Defining the “triple threat”:
Frequency of co-occurrence and notable disparities

U13 Conference: Sensory Impairments and Cognitive Decline
Oct 2, 2017

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Disclosures

Current funding:

• R37AG11099 and R01AG021917 from the National Institute on Aging

• U10EY06594 from the National Eye Institute

• An unrestricted grant from Research to Prevent Blindness.

The content is solely the responsibility of the author and does not necessarily reflect the official views of the National Institutes of Health.

Other financial relationships: None

Conflicts of interest: None

Epidemiology of Hearing Loss Study
Overview

• Aging and co-morbidity
• Sensory co-morbidity and cognition
• Gaps and opportunities
Co-morbidities and Aging

Sensory and cognitive systems involve neural processing and share a common environment
Sensory Co-morbidity: EHLS

Hearing: 43.9%
Vision (CS): 15.1%
Olfaction: 17.2%

10-yr Incidence of Cognitive Impairment: EHLS

### Sensory Impairments and 10-yr Incidence of Cognitive Impairment

<table>
<thead>
<tr>
<th></th>
<th>HR</th>
<th>95%CI</th>
<th>Sens</th>
<th>Spec</th>
<th>PPV</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hearing</td>
<td>1.90</td>
<td>1.11, 3.20</td>
<td>72.9</td>
<td>59.0</td>
<td>14.6</td>
<td>95.7</td>
</tr>
<tr>
<td>Vision</td>
<td>2.05</td>
<td>1.24, 3.38</td>
<td>46.4</td>
<td>81.3</td>
<td>19.3</td>
<td>94.0</td>
</tr>
<tr>
<td>Olfaction</td>
<td>3.92</td>
<td>2.45, 6.26</td>
<td>47.6</td>
<td>85.8</td>
<td>24.5</td>
<td>94.4</td>
</tr>
<tr>
<td>All 3</td>
<td>21.7</td>
<td>96.9</td>
<td>40.0</td>
<td>92.8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Adjusted for age, sex, education, smoking status, BMI, exercise, alcohol consumption, hypertension, diabetes mellitus, number of high inflammatory markers, non-HDL cholesterol, mean IMT, frailty score, longest held job, cold or stuffy nose, nasal polyps, deviated septum, allergies, head injury, stroke/TIA, and epilepsy.

Sensory Co-morbidity: BOSS

Hearing 14.2%
Vision 7.8%
Olfaction 3.8%

All 3: 14, 35 and 17 seconds longer

Sensory Impairment and Cognitive Function: BOSS

<table>
<thead>
<tr>
<th>Test (N)</th>
<th>TMTA (2453)</th>
<th>TMTB (2450)</th>
<th>GPT (2450)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>β (95%CI)</td>
<td>β (95%CI)</td>
<td>β (95%CI)</td>
</tr>
<tr>
<td>Hearing</td>
<td>1.7 (0.67, 2.8)</td>
<td>5.0 (1.6, 8.4)</td>
<td>4.2 (2.3, 6.0)</td>
</tr>
<tr>
<td>Olfaction</td>
<td>6.4 (4.5, 8.3)</td>
<td>10.2 (4.3, 16.1)</td>
<td>4.0 (0.7, 7.3)</td>
</tr>
<tr>
<td>Vision</td>
<td>2.7 (1.3, 4.0)</td>
<td>9.6 (5.3, 13.8)</td>
<td>5.1 (2.7, 7.5)</td>
</tr>
</tbody>
</table>

Adjusted for age, sex, education, smoking, waist, exercise, carotid plaque, hsCRP>3.0 mg/L, VCAM. 635.4 ng/mL, a1c, non-HD cholesterol, depressive symptoms.
Sensory Co-morbidity: Blue Mountains Eye Study

No associations with 5 or 10 yr declines in MMSE-blind

Sensory and Cognitive Co-morbidity: NC EPESE

Changes in Sensory and Cognitive Function: Maastricht Aging Study

- N=418, Mean age 66 years
- Best Corrected VA (Landolt-C), binocular, \( \leq 0.5 \) (n=36)
- Audiometry (1,2 and 4 kHz), better ear, \( >35 \) dB (n=30)
- Visual Verbal Learning Test
- Stroop Color Word Test
- Concept Shifting Task (mTMT)
- Verbal Fluency Test
- Letter-Digit Substitution Scale

Cross-sectional
- Baseline vision associated with SCWT, CST, LDST
- Baseline hearing not associated

Longitudinal (6 years)
- \( \Delta \) VA (but not baseline) associated with declines in VVLT, SCWT, CST, LDST
- \( \Delta \) hearing associated with declines in VVLT; baseline associated with declines in SCWT, LDST

Sensory measures differ in scale, severity, and require central processing. Cognitive tests rely on sensory input.
Knowledge Gaps

• What aspects of function should we measure?
• When do declines in sensory and cognitive function begin?
• What causes early changes in sensory and cognitive function?
• Which comes first – changes in hearing, vision, olfaction, cognition, or do they co-occur?
• Are sensory changes an early warning sign of neurodegenerative disease? Why?
• Are there racial/ethnic differences in these associations or pathways?
Research Opportunities

- Improved measures of visual and auditory systems and cognitive function; imaging techniques; collaborative studies, interest in sensory function
- Longitudinal studies of sensory and cognitive function across the lifespan
- Epidemiologic studies in racially/ethnically diverse cohorts
- Multinational studies of patterns over time, geographic location, and migration
- Impact of sensory and cognitive co-morbidities on independence and quality of life in aging
Acknowledgements

- Participants in the studies
- Community of Beaver Dam, WI
- Collaborators, students and staff
- Funding from NIH, RPB, and UW