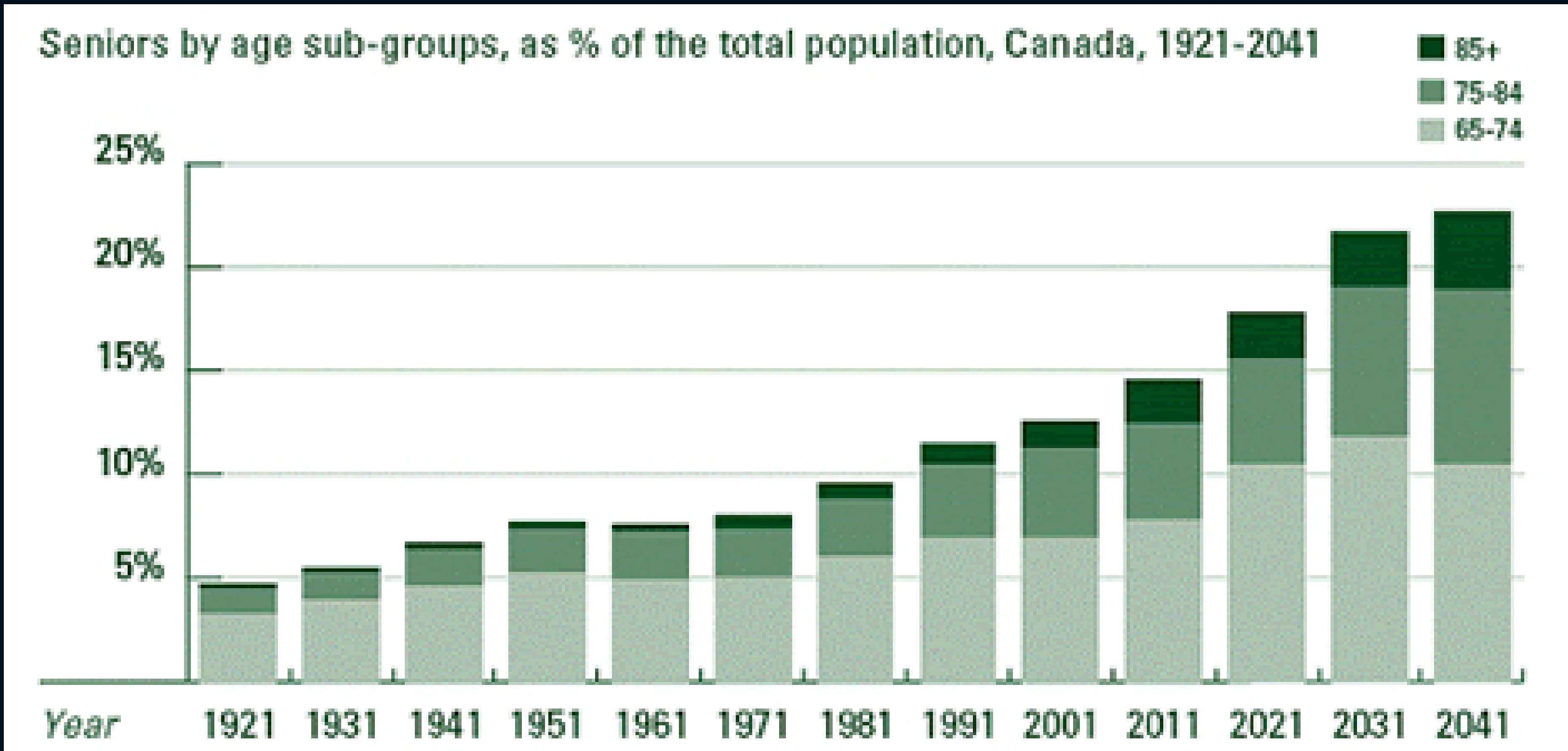
Hearing Aid Controls and Manual Dexterity Issues

Gurjit Singh
University of Toronto
Toronto Rehabilitation Institute

Demographic Shift: Graying in the Developed World



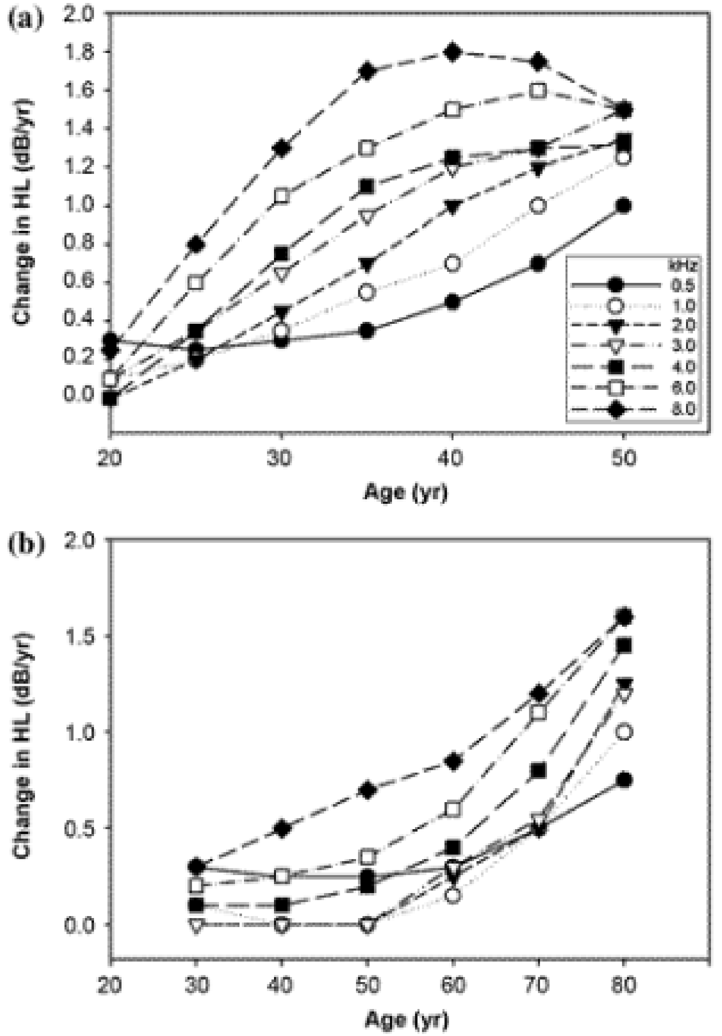
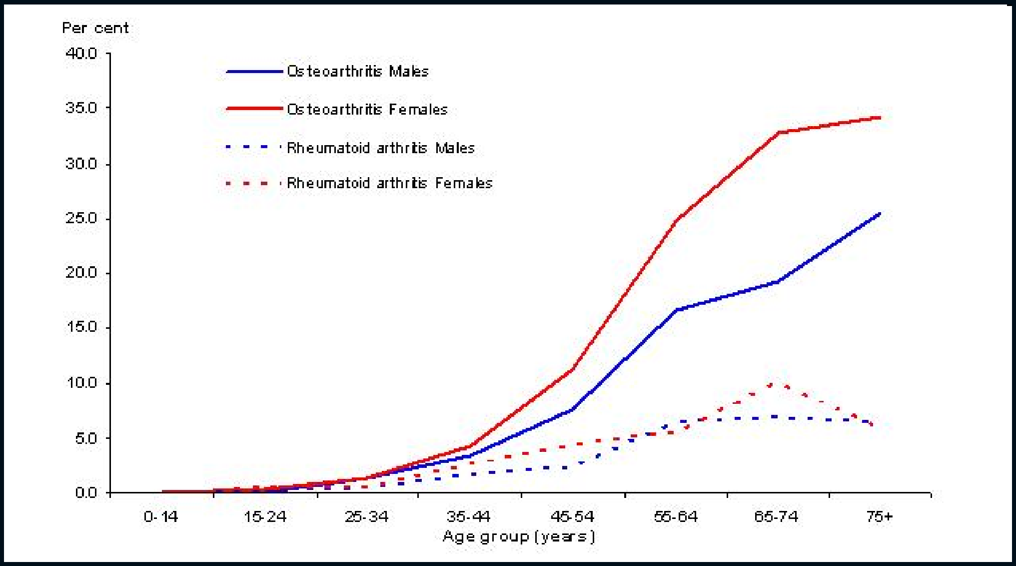


Figure 1.
Average 10-year longitudinal changes in pure-tone hearing level (HL) thresholds across frequency for **(a)** men and **(b)** women, from Baltimore Longitudinal Study on Aging. *Source:* Pearson JD, Morrell CH, Gordon-Salant S, Brant LJ, Metter EJ, Klein LL, Fozard JL. Gender differences in a longitudinal study of age-associated hearing loss. J Acoust Soc Am. 1995;97:1196–1205.

Prevalence rate of arthritis in older adults

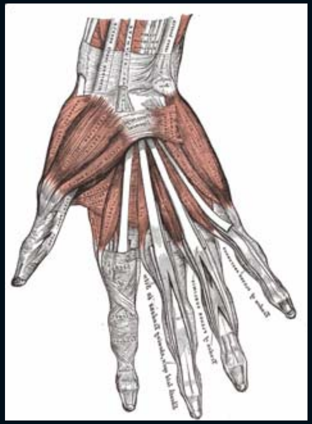


2004-2005 National Health Survey (Australia)

The Aging Hand

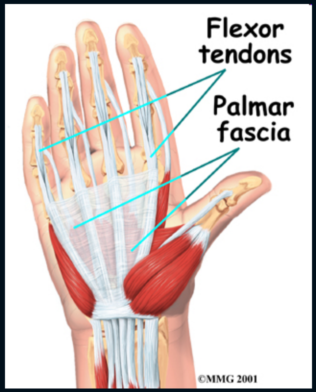
26 Hand muscles:

- 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

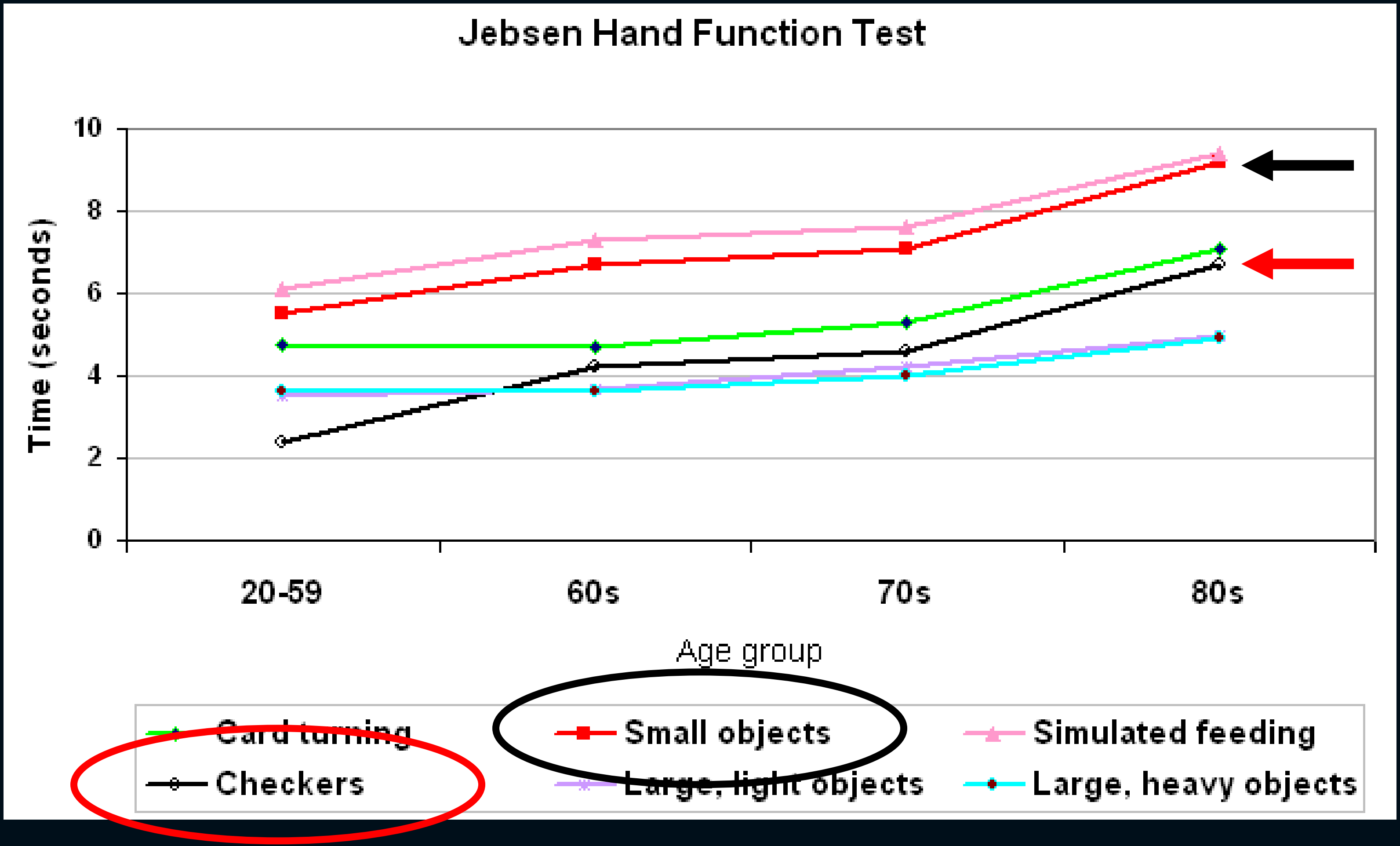
Rheumatoid arthritis: Inflammatory condition

- 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



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)

Better performance on an objective test of dexterity (Purdue pegboard test):

2 Predicts who accepts, rather than rejects, linear hearing aids

(Humes et al., 2003)

3 Associated with wearing a hearing aid more often, reporting more success, and being more satisfied with hearing aids

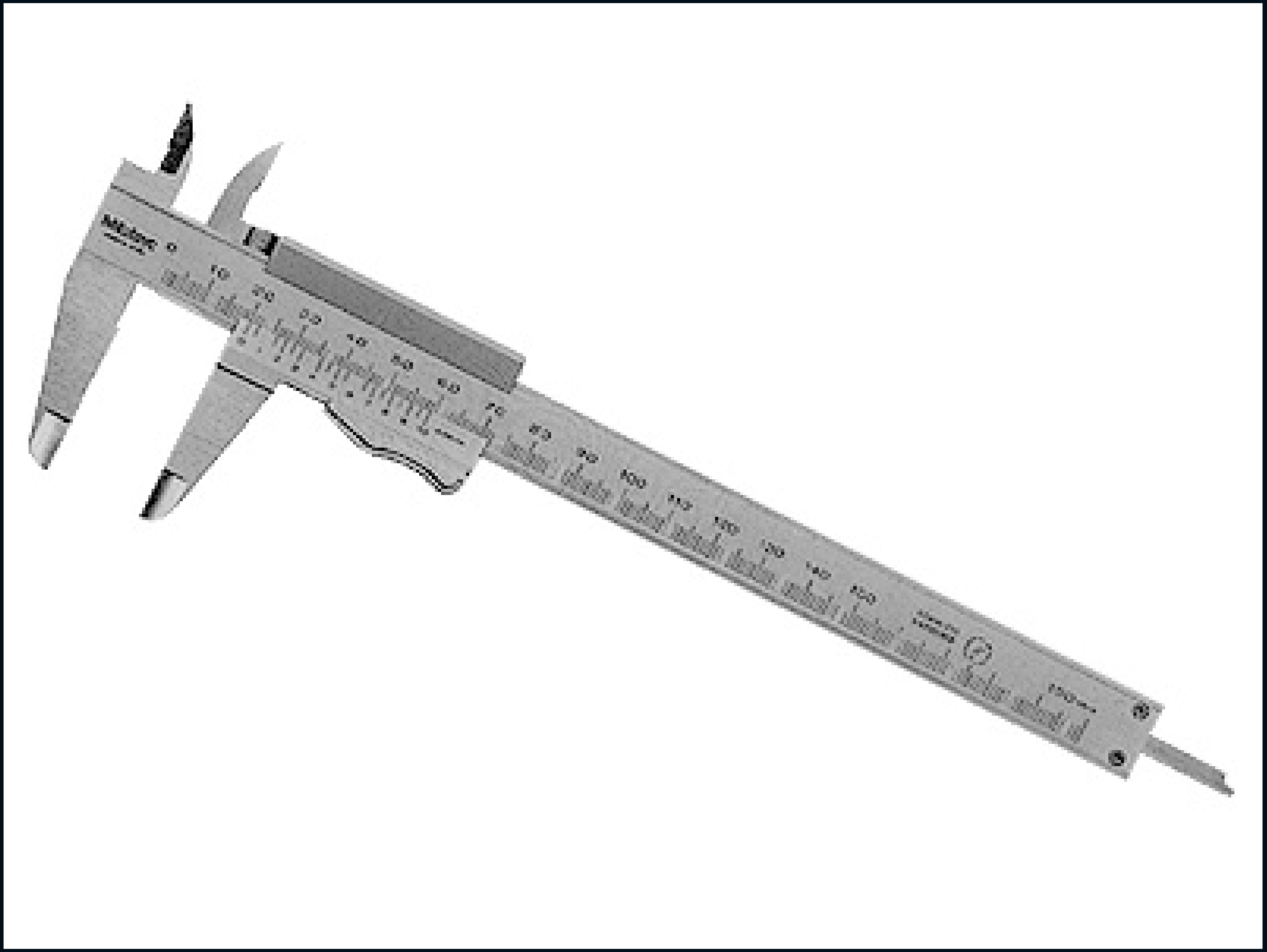
(Kumar et al., 2000)

Current Research: Battery of Fine Motor Tasks
Ability to Manipulate a Hearing Instrument

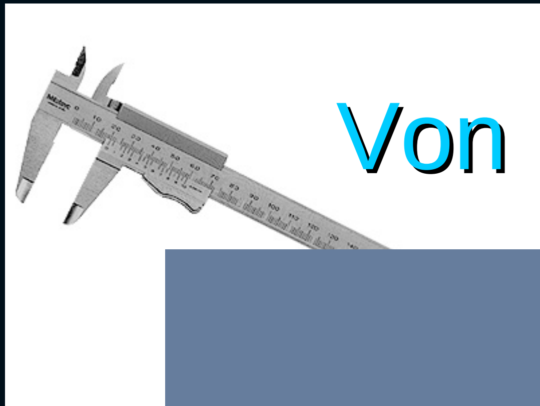
Age-Related Changes: Button Pressing

- 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

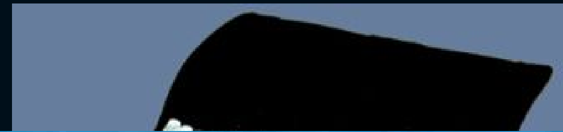


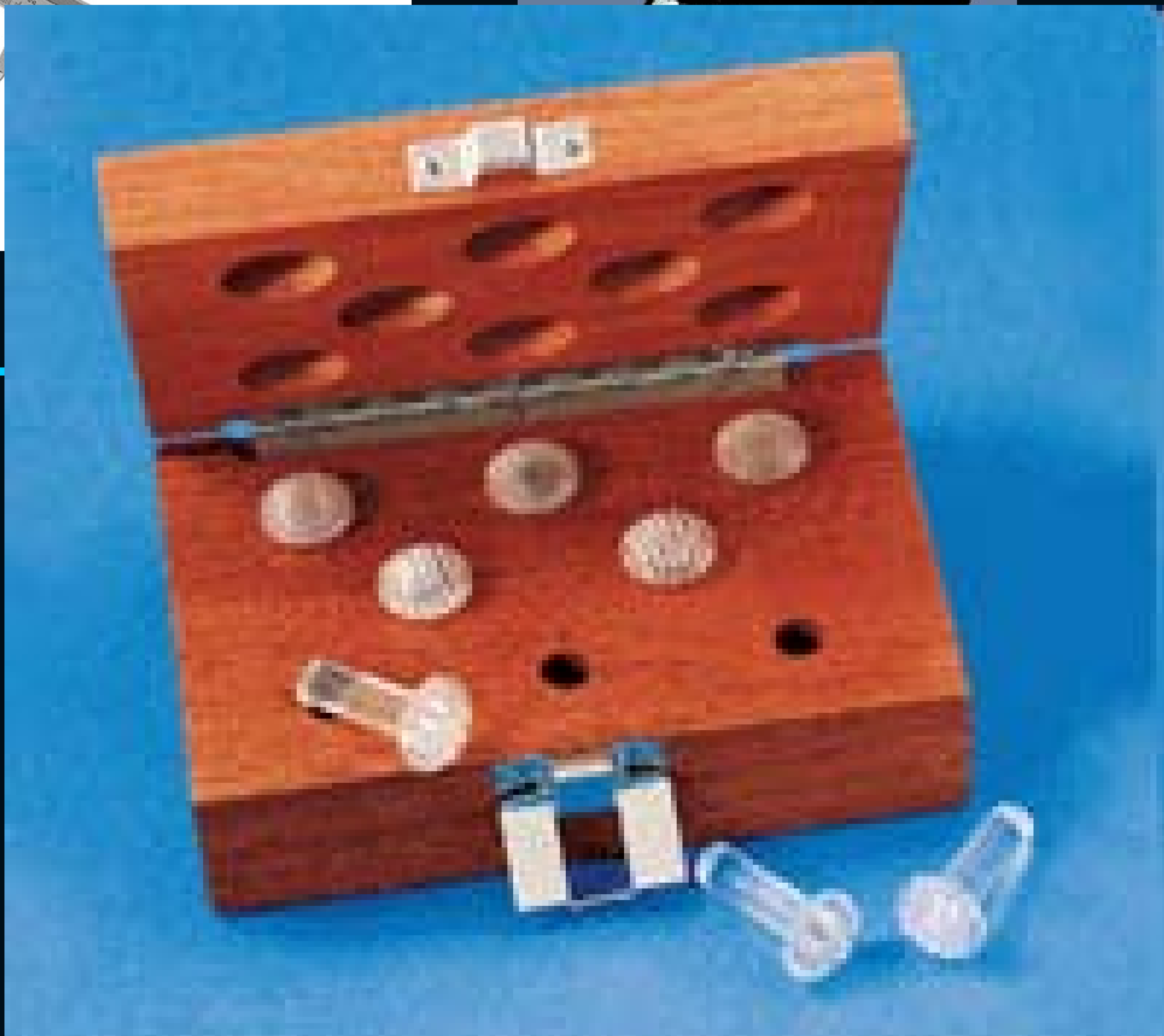
Von Frey Hair Detection Task



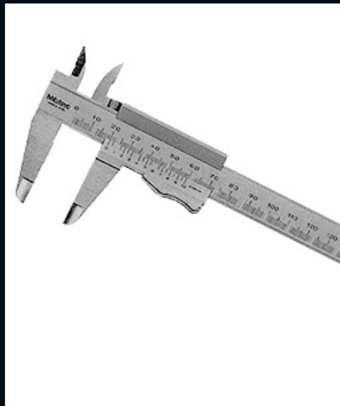
2

Th





JVP Domes test of tactile spatial resolution

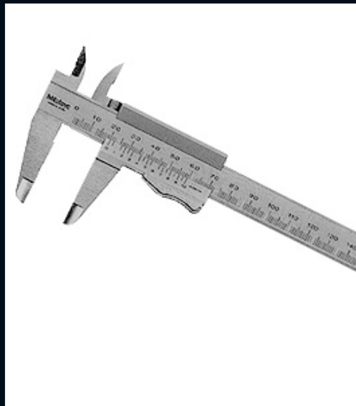


2 Poin

Thresho

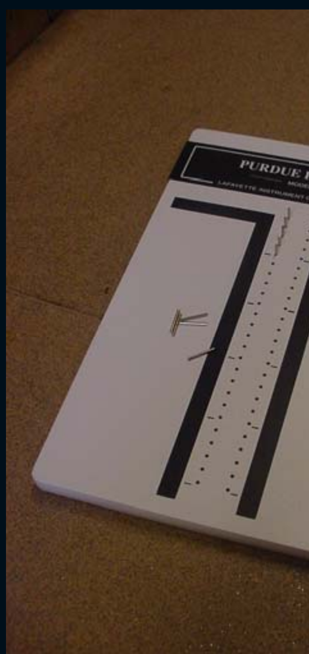
Purdue Pegboard

VP Domes

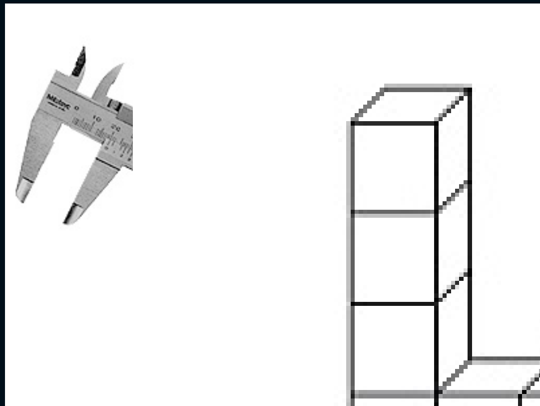


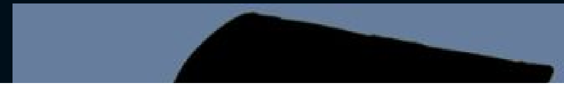
2 Point

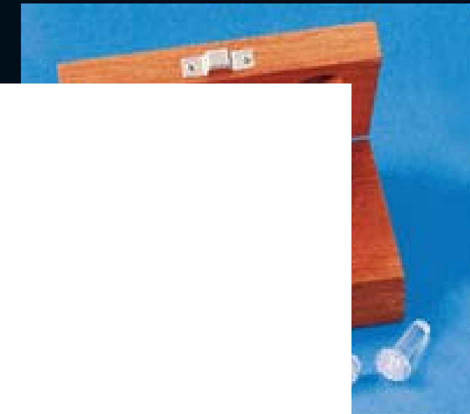
VP Domes



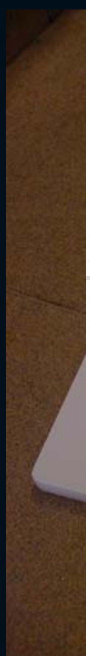
Purdue Pe







es



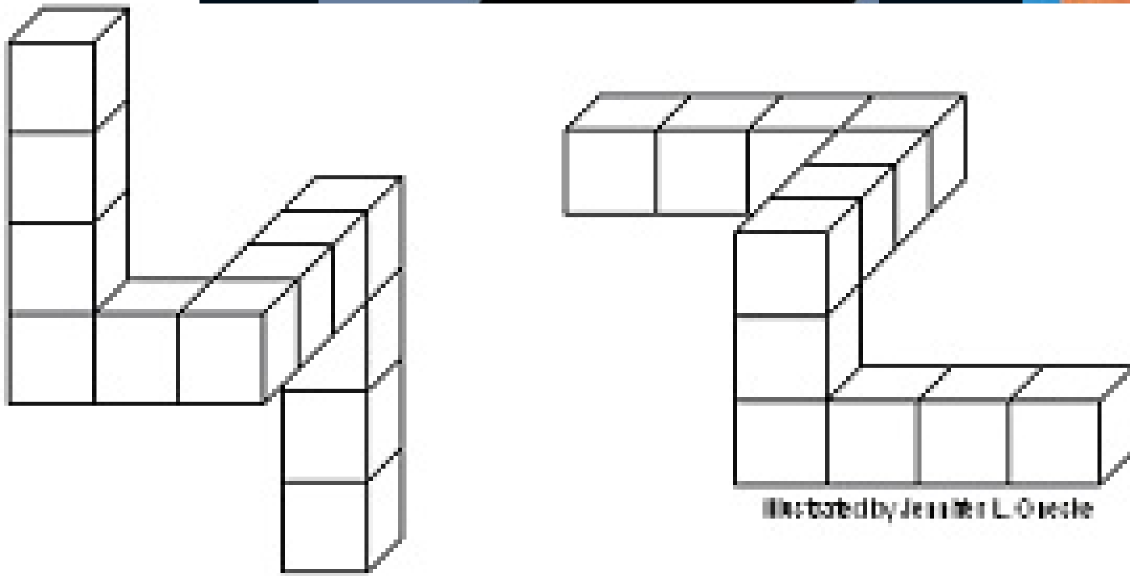
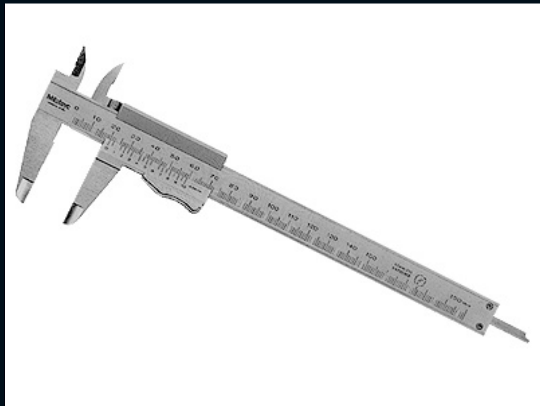


Figure 1: Based on Shepard & Metzlar's 'Mental Rotation Task'

Pur

Figure 2: Mental Rotation Task Based on Canonical Orientations



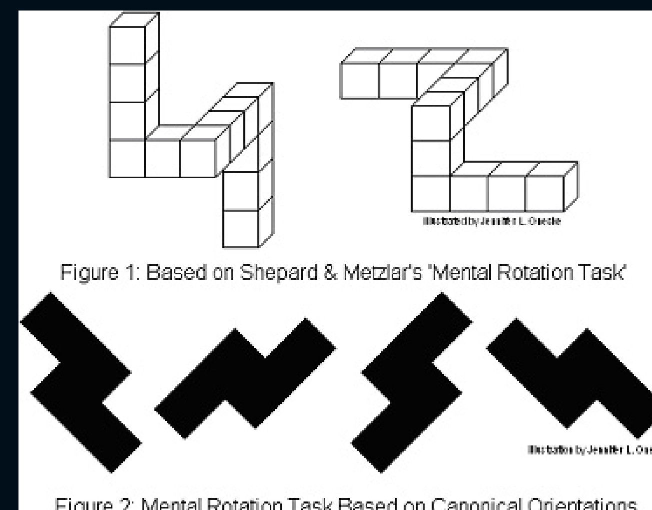
2 Point θ

Von Frey Hair Test

JVP Domes

Purdue Pegboard

Grooved Pegboard



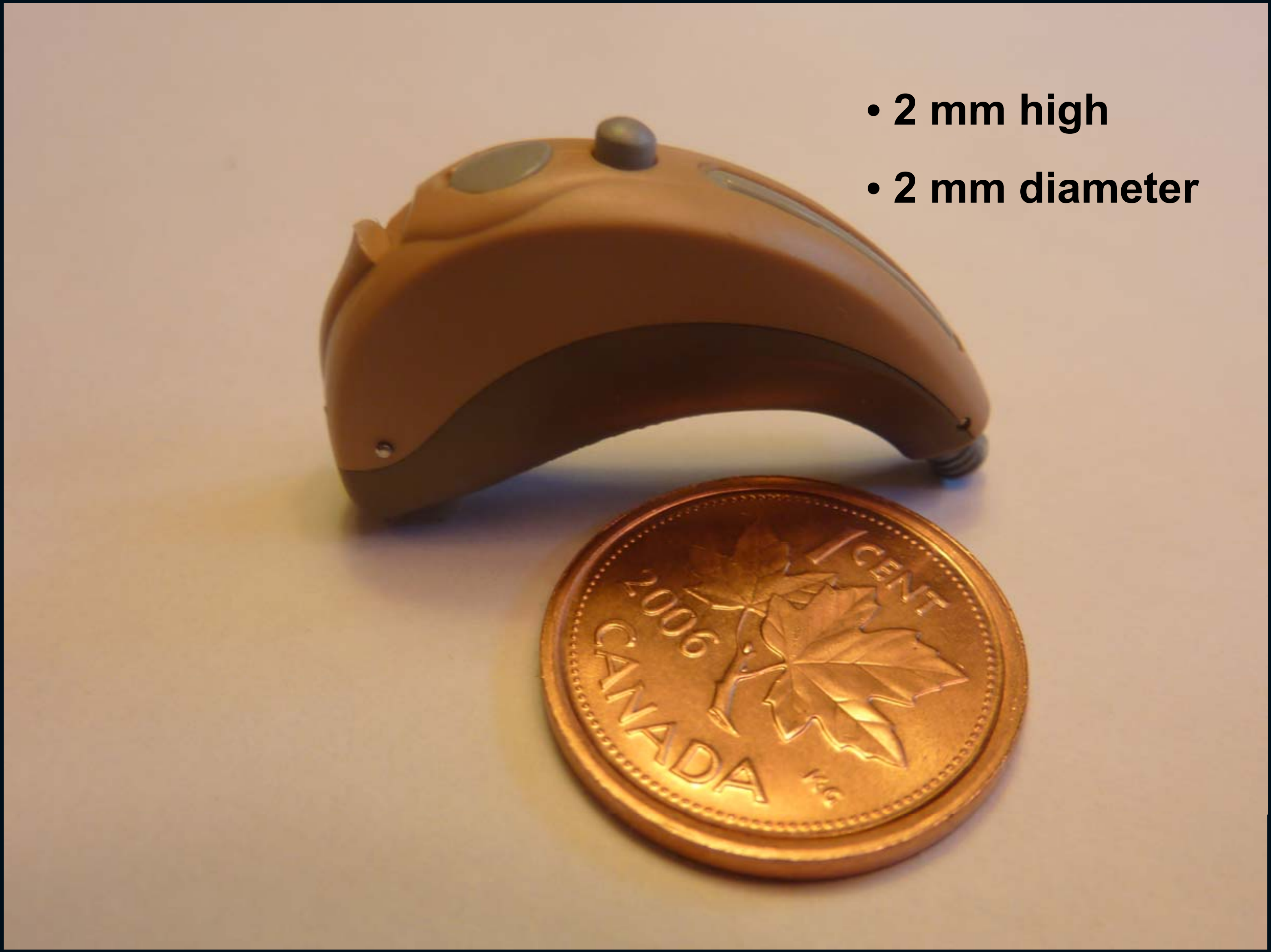
Mental Rotation Test (MRT)

Questionnaire

Disability of Arm, Shoulder, and Hand (DASH)

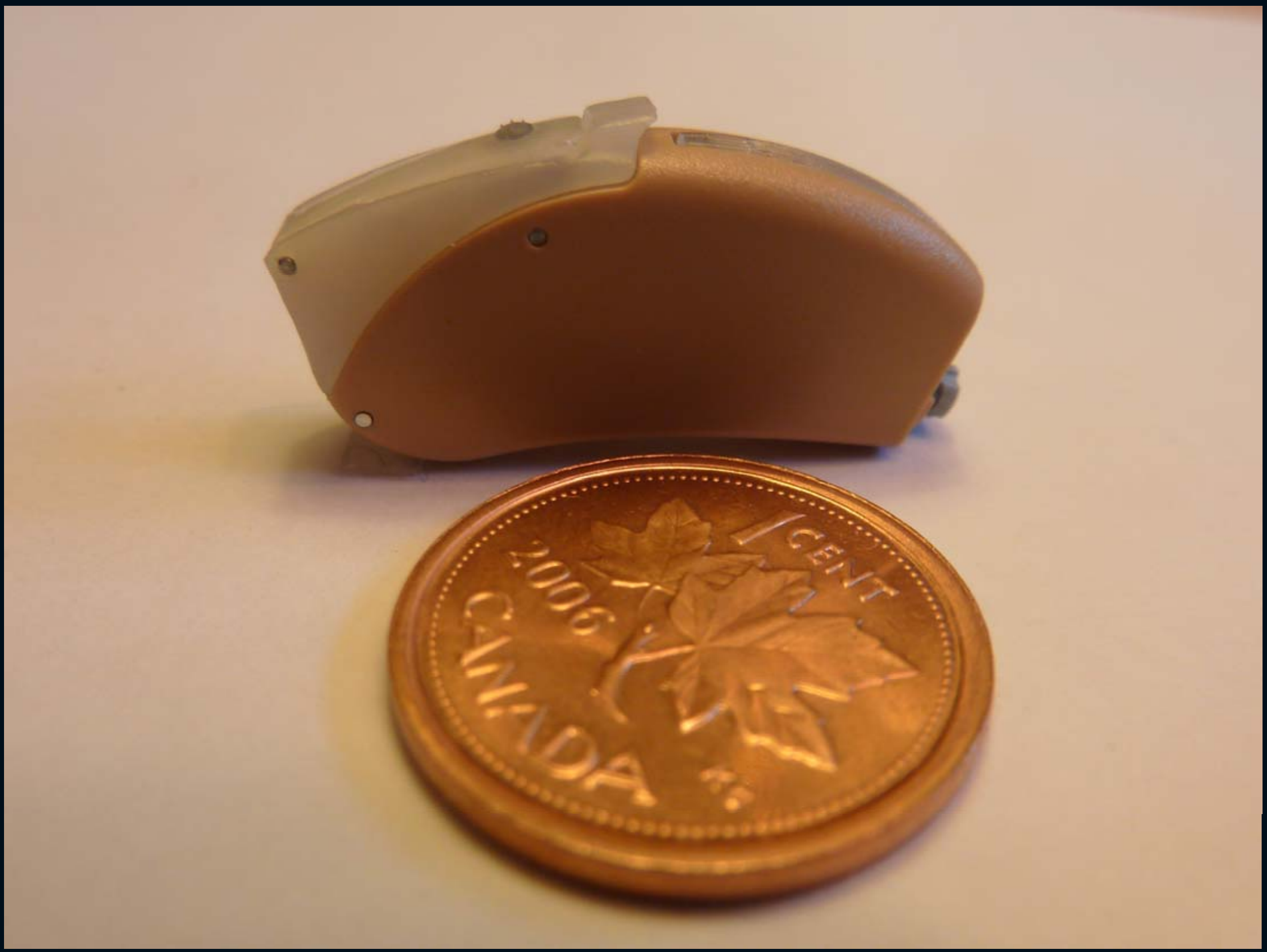
- 15-item measure assessing pain and disability
- 0 = no pain or no difficulty
- 10 = worst pain or unable to perform

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 can not be shown here.

Thank you for your understanding.

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

An International Conference sponsored by Phonak

PHONAK life is on

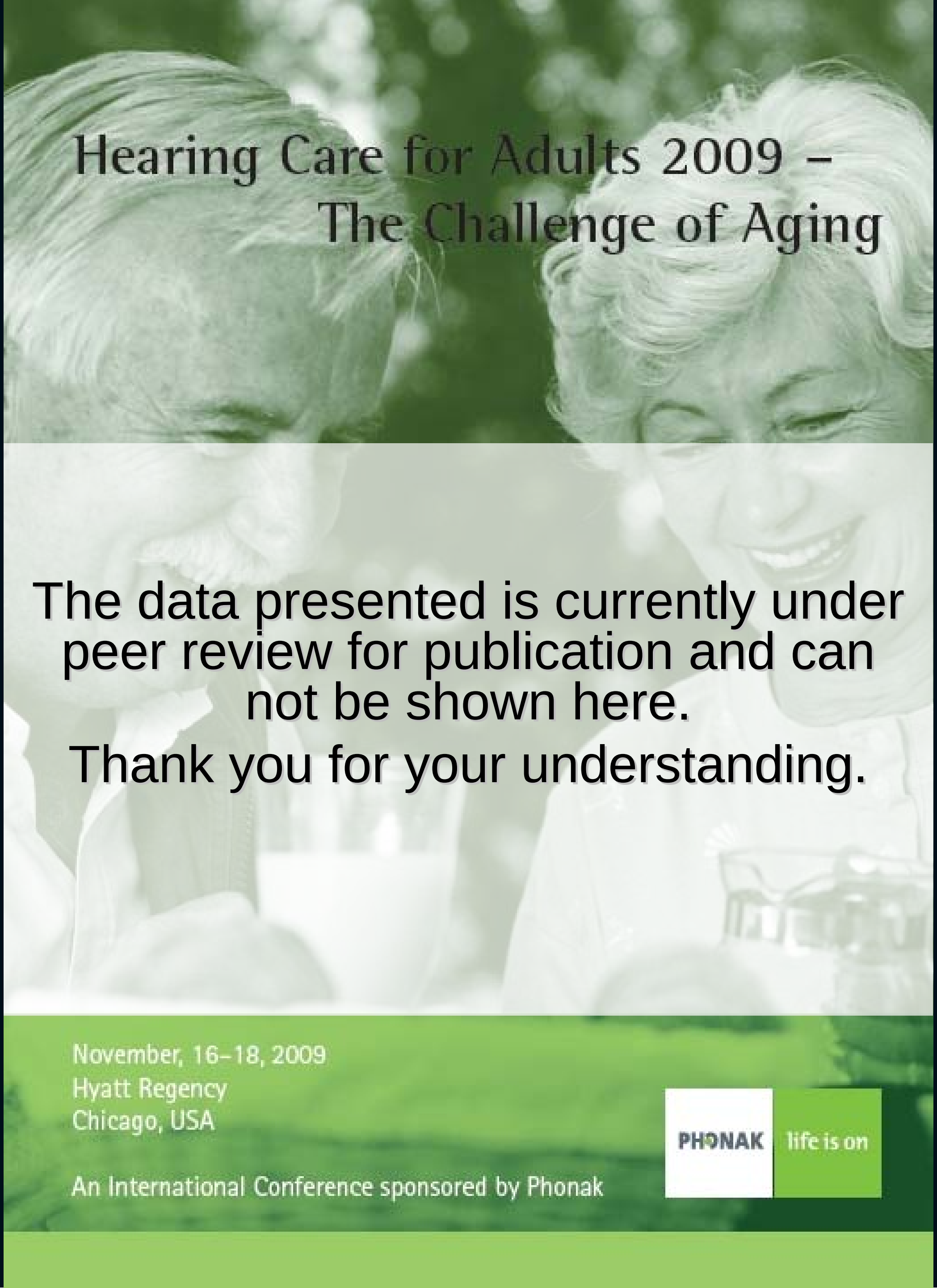
Summary effects

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 9^{th} 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

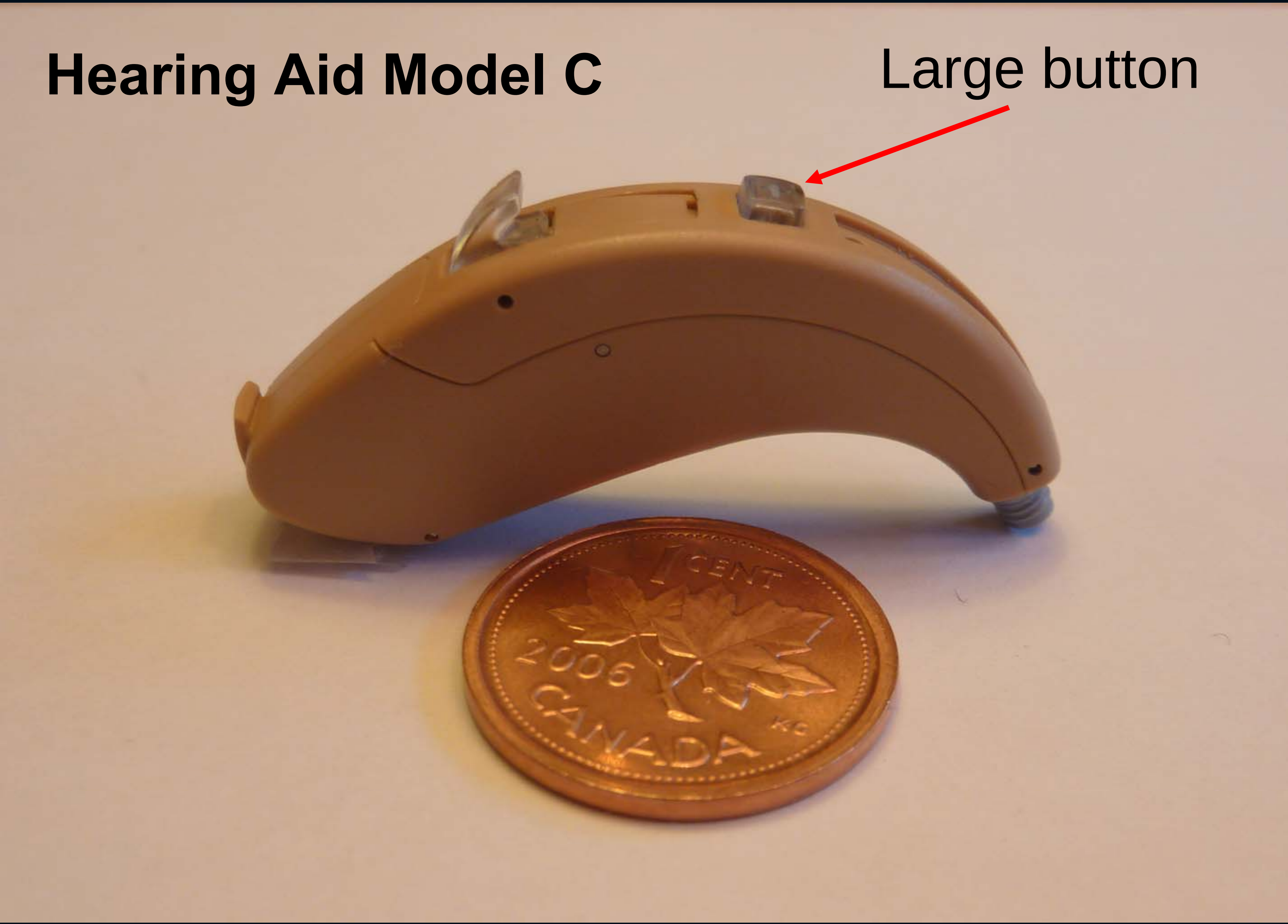

Hearing Care for Adults 2009 –
The Challenge of Aging
The data presented is currently under peer review for publication and can not be shown here.
Thank you for your understanding.
November, 16–18, 2009
Hyatt Regency
Chicago, USA
An International Conference sponsored by Phonak
PHONAK
life is on

Hearing Instruments

Model A Raised

Model B Flat

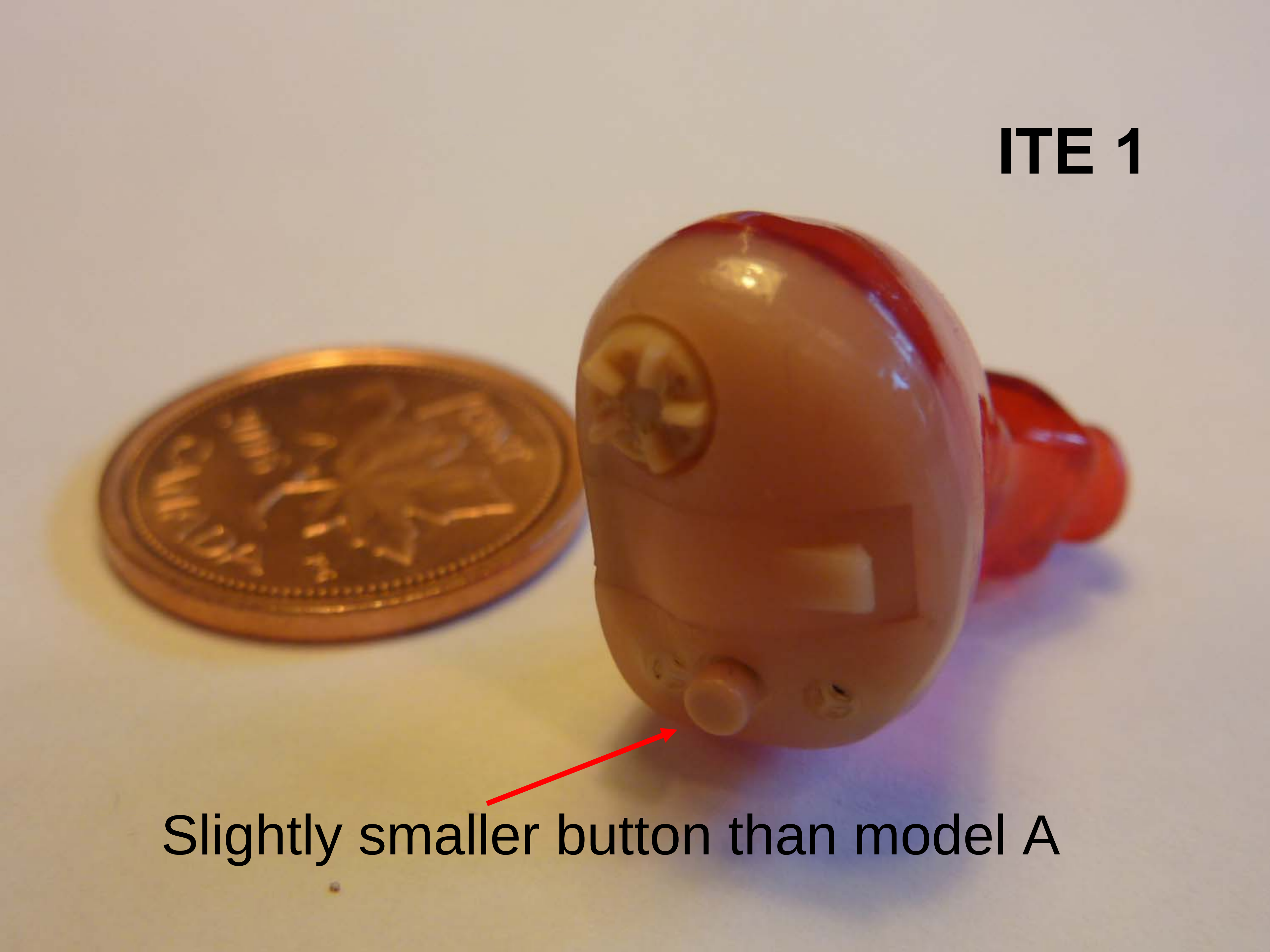
Hearing Aid Model C



Model A
Raised

Model B
Flat

Model C
Large

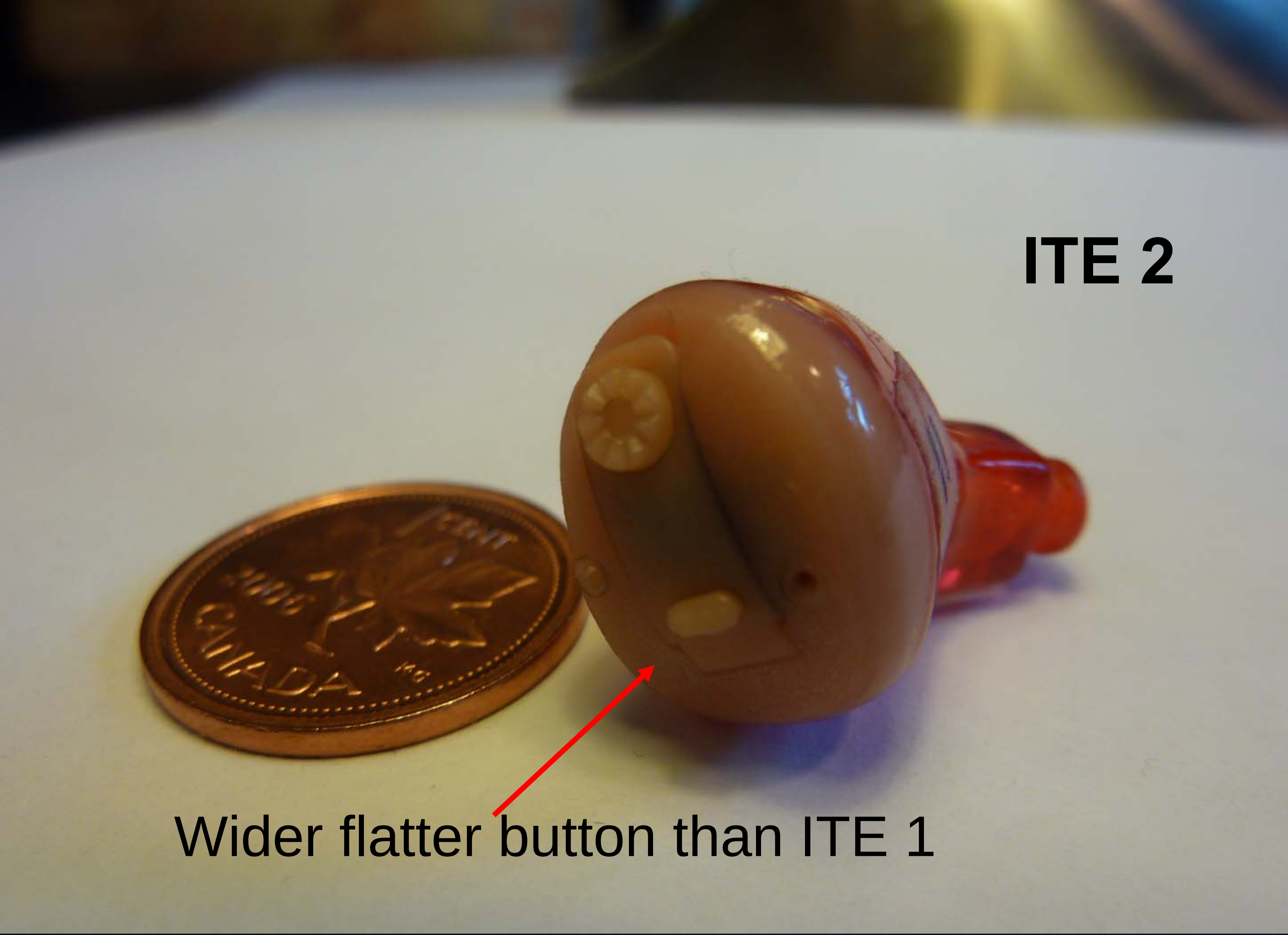

ITE 1
Slightly smaller button than model A

Model A
Raised

Model B
Flat

Model C
Large

ITE 1 Standard


ITE 2
CANADA
Wider flatter button than ITE 1

Model A
Raised

Model B
Flat

Model C
Large

ITE 1 Standard ITE 2 Wide & Flat

Remote

Model A
Raised

Model B
Flat

Model C
Large

ITE 1 Standard

ITE 2 Wide & Flat

Remote

Hearing Care for Adults 2009 – The Challenge of Aging

The data presented is currently under peer review for publication and can not be shown here.

Thank you for your understanding.

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

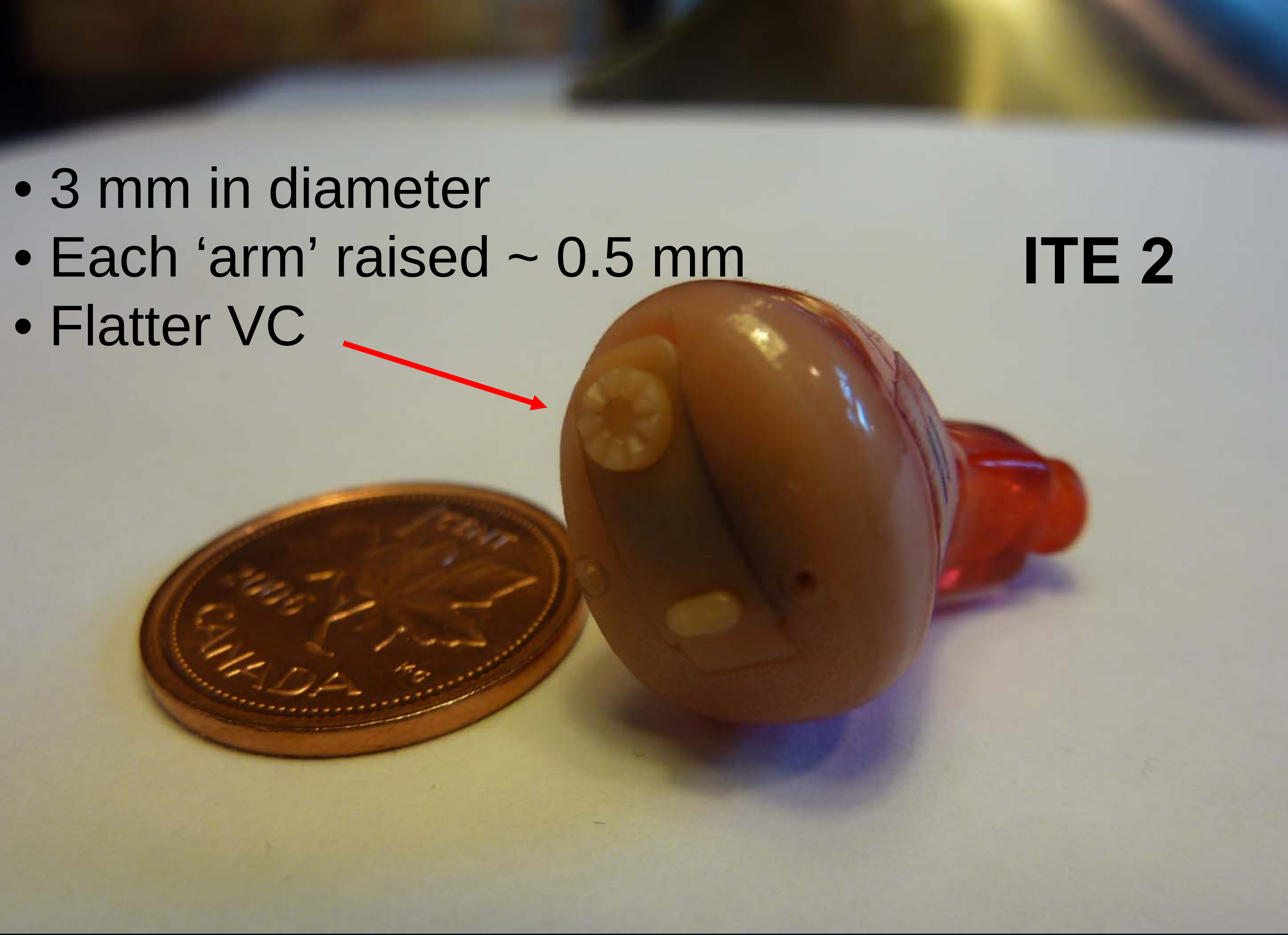
An International Conference sponsored by Phonak

PHONAK life is on

VC manipulation task

ITE 1

- Large raised VC
- 4 mm in diameter
- Each ‘arm’ raised ~1 mm

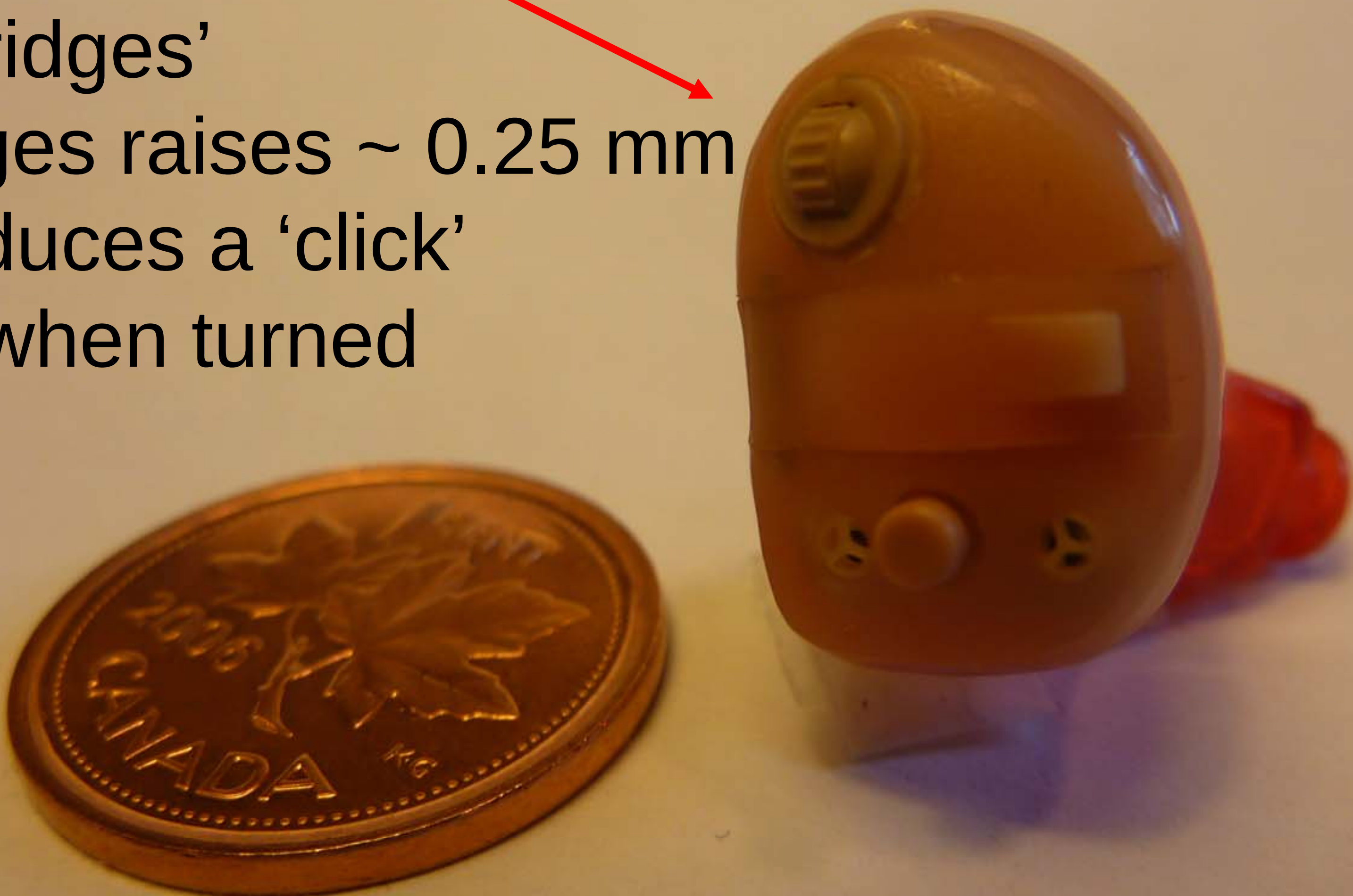

• 3 mm in diameter
• Each ‘arm’ raised ~ 0.5 mm
• Flatter VC
ITE 2

ITE 1 Large

ITE 2 Flat

ITE 3

- 2 mm in length
- 1.5 mm wide
- 15 ‘ridges’
- Ridges raises ~ 0.25 mm
- Produces a ‘click’
  when turned



ITE 1 Large

ITE 2 Flat

ITE 3 ‘Clicks’

Hearing Aid Model C

- 5 mm in length
- 3 mm wide

ITE 1 Standard

ITE 2 Flat

ITE 3 'Clicks'

Model C - Large

Hearing Care for Adults 2009 – The Challenge of Aging

The data presented is currently under peer review for publication and can not be shown here.

Thank you for your understanding.

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

An International Conference sponsored by Phonak

PHONAK life is on

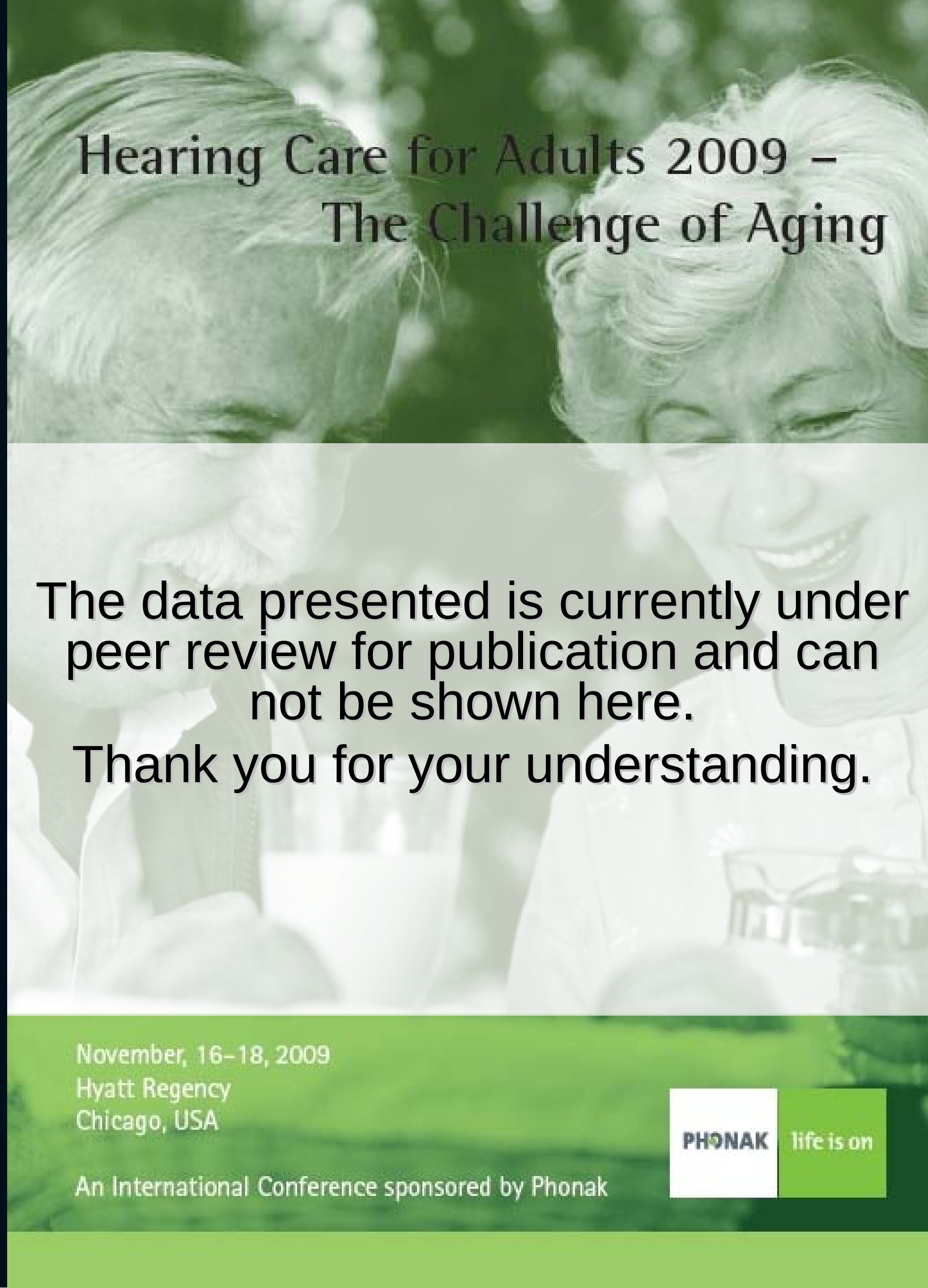
Predicting Hearing Aid Success

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 can not be shown here.

Thank you for your understanding.

Summary effects

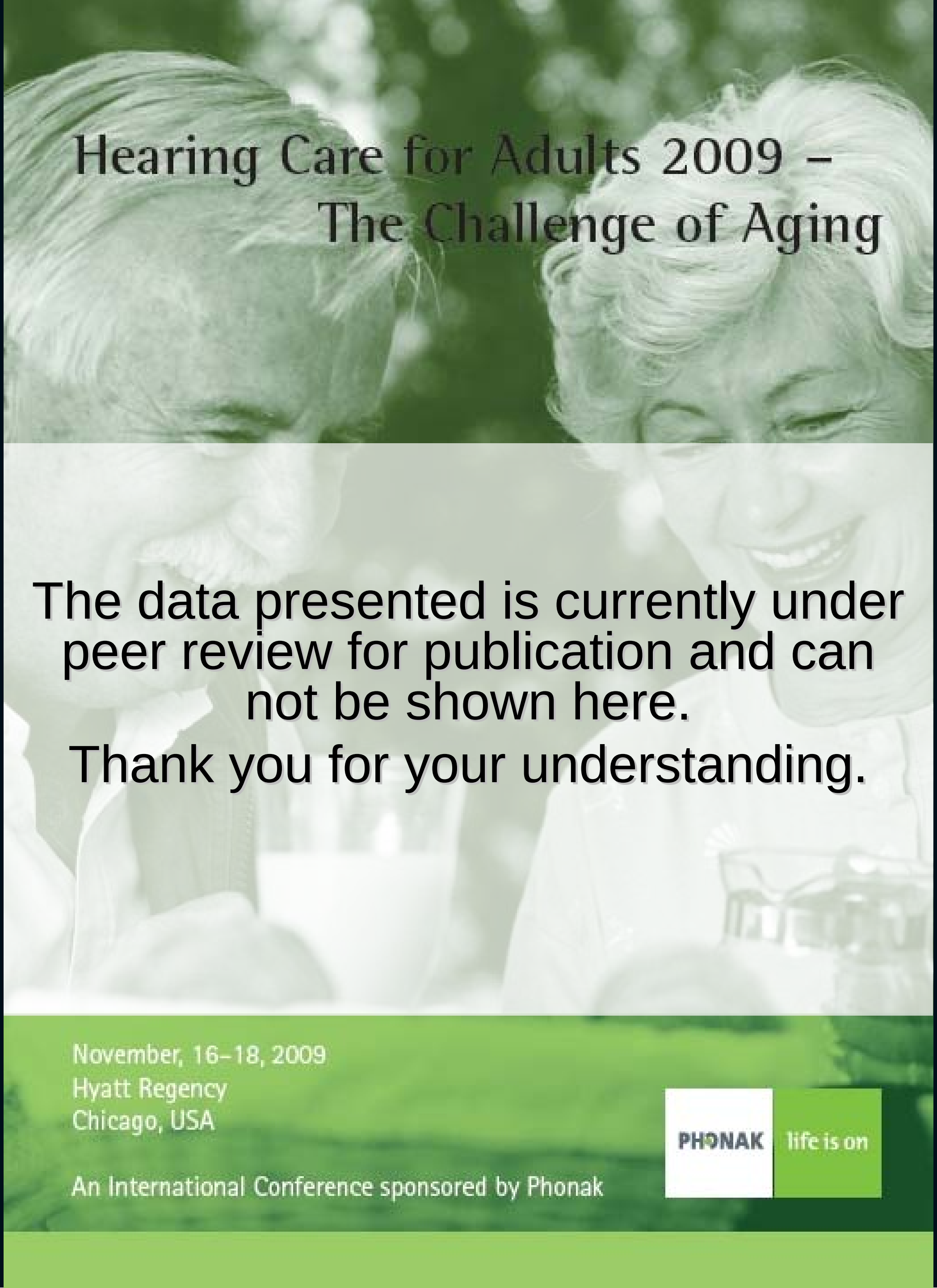
1. Button Pressing:
   - Size and haptic feedback
2. VC adjustments
   - Haptic feedback
3. Dimensions of successful hearing aid use for both BTEs and ITEs
   - Dexterity, haptic sensitivity, and disability

Data from Experiment II

Reported on 56 individuals

Actually collected on:

- 23 subjects: self-reported “normal” hand function
- 23 subjects: self-reported arthritis



The data presented is currently under peer review for publication and can not be shown here.

Thank you for your understanding.

Manipulative Success Arises From:

[redacted]

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' 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