Assessment of Fluid Cognition in Deaf Young Adults Using the NIH Toolbox

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BACKGROUND

- In 2013, National Institutes of Health (NIH) released a comprehensive set of standardized tests that assess cognitive, emotional, sensory, and motor functions across the lifespan (Hodes, Insel, & Landis, 2013). It is known as the NIH Toolbox.
- This study focuses on the NIH Toolbox Cognition battery, and in particular the measures used for Fluid Cognition Composite.
- The NIH Toolbox was developed for English and Spanish speakers, but not for people who use American Sign Language (ASL).
- Deaf and hard-of-hearing adults (DHH) have been reported to display cognitive differences when compared with their Typically Hearing (TH) peers (Hall & Bavelier, 2003).
- DHH adults are often bilingual (ASL and English) resulting in access to speech-based and sign-based codes (Emmorey et al., 2008).

In this study, we sought to test the factor analytic structure of the Fluid Cognition Composite for DHH adults. We hypothesize that the latent factor structure of the NIH Toolbox Cognition Battery Fluid Composite measure will be different for TH and DHH adults.

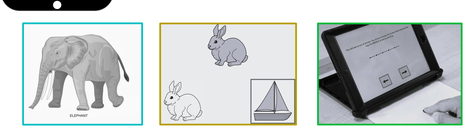
METHODS

As part of a larger project on the impact of cochlear implantation and sign language acquisition on cognition, we collected behavioral and psychophysiological data from over 300 adults aged 18-30 years. Here, we present the initial findings from 169 DHH and 59 TH participants who completed the NIH Toolbox Fluid Cognition battery.

DHH Demographic Data

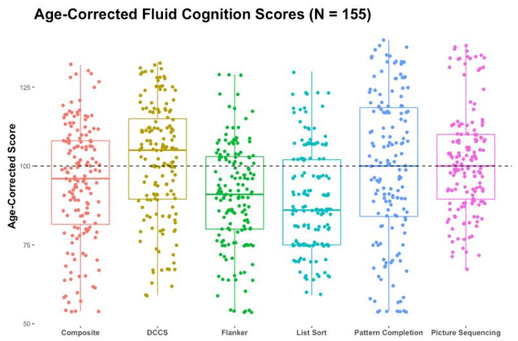
97	White	4	American Indian or Alaskan Native
30	Asian	1	Native Hawaiian or Other Pacific Islander
27	Black	4	Did not respond
6	More than one race		

- Dimensional Change Card Sort *(Shifting)*
- Flanker *(Inhibition)*
- List Sort *(Working Memory)*
- Pattern Comparison *(Processing Speed)*
- Picture Sequence *(Episodic Memory)*



All tasks were administered using an iPad by a DHH researcher in ASL or a TH researcher able to communicate in both ASL or spoken English. Language of administration followed participant preference.

RESULTS



STEP 1

Confirmatory Factor Analysis (CFA) was used to check for measurement invariance. Specifically, we wanted to know if both groups, DHH and TH, have the same underlying factor structure.

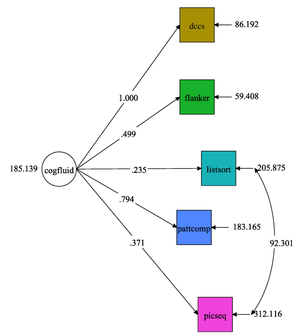
Configural (30 parameters) $\chi^2 = 71.36$, df = 10, $p < .0001$
Metric (26 parameters) $\chi^2 = 77.07$, df = 14, $p < .0001$
Scalar (22 parameters) $\chi^2 = 234.89$, df = 18, $p < .0001$

The analysis shows that configural and metric measurement invariance are weak. Differences on subtest scores cannot be entirely explained by differences in cognitive fluidity. Other factors may be influencing subtest scores either directly or by interacting with cognitive fluidity.

STEP 2

CFA was used to verify factor structure for TH participants. Only minor modifications were required to achieve an acceptable fit between the single factor model and the data..

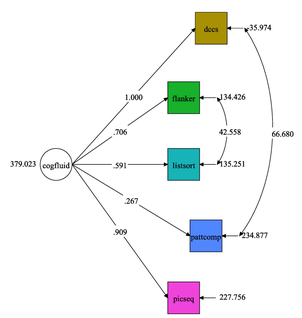
Bayesian Information Criteria (BIC) 2440.864
Chi-Square Test of Model Fit 3.10, df = 4, p = 0.542
RMSEA [0.000, 0.175], P <= .05 = 0.612
CFI 1.000
SRMR 0.040



STEP 3

CFA was used to look at factor structure for DHH participants with modification indices to create best fit between model and data.

Bayesian Information Criteria (BIC) 6168.647
Chi-Square Test of Model Fit 1.56, df = 3, p = 0.668
RMSEA [0.000, 0.105], P <= .05 = 0.782
CFI 1.000
SRMR 0.011



DISCUSSION

The NIH Toolbox Fluid Composite does not exhibit strong measurement invariance for DHH and TH young adults. Caution should be exercised when inferring group differences based upon this measure.

- Possible reasons include:
  - Increased peripheral attention leading to greater processing of task irrelevant flankers in the Flanker Inhibition task (Dye, Baril, & Bavelier, 2007).
  - DHH participants using a sign-based code for the List Sort Working Memory task. Stimulus material selection issues use of a speech-based English code (Morford et al., 2011).

Overall, results from this study suggest that future analyses will need to be done to determine latent structure as a function of additional factors:

- **Direct influences -** changes in perceptual and attentional processing due to cross-modal reorganization of unisensory systems
- **Indirect influences -** differences in language acquisition histories, including timing and quality of access to linguistic input - may affect fluid cognition outcomes in DHH young adults

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