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Remotely administered computerized cognitive test battery with older adults

Background: Computerized cognitive assessments are an efficient and sensitive method of identifying cognitive impairments in aging and cognitively impaired populations. The current study examines the feasibility and reliability of remote, home testing with a new tool, the California Cognitive Assessment Battery (CCAB).

Method: The CCAB runs on a remote tablet platform (Figure 1) and includes telemedical interaction with an examiner via video chat (Figure 2). Examiners administer a comprehensive set of cognitive tests, including verbal, visual, memory, and processing speed tasks, as well as psychological questionnaires (Figure 3). The tasks are scored automatically, including consensus automated speech recognition (CASR) for the transcription of responses on verbal tasks (e.g., list-learning memory tasks, picture description, verbal fluency). For the current study, the CCAB was administered remotely to 185 healthy older military veterans (aged 60-89; 18% women) in their homes, with testing sessions under video and audio supervision and assistance. The battery was administered three times within one week to assess test-retest reliability.

Result: Reaction times, word onset latency, response accuracy, error types, and speech samples were collected and analyzed. Participant experience was generally favorable: 98% of participants completed all three testing sessions, with 99% of all tests in those sessions completed successfully. Additionally, after a mid-year software and examiner procedure reformulation of a small subset of CCAB tests, there was a 42% decrease in test failures and a 6% decrease in repeated tests. Individual test times were overall highly uniform across participants (Figure 4), with an entire CCAB battery having low daily test time variability. Also, compared to home noise levels, recorded speech levels were sufficient to support CASR transcript generation for scoring verbal tasks (Figure 5). Finally, in a subset of 50 participants, similar test battery characteristics were found when a CCAB session was repeated later under laboratory conditions.

Conclusion: The CCAB shows promise as an objective, reliable automated digital assessment tool to evaluate cognitive functioning in adults both at home and in the laboratory or clinic.



Figure 1: CCAB Test Kit with headset, mouse, touchscreen tablet, and instructions.

The screenshot displays the CCAB browser portal interface. At the top, a video feed shows a participant wearing headphones. To the right of the video are controls for 'Subject Video' and 'Subject Audio', both checked, and a 'Test Station A/V' section with a slider and 'Out: Audio+Video' label. Below the video is a dark blue panel with the user initials 'tjh' and test details: Start Time: 10:34:27 AM, Elapsed Time: 7:37, Group: CCAB, Sequence: Main, Test Version: 0.005.004, Mousing Hand: Right, Drawing Hand: Right, Audio Attenuation: 21 dB, and Chat API: Opentok. A green bar indicates 'BAVLT Encoding and Recall running' with 'Pause' and 'Quit Test' buttons. Below this is a '+ Session Comments' button. A sidebar on the left lists test components: Day Two Introduction, Simple Mood Questionnaire, Progress Update, BAVLT Encoding and Recall (highlighted), Progress Update, Figure Copy, Progress Update, Mental Rotation, Progress Update, and Forward Digit Span. The main area shows 'Run 2' details: Start Time: 10:40:36 AM, Duration: 1:28, Status: Running, Start Position: List 2 Encode, and Current Block: Encoding 3. A bar chart titled 'Recall by List' shows '# Recalled Correctly' on the y-axis (0-8) and 'List' on the x-axis (2). The bar for List 2 reaches the value 2. An 'Ignore this test run' checkbox and an 'Add Comment' button are at the bottom.

Figure 2: Examiner view during a CCAB test using the browser portal. Audio and video of the participant is always available. Chat is available between tests. Full control of test flow is available on the left and top. Provisional scores are available on the bottom right. Test low performance warnings and hardware error logs are also displayed immediately.

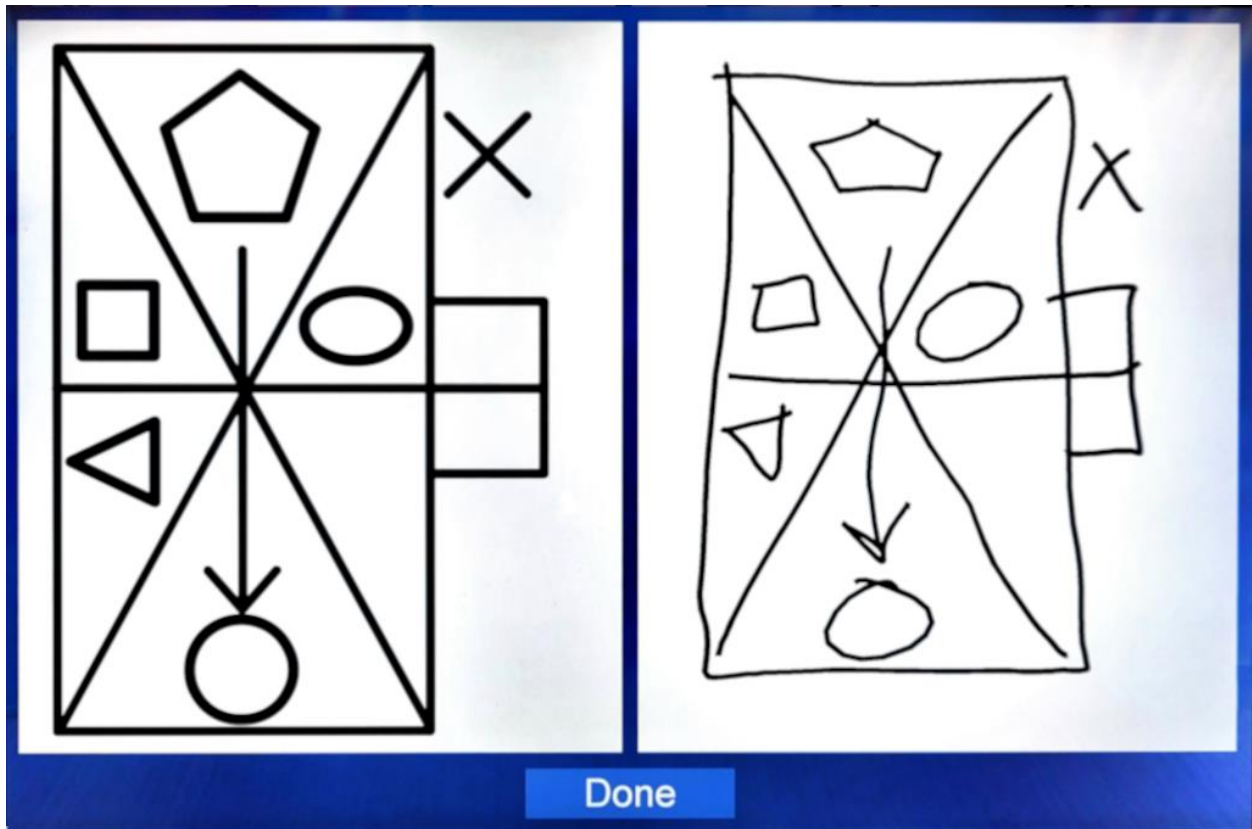


Figure 3: Screenshot of a CCAB test station while a participant is performing a Figure Copy trial using the touchscreen.

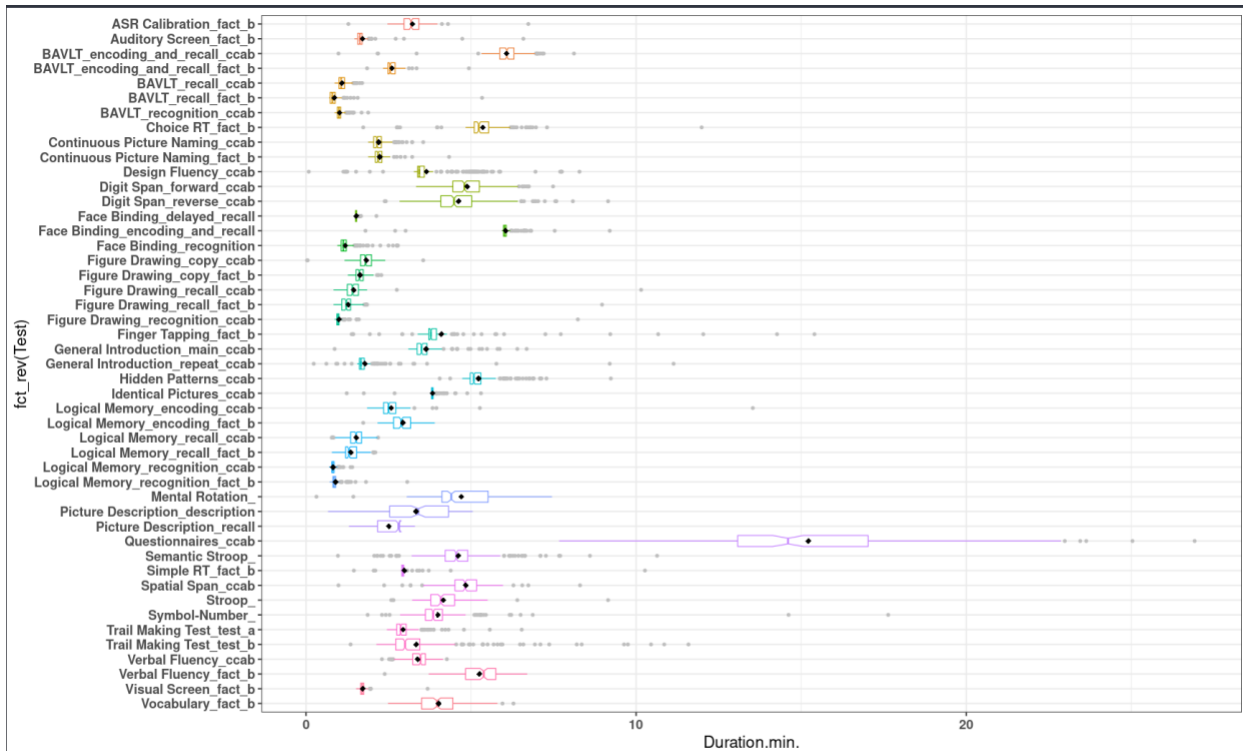


Figure 4: Notched Box & Whisker Plots of Total Test Times of CCAB Tasks. A notched box shows a test distribution's 3 quartiles (Q1, Q2, Q3), the whisker lines cover $Q1 - 1.5 * (Q3 - Q1)$ to $Q3 + 1.5 * (Q3 - Q1)$, grey circles are outliers outside of the whiskers, and black diamonds are means. Times include software and hardware failures, extra test training, instructions, examiner interventions, home testing disruptions, unplanned breaks, test failures, etc.

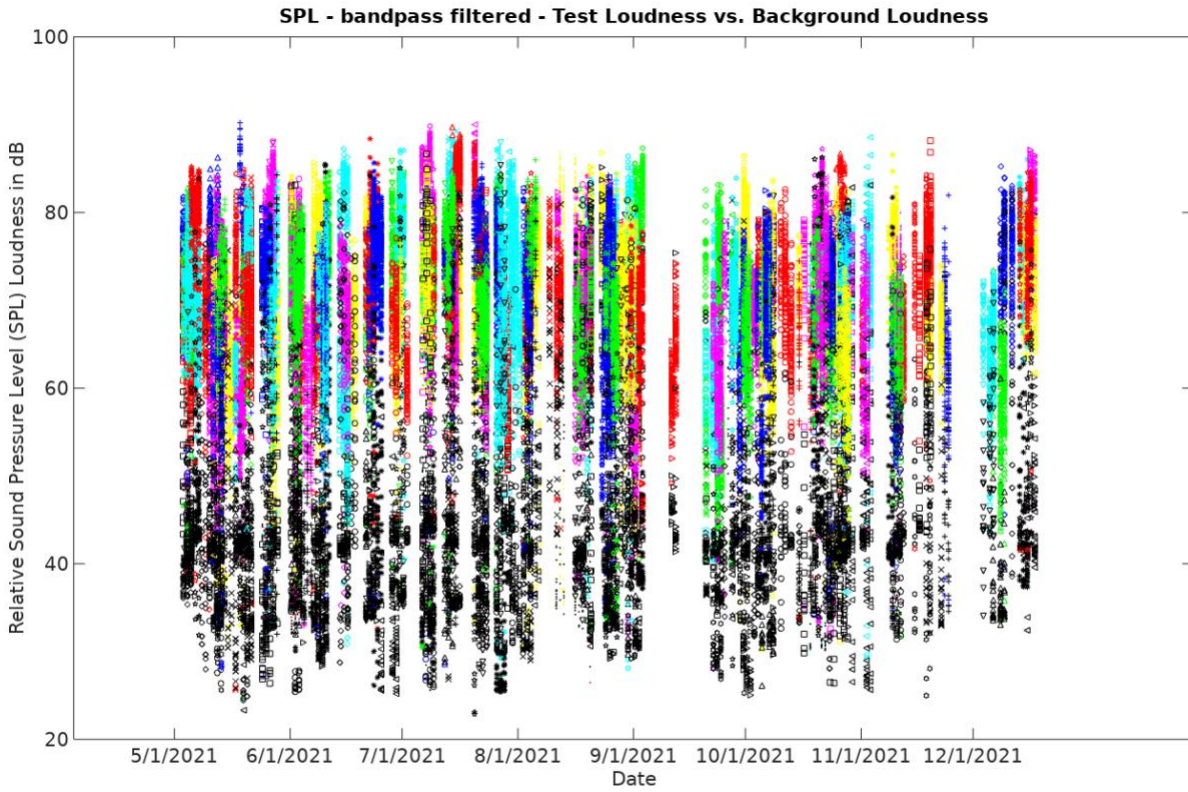


Figure 5: Loudness of CCAB speech samples (colored symbols) and background noise samples in between tests (black symbols) recorded by the kit headset. One color/symbol used per participant.