Testing Vestibular Function

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For more information, please visit www.nihtoolbox.org
Disclosures

Dr. Rine is a member of the NIH Toolbox Vestibular Team and has no disclosures to report.
Vestibular Team Members

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• The inner ear
• Transduce & process
  • Angular & linear acceleration/deceleration of head
  • Enable: balance, locomotion, gaze stability
• An inertial guidance system
  • Integrated into a complex multi-sensory interplay between the CNS, eye, inner ear & somatosensory inputs
Vestibular Function

- **Gaze – Vestibulo-ocular reflex (VOR)**
  - Minimize/correct retinal slip, oscillopsia
  - Dynamic visual acuity (DVA) test

- **Balance – Vestibulospinal (Vsp)**
  - Postural set, correct for challenge
  - Balance measure (NIH Toolbox Motor Domain)

Comprehensive testing of vestibular function must include VOR and Vsp, w/ control for other contributions.
Gaze Stability Mechanisms: Need for Speed

- Only vestibular system can stabilize gaze & posture across the ADL’s
  - Fall risk, prevention
  - Reading, driving
- Populations: Demyelination, injury (TBI), ototoxicity, pathology of ear or CNS
- Underestimated in children
Dynamic Visual Acuity (DVA)

- DVA -
  - Indirect measure of VOR
  - Quantify visual acuity difference w/head stable vs. moving

- Test requirements:
  - Optotype visible $\leq 80$ msec
  - Control visual contribution via head movement rate

- Computerized optimal:
  - reduce training & assure requirements

- No prior pediatric version
DVA Development
lead = M Schubert, Ph.D. & Dale Roberts, M.S.

- Computerized version
  (Software & hardware)
  - Identify optotype w/head stable & moving @ 180 °/sec
  - Score: static acuity – acuity with movement (LogMAR)
  - Movement rate controlled via accelerometer on headband
DVA Test – Method

• Static acuity test
  • Begin @ 20/60 – larger until all correct; progressively smaller until miss 1

• Dynamic – same except:
  • Turn head
  • Begin 3 sizes above static score
  • With head turn to R and L
Validation: Computerized DVA

- **Test/retest:**
  - 301 subjects, no pathology
  - 17 subjects with pathology
    - 3-7 y.o. N = 126 (3)
    - 8-17 y.o. N = 127 (8)
    - 18-80 y.o. N = 48 (6)

- **Compared:**
  - symbol vs. letter

- **Examined:**
  - Reliability & validity

- **Sensitivity & specificity:**
  - Compare to previous versions
  - Rotary chair test results
Reliability

- Static: ICC = .9 (all age groups)
- Dynamic ICC = .7-.9 adults
  - Moderate for children (.5)
  - Minimal variance
    - Minimal age effect
    - Few with pathology
Validation – vestibular

- Scores differed in those with pathology
  - Children $p < .04$
  - Adults $p < .03$
- Sensitivity: 77.8-86.7%
- Specificity: 50.7-73.1%
- NPV: 98.2-98.6%

DVA Test

- Optotypes – what to keep
  - LEA 3-12 years
  - HOTV 3-12 years
  - ETDRS 7-12 years

- Completion rates (3 and 4 y.o.)
  - Static: larger w/ Lea (91 vs. 85%)
  - Dynamic: larger w/ Lea (74 vs. 69%)

- Correlation w/gold standard static vision measure = HOTV not Lea

- ETDRS and HOTV are default
Norming – Ongoing analysis

- Successfully completed $n = 1723$
  - 3-12 years $n = 707$; 13-19 years $n = 443$
  - 20-29 years $n = 99$; 30-39 years $n = 137$
  - 40-49 years $n = 104$; 50-59 years $n = 96$
  - 60-69 $n = 66$; 70-85 years $n = 69$
Norming – Age Effect

![Bar graph showing the DVA Score (logMAR) across different age groups.](image-url)
Future Directions

• Validation studies
  • Children & adults with & without pathology
  • Varying diagnoses

• Epidemiological on children and elders
  • Incidence
  • Specific diagnoses (TBI, central lesions)
  • Ototoxicity - chemotherapy
Demonstration

- Watch for
  - Head movement too large
  - Progressive lenses
Demonstration: NIH Toolbox
Dynamic Visual Acuity Test
For more information visit
www.nihtoolbox.org