Transforming Raw Data to Interpretable Metrics: Standardizing BRACE Cognitive Scores within the iHOME Study

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Background: Mild to moderate cognitive impairment persists among people with HIV (PWH) despite effective antiretroviral therapy. The BrainBaseline Assessment of Cognition and Everyday Functioning (BRACE) is an iPad-based tool developed to detect mild cognitive impairment in PWH, but its raw output requires extensive processing before it is suitable for statistical analysis. The iHOME study examines the intersection of HIV, oral health, biological aging, and brain function, characterizing the oral microbiome, epigenetic aging, and cognition across these domains. This project applied Brain Health Program's standardized BRACE processing pipeline to iHOME study data to generate interpretable cognitive outcomes for downstream analysis.

Methods: A reproducible BRACE processing pipeline was implemented for 85 eligible iHOME participants assessed across 9 BRACE tests. Raw outputs from BrainBaseline underwent summary data extraction, application of predefined validity rules, log transformation, and reverse scoring where indicated; results failing performance cutoffs were excluded. Two outcome types were derived: T-scores (using a published extraction file and published normative coefficients with demographic adjustment) and factor scores (using an unpublished extraction file and still requiring application of unpublished normative coefficients). T-scores were averaged into a global composite (mean 50; impairment cutoff <40, 1 SD below the mean). Principal component analysis (PCA) was used to derive domain-level cognitive factor scores that can be converted to T-scores using normative coefficients when published.

Results: The cohort comprised 54 PWH (mean age 48.8 ± 13.52; CD4 706.13 ± 359.82; CD8 849.61 ± 435.6) and 31 PWoH (mean age 45.64 ± 15.07). PCA yielded 5 factors with eigenvalues >1, accounting for 78.1% of total variance, with the scree plot leveling near component 5. Raw BRACE outputs were successfully transformed into both T-scores with global composites and factor scores spanning 5 cognitive domains. Factor scores offer an additional analytic pathway, though normative demographic beta coefficients can also be leveraged to establish impairment cutoffs.

Conclusions: A reproducible pipeline generating both T-scores and domain-level factor scores was established for the iHOME study. This standardized approach facilitates future cross-sectional and longitudinal analyses linking oral health, epigenetic aging, and cognitive function in PWH.