Hearing Aid Controls and Manual Dexterity Issues

Gurjit Singh
University of Toronto
Toronto Rehabilitation Institute
Demographic Shift: Graying in the Developed World

Seniors by age sub-groups, as % of the total population, Canada, 1921-2041


- 85+
- 75-84
- 65-74
Prevalence rate of arthritis in older adults

2004-2005 National Health Survey (Australia)

Figure 1.
The Aging Hand
26 Hand muscles:
- 25-40% muscle mass loss
- 20-25% loss of strength
- Accelerated loss in very old age

Tendons: Attach muscles to bones and contribute to stretching/elongation
- 30-50% loss of tensile strength
- Decreased range of motion
- Accelerated loss in very old age
The Aging Hand continued

Bones and Joints:

Osteoarthritis: Age-related wear & tear
- Comprises > 100 diseases
- Pain, swelling, stiffness, bone spurs, restricted hand/wrist motion

Rheumatoid arthritis: Inflammatory condition
- Progressive condition
- More severe pain, swelling, and stiffness, restricted hand/wrist motion
Age-Related PNS, Sensory, & Cutaneous Changes

- Nervous system changes (motor neurons)
- Poorer vascularization (hands become cold)
- Less haptic (touch) sensitivity both to force and temperature
- Skin becomes increasingly drier, more fragile, and heals more slowly
- Cosmetic changes (wrinkling, veining, age spots)
Functional Hand Changes: Jebsen Taylor

Jebsen Hand Function Test

- Card turning
- Small objects
- Checkers
- Simulated feeding
- Large, light objects
- Large, heavy objects

Data from: Hackel et al., 1992, Physical Therapy, 72, 373-377; Govender, 2008, Master’s Thesis, University of Witwatersrand, Johannesburg
Manual Dexterity and Hearing Aid Use

Better perceived management of a hearing aid:

1. Predicts hearing aid use 6 months post-fitting  
   (Hickson, 1986)

2. Better performance on an objective test of dexterity (Purdue pegboard test):
   - Predicts who accepts, rather than rejects, linear hearing aids  
     (Humes et al., 2003)
   - Associated with wearing a hearing aid more often, reporting more success, and being more satisfied with hearing aids  
     (Kumar et al., 2000)
Current Research: Battery of Fine Motor Tasks

Ability to Manipulate a Hearing Instrument
Age-Related Changes: Button Pressing

- 20 Young \((M = 20.5; SD = 1.7)\)
- 20 Younger-Old \((M = 66.8; SD = 3.0)\)
- 20 Old-Old \((M = 74.0; SD = 2.3)\)
- Assessed hand function on a battery of tests
- Compared the ability to manipulate a button on 2 different BTE slim-tube hearing aids
- Subjects had not previously worn a hearing aid
2 Point Discrimination
Von Frey Hair Detection Task
JVP Domes

test of
tactile
spatial
resolution
Purdue Pegboard

2 Point Threshold

VP Domes
2 Point Von Frey Hair Test

Purdue Pegboard

JVP Domes
Figure 1: Based on Shepard & Metzler's 'Mental Rotation Task'

Figure 2: Mental Rotation Task Based on Canonical Orientations
2 Point $\theta$

Von Frey Hair Test

JVP Domes

Purdue Pegboard

Grooved Pegboard

Mental Rotation Test (MRT)
Questionnaire

Disability of Arm, Shoulder, and Hand (DASH)

- 15-item measure assessing pain and disability
- 0 = no pain or no difficulty
- 10 = worst pain or unable to perform
Hearing Aid Model A

- 2 mm high
- 2 mm diameter
Hearing Aid Model B
Results
Hearing Care for Adults 2009 – The Challenge of Aging

The data presented is currently under peer review for publication and cannot be shown here. Thank you for your understanding.

November, 16–18, 2009
Hyatt Regency
Chicago, USA

An International Conference sponsored by Phonak
Summary effects

1. Age effect
   - Younger adults significantly faster than older adults

2. Button effect
   - Participants were faster with button A than B

3. Practice:
   - by the 9th trial, all effects were minimized
Experiment II: Hearing Aid Success Across Different Hearing Instrument
Manual Dexterity and Different Hearing Instruments

- 56 Adults \((M = 71.5; SD = 5.1)\)
- Assessed hand function on a battery of tests
- Added another disability questionnaire (AUSCAN)
- Compared 6 push buttons
- Compared 4 volume controls
The data presented is currently under peer review for publication and cannot be shown here.
Thank you for your understanding.
Hearing Instruments
Model A
Raised

Model B
Flat
Model A
Raised

Model B
Flat

Model C
Large
ITE 1

Slightly smaller button than model A
<table>
<thead>
<tr>
<th>Model A</th>
<th>Model B</th>
<th>Model C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raised</td>
<td>Flat</td>
<td>Large</td>
</tr>
</tbody>
</table>

ITE 1 Standard
ITE 2

Wider flatter button than ITE 1
<table>
<thead>
<tr>
<th>Model A</th>
<th>Model B</th>
<th>Model C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raised</td>
<td>Flat</td>
<td>Large</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ITE 1 Standard</th>
<th>ITE 2 Wide &amp; Flat</th>
<th>Remote</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The data presented is currently under peer review for publication and can not be shown here. Thank you for your understanding.
VC manipulation task
• Large raised VC
• 4 mm in diameter
• Each ‘arm’ raised ~1 mm
• 3 mm in diameter
• Each ‘arm’ raised ~ 0.5 mm
• Flatter VC
• 2 mm in length
• 1.5 mm wide
• 15 ‘ridges’
• Ridges raises ~ 0.25 mm
• Produces a ‘click’ when turned
Hearing Aid Model C

- 5 mm in length
- 3 mm wide
The data presented is currently under peer review for publication and cannot be shown here.
Thank you for your understanding.
Predicting Hearing Aid Aid Success
Question: What are the factors that predict success with each of the hearing aids?

- Composite BTE score
- Composite ITE score

Conducted a multiple regression using:

- The battery of dexterity and haptic measures and the DASH and AUSCAN questionnaires
The data presented is currently under peer review for publication and cannot be shown here. Thank you for your understanding.
Summary effects

1. **Button Pressing:**
   - Size and haptic feedback

2. **VC adjustments**
   - Haptic feedback

3. **Dimensions of successful hearing aid use for both BTEs and ITEs**
   - Dexterity, haptic sensitivity, and disability
Data from Experiment II

Reported on 56 individuals

Actually collected on:
- 23 subjects: self-reported “normal” hand function
- 23 subjects: self-reported arthritis
Hearing Care for Adults 2009 –
The Challenge of Aging

The data presented is currently under peer review for publication and cannot be shown here.
Thank you for your understanding.

November, 16–18, 2009
Hyatt Regency
Chicago, USA

An International Conference sponsored by Phonak
Manipulative Success Arises From:

- Client A
  - Hand: Green
  - Instrument: Red
  - Cognition: Cyan

- Client B
  - Hand: Green
  - Instrument: Red
  - Cognition: Cyan
Challenge: The Invisible Hearing Aid

“By developing expertise in the use of objects, we effectively embody new means of projecting ourselves onto the world. In this way, the tennis player’s racquet, the painter’s brush, and the sculptor’s chisel become extensions of the limbs”.

The body in culture, technology, and society, Chris Shilling, p. 55
The Research Team

**Collaborators**

- Dr. Kathy Pichora-Fuller  
  University of Toronto
- Dr. Don Hayes  
  Unitron Hearing
- Dr. Heather Carnahan  
  Toronto Rehabilitation Institute
- Dr. Herb von Schroeder  
  Toronto General Hospital

**Research Assistants**

- Christine de Luca
- Chris Gonsalves
- Jane Carey