Overview of Presentation

› Review basic auditory temporal processing limitations of older people
› Consider issues on perception of accented speech by older listeners
› Review previous research on perception of accented English and other relevant studies
› Present current investigation of perception of accented speech and non-speech sequences
› Summarize findings and implications

Temporal Cues in Speech Perception: Effects of Aging
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Background: Auditory temporal processing deficits of older people

› Older listeners exhibit difficulty in processing changes in temporal cues
  - Duration discrimination for tones and gaps (Fitzgibbons & Gordon-Salant, 1994, 1995; Lister et al., 2002)
  - Temporal gap resolution (He et al., 1999)
  - Sequence discrimination (Fitzgibbons & Gordon-Salant, 2001)
  - Temporal-order perception (Fitzgibbons & Gordon-Salant, 1998; Fitzgibbons et al., 2006)
  - Temporal fine structure (inter-aural phase differences) (Croz & Month, 2010)

› Older listeners have difficulty perceiving duration cues in speech segments:
  - Voice onset time
  - Vowel duration
  - Silent interval duration
  - Transition duration

› Older listeners show difficulty understanding temporally altered speech
  - Time-compressed speech (e.g., Anglefield et al., 1993)
  - Reverserental speech (Gordon-Salant & Fitzgibbons, 1996)
  - Interrupted speech (Gordon-Salant & Fitzgibbons, 1996)

› Age-related deficits in processing temporal changes in speech and non-speech signals are exaggerated for brief stimuli, sequences presented at fast or variable rates, and paradigms that stress cognitive demands

Background: Accented speech

› 23% of the U.S. population is foreign born or native born with at least one foreign-born parent (US Census Bureau, 2010)
  - 28% of the US population > 5 years speaks their first language at home
  - Most prevalent non-English language spoken in the US is Spanish (spoken by 62% of this population)

› Temporal changes associated with Spanish-accented English
  - Segmental level
    - Reduction in vowel duration
    - Delay in voice onset for word-initial voiced fricatives
    - Reduced duration of closure during word-final affricates
  - Supra-segmental level (prosody)
    - Stress patterns of native language superimposed on English (e.g., syllable timing - altered tempo)
    - Pauses inserted at inappropriate intervals (not phrase boundaries)
    - Addition of inappropriate vowels with consonant clusters (ex: estar)
    - Increase in overall sentence duration

› Why study perception of accented English by older people?
  - Age-related problems with perception of alterations in timing with speech and non-speech signals
  - Prevalence of exposure to accented English that is characterized by altered timing
  - Older people report difficulty understanding accented speech
Effect of accent on recognition of English words in quiet

Experimental question: Are age effects observed for recognition of accented English in quiet?

Method:
Four listener groups (native speakers of English)

Stimuli:
- Isolated words (all feature a temporal cue for word identity)
- Low-context sentences, final target word is same as isolated words
- Three talkers: no accent, mild accent, moderate accent (L1 = Spanish)

Results show:
- Effects of accent
- Effects of group (older hearing-impaired listeners perform more poorly than other groups)
- Minimal effect of stimulus context

Goal: Examine effect of prosody of carrier sentence on final word recognition in noise

Stimuli: low context sentences
- spoken by native English speaker and Spanish-accented speaker
- 2 hybrids
  - Final word (CVC) – had a contrasting word varying in a temporal cue

Conditions: Q and N (SNR = +5 dB)

Results:
- Effect of accent observed primarily for perception of final target word
- Age and hearing loss effects observed when final word spoken by native English speaker
- Age effects only observed when final word spoken by accented speaker
- Prosody of carrier sentence had little effect
Interval Repetition

- Goal: examine if repetition of a stimulus interval improves discrimination performance
- Method:
  - 3 groups: YN, ON, OHI
  - Stimuli sequences with 4kHz, 20 ms tone bursts, with 2, 3, or 5 intervals
  - 3 presentation rates: 25, 50 and 100 ms IOI
  - (fast, medium and slow rates)
- Results:
  - Interval discrimination improves with greater interval repetition
  - Older listeners show poorer discrimination performance than younger listeners
  - Performance improvement with multiple repetitions is greatest for older listeners (fastest rate)

Fitzgibbons & Gordon-Salant, 2011

Current experimental questions

- Does accent affect perception of sequences featuring increasing number of target components?
- Is performance mediated by stimulus context or increased variability of number of components from trial to trial?
- Are effects of age and hearing loss observed for unaccented and accented stimulus sequences?

Speech Study: Method

- Participants:
  - 3 groups: YN, ON, OHI (n ≈ 14/group): native speakers of English
- Stimuli:
  - Sets of 1, 2, 3, and 4-syllable words based on same initial syllable
  - Ex: ant, antique, antelope, anticipate
  - Lists formed of all 1-syllable words, all 2-syllable words, etc.
  - Frequency of occurrence balanced across items in lists (Kucera & Francis, 1967)
  - “Mixed” list consisted of items taken from uniform lists
  - Items recorded as isolated words and final word of low-context sentences
    - Three talkers:
      - L1 = English
      - L1 = Spanish, L2 = English with mild accent
      - L1 = Spanish, L2 = English with moderate accent
- Procedures:
  - 30 conditions (5 lists x 3 talkers x 2 contexts)
  - Signal level: 85 dB SPL
  - Stimuli presented in 12-talker babble (SNR = + 10 dB)
  - Listeners recalled entire stimulus
  - Percent correct scores based on target word recognition

Isolated Word Stimuli

- Native English Talker
- Middly Accented Talker
- Moderately Accented Talker

- Speaker: p<.001
- List: p<.001
- Group: p<.01
- List x group, p<.01
Words in Sentences

Effect of Stimulus Context

Effect of Stimulus Uncertainty (uniform vs. mixed lists)

Summary of Speech Findings

- Performance is poorest for monosyllabic words and improves with # of syllables
  - Performance improvements appear to be related to lexical neighborhood density
- Performance declines with degree of accent for all listener groups
  - For unaccented speech (monosyllabic words), hearing loss effects emerge.
  - For accented speech, age and hearing loss effects are observed
- Performance improvements with increasing number of syllables are affected by accent
- Context effects are seen with accented speech for older listeners but not younger listeners, and when observed, performance is poorer in sentence contexts
- Variation in number of syllables within a list primarily influences performance in moderately accented conditions.
Psychoacoustics: Method

- Participants: same groups as tested in speech study
- Stimuli:
  - 6-tone sequences featuring 1kHz tone bursts
    - Baseline: all tones fixed at 40 ms, IOI fixed at 100 or 200 ms
    - "Accented" tone sequences: second tone elongated by 100%
    - "Accented" interval sequences: second interval elongated by 100%
- Procedure
  - Discriminate one or two target intervals within the sequences in separate conditions
  - 2 presentation rates: fast (100 ms IOI) and slow (200 ms IOI)
  - 12 conditions: 2 presentation rates x 3 sequence types x 2 target interval conditions (1 or 2 target intervals)
  - Target interval duration DLs measured using adaptive 2AFC procedure converging on 70.7% discrimination threshold

Psychoacoustic tone sequences

Discrimination Performance for 3 sequence types

Discrimination performance for 3 sequence types
Summary of Psychoacoustic Findings

- For both slower and faster sequences, there were effects of accent, number of targets, and group
  - **Group effect:** Young normal hearing listeners performed better than the two older groups
  - **Accent effect:** Performance was poorer for accented sequences compared to unaccented sequences
  - **Target number:** Performance was better for 2 targets than for 1 target, confirming the beneficial effects of target repetition
- The benefits of target repetition are observed and enhanced in accented sequences
- For faster, but not slower sequences, performance was poorer for accented intervals compared to accented tones

Overall Summary and Conclusions

- **Accent** has a detrimental effect on perception of speech and non-speech stimuli
  - An age effect is observed for accented non-speech sequences
  - Age and hearing loss effects are observed for accented words and words in sentences
- **Increasing number of syllables/targets** improves performance for speech and non-speech stimuli
- There is an interaction between accent and number of syllables/targets:
  - For non-speech signals and in some conditions, improvements with number of stimulus intervals are greater for accented stimuli than unaccented stimuli
  - For speech signals, it appears that moderate accent disrupts the expected benefit of increased # of syllables within a word (3→4 syllable)
  - This tentatively suggests that accent affects the relative stress patterns within multisyllabic words

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