Learning Outcomes:

1. . . . recognize the cognitive nature of listening in complex listening situations.
2. . . . recognize the effects of normal aging on cognitive processing
3. . . . develop a toolbox of intervention techniques that can address both the hearing loss and cognitive changes associated with aging
The Acoustic Explanation of Speech Understanding
What are the limitations?

Speech Understanding:
A Cognitive Process
Object Formation:

• Normally, speech takes on meaning over time

...
Object Formation:

- Normally, speech takes on meaning over time
- Normally automatic, effortless
- Immediate recognition of something meaningful
Noise?

Complex Environments

Multiple talkers
Movement
Stable, non-speech sources
Unstable, non-speech sources
Distractions
Shifting focus
A little bit of everything
How good is the brain?

Before caller I.D. . . .
Party survival skills. . .

Laundry Day . . .
Speech Understanding is a **Cognitive Function**

Natural Voice Separation & Tracking:

Harmonic Structure  
Supra-segmentals  
Visual Cues  
Linguistics  
Loudness  
Location  
Timbre  
Rate  
etc.
How does the brain get the job done?

The brain strives to organize
Real-time Speech Understanding

- More than word recognition
- The ability to extract meaningful information from on-going conversation
- On-going, real-time
- Normally effortless
- Externally Paced
A & D components of hearing impairment

Inner Hair Cells

Normal  Damaged  Aided

Yost & Nielsen, 1985
Inner Hair Cells

- Normal
- Damaged
- Aided

Yost & Nielsen, 1985

What else has to go right?
SNHL: Poor Coding of the Acoustic Signal
Age-related Cognitive Effects
2: Word Recognition captures the information that you need

Davis and Silverman (1970, p. 76)

Speech happens over time
Which Skills Are Affected?
- motor skills
- sensory sensitivity & acuity
- short term memory
- sensory-motor reaction time
- processing & decision speed
- selective attention

Which Skills are Retained?
- Long-term memory (recall)
- intelligence
- linguistic skills

Normal Aging

Neural Slowing
Do cognitive declines affect basic speech understanding?
Relationship between cognitive abilities and speech understanding in noise

Lunner, 2003
Relationship between cognitive abilities and speech understanding in noise

Lunner, 2003

Aging: Loss of Efficient Cognitive Processing
Loss of the ability to *organize* sound

Speech Understanding in Noise:

- Audible?
- Above the noise?
- How sensitive to noise? (distortional component)
- Where does the noise come from?
- What constitutes the “noise”?
- Who is the talker?
- Support cues?
- How much effort is the listener investing?
- How good is the patient at piecing together a partial signal?
Does that mean a hearing aid will not be useful for the older patient?

Population study of the ability to benefit from amplification and the provision of a hearing aid in 55–74-year-old first-time hearing aid users

Adrian Davis
MRC Institute of Hearing Research, University Park, Nottingham NG7 2RD, UK

Compensation Strategies

- Patient Education & Realistic Expectations
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- Patient Education & Realistic Expectations
- Excellent Speech Processing (preserve information)
- Signal-to-Noise ratio improvement
Compensation Strategies

- Patient Education & Realistic Expectations
- Excellent Speech Processing (preserve information)
- Signal-to-Noise ratio improvement
- Fully Automatic Design

- Pacing & complexity of message
Spoken Language Comprehension in Older Adults: Interactions between Sensory and Cognitive Change in Normal Aging

Arthur Wingfield, Ph.D., and Patricia A. Tun, Ph.D.

Seminars in Hearing, 2001
Compensation Strategies

- Patient Education & Realistic Expectations
- Excellent Speech Processing (preserve information)
- Signal-to-Noise ratio improvement
- Fully Automatic Design
- Pacing & complexity of message
- Clear Speech

Clear Speech: Research History

- Picheny, Braida, & Durlach: Mid 1980’s
  - coined the term, contrasted to “conversational style speech”
  - documented acoustic changes
  - documented intelligibility improvement
Acoustic Changes

- Slower rate of speech
- More frequent and longer pauses
- Longer phoneme durations (consonants & vowels)
- More released word-final stops
- Greater differentiation of vowels
- Improved Consonant/Vowel ratio

Effect?

15-20% WR improvement
Clear Speech Training

Who?
What?
When?
Where?
How?
Clear Speech Training

- Explain Importance
- Define/describe Clear Speech
- Demonstration & Practice
  - Demonstrate reductions
  - Demonstrate emphasis of key words
  - Demonstrates phrasing
- Continuous Discourse
- Other Communication Tactics

Compensation Strategies

- Patient Education & Realistic Expectations
- Excellent Speech Processing (preserve information)
- Signal-to-Noise ratio improvement
- Fully Automatic Design
- Pacing & complexity of message
- Clear Speech
- Follow-up Programs
Nature of Aging plus Sensorineural Hearing Loss:

Loss of the ability to organize sound