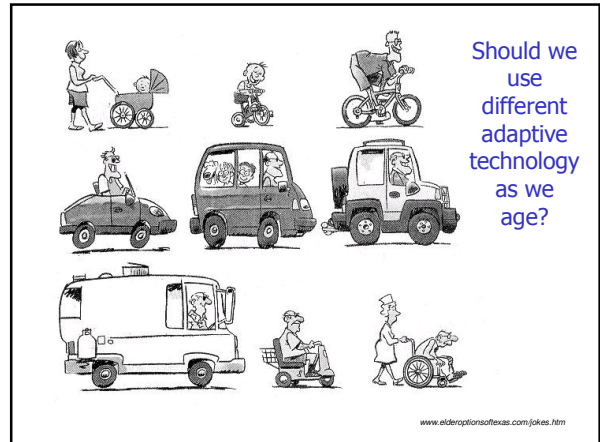


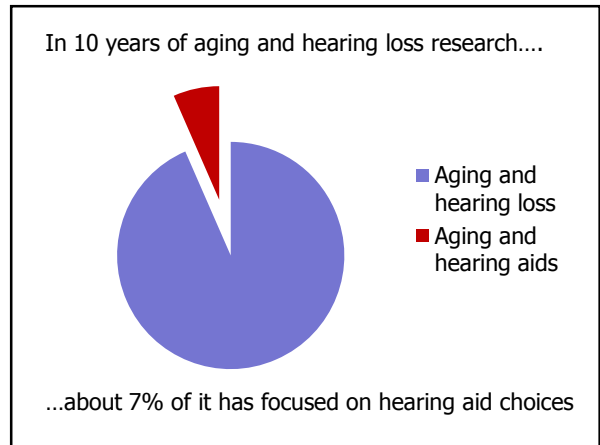
# Aging, Auditory Perception and Hearing Aids

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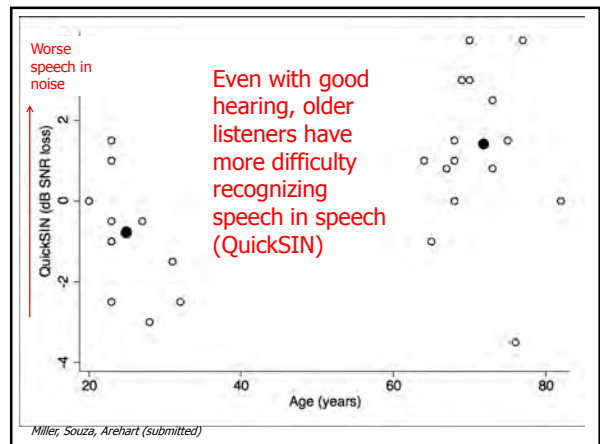
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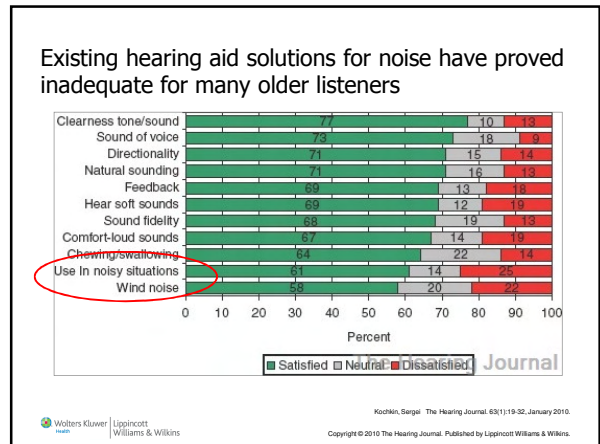
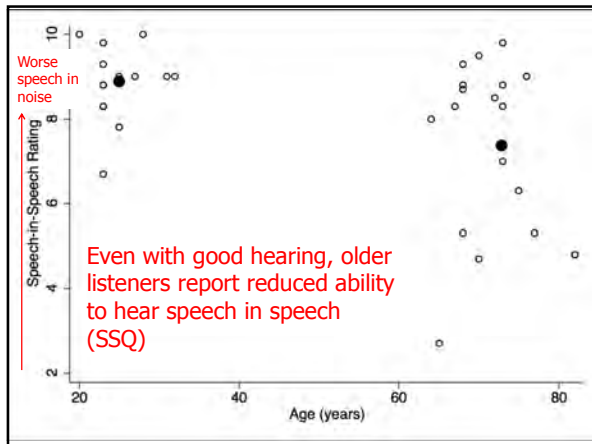


Clinical decision	My preference is to:	I do this because of evidence-based practice	I do this because it seems like common sense
Cognitive assessment			
Hearing aid style			
Hearing aid features			
Directional microphone			
Digital noise reduction			
Compression parameters			
Participation of family members in fitting process			
Counseling topics			
Number or duration of follow-up appointments			
Length of trial period			



Clinical decision	My preference is to:	I do this because of evidence-based practice	I do this because it seems like common sense
Cognitive assessment	→	Hearing aids + cognition	
Hearing aid style			
Hearing aid features			
Directional microphone	→	Understanding speech in noise	
Digital noise reduction	→	Setting hearing aid parameters	
Compression parameters	→		
Participation of family members in the fitting process			
Counseling topics			
Number or duration of follow-up appointments			
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Clinical question #1: do older listeners use different cues to separate speech from background (speech) than younger listeners do?

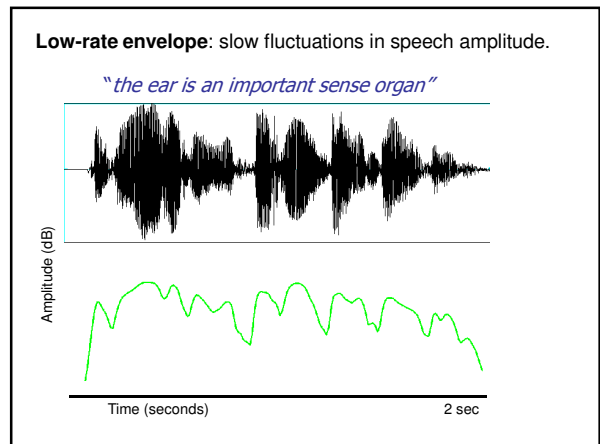
### A possible culprit: fine structure

- Rapid (> 500 Hz) variations in speech amplitude
- Proposed to be deficient in older listeners, due to loss of neural synchrony (Pichora-Fuller and colleagues)

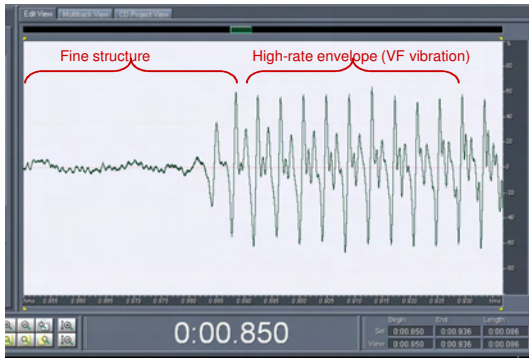
### Speech cues are carried by the temporal variations of the signal

	Modulation rates	Information
<b>Low-rate envelope</b>	2-50 Hz	Voicing, manner, vowel identity
<b>High-rate envelope</b>	50-500 Hz	Voicing, manner, stress, intonation
<b>Fine structure</b>	600 Hz +	Place of articulation

Adapted from Rosen, 1992



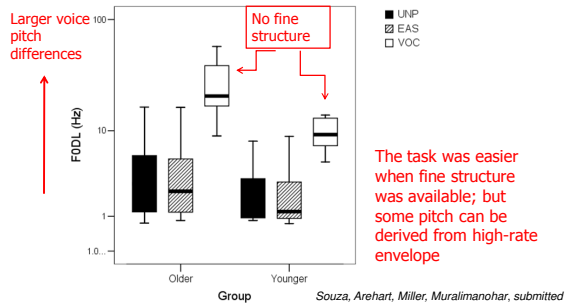
"po" from "important" illustrating fine structure and high-rate envelope



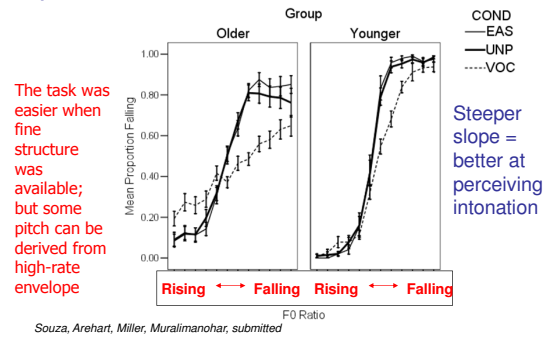
### What is fine structure good for?

- Perceive voice pitch
- Track voice pitch as it varies over time
- Detect a difference in voice pitch between talkers
- Follow one talker in the presence of another ("listen in the dips")

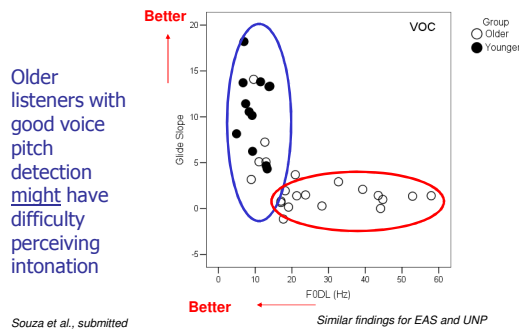
Older listeners had difficulty distinguishing between two (synthetic) voices that were similar in pitch



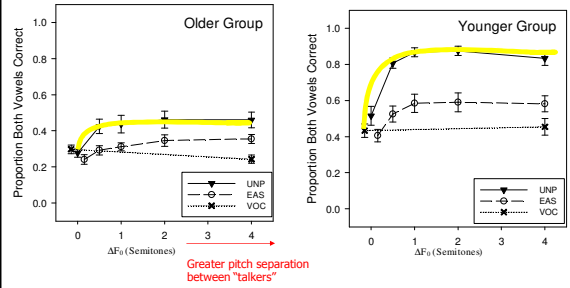
Older adults had difficulty tracking voice pitch over time



Older listeners with poor voice pitch discrimination always had difficulty perceiving intonation

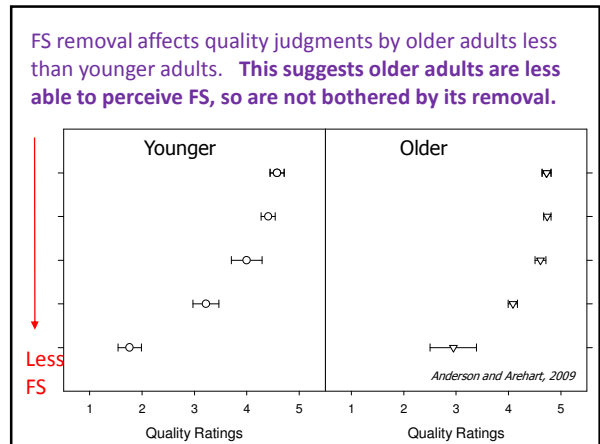


Fine structure is needed to distinguish between two simultaneous talkers with different voice pitch...



...but larger voice pitch differences between simultaneous talkers are of less benefit to older listeners

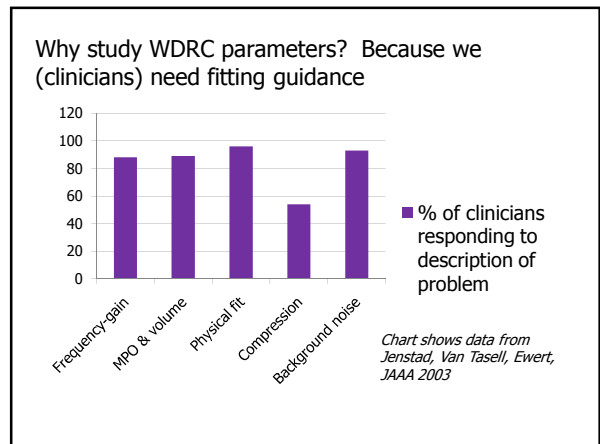
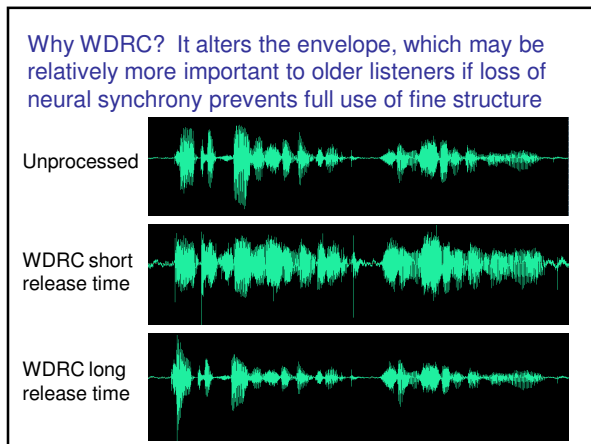
Condition	Rationale	Description
Unprocessed	Baseline for quality	Bandpass-filtered (16 channels)
Temporal Envelope Modulated (TEM): Vocoder noise	Designed to remove fine structure cues and leave TE cues.	Within each channel, envelopes were obtained by Hilbert transform and followed by low-pass filtering at 300
Unmodulated (UM)	Designed to remove both TFS and TE cues.	Consisted of stationary Gaussian noise.



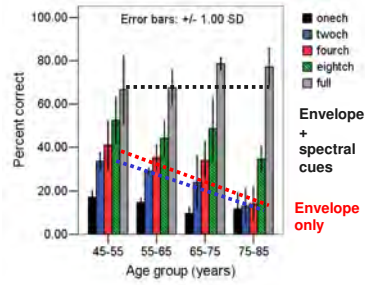
Summary: use of fine structure by older listeners

- In quiet, many older listeners can use fine structure to cue voice pitch and intonation, but a subset cannot.
- Fine structure is necessary to distinguish between two simultaneous talkers. However, older listeners receive little benefit from this cue in multitalker situations.

Clinical question # 2: Should device settings be different for older listeners?



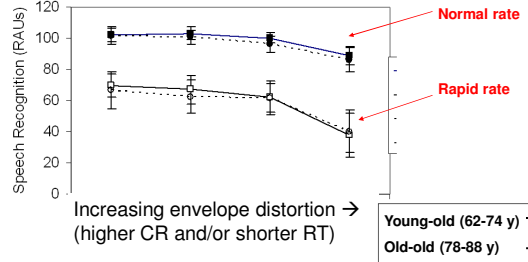
Hearing aids  
aside: we  
know that  
older adults  
have more  
difficulty  
using  
envelope  
cues to  
speech



Souza & Boike 2006

Schroeder/envelope VCVs

WDRC which distorts envelope reduces recognition for older listeners, especially for difficult materials



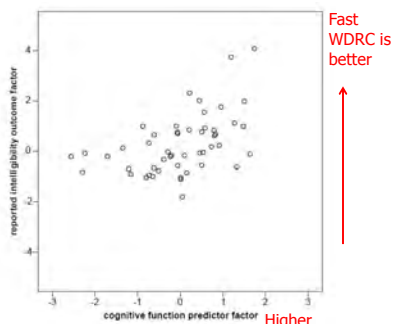
Jenstad & Souza, 2007

Clinical question # 2: Should device settings be different for older listeners?

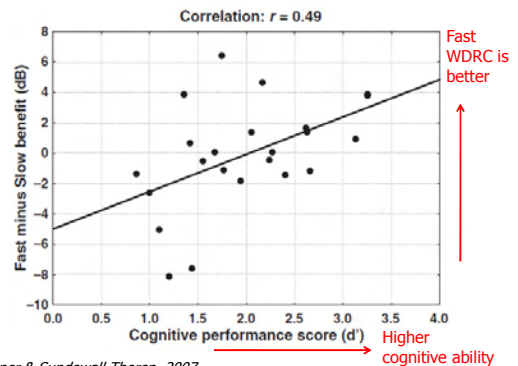
*(?) For older listeners with poor fine-structure perception, avoid envelope distortion (by using conservative compression parameters)*

BUT: don't forget about cognitive assessment

Listeners with higher cognitive function have greater reported intelligibility with fast WDRC (compared to slow WDRC)



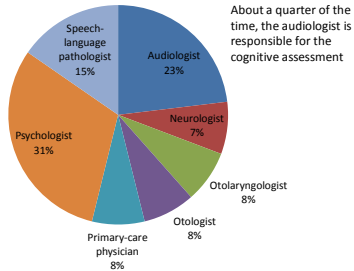
Gatehouse, Naylor, Elberling, 2006



Lunner & Sundewall-Thoren, 2007

## Cognitive evaluation as a component of hearing device provision?

28% of respondents indicated that cognitive status is routinely used in their clinic's CI candidacy protocol for adults; 72% reported it is not.



Rossi-Katz and Arehart, 2009

## What do clinicians want to know?

31% of survey respondents reported participating in professional development related to service provision for older adults

### Interest in professional development related to:

	Very interested	Somewhat interested	Not interested
General issues related to aging	30%	58%	12%
→ Aging & cognition	53%	39%	8%
Aging & CI candidacy	68%	28%	4%
Aging & CI programming	50%	50%	--
Aging & CI outcomes	57%	39%	4%
Aging & CI rehabilitation	56%	44%	--

Rossi-Katz & Arehart, 2009

## Putting the story together:

- As a group, older adults have poorer perception of fine structure. This likely makes them more susceptible to envelope distortion from hearing devices
- Evidence for peripheral deficit: age-related neural dyssynchrony
- Evidence for cognitive deficit: those with higher cognition can compensate for distortion
- We could play it safe and avoid envelope distortion for all older listeners; but this means potential loss of improved audibility for those older listeners with good tolerance.

## What next?

- Identify the factors that underlie the variability among older listeners
- Develop (cognitive? TFS?) screening tests that could be used to identify individuals unlikely to benefit from "standard" device parameters
- On the basis of such tests, select appropriate signal processing strategies for each person
- Fit the device as part of a comprehensive rehabilitation plan which considers peripheral and cognitive abilities



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