningful across-time variation
- Expected correlations with standard tests
- Expected effects of age



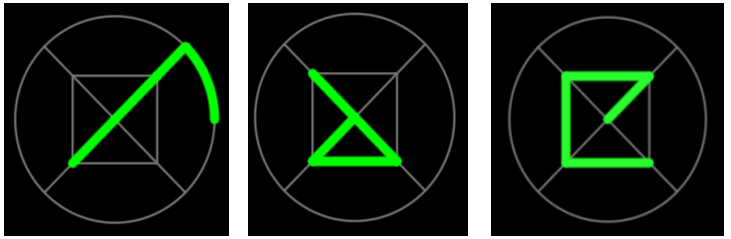


- Ease of recall varying across symbols
- Some participants reaching ceiling

Stage 2: Design refinement using web-based testing

Goals for next stage

- Changing symbol design and bank of symbols to reduce verbal strategies
- Titrating the difficulty level without increasing patient burden – role of symbol complexity, timing parameters and number of symbols
- Change to Apple Watch



Methods

- Series of experiments using Amazon M-Turk with redesigned stimuli
- Assessed impact of presentation timing, number and design of symbols
- N=944 participants aged 20-64 in total
- N=88 also completed two full-length CANTAB tests (+ve & -ve controls)

Stage 3: Real world testing in naïve healthy participants

Findings from stage 2

- Determined display time parameters
- Large bank of symbols developed
- Number of symbols chosen

Goals for stage 3

- Confirm the same parameters work on the watch as on the web
- Ensure participants tolerate paradigm over an extended time / schedule
- Ensure app is stable and fit for purpose
- Minimise barriers to patient adherence and understanding

Success in stage 3 = ready for FPFV

Protocol design for mobile & wearable studies

Not acceptable to compromise on validity, usability or regulatory compliance

Compromises are possible in aspects of protocol design

- Which device
- How much assessment & how frequently
- Ways to motivate adherence: prompts, feedback, the right level of challenge
- Comfort levels differ, can be improved with explanation and support

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