

Age-related changes in cognition: Implications for speech perception

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Overview

- Methodological considerations
 - Current and previous approaches to studying cognition and aging as related to speech perception
- Early results with global cognitive measures
- Speech-specific cognitive abilities and aging: The case of inhibition
 - Evidence for the importance of inhibition in speech perception
- Conclusions
- Theoretical and clinical implications

The goal and the problem

- Goal: Understand the relative contributions of age-related sensory and cognitive declines as factors contributing to the speech perception difficulties of older adults
- The problem
 - There is an inherent confound because BOTH sensory and cognitive abilities are impaired in older adults
 - Both could reasonably affect speech perception.

Previous approaches

- Make young adults look like older adults
 - Use hearing-impaired young adults
 - Difficult to find
 - Differences in etiology
 - Differences in underlying pathology
 - Introduce masking noise to young adults to match average hearing loss of older adults
 - Issue of variability
 - Issue of cochlear pathology
 - Use masking noise in both older and younger and match on one-to-one basis
 - Issue of cochlear pathology remains

Previous approaches

- Make older adults look like young adults
 - Increase presentation level for old compared to young
 - Potential problem of speech perception at high levels
 - Effects of presentation level on other psychoacoustic abilities
 - Frequency selectivity declines at higher presentation levels
 - Use older adults with clinically normal hearing
 - Still have a hearing loss
 - Representativeness of the sample
 - But is a relative conservative approach
- Compare healthy older adults and individuals with Alzheimer's disease
 - Examine speech perception in individuals
 - With similar age and hearing
 - Differ in cognitive abilities

Studies of speech, cognition, and aging

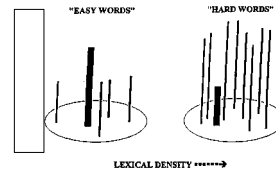
- Most earlier studies failed to find significant relationships between speech perception and cognition, including
 - No relationship between IQ and speech perception
 - No relationship between vocabulary and speech perception
 - No relationship between measures of memory and speech perception
- More recent focus on
 - Identifying cognitive abilities specific to speech perception
 - Use of theories and models from cognitive aging

Theories of cognitive aging: Implications for speech perception

- Inhibitory deficit hypothesis (Hasher & Zacks, 1988)
 - Older adults have a reduced ability to inhibit or suppress irrelevant information
- Implications for models of speech perception
 - The Neighborhood Activation Model (NAM; Luce and Pisoni, 1998)
 - Mental lexicon organized into similarity neighborhoods
 - Words in similarity neighborhood differ from target by single phoneme
 - » Target word: CAT; Neighbors include: KIT, AT, SCAT
 - During word recognition
 - All words in a neighborhood (including target) are activated
 - Correct identification requires inhibition of all neighbors

The NAM, Age and Speech perception

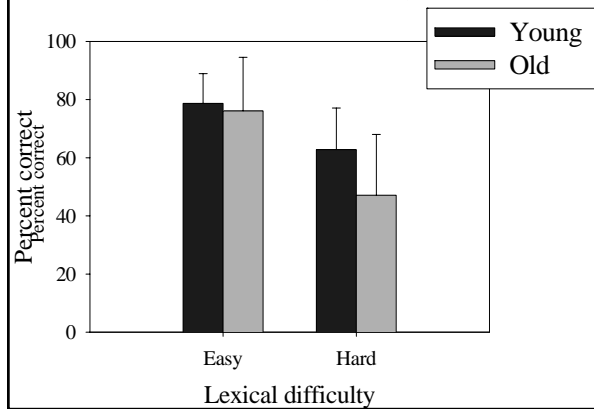
- Based on NAM can derive two categories of words
 - Easy words (e.g., young)
 - Low neighborhood density
 - Relatively minimal inhibitory demands – few neighbors to inhibit
 - Hard words (e.g., cat)
 - High neighborhood density
 - Substantial inhibitory demands – Many neighbors to inhibit



Age, inhibition and the NAM

- Aging associated with declines in ability to inhibit activated but no longer relevant items
 - Inhibitory demands greater for hard than for easy words
 - Differences between easy and hard words should be greater for older than for younger adults
- Experiment 1
 - Young normal-hearing adults
 - Older adults with clinically normal (< 20 dB HL) hearing up to 4 kHz
 - Test using open-set word ID in background babble
 - Slightly higher S/B for older

Lexical difficulty and age



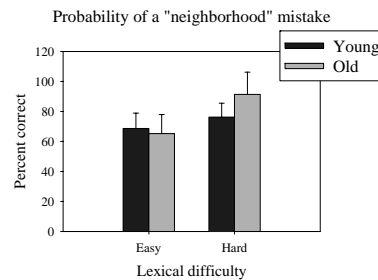
Potential explanation based on hearing not cognition

- Older adults have normal hearing up to 4 kHz
- Fricatives have important information above 4 kHz
- If hard words have a disproportionate representation of fricatives age differences in lexical difficulty could be due to high-frequency hearing loss

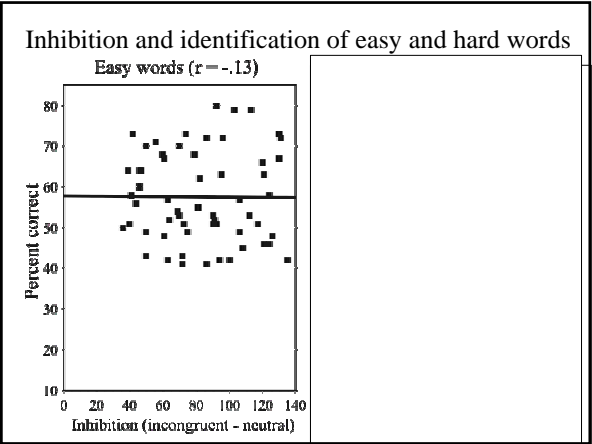
Phoneme type	Initial consonant		Final consonant	
	Easy	Hard	Easy	Hard
Stops				
Voiced	18	18	9	14
Unvoiced	11	12	17	25
Fricatives				
Voiced	1	0	11	0
Unvoiced	15	5	18	4
Affricates				
Voiced	2	2	5	0
Unvoiced	3	2	2	0
Nasals	8	13	14	20
Liquids	17	21	8	11

Role of inhibition – Part 1

- Do older adults make more “neighborhood” mistakes?
- If age differences due to inhibitory deficits
 - Older adults should be more likely to produce a neighbor for incorrect response
 - Should be particularly susceptible to such mistakes for hard words

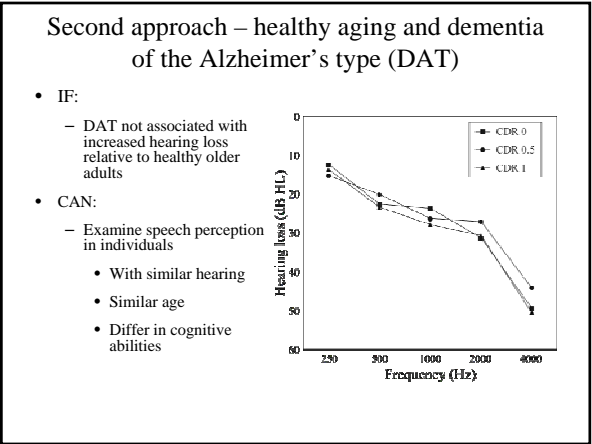
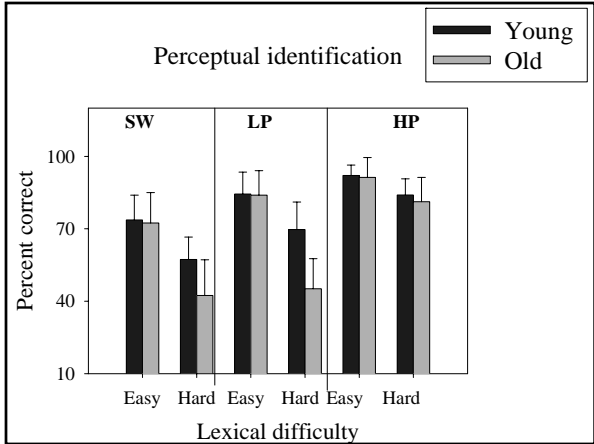


- ### Role of inhibition – Part 2
- Replicate easy-hard perceptual identification experiment
 - Same groups as previous experiment (NH young and old)
 - Measure inhibition
 - Auditory Stroop task
 - Participant must identify gender of talker
 - 3 conditions:
 - Congruent (male talker says “male”, female talker says “female”)
 - Neutral (male and female talker say word “person”)
 - Incongruent (male talker says “female”; vice-versa)
 - Difference in RT (incongruent – neutral) index of inhibition
 - Do older adults with poorest inhibition show greatest difficulty identifying hard words?



- ### Role of inhibition – Part 3
- Reduce inhibitory demands by providing semantic context
 - Sommers and Danielson (1999) propose that context functions to reduce number of activated candidates
 - In isolation LARK is a neighbor of SHARK
 - In context “I was attacked by a _____” LARK is not activated or activation is much lower than in isolation
 - If context functions to reduce inhibitory demands it should
 - Have greater effects on hard than easy words
 - Have greater effects on old than young adults

- ### Age, context, and easy versus hard words
- Use Normal-hearing younger and older adults
 - 180 words
 - 90 easy and 90 hard
 - Presented in one of 3 conditions
 - Single words (SW)
 - Low-predictability (LP) contexts (He was thinking about the SHARK)
 - High-predictability (HP) contexts (I was attacked by a SHARK)
 - 60 words in each condition (30 easy; 30 hard)
 - Asked to identify the word (SW) or last word in sentence (LP and HP)
 - All but last word of sentences presented in clear



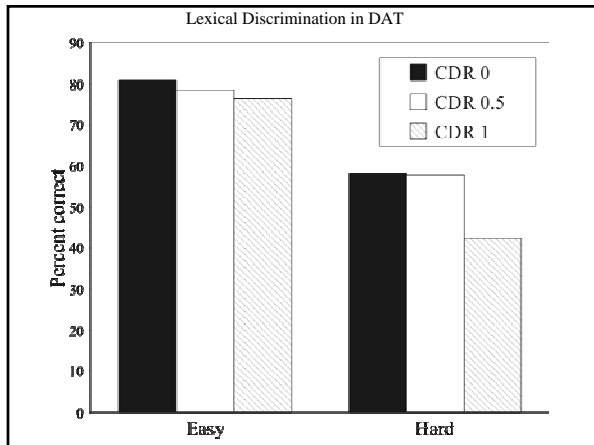
Lexical Discrimination in healthy older adults and DAT

- 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?
- Procedure
 - Identify 76 “easy” words (mean neighborhood density = 10.8)
 - Identify 76 “hard” words (mean neighborhood density = 26.4)
 - All testing done with 6-talker babble and SNR of +2
- Predictions
 - If inhibition important for speech perception
 - All groups should perform similarly on easy words
 - Poorer performance on hard words with increased severity of DAT

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**
Inhibition			
Auditory Stroop	84.9	112.3*	180.8**
Color Stroop	31.8	62.4*	100.7**
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

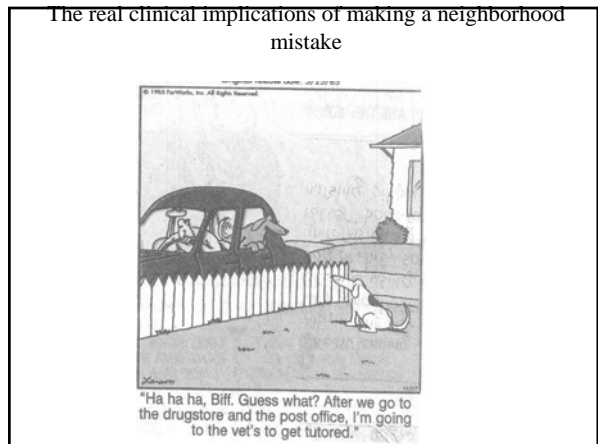


Summary and conclusion

- Methodological considerations
 - Variety of methods for examining importance of cognitive abilities in understanding the speech perception abilities of older adults
 - Two least problematic are
 - Compare older and younger NH
 - Compare healthy older and DAT
- Evidence for importance of inhibition in speech perception difficulties of older adults
 - Young and old NH similar performance on easy words but older impaired on lexically difficult words
 - Older more likely to make within-neighborhood mistakes
 - Measures of inhibition (Stroop) correlated with performance on hard words
 - Reducing inhibitory demands (context) reduces age differences in hard word identification
 - Alzheimer’s disease associated with impaired inhibition and impaired identification of hard words

Clinical implications

- Measures of sensitivity alone may not accurately predict speech perception
- Improving audibility with sensory aids may not restore speech perception
 - Deficits in inhibition may also contribute to greater difficulty with speech in noise perception
 - Have to inhibit irrelevant stimuli (noise)
- Can measure inhibitory abilities relatively quickly
 - Along with other measures of cognition measures of inhibition may provide better prediction of speech perception under real world conditions



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