

CSI Audiology: Television Listening for Patients with Hearing Loss

ERIN M. PICOU, AUD, PHD

VANDERBILT UNIVERSITY MEDICAL CENTER

CANADIAN ACADEMY OF AUDIOLOGY



Disclosures

Employed by Vanderbilt University
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Associations

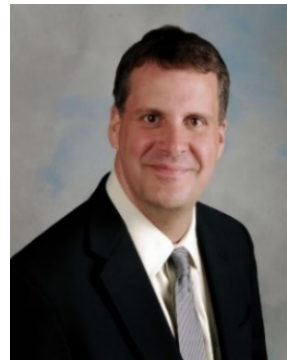
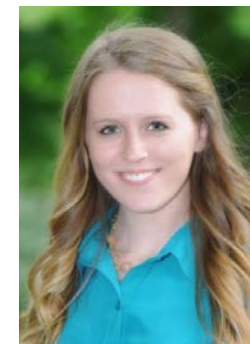
- Editorial Board of the *American Journal of Audiology*
- Associate Section Editor for *Ear and Hearing*

Collaborators

- Becky Wiacek, Todd Ricketts
- Javier Santos, Keerthana Velappan, Amy Stahl, Sarah Alfieri, Gabby Buono, Haiping Huang

Receive funding for research from

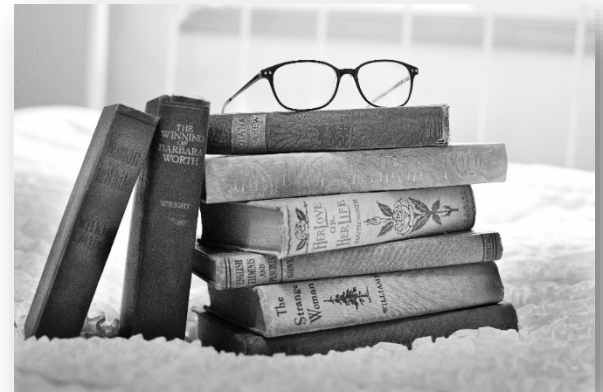
- National Institutes of Health
- National Science Foundation
- American Speech-Language Hearing Association
- Sivantos
- Oticon
- Phonak / Sonova
- Resound
- Starkey



Learner Outcomes

Upon completion, participants will be able to:

- 1) describe the effects of hearing loss on television listening
- 2) describe the effects of speaker configuration on television listening



CSI Audiology

CSI: Crime Scene Investigation is a drama about

- a team of forensic investigators
- trained to solve criminal cases
- by scouring the crime scene,
- collecting irrefutable evidence,
- and finding the missing pieces that solve the mystery



The Crime

"I can't understand

"The words are jum

"I can't hear the wo

"My wife complains

"My neighbor comp



my grandkids"

The Crime

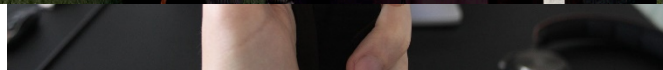
"I can't tell you what I did."

"The"

"I can't"

"My"

"My"



CSI Audiology

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- by scouring the crime scene,
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- and finding the missing pieces that solve the mystery

Many different “teams”

- CSI: NY
- CSI: Miami
- CSI: Dark Motives
- CSI: Audiology



CSI Audiology

CSI: Crime Scene Investigation is a drama about

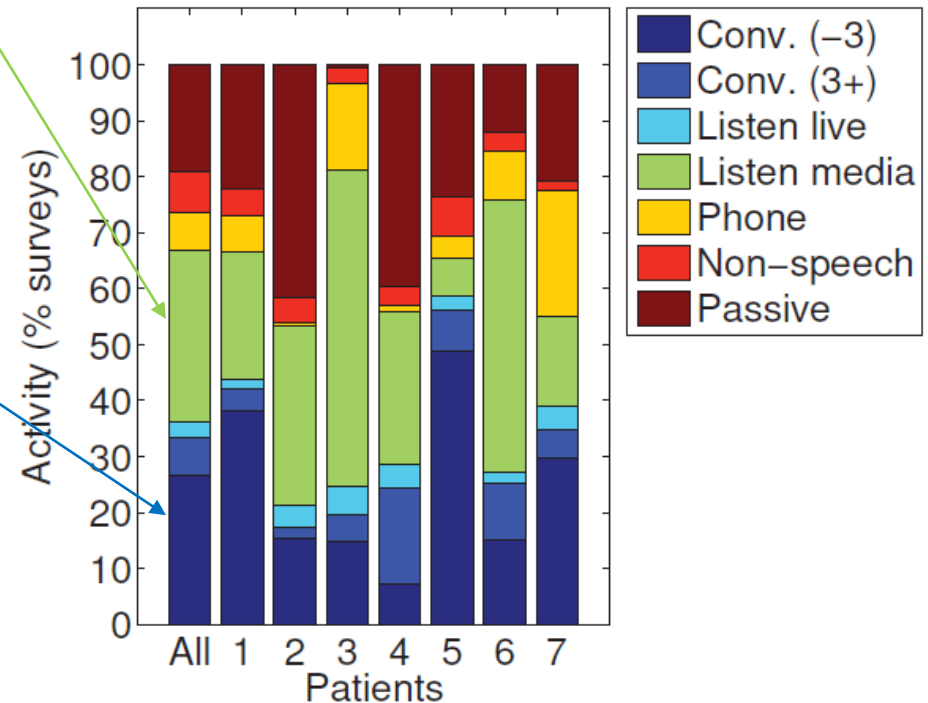
- a team of forensic investigators
- trained to solve criminal cases
- **by scouring the crime scene,**
- collecting irrefutable evidence,
- and finding the missing pieces that solve the mystery



How Prevalent Is Media Viewing?

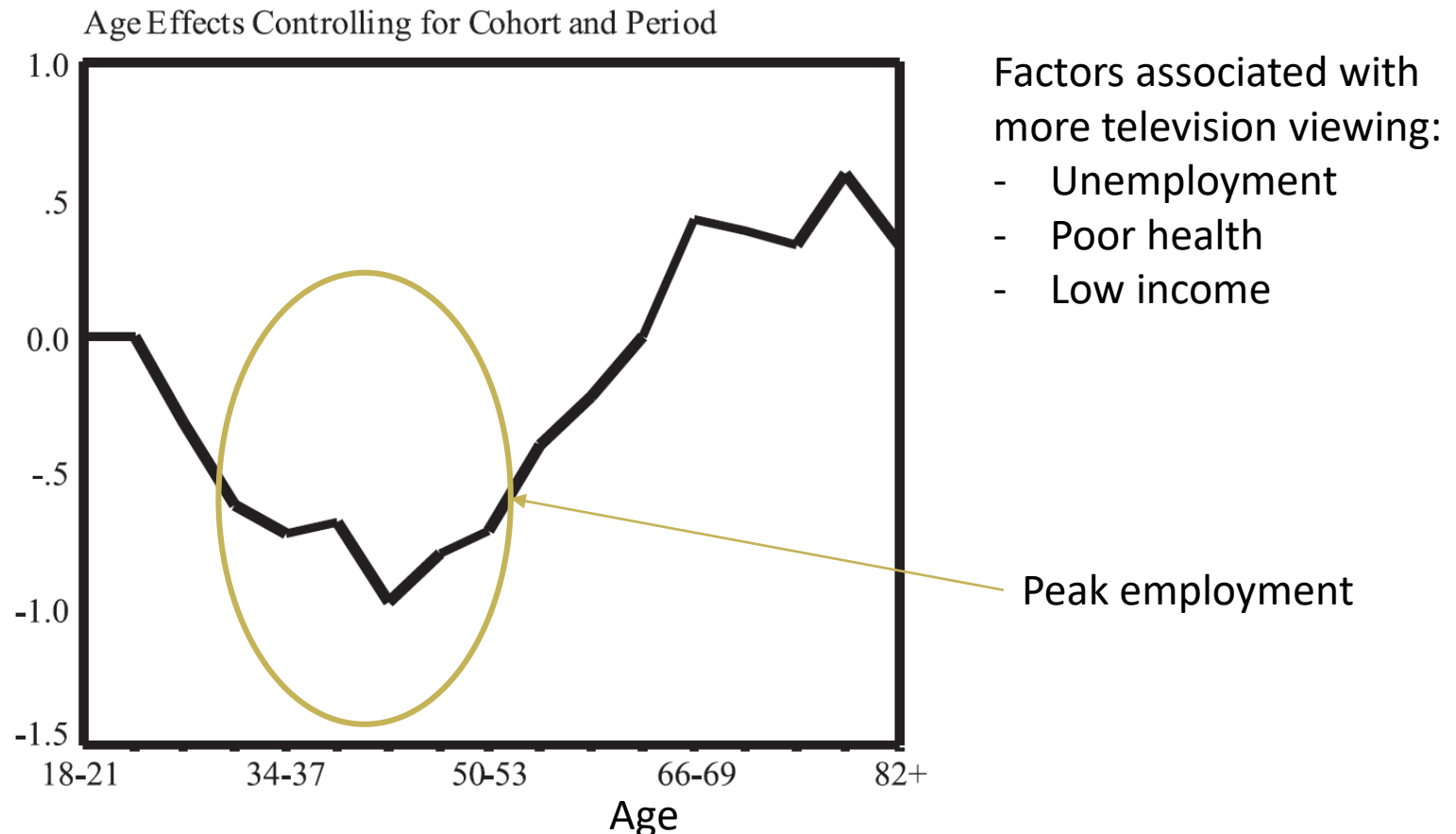
Listening to media is the 2nd most common listening activity

- 31% of the time listening to media
- 33% of the time listening was in a conversation



During a 16 hour day, about 5 hours of media viewing

Television Viewing Common in Older Adults



Not Only More Leisure Time

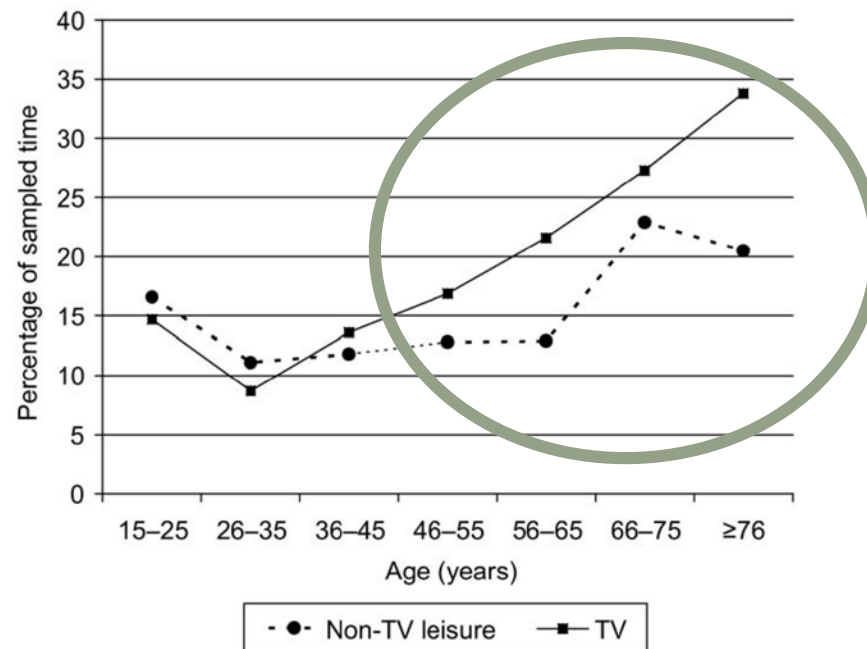


Figure 1. Percentage of sampled time engaged in TV and non-TV leisure activities by age
Note: Values are sample weighted. Percentage of sampled time (excluding sleeping and grooming) was calculated as duration engaged in the activity divided by summed duration of all sampled activities within each strata.

Hearing Loss Common in Older Adults

Hearing loss increases social isolation and communicative disengagement

- Kramer et al (2006) *Int J Audiol*, 45, 503-512
- Hawthorne (2008) *Soc Psychiatry Psychiatr Epidemiol*, 43, 140 – 150

Patient reports

I don't get out much any more
I don't listen to much besides my TV
I can't see well enough to read, so I listen to the TV



Why Do People Watch Television?

Relaxation and mood improvement

- Lee & Lee (1995) *J Advert Res*, 35, 9 - 19
- Depp et al (2010) *Am J Prev Med*, 39, 173-178

Identification and feeling of belonging

- Rusell & Puto (1999) *Mark Lett*, 10, 393 – 407

Vicarious feelings of joy

- Riess & Wiltz (2004) *Media Psychol*, 6, 363-378

Addiction

- Sussam & Moran (2013) *J Behav Addict*, 2, 125 - 132

“I need to stop,”

I whispered to myself, as I
clicked ‘next episode’.



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Do People with Hearing Loss Have Difficulty Understanding the Television?

Need to increase volume on the television a documented problem for the patient with hearing loss (and their significant other)

- Héту et al (1988) *Br J Audiol*, 22, 251 – 264

One of the most common complaints for people and perhaps one of the early indicators of hearing loss

- Second most common report behind “can’t hear a whisper”
 - Gates et al (2003) *J Fam Pract*, 52, 56 – 62
- More than 50% of participants with unilateral or mild hearing loss reported trouble understanding the television
 - Newman et al (1997) *Ann Otol Rhinol Laryngol*, 106, 210 - 214



Why is the television difficult?

Rapid dialogue

Accented speech

Intermittent visual cues

Loudspeakers

Poor dialogue-to-
background ratios



Rapid Dialogue

Many forms of broadcasts are quick (news reports, sports commentary, dramas)

Some broadcasts are time compressed (benefits for commercial air time)

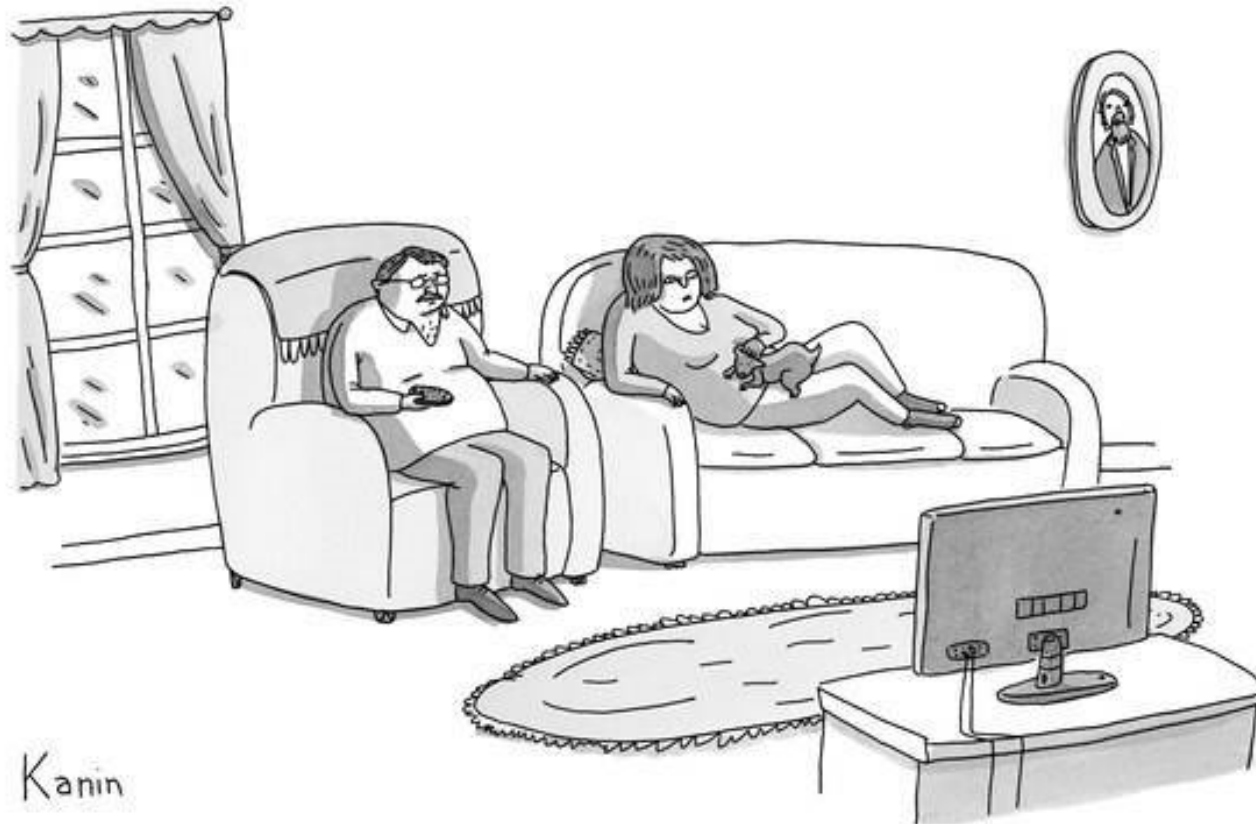
Effects of age and hearing loss on rapid speech recognition exacerbated by limited semantic context



Accented Speech

Television and movies portray places and talkers that might not otherwise encounter





"At some point, there's only so high you can raise the volume before you admit you're never gonna understand what British detectives are saying."

Intermittent Visual Cues

Movies filmed in different language are dubbed

Lip-reading not available when speaker not facing the camera



Why Are Speakers A Problem?



Where did the speakers go?

Where Did The Speakers Go?



Consequences of “Default” TV Speakers

Reduced sound quality due to speaker size

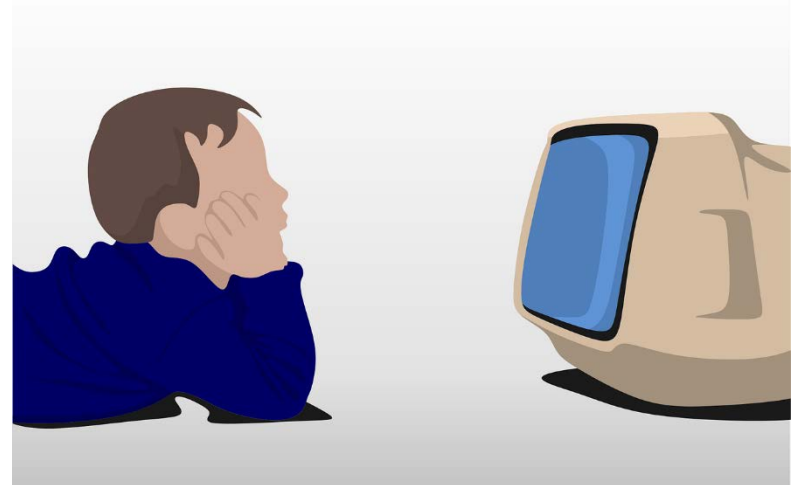
Reduced or eliminated spatial release from masking

Introduction of reverberation

Implications:

Spatial separation and limited reverberation affect speech recognition

Listeners with hearing loss may be more susceptible to reverberation than their peers with normal hearing



Dialogue-to-Background Ratio

Signal-to-noise ratio has a large impact on understanding

In the case of television / movie viewing, the “noise” might also be interesting and important

- Music
- Sound effects
- Competing talkers

Push for “realistic” sound



What are the consequences of struggling with the television?

Television viewing serves function (relaxation, vicarious joy, addition)

Older adults watch more television, but enjoy it less than younger viewers

- Depp et al (2010) *Am J Prev Med*, 39, 173-178

Implications for well-being and quality of life



CSI Audiology

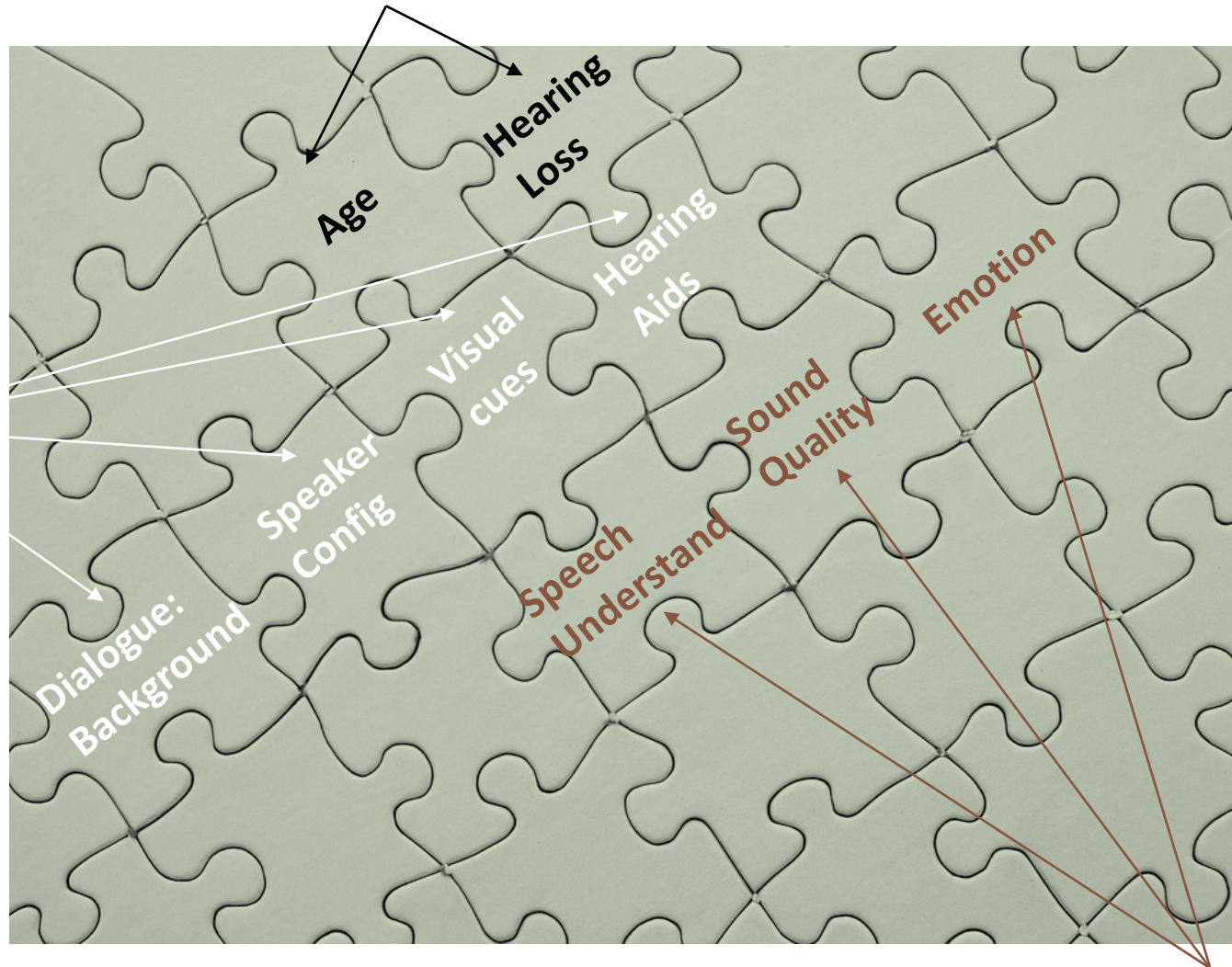
CSI: Crime Scene Investigation is a drama about

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Participant Factors

Malleable Factors

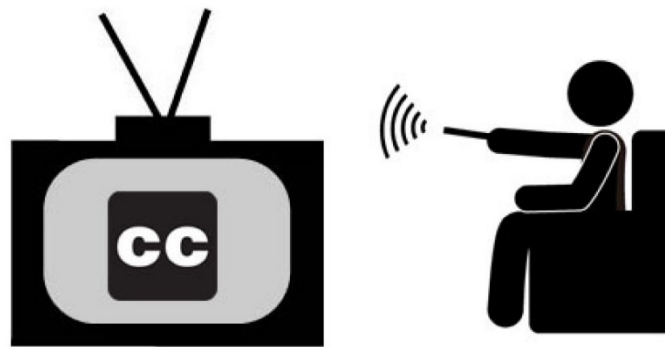


Outcomes

Solving the Mystery: Visual Cues Through Captions

Closed captions

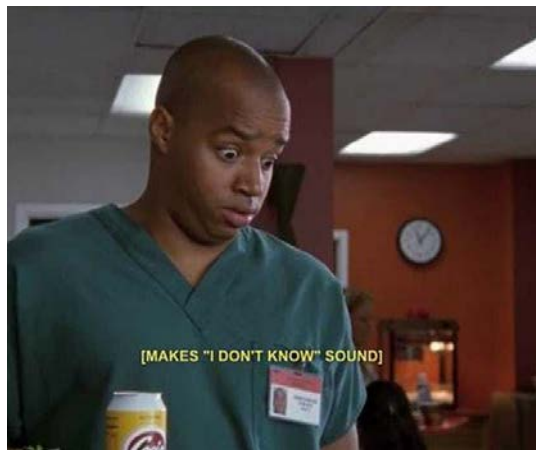
- Text display superimposed on video average 141 words per minute
- Average conversational speech is 140 – 180 words per minute
- Federal Trade Commission mandated that all televisions > 13" have circuitry to decode and display closed captions after 1993
- Also exists in movie theatres with rear window captioning



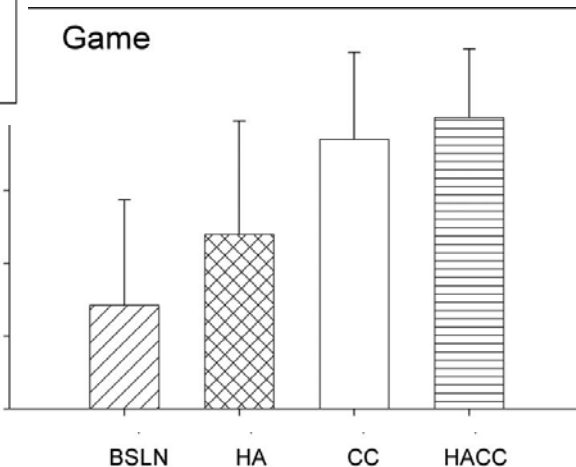
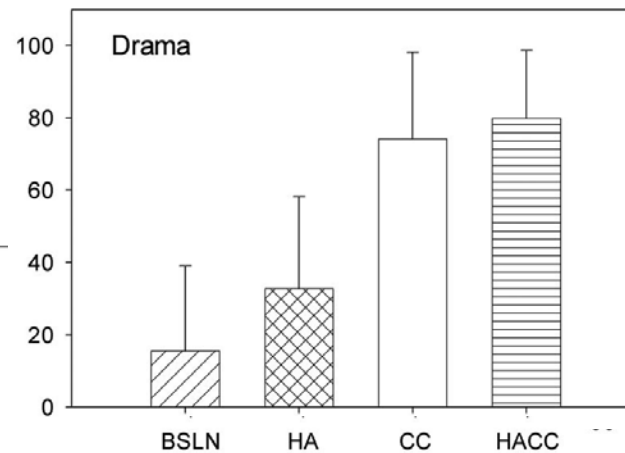
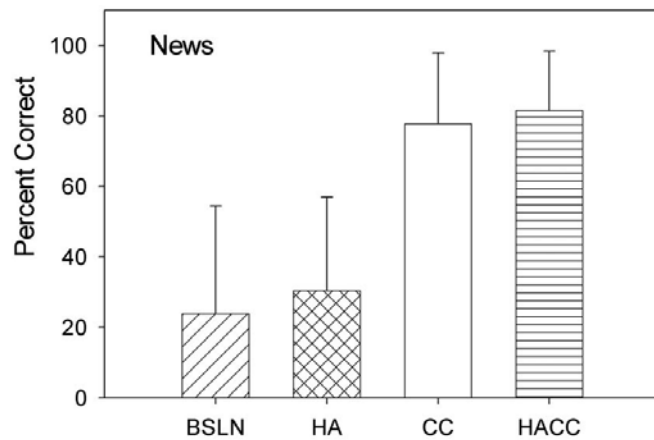
Solving the Mystery: Visual Cues Through Captions

Limitations of closed captions

- Some television content is fast – over 210 words per minute
- Captions aren't always accurate – average 5% of content is edited, range 0 – to 19%
 - Ad libbing (e.g., newscast versus interviews in morning shows)
 - Captioning sounds
 - Live broadcasts (e.g., football)
 - Shorten scripts (e.g., Hanging with Mr. Cooper)



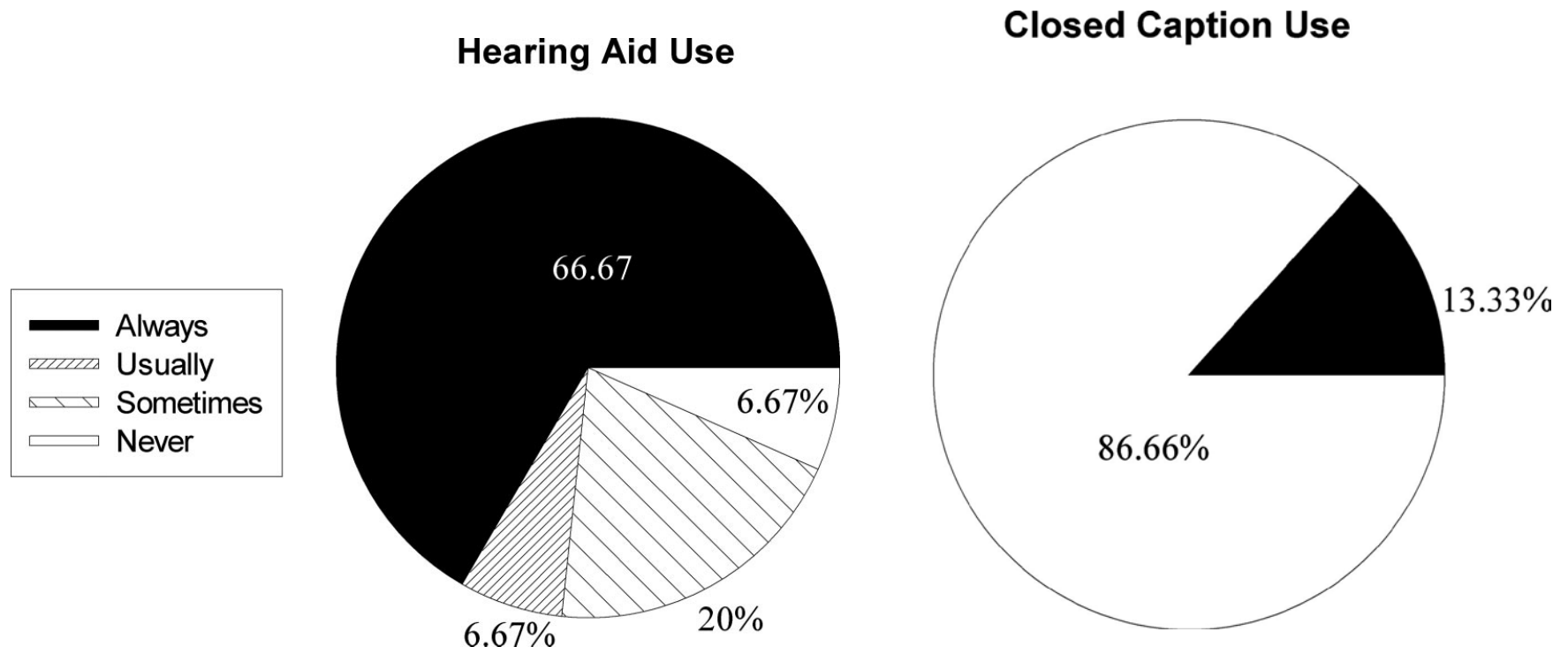
Closed Captions Can Improve Recognition (Hearing Aids Don't)



4 conditions:

- 1) Baseline
- 2) Hearing aids
- 3) Closed captions
- 4) Closed captions with hearing aids

What do people use?



Visual Cues More Beneficial for Young Than Older Adults

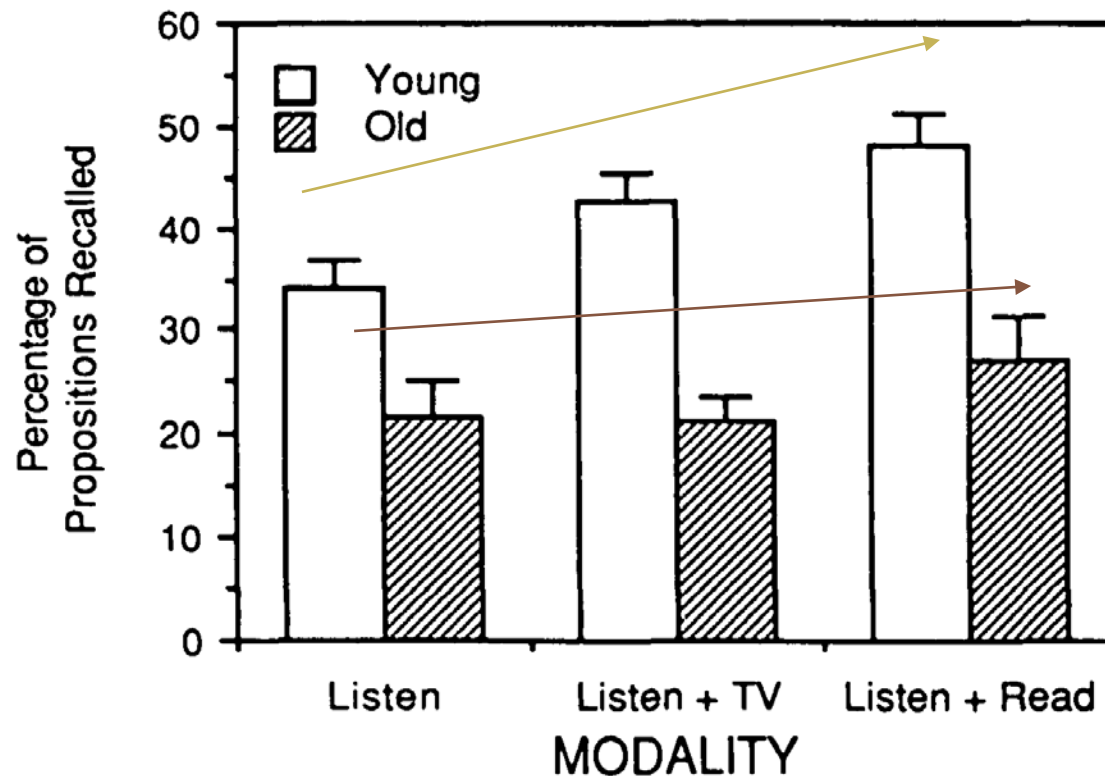
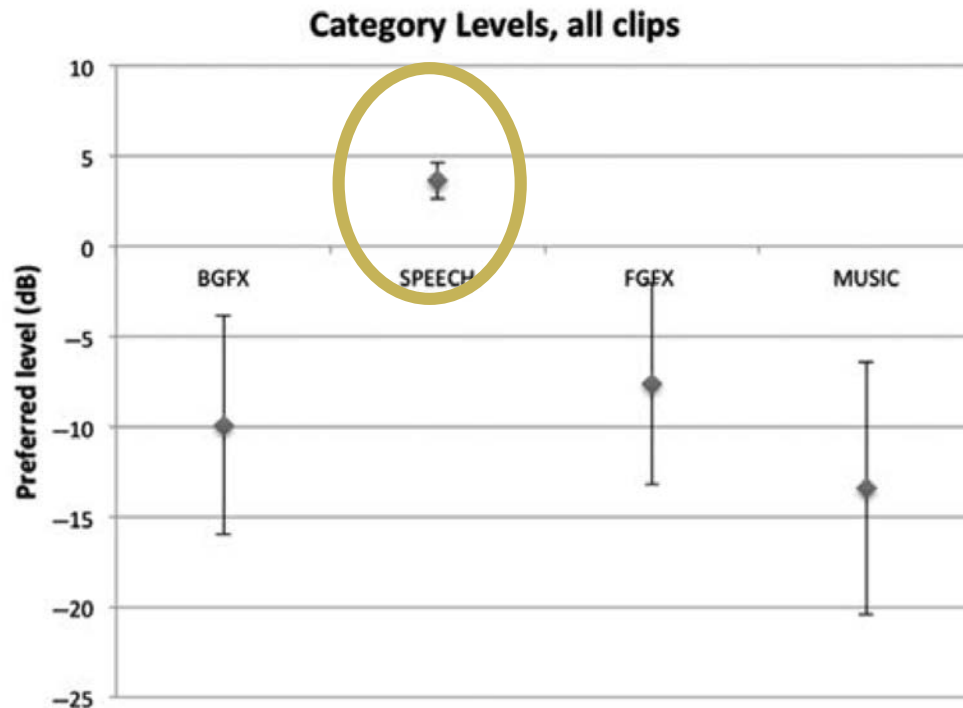


Figure 1. Percentage propositional recall as a function of age and input condition. (Data are shown for immediate recall only.)

Dialogue to Background Levels



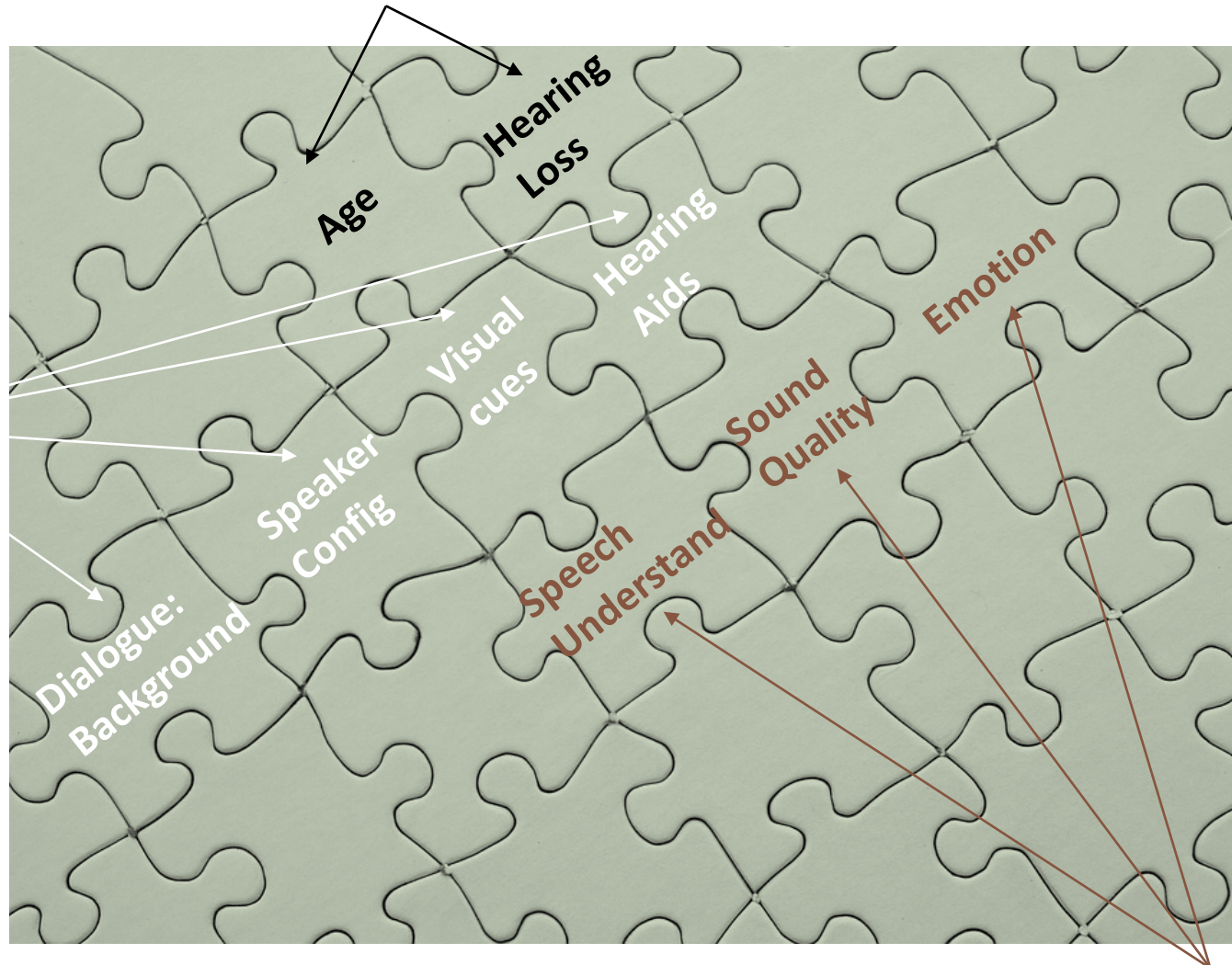
"First time I have been able to understand dialogue without subtitles in a very long time, I really liked being able to control the sounds"

- Participant 13 (pg 299)

Fig. 6. Mean preferred levels for each sound category, 0dB represents the default level set by the production mixer, error bars indicate 95% confidence intervals.

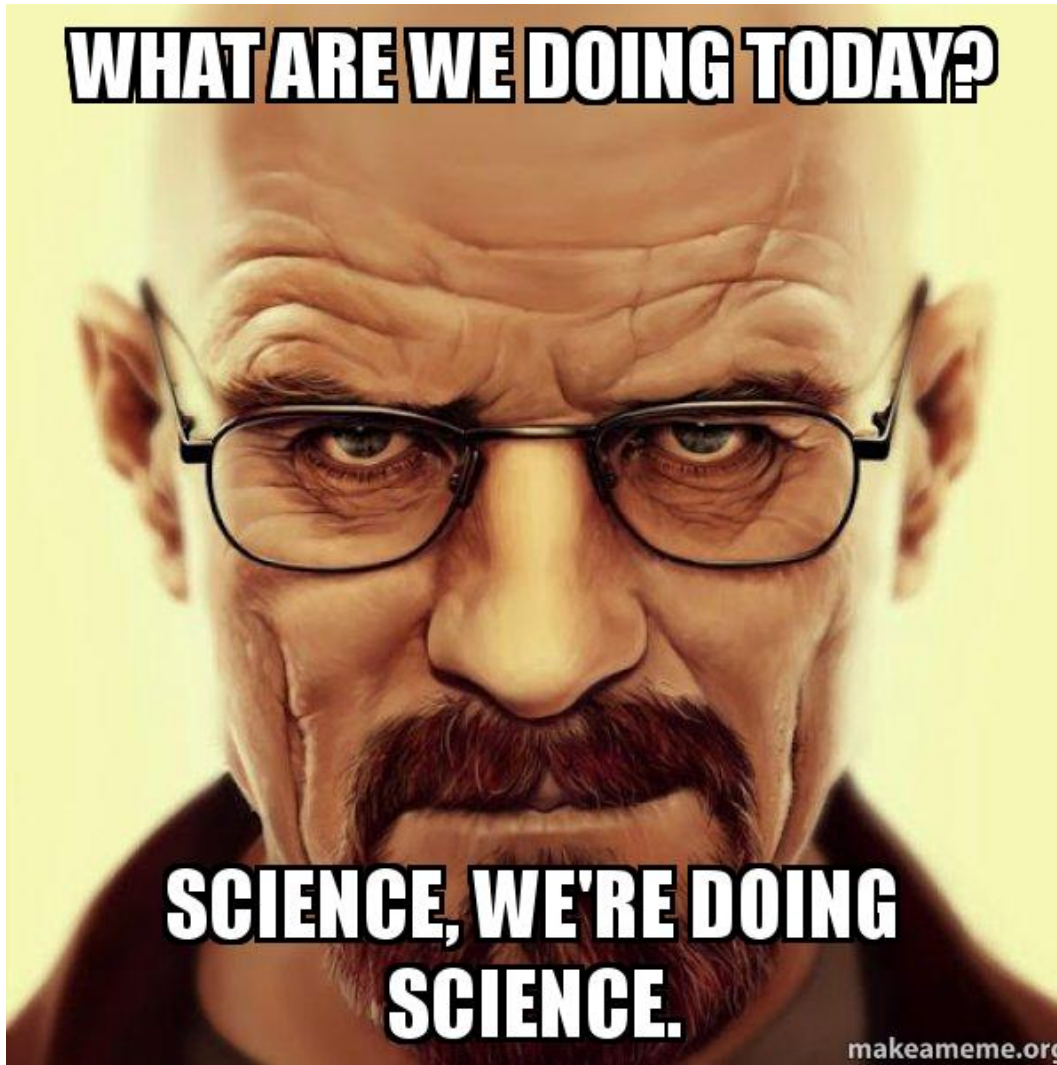
Participant Factors

Malleable Factors



Outcomes

WHAT ARE WE DOING TODAY?



**SCIENCE, WE'RE DOING
SCIENCE.**

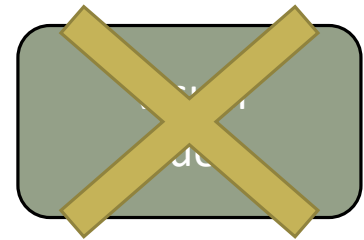
makeameme.org

Ongoing Study

Malleable
Factors

Loudspeaker
Configuration

Dialogue:
Background
Ratio



Group
Variables

Age

Hearing Loss

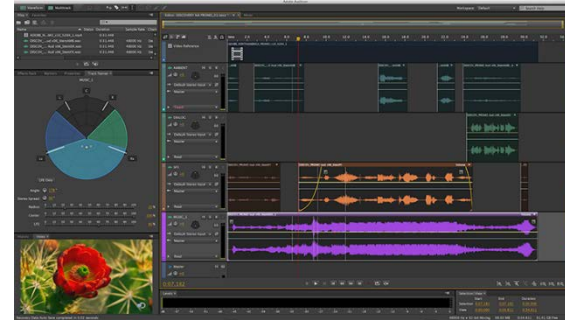
Outcome
Dimensions

Speech
Intelligibility

Sound
Quality

Emotional
Response

Obtaining Materials



Connect
& Wire

Search
& Listen

Analyze
& Edit

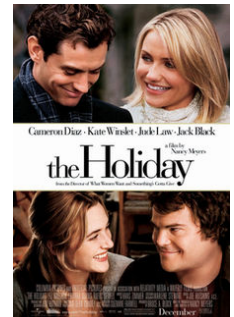
Study Stimuli

10 second clips from 12 sources

Goals of selection:

- Speech: American and foreign accents, male and female talkers, different rates of speech
- Noise: conversations, variety of music, “noise”

- 1) Speech in Classical Music
- 2) Two Men in Background Music
- 3) Conversation in Modern Music
- 4) Women in Cafeteria Noise
- 5) Restaurant Conversation
- 6) Conversation in Background Noise



Methods

Participants

- Young adults with normal hearing
- Older adults with “normal” hearing
- Older adults with bilateral, SNHL, non-hearing aid users

Clips

- 10 seconds each
- Counterbalanced across condition
- Presented at 70 dB

Conditions

- Modality (Auditory-only, Auditory-visual)
- Loudspeaker configurations (TV, Stereo, Surround)
- Dialogue-to-background ratio (+7, +12)

Clip Examples

Good (+12 dB SNR)



Bad (+7 dB SNR)



Project Set Up



More on Speaker Configuration

TV Speakers

“Out of the box”

For the average TV watcher

Typically stereo, but low quality (poor frequency response), and pointed in less than optimal directions (down/back)

External Stereo Speakers

Higher quality (better frequency response) than TV speakers

Broader acoustic image between the two speakers

Perceive a horizontal panorama of sound

Surround Sound

Additional center speaker and surround sound (back) speakers

Enhance immersion and spatial cues

Spatial separation improve speech understanding?

Survey Questions

How much of the speech could you understand?

- 1 (all of it) – 7 (about half of it) – 13 (none of it)

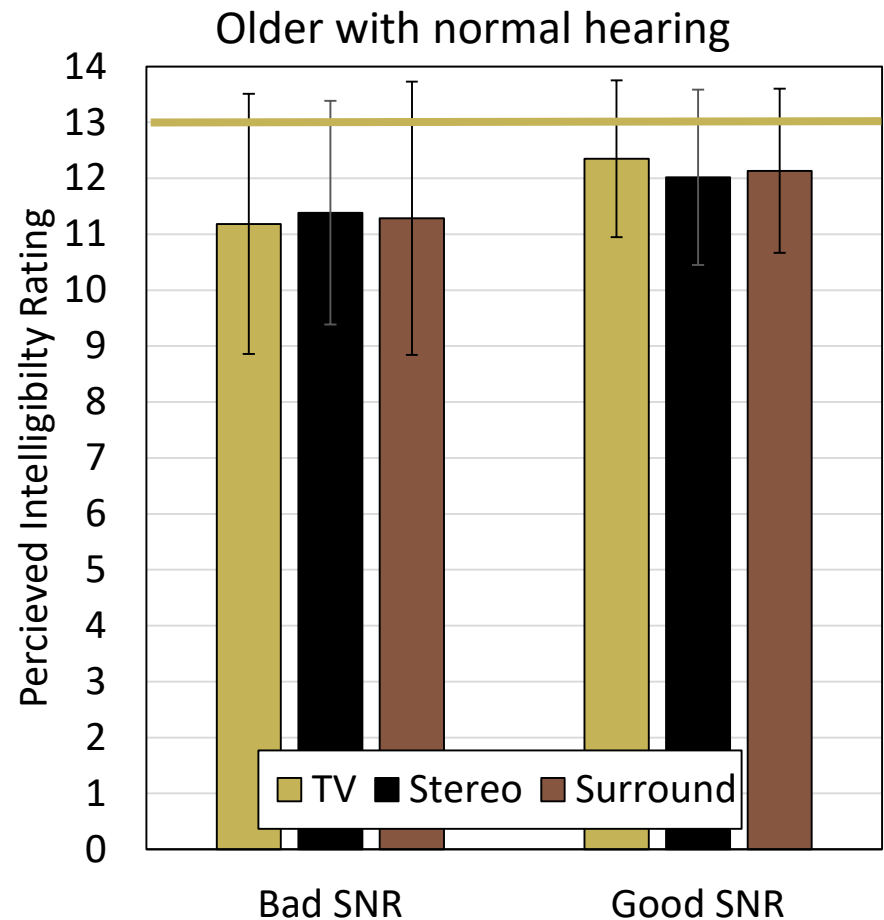
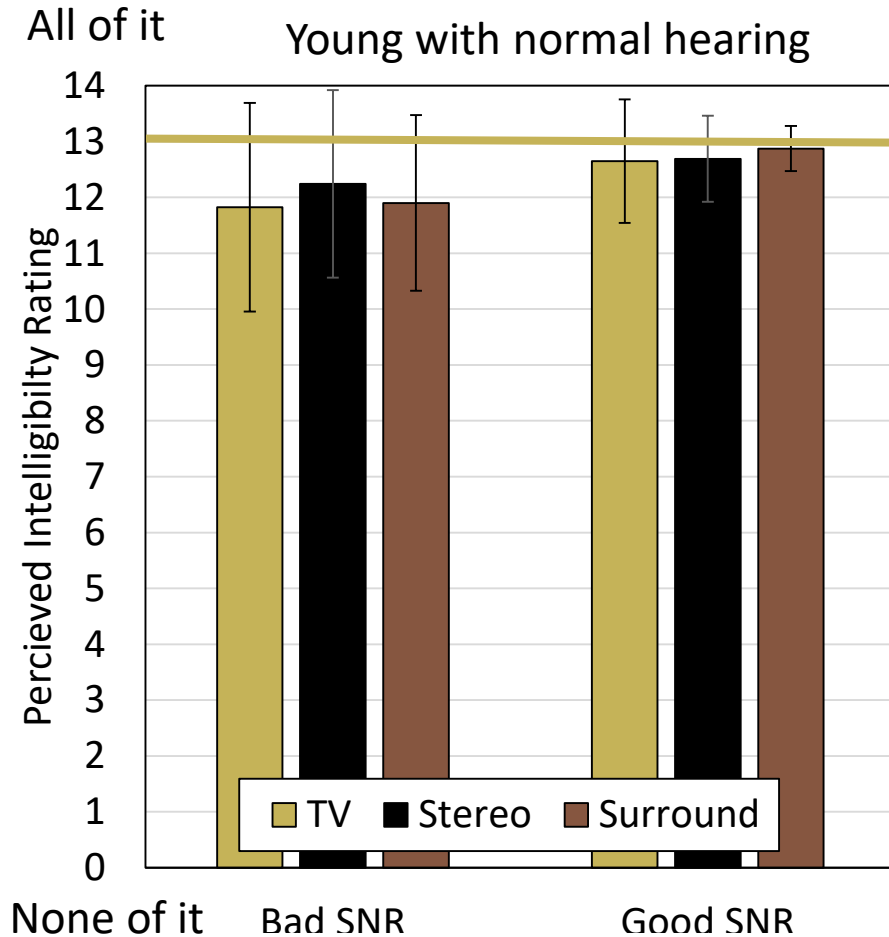
How would you rate the overall sound quality of that clip?

- 1 (very good) – 7 (average) – 13 (very bad)

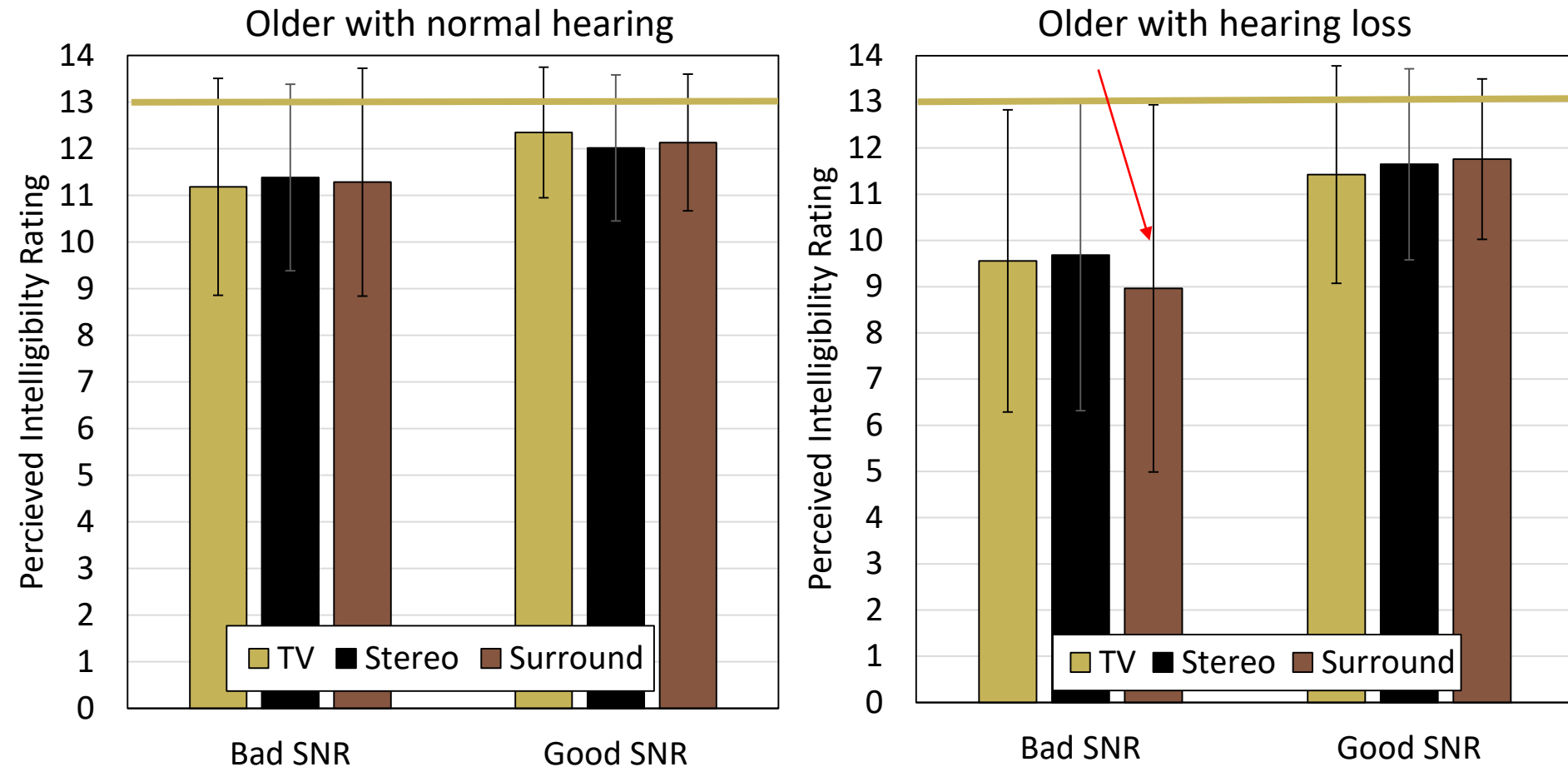
How would you adjust the speech to make this the best possible listening experience? The level of the background sounds (e.g., music, noise) will stay the same.

- 1 (speech needs to be MUCH LOUDER) – 7 (speech is PERFECT) – 13 (speech needs to be MUCH QUIETER)

Perceived Intelligibility: Age



Perceived Intelligibility: Hearing Loss



Perceived Intelligibility Summary

Visual cues help everyone

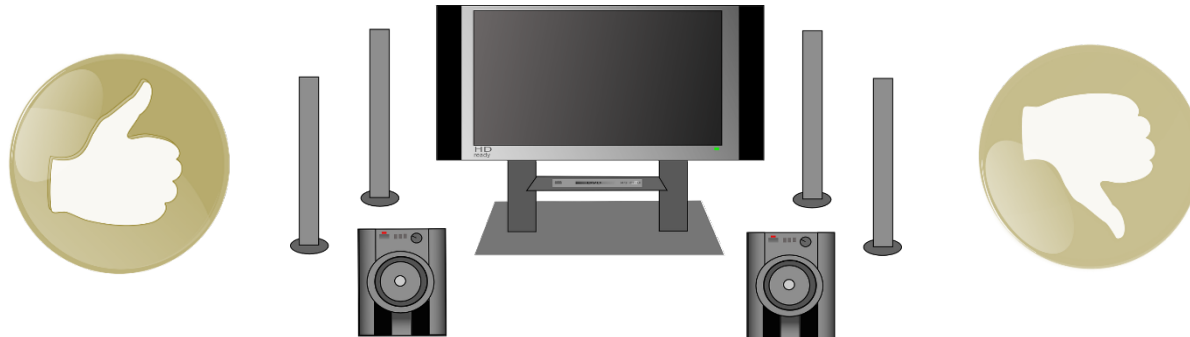
Intelligibility ratings high for listeners with normal hearing

Dialogue-to-background ratio matters

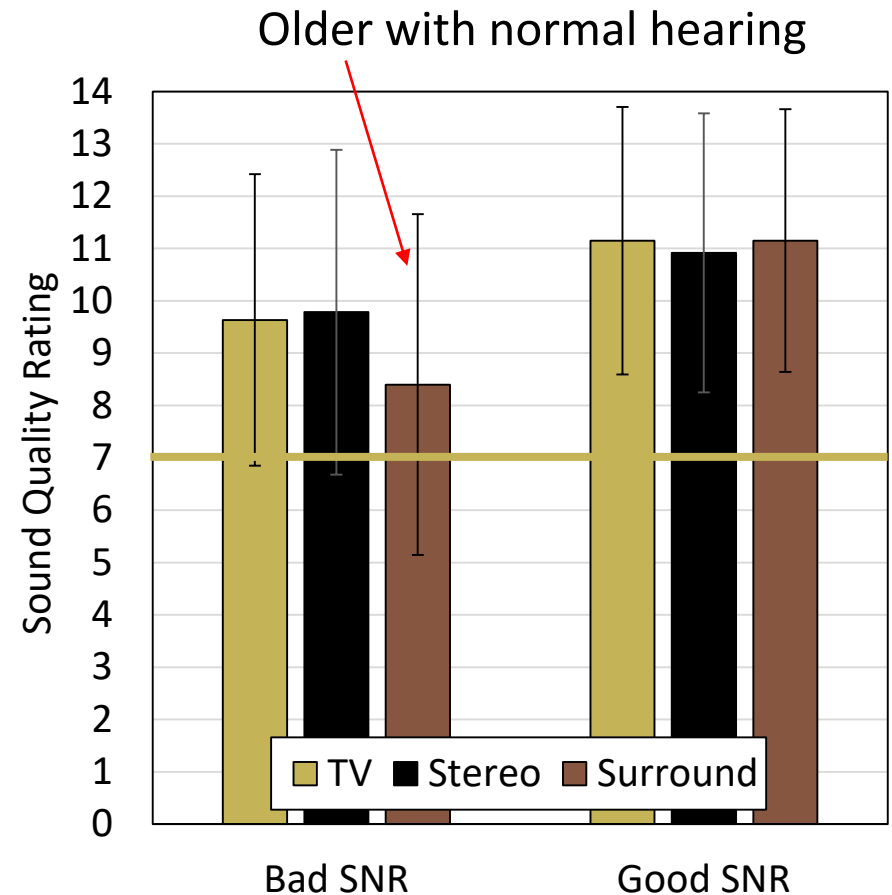
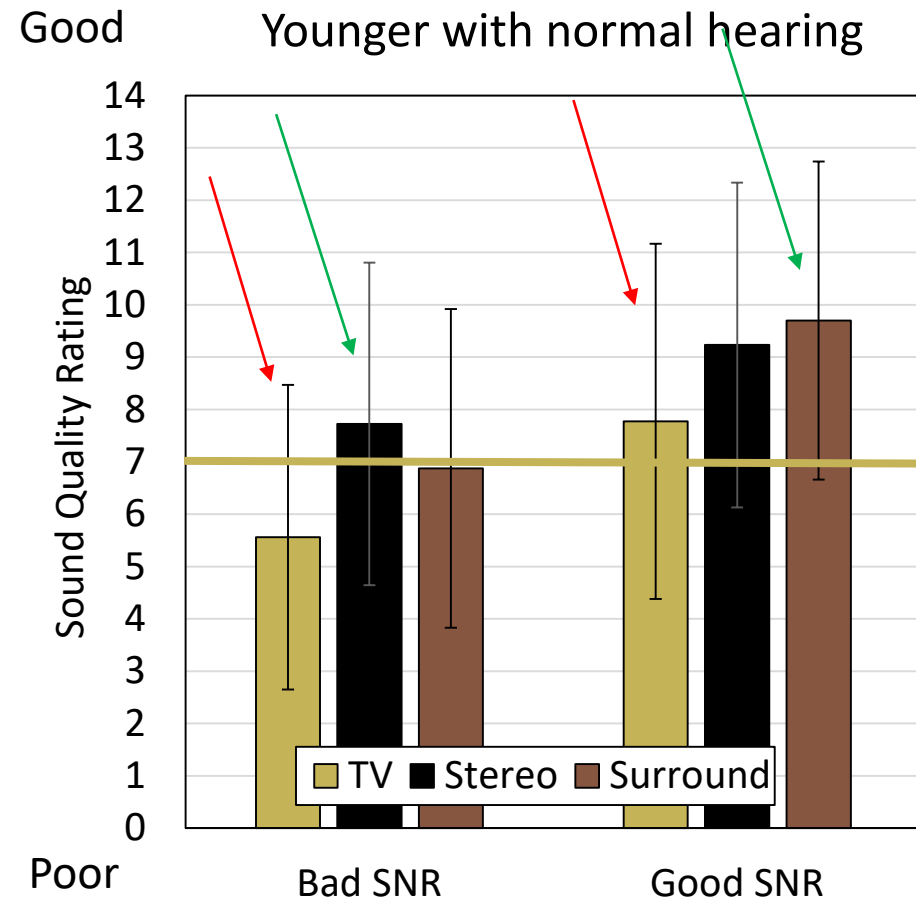
Listeners with hearing loss report lower perceived intelligibility

No clear speaker configuration “winner”

- Surround sound sometimes hurts intelligibility for listeners with hearing loss



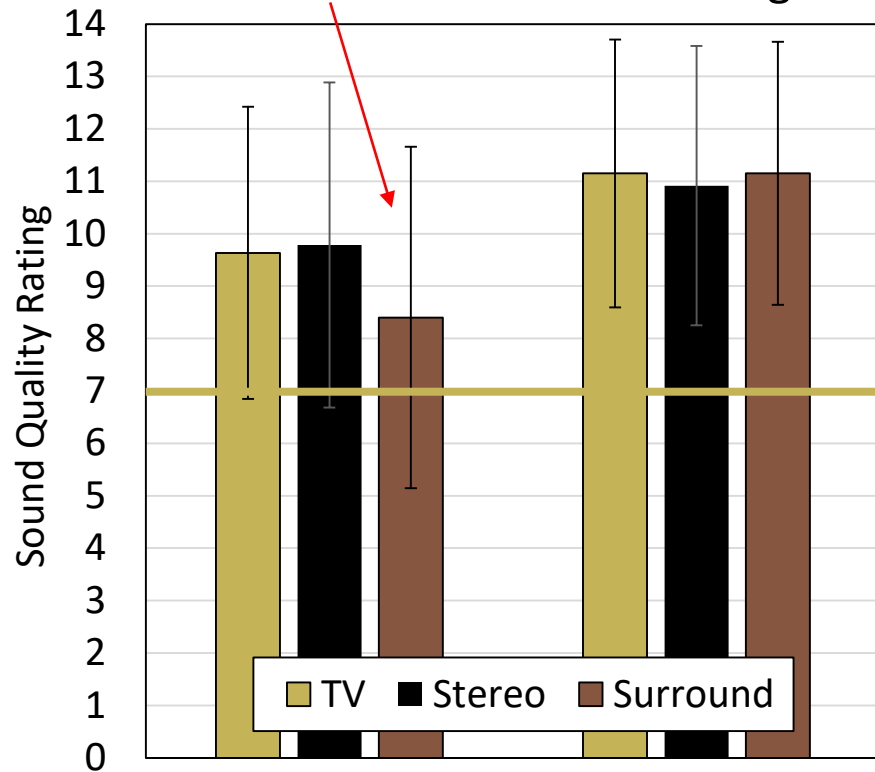
Sound Quality: Age



Sound Quality: Hearing Loss

Good

Older with normal hearing

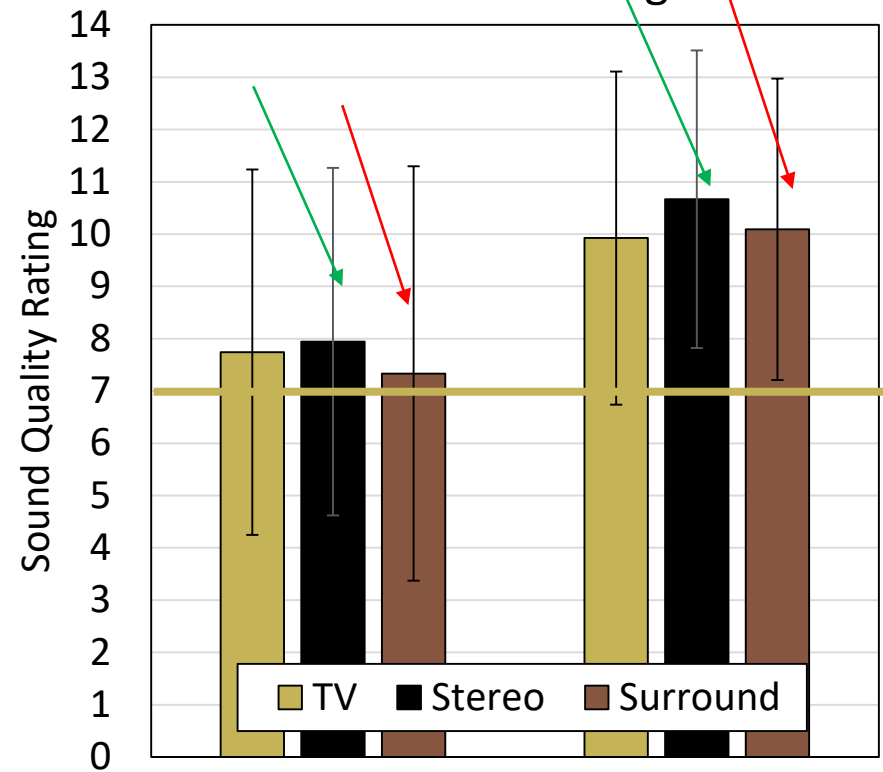


Poor

Bad SNR

Good SNR

Older with hearing loss



Bad SNR

Good SNR

Sound Quality Summary

Better dialogue-to-background ratio improved sound quality ratings

Listeners with hearing loss reported lower sound quality

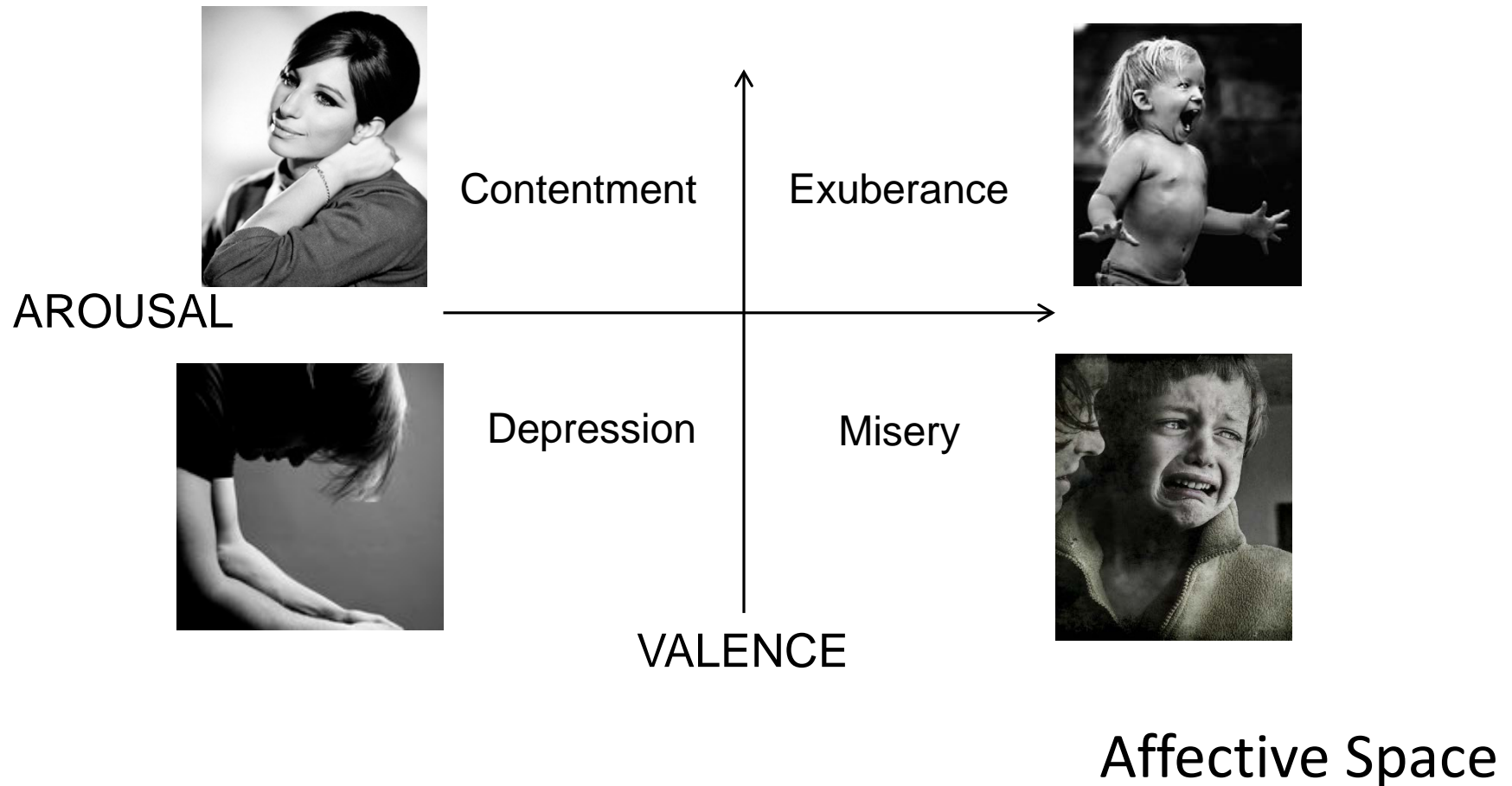
- Unrelated to age

Speaker configuration “winner” depends on group

- Younger with normal hearing: NOT television speakers
- Older listeners: NOT surround
- Older listeners with hearing loss: NOT surround, YES stereo

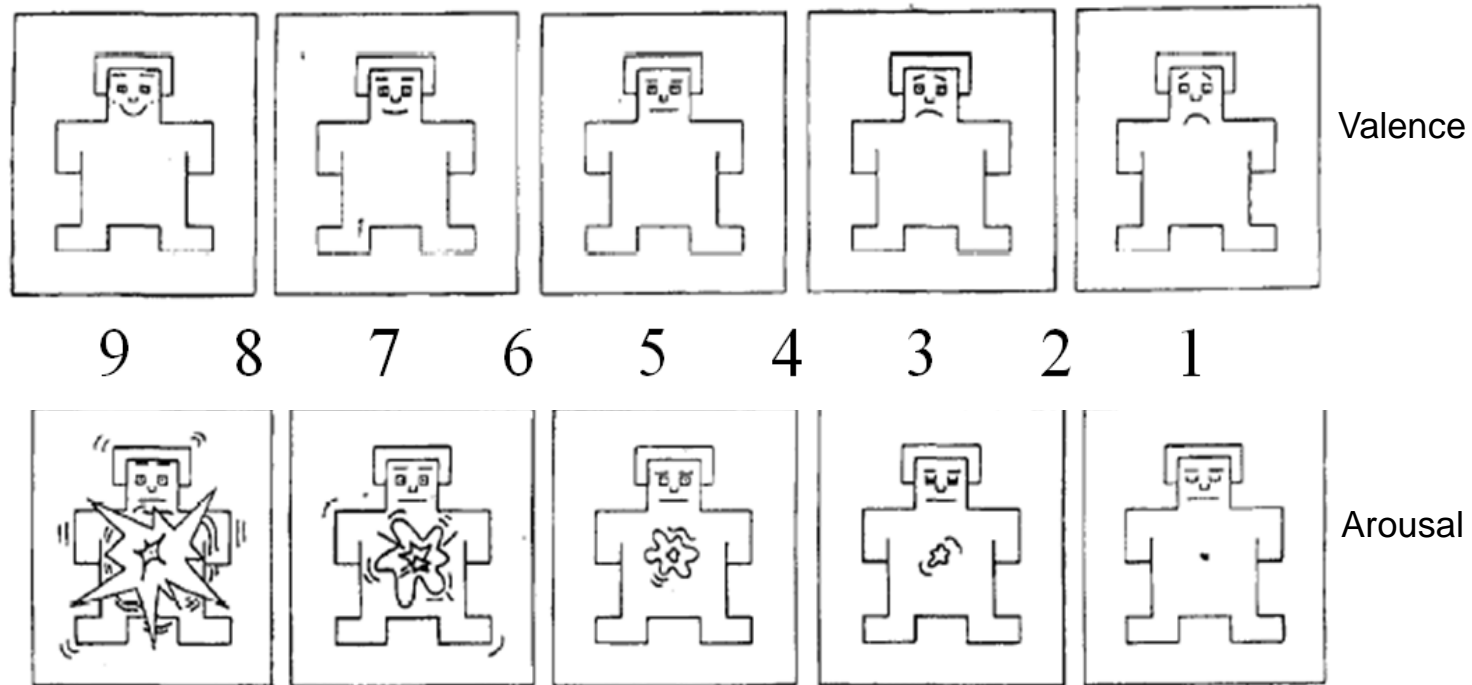


Dimensional View of Emotion

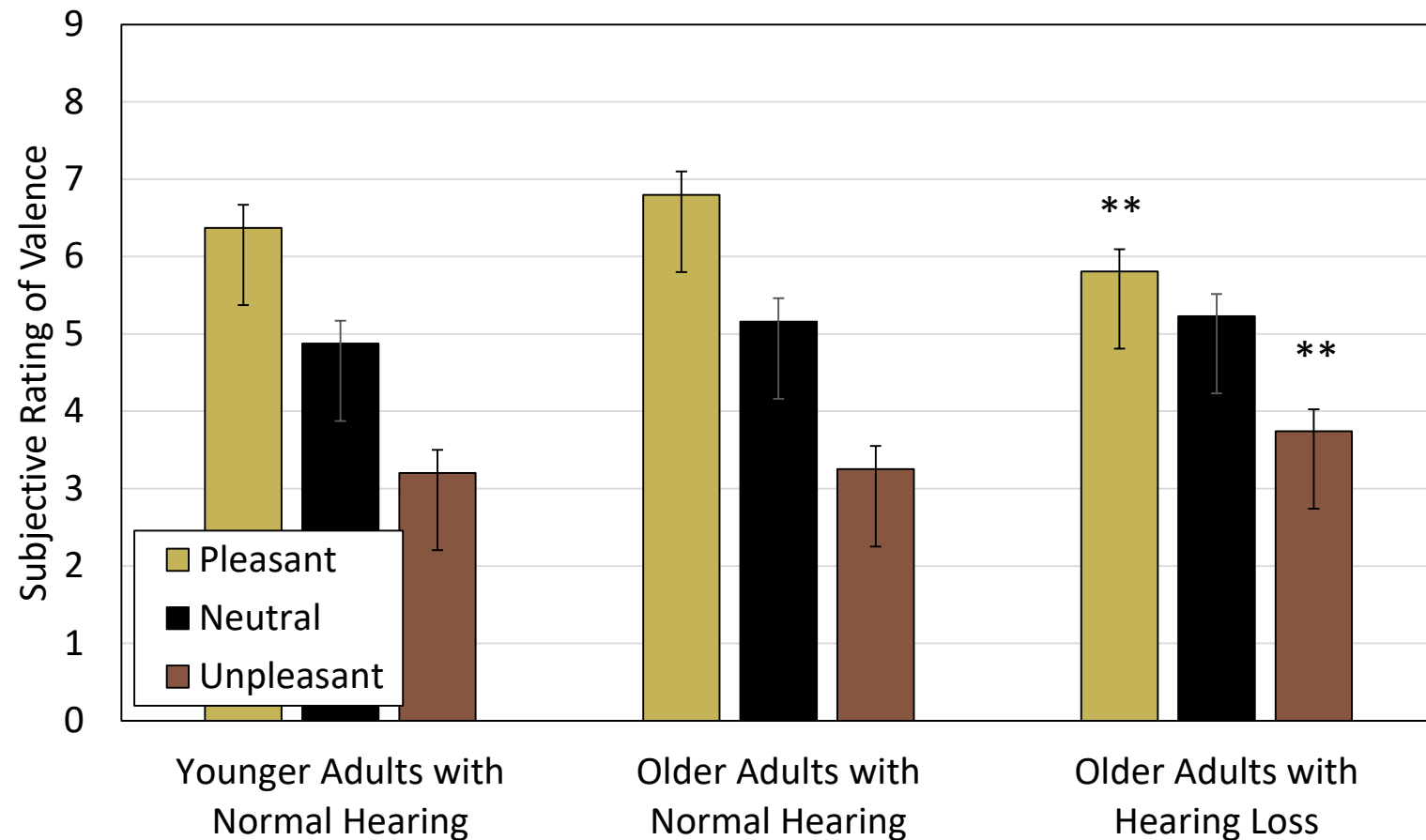


Assessing Emotional Responses

Self-assessment Manikin (SAM)



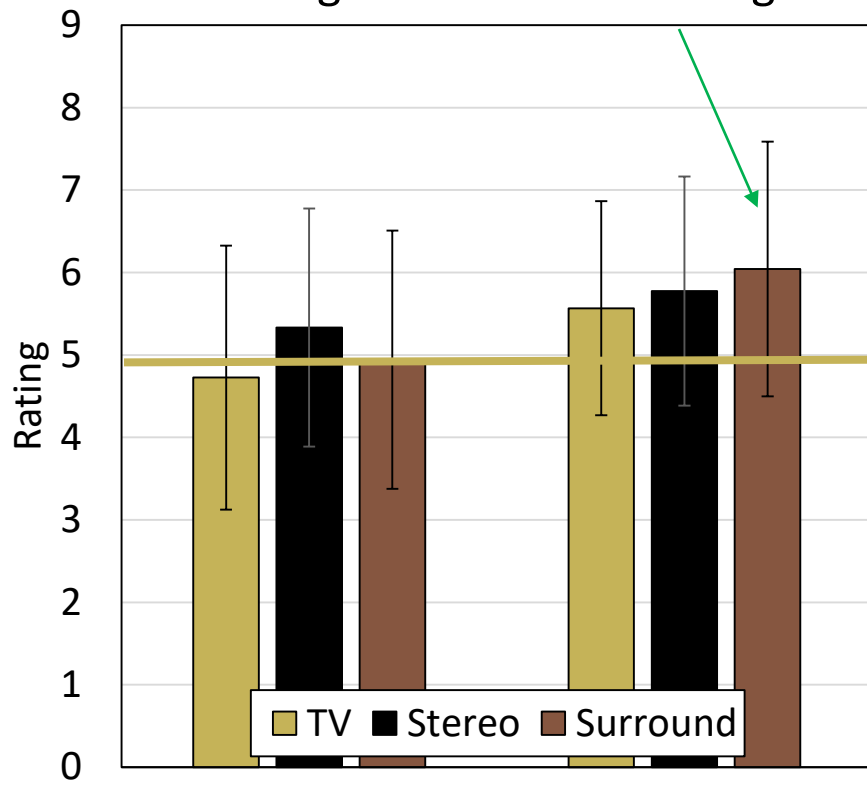
Hearing Loss (Not Age) Disrupts Emotional Responses to Sound



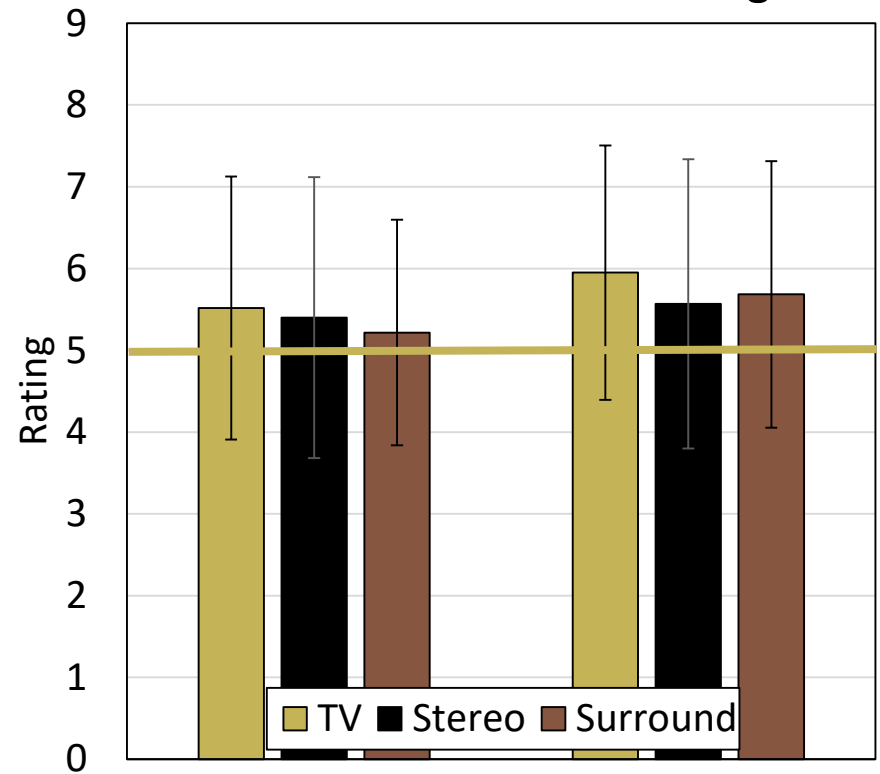
Valence: Age

Pleasant

Young with normal hearing



Older with normal hearing



Unpleasant

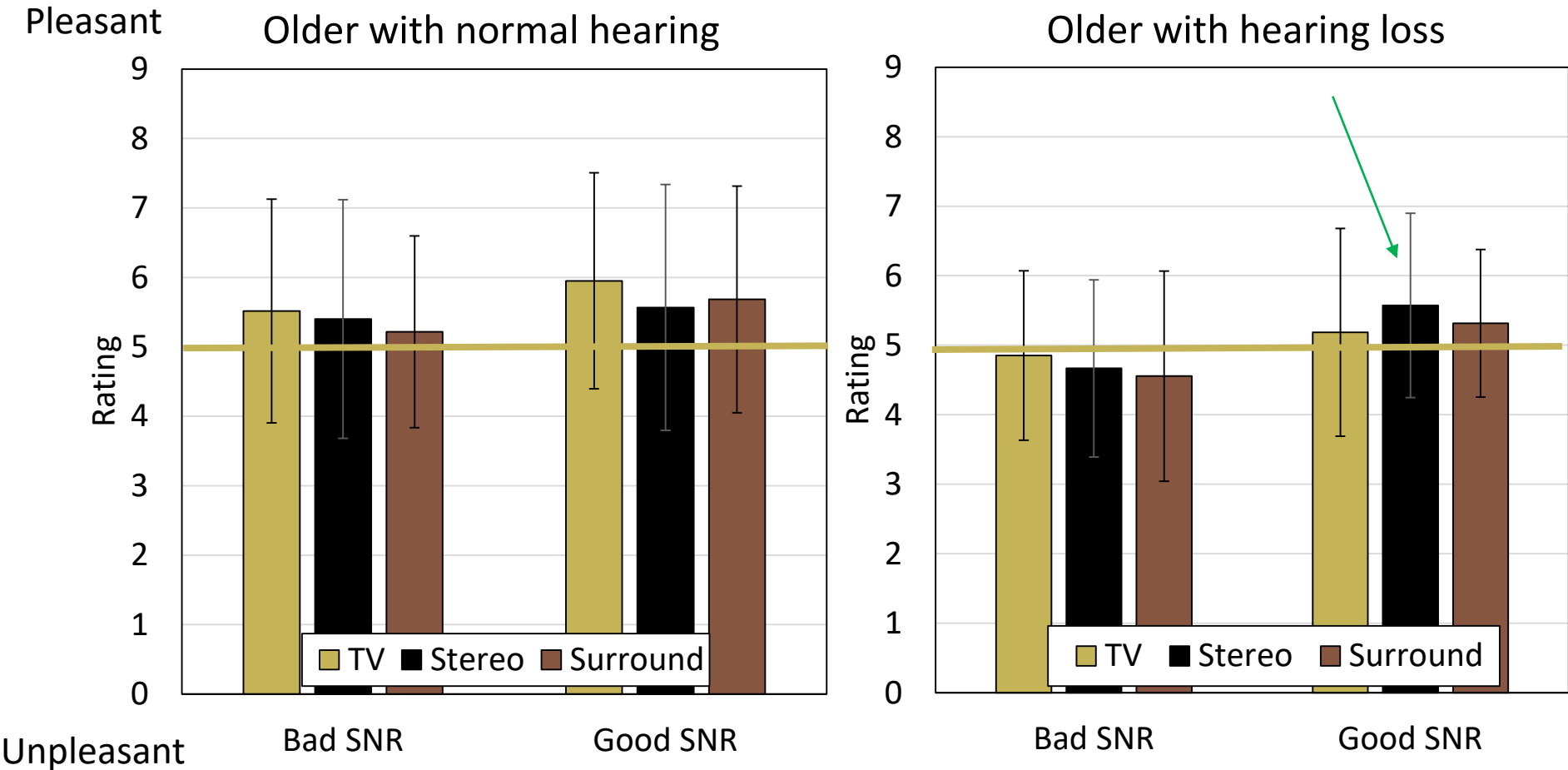
Bad SNR

Good SNR

Bad SNR

Good SNR

Valence: Hearing Loss



Valence Summary

Visual cues improved ratings of valence

Better dialogue-to-background ratio improved ratings of valence

Listeners with hearing loss reported lower ratings of valence

No clear speaker configuration “winner,” although for listeners with hearing loss, stereo configuration resulted in highest ratings of valence



Putting it all together...

Visual cues and favorable dialogue-to-background ratios

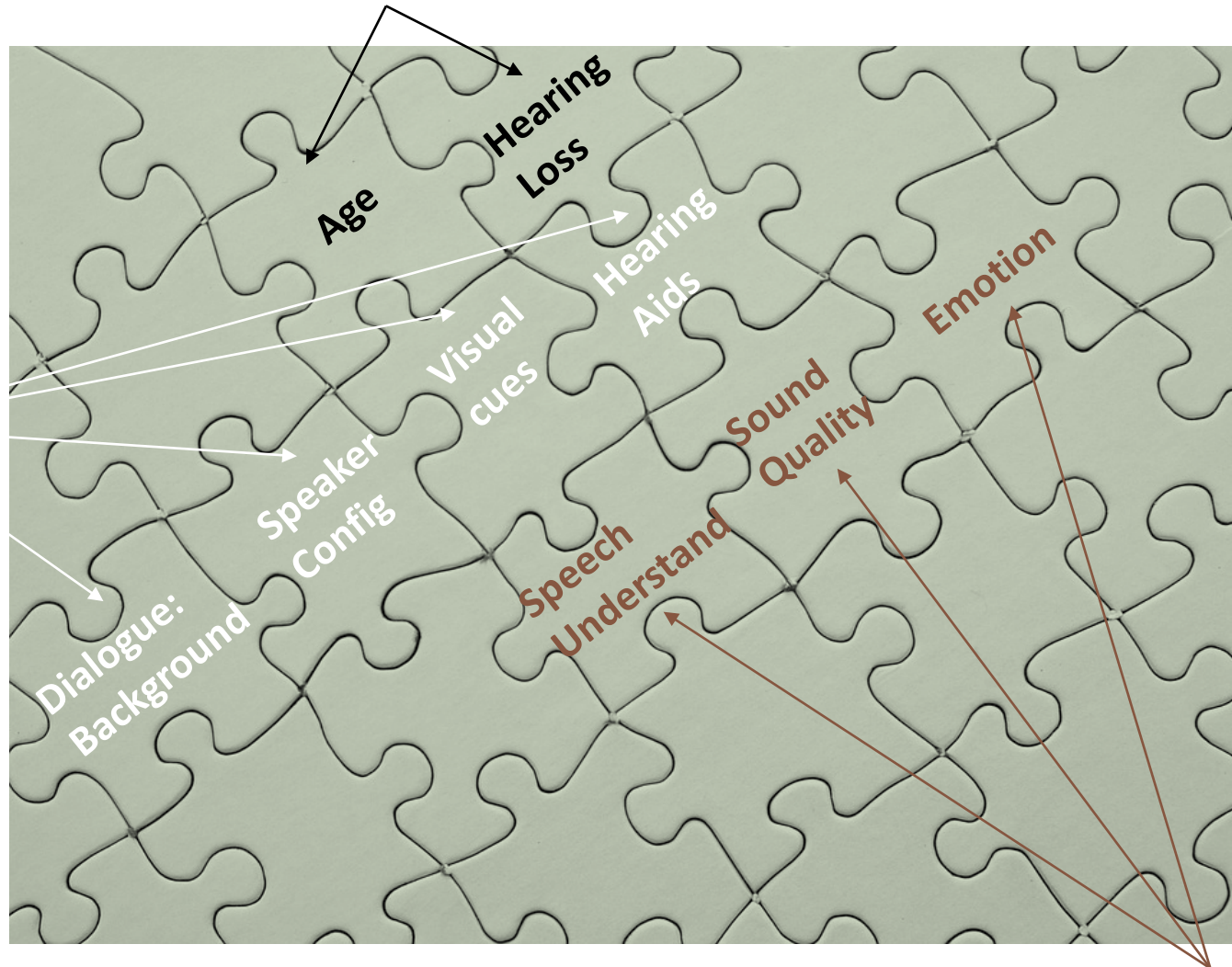
- Improve perceived intelligibility
- Sound quality ratings
- Ratings of valence

Hearing loss negatively affected ratings in all categories

- Reduced ability to understand the speech
- Poorer sound quality
- Feeling less happy listening to the television

Speaker configuration had small effect

- Stereo configuration resulted in most consistent benefits
- TV loudspeakers most often lowest ratings, especially of sound quality
- Surround sound didn't have the expected benefits

Participant Factors**Malleable Factors****Outcomes**

Finding the missing pieces that solve the mystery

Closed captioning

Improved closed captioning
television and video

Built-in telecaptioning
on the television

Surround sound
might not be a



benefits

re of

ects

but

More pieces yet to be discovered

- Hearing aid streaming
- End user control – object-based dialogue
- Spouse's perception – can we be marriage savers?

Summary of the Evidence

Anecdotal reports of television listening problematic

People spend considerable time viewing media, particularly elderly

Difficulties with media viewing related to rapid dialogue, accented speech, intermittent visual cues, loudspeakers, and poor dialogue-to-background ratios

Near-term solutions

- Closed caption
- Change loudspeaker (most likely stereo)
- Hearing aids (?)
- Streaming (?)

Mid-term solutions

- Control dialogue to background ratios
- Optimization of streaming configurations

CSI: Audiology

Monday morning patient

How do I help the next patient who walks in my door and has trouble with the television?

They're probably right:

- Reduced intelligibility
- Poorer sound quality
- Reduced feelings of happiness

Suggested recommendations:

- Hearing aids
- TV ears
- Closed captioning
- Different speaker configuration



Learner Outcomes

Upon completion, participants will be able to:

1) describe the effects of hearing loss on television listening

* People with hearing loss, especially those who are elderly, have difficulty understanding the television as a result of rapid speech, inconsistent visual cues, accented speech, and poor dialogue to background ratios.

* In our study, patients with hearing loss reported lower perceived intelligibility, lower reported sound quality, and feeling less happy while listening to television

2) describe the effects of speaker configuration on television listening

Speaker configuration has small effect on intelligibility, sound quality, and ratings of valence, although the “stereo” configuration offered the most consistent benefits relative to the other configurations

Thank You!



Questions?