A Computerized Cognitive Assessment Battery Optimized for At-Home Testing

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Introduction

The administration of cognitive tests in patients' homes facilitates access for underserved communities and can increase testing capacity and efficiency. However, the validity of at-home computerized cognitive tests is often questioned because of limitations in examiner monitoring, distractions, environmental noise, and potential cheating. Here, we compare performance of the computerized California Cognitive Assessment Battery [1] (CCAB) when administered at-home or in the laboratory using otherwise identical procedures.

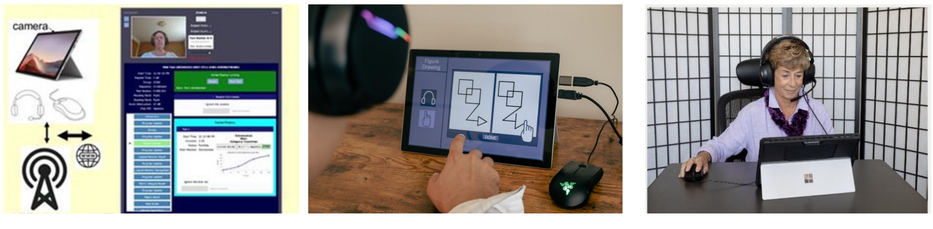
Methods

Participants: 415 participants (mean age = 70.1; 50% female) were recruited from the VA Northern California Healthcare System and from communities in Oakland, CA. Participants underwent 3 days of initial testing (three 90-minute sessions), and longitudinal testing of a single test session at 6 months (n=277) and 18 months (n=200).

Test Location: 100% of enrollment test sessions were performed during the COVID pandemic in participants' homes. At 6 months, 46% of participants were tested in the lab, and at 18 months 57% were tested in the lab.

Technology: The California Cognitive Assessment Battery (CCAB) includes 17 verbal and 15 non-verbal tests that have been normed for at-home assessment on tablet computers. Verbal stimuli are adjusted for hearing loss, and participants use noise-attenuating headphones and mics to reduce the influence of environmental noise on both perception and digital recordings of verbal responses.

Critically, CCAB test administration is proctored through a control interface that warns of potential error conditions, displays test performance in real time, facilitates patient observations, and incorporates video chat and test-control capabilities.



Results

- Regressed z-scores are produced by models that incorporate factors such as age, gender, race, education, computer use, and vocabulary level.
- Using enrollment performance as a predictor for 6-month and 18-month z-scores greatly improves model fit and increases sensitivity to interventions or decline

Correlations of enrollment and follow-up testing

Test Site	6 - Mo	18 - Mo
Lab	.95	.93
Home	.93	.92

Mean z-scores

Test Site	6 - Mo	18 - Mo
Lab	-.04 (.91)	.03 (.94)
Home	.03 (1.07)	-.03 (1.07)
t-test	*-.56 NS*	*.44 NS*

Environmental noise and test failures

Test Site	dB Interval	dB Speech	Test failure rate
Lab	43.75	64.76	.05%
Home	47.24	66.26	.05%

Summary

- Test-retest reliability was extremely similar for at-home/at-home and at-home/at-lab pairs
- No significant difference in z-scores was found as a function of test site at 6-months or 18-months
- Analysis of audio recordings reveal small differences in background noise and signal to noise ratio
- Accessibility to reliable and sensitive cognitive assessment at home reduces barriers to the identification of cognitive decline.

Discussion

- Remotely monitored cognitive testing using CCAB is as valid as in-lab results
- Loud acoustic stimuli, noise-attenuating circumaural headphones, and remote proctoring minimize the impact of environmental noise and distractions.
- Test-retest reliability numbers are excellent both at-home and in-lab.
- Using baseline testing as a predictor for future performance drastically reduces the RMSE and greatly increases the sensitivity to interventions or declines in cognitive health.
- At-home testing is preferred by participants, facilitates the recruitment of racial and ethnic minorities, and removes capacity and scheduling challenges associated with in-lab testing.

References

[1] The California Cognitive Assessment Battery (CCAB). Woods, et al., Front Hum Neurosci, 2023

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