Mobile Cognitive Assessment:
Validation of Neuropsychological Assessment Administered on an Android Tablet

Mobile Devices for Cognitive Assessment

Tests of neuropsychological function, including memory, attention and processing speed, are widely used to assess the impact of illness, physiological state or drug treatment on cognitive function. Portable devices allow assessments to be made in a wide range of settings for example in the context of everyday life, or practitioners may carry out tests when visiting patients. Touchscreen devices have been used for this purpose for some years (see, e.g. Tiplady 1994; Cameron et al., 2001), Smartphones and tablets are now becoming more widely available, making this an attractive mode of administration.

It important to assess the validity of assessments made on these devices, as the interface differs from that of conventional computer-based tests. Validation has a number of different aspects, and a three-level model is proposed.

The Android Test Battery

The test battery consists of the following assessments of attention, memory, processing speed and spatial and executive function:

Rapid Information Processing
Four-Choice Reaction Time
Memory Scanning
Sentence Verification
Symbol Digit
Word Number
Arrow Flankers
Little Man
Number Pairs
Serial Sevens
Trails A & B

The battery runs on any Android tablet with a large enough touchscreen (≥ 5”). The version tested is set up on an MID X5A Tablet (7” screen).

contact: brian@penscreen.com
www.penscreen.com

The Validation Model

Level	Examples of Tasks
Device Validation: Establishing correct operation of device and software application.	1. Scripted completion of tests with specified numbers of correct and incorrect responses of different kinds, which are then compared to data file. 2. Video recording of test completion to measure reaction times for comparison with values measured internally by test software
Intrinsic Validation Showing differences in test performance by individuals that reflect expected differences due to nature of test stimuli	1. Measuring differences in reaction times between stimuli of differing difficulty. For example those where distraction is present to compared to those with no distracting element. 2. Showing slowing of responses following an incorrect response
Extrinsic Validation Evaluating the ability of a test to discriminate between states affecting cognition within or between individuals	1. Measuring the difference in performance due to influences known to affect performance within an individual, such as alcohol, sleep deprivation. 2. Ability to detect differences between individuals, e.g. Those with and without a particular diagnosis

References.
Acker W (1983) International Journal of Man-Machine Studies, 18: 361
Cameron E et al., (2001) Journal of Psychopharmacology, 15: 105
Farquhar K et al (2002) Journal of Psychopharmacology, 16: 379
Tiplady B (1994) British Journal of Clinical Pharmacology, 37: 523P

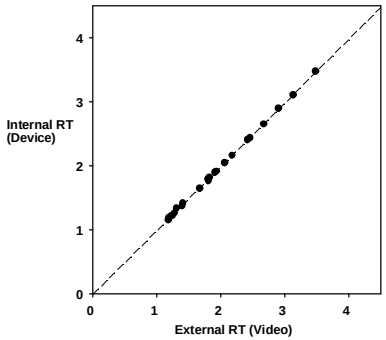
Brian Tiplady,
University of Edinburgh, UK

The Little Man Test

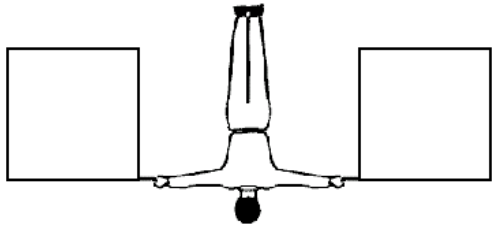
This is based on the test described by Acker (1983). Each stimulus shows a little man holding two flags. The man may be facing or back to you, right way up or upside down. The word “Right” or “Left” appears below, and the task is to tap the flag held in the man’s corresponding hand as quickly as possible.

Device Validation

Tests runs are carried out and recorded using a video camera running at 210 frames per second. Each response time is measured from the video file using frame counting, and compared to the corresponding internally recorded time. A typical run is illustrated, giving a correlation coefficient r = 0.9998



Intrinsic Validation



Congruent stimuli (where the flag to be tapped is on the same side relative both to the subject and to the little man) are easier than incongruent stimuli. The stimulus shown here is incongruent. Incongruent stimuli typically take about 50% longer than congruent stimuli.

Extrinsic Validation

Alcohol is a valuable standard influence, slowing most psychomotor tasks and increasing errors, and impairing attention, memory, and executive function. A number of studies have been carried out on mobile phone and tablet versions of the test battery. An earlier implementation of Little Man shows significant slowing with alcohol at a dose close to the UK legal limit for driving (Farquhar et al., 2002).

Summary and Conclusions

The three level validation model provides a useful framework for planning, describing and analysing the validation of cognitive assessments