Comparability and Usability of Cambridge Neuropsychological Test Automated Battery (CANTAB®) tests delivered via a smartphone

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Background

Delivering cognitive tests on smartphones supports increased accessibility across settings. This is particularly important for increasing access to screening tools for participants at risk of cognitive impairment including Alzheimer's Disease and Mild Cognitive Impairment (MCI).

CANTAB ® Spatial Working Memory (SWM) is a short (4-6 minute) measure of working memory and executive functioning, and CANTAB® Match to Sample Visual Search (MTS) is a short (7 minute) task of attention. CANTAB® tasks are currently validated for delivery on tablet, laptop or desktop devices. In 2022 Cambridge Cognition adapted the Paired Associates Learning (PAL) task, assessing learning and memory, for use on smartphones. This work has now been extended to include the SWM and MTS tasks to encompass a wider range of cognitive domains measurable on a smartphone device.

It is important to understand and quantify differences between versions of the tasks carried out on different devices. In addition, for tasks delivered direct to the home of the patient, where quality of support may vary, usability is especially important. This study was therefore designed to compare task performance on smartphone and desktop devices, and usability of SWM and MTS on smartphone devices.

Methods

In separate SWM and MTS studies with the same design, healthy volunteers, (SWM: N=108, age M=58, SD=6.48, 44% male, MTS: N=99, age M=57, SD=5.79, 43% male) were recruited through the Prolific online platform to complete both smartphone and desktop versions of the task on two consecutive days followed by a short usability questionnaire. A cross-over design was used with 50:50 participants smartphone-first: desktop-first to counterbalance for exposure to the task. Participants used their own devices for assessment.

Performance across Device and Visit was assessed in key outcome measures for each of the tasks using a two-way ANOVA, and reliability and bias were explored using Pearson correlation and Bland-Altman plots.

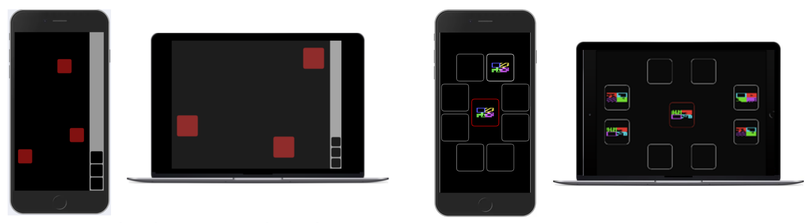

Figure 1. SWM (left) and MTS (right) on a smartphone and desktop device.

Results

Comparability

SWM showed no effect of device on strategy or error scores. MTS also showed no significant effect of device. Performance in smartphone and desktop versions showed good inter-device correlations (SWM: $r = .58$, $p < .001$, MTS: $r = .55$, $p < .0001$). Inspection of Bland-Altman plots showed good agreement between devices of both tasks, with no systematic bias.

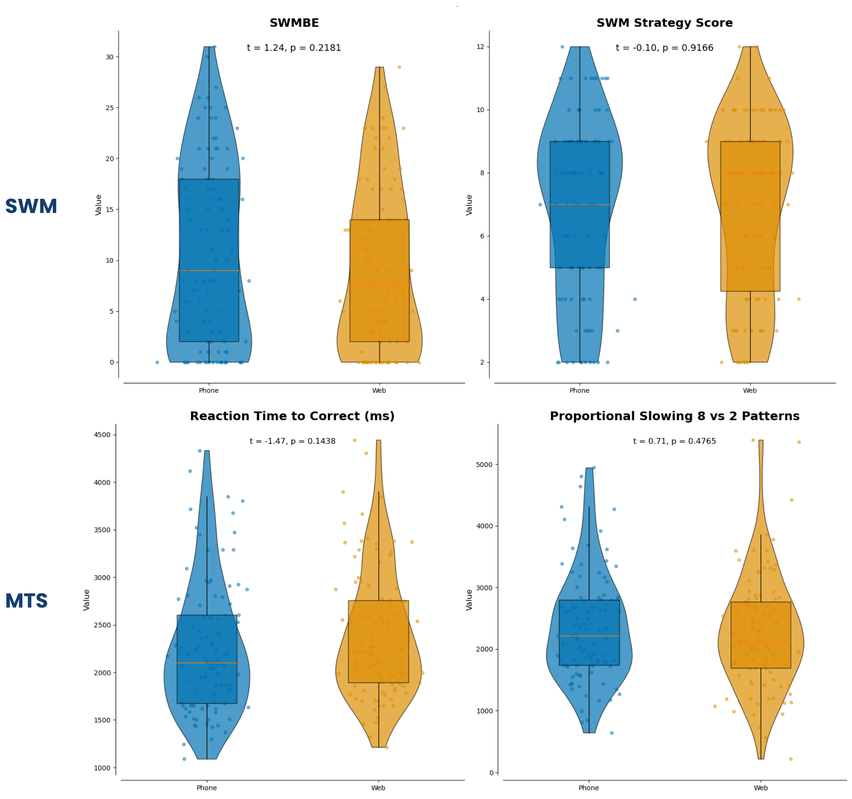

Figure 2. Comparisons of scores between devices on SWM and MTS.

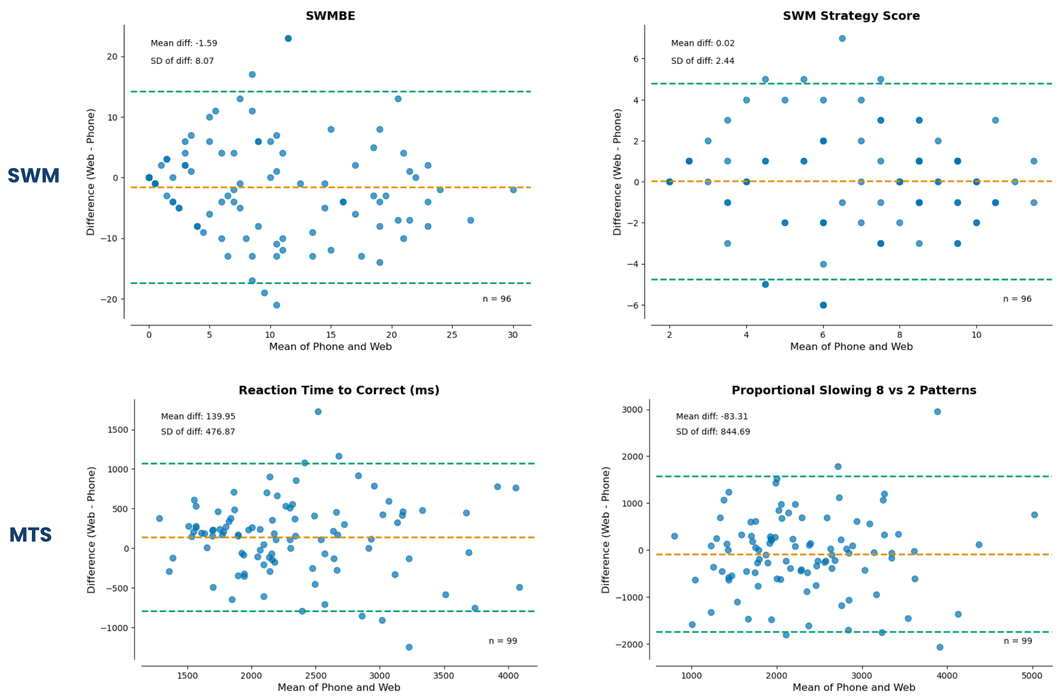

Figure 3. Bland Altman plots comparing SWM and MTS data collected on a smartphone vs desktop (web) device.

Results

Usability

Task usability was rated highly by participants, with all participants agreeing or strongly agreeing that the task instructions were clear and easy to follow and that they could see stimuli easily on their smartphones. When asked which version of the task they would prefer to complete if they had to do the task again 48% of SWM and 52% of MTS participants indicated either no preference or preference for completing on a smartphone device.

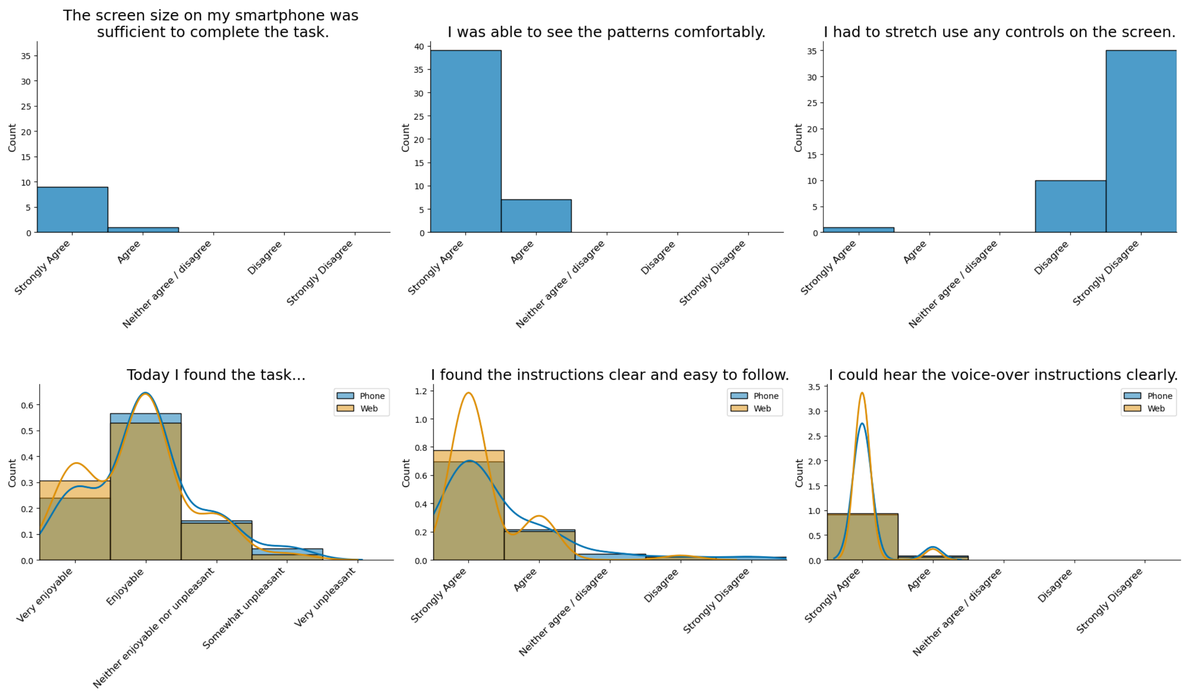

Figure 4. Usability responses to task delivery on smartphone and desktop devices.

Conclusions

This study comparing smartphone with other remote versions of SWM and MTS showed overall good comparability between smartphone and desktop devices, used at home in a Bring Your Own Device (BYOD) study. This supports the use of CANTAB® tasks remotely, on widely available devices, as a viable method of cognitive assessment.

This comparability suggests normative data and other measures associated with existing versions of the tasks are relevant to the smartphone format. Useability answers suggested that smartphone versions of these tasks are as acceptable as other versions for healthy volunteers.

Future work will investigate repeated administration of batteries combining multiple smartphone CANTAB® tasks to understand reliability and psychometric properties of the measures when deployed in this format.

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