

Speech perception in individuals with dementia of the Alzheimer's type (DAT)

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Overview

- Goals of studying speech perception in individuals with DAT
- Theoretical importance
- Characterizing dementia severity
- Sensory abilities and DAT
 - Thresholds
 - SRTs (with and without spectral shaping)
- Cognitive abilities needed for speech perception
 - Lexical discrimination (with and without spectral shaping)
 - Talker normalization (with and without spectral shaping)
- Summary and conclusions
- Clinical implications

Speech Perception and Alzheimer's disease

- Goals
 - Characterize hearing and speech perception abilities of age-matched individuals who differ in cognitive status
 - Identify possible behavioral indicators distinguishing earliest stages of the disease
 - Importance of early intervention
- Theoretical importance
 - Allows study of how cognitive declines affect speech perception in groups matched for age
 - Use of spectral shaping allows assessment of relationship between sensory and cognitive abilities
 - If spectral shaping improves cognitive abilities needed for speech perception
 - Suggests that processing degraded signal not only impairs perception, but has downstream consequences
 - Example of study by McCoy et al. (2005).

Dementia severity of dementia

- Participants recruited from Washington University ADRC
 - Annual cognitive evaluation
 - Determine dementia status
 - Battery of neuropsychology tests
- Classification of dementia severity
 - Clinical Dementia Rating (CDR)
 - 90-minute interview by board-certified neurologist assessing
 - Memory, orientation, judgment, community affairs, home and hobby, personal care
 - Separate interview with collateral source (family member) assessing changes in these areas
- CDR ratings
 - CDR 0 – Healthy older adults
 - CDR 0.5 – Very mild DAT (similar to current MCI diagnosis)
 - CDR 1 – Mild DAT
 - CDR 2, 3 – Moderate and severe dementia (not tested)

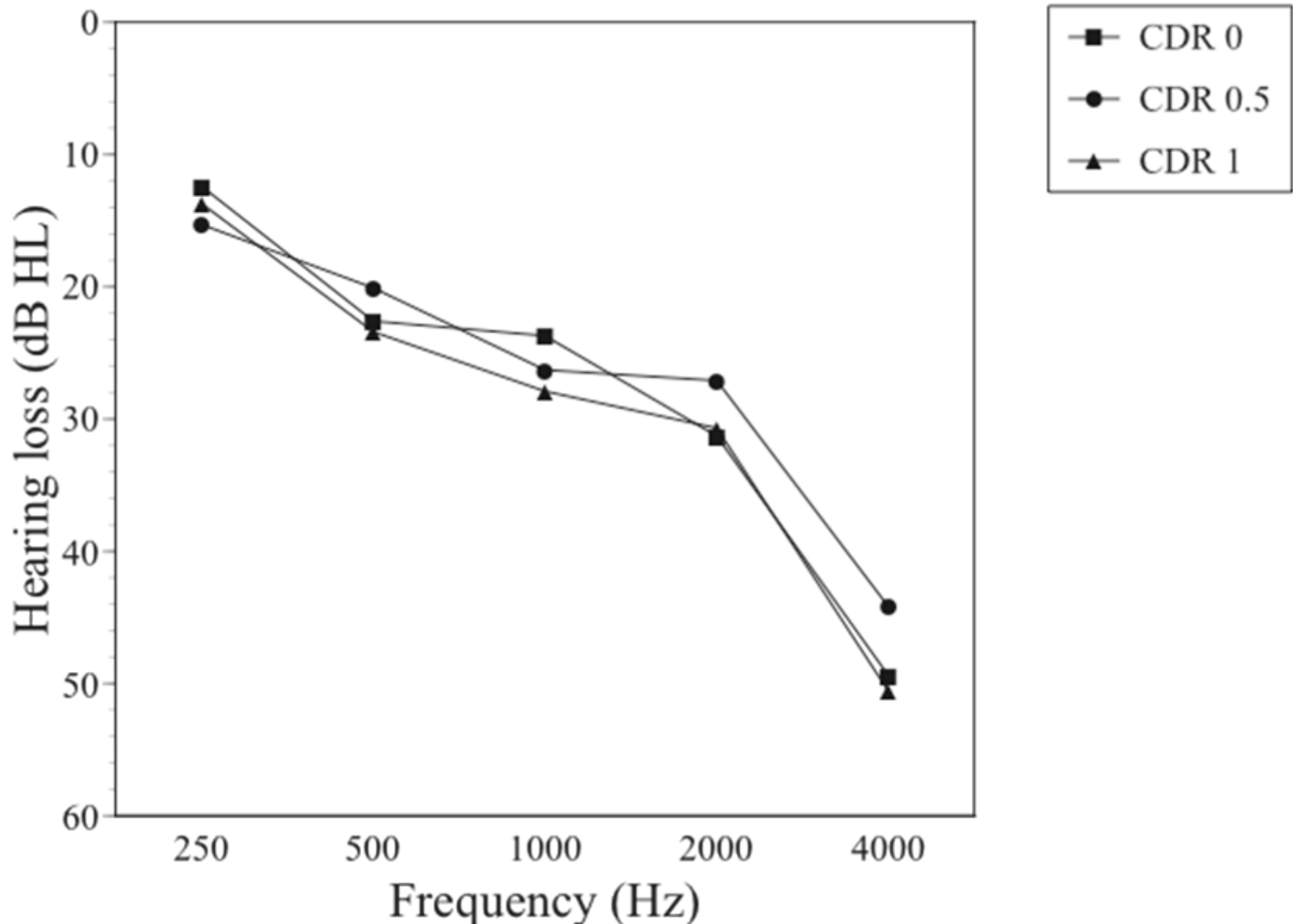
Participant characteristics

	CDR 0 (n=53)	CDR 0.5 (n =47)	CDR 1 (n = 45)
Demographic measures			
Age	78.2	75.9	74.3
Education	13.9	13.3	14.1
Memory measures			
Digit span forward	6.4	6.4	5.8
Digit span backward	4.8	4.4*	3.5**
Paired associates	14.4	9.4*	7.1**
Processing speed			
Digit-symbol	40.1	36.8*	23.8**
Language measures			
WAIS vocabulary	53.4	43.7*	35.5**
Boston naming	53.9	44.6Z*	35.0**

*Significant difference between CDR 0 and CDR 0.5

**Significant difference between CDR 0.5 and CDR 1

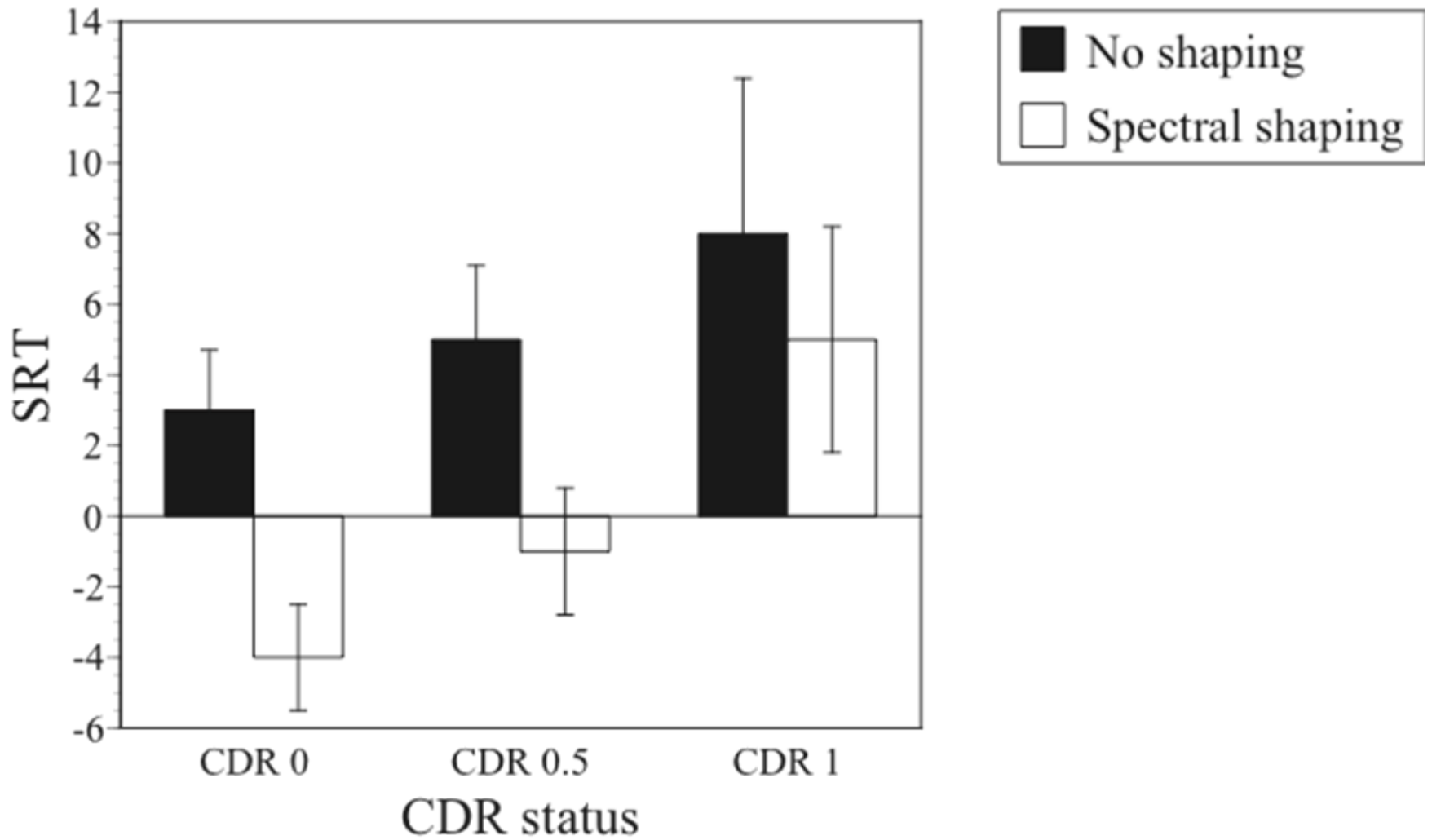
Effects of DAT on pure-tone thresholds



DAT and speech reception thresholds

- SRTs
 - Signal-to-noise ratio 50% correct word identification
 - Current study uses 100 words excised from low-predictability SPIN sentences
- Procedure
 - First word presented in multi-talker babble at SNR below threshold
 - Increment level in 4-dB steps until word identified correctly
 - Subsequent words presented using simple up-down tracking with 2-dB steps
 - Average SNR values at reversals (used as SRT)
- Conditions
 - No spectral shaping
 - Spectral shaping
 - Signal amplified using 1/3 octave band amplification
 - Signal amplified individually so that signal level 15-18 dB above threshold for frequencies up to 4000 Hz

SRTs in healthy older adults and individuals with DAT



Lexical Discrimination

- Ability to distinguish similar sounding items (bat, pat)
- Neighborhood activation model (Luce and Pisoni, 1998)
 - Word identification determined by number of similar neighbors
 - Neighbors defined as words differing from a target item by addition, deletion, or substitution of a single phoneme
 - Neighbors of CAT include: KIT, PAT, AT, SCAT
- Correct identification of target item requires
 - Activation of target item AND inhibition of neighbors
- Words differ in size or density of their neighborhoods
 - Hard words (CAT): many similar sounding words (resides in a dense neighborhood), considerable demands on inhibition
 - Easy words (SONG): few similar sounding words (resides in a sparse neighborhood)

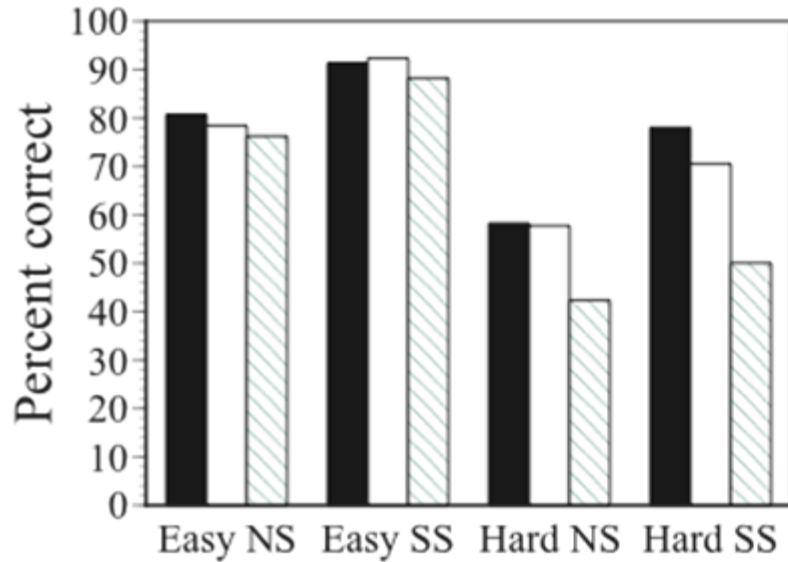
Lexical Discrimination in healthy older adults and DAT

- Age, inhibition, and lexical discrimination
 - Older adults have deficit in ability to inhibit irrelevant information
 - Sommers (1996) compares young and old identification of easy and hard words
 - Find much bigger age difference for lexically hard words than for easy words
 - Sommers and Danielson (1999) age differences in lexical discrimination due to differences in inhibition
- DAT and lexical discrimination
 - Good evidence that DAT produces additional deficits in inhibition
 - Do individual with DAT have greater difficulty than healthy older adults perceiving lexically hard words?
 - Does spectral shaping improve identification of lexically hard words in either healthy old or DAT

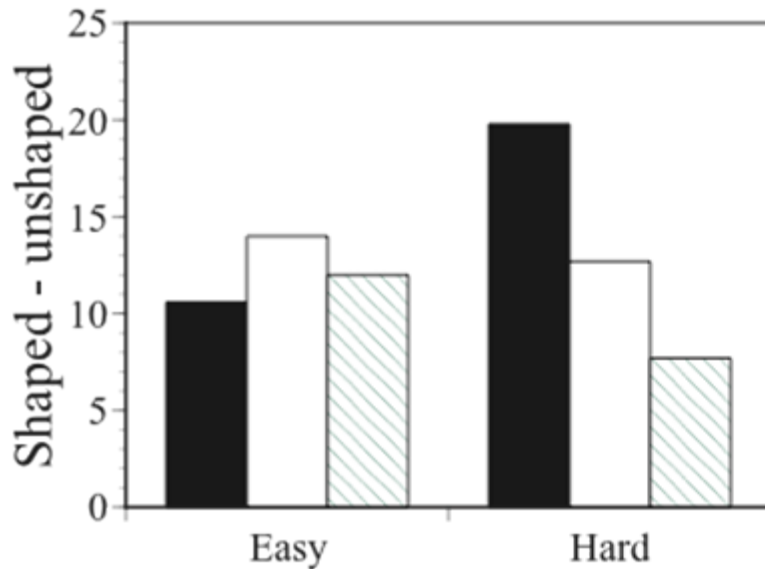
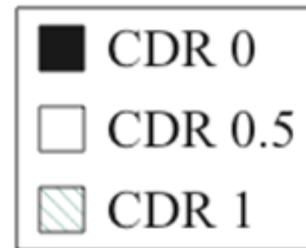
Procedure

- Same participants as in SRT study
 - Identify 76 “easy” words (mean neighborhood density = 10.8)
 - Identify 76 “hard” words (mean neighborhood density = 26.4)
 - Average frequency of easy and hard words do not differ
 - All testing done with 6-talker babble and SNR of +2
 - Half of easy and hard words presented with no spectral shaping
 - Half identified following spectral shaping (same as in Experiment 1)

Lexical Discrimination in DAT



NS = not shaped
SS = specially shaped



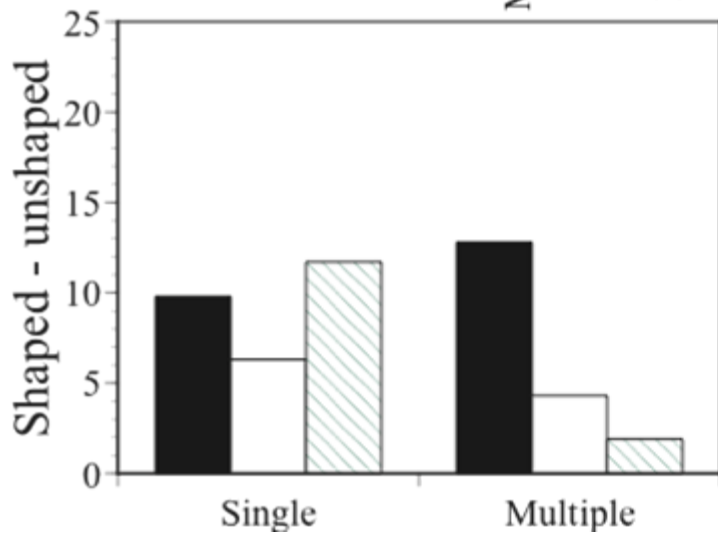
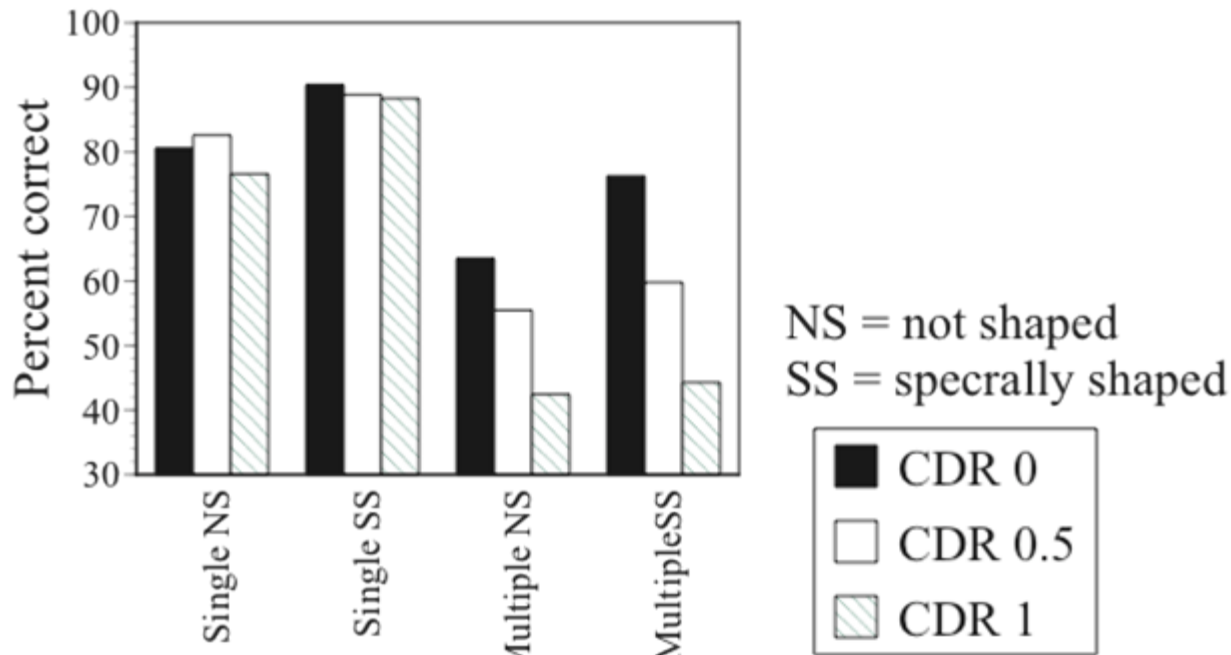
Talker normalization in DAT

- Talker normalization
 - Process of adjusting to different talkers
 - Same word spoken by male, female, child have dramatic acoustic differences
 - Even same word by same person differs acoustically
 - Need to adjust or normalize incoming signal to match representations stored in memory
- Testing for talker normalization
 - Compare conditions with single talker and multi-talkers
 - Single talker – all words spoken by same talker
 - Multiple talker – words spoken by 10 different talkers
 - Talker presented on any given trial varies randomly
- Differences between single and multiple talker conditions
 - Index of normalization costs

Talker normalization and DAT

- Same participants as in earlier studies
- 75 words presented in single talker condition
 - Specific talker used rotated
- 75 words presented in multiple talker condition
 - 5 males and 5 females
 - Talker presented on any given trial selected randomly
- Words presented in 6 talker babble at +2 SNR

Talker normalization and DAT



Summary and conclusion

- DAT, sensory abilities and speech perception
 - No affect of DAT on hearing thresholds
 - DAT have greater difficulty than age and hearing matched older adults understanding speech in noise
 - SRTs increase progressively from CDR 0, CDR 0.5, and CDR1
 - Also progressive benefit from spectral shaping
 - Greater benefit for CDR 0 than for DAT
- DAT, cognitive abilities and speech perception
 - Lexical discrimination
 - Similar performance and benefits from shaping for easy words
 - CDR 0 and 0.5 show similar declines from easy to hard
 - CDR 1 show even greater declines from easy to hard
 - Systematic decline in benefits of spectral shaping
 - CDR 0 show greatest benefits; CDR 1 least

Summary and conclusion

- DAT, cognitive abilities and speech perception
 - Talker normalization
 - Similar performance and benefits from shaping for single talkers
 - Systematic decline from single to multiple talkers
 - CDR 0 exhibit large benefits from spectral shaping
 - Relatively small benefits of shaping for DAT patients

Clinical implications

- DAT patients do benefit from spectral shaping to improve audibility
 - Hearing aids likely to have benefits both for patients and caregivers
- Spectral shaping has some benefit for DAT patients but less than for age-matched healthy controls
 - Other possible strategies
 - Avoid noisy situations for communicating important information
 - SRT results suggest increased susceptibility to noise in DAT
 - Spoken communication by single person likely to be most effective
 - Multiple talker situations (e.g., family gatherings) likely to be very problematic for DAT individuals
- Early identification of DAT patients
 - Changes in SRTs and talker normalization may provide additional cues to changes in cognitive status
 - Currently incorporated into annual assessment at ADRC

Support and acknowledgments

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