Aging and Distraction by Competing Speech

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Age changes that could affect comprehension of speech with distraction

- Hearing (peripheral and central auditory processes)
- General slowing
- Declines in working memory and executive function
- Age differences in dividing attention
  - e.g. increased difficulty listening while tracking visual target
- Inhibitory control

Evidence for age differences has been mixed, so... It depends on what you look at...

What might influence effects of distraction?

- Listener characteristics
  - Hearing (peripheral and central auditory processes)
  - Age (young-old or old-old)
  - Education
  - Cognitive ability (verbal, working memory, executive function, processing speed)
  - Motivation, sense of control
- Characteristics of target and distracter
  - Sound level, signal-to-noise ratio, voice qualities
  - Linguistic level: Words, sentences, or connected text (context)
  - Semantic content of target and distracter (meaningful, related)
- Listening situation: task demands
  - Predictability
  - Listening goals/instructions
  - Task measured: comprehension, recognition, recall

We will discuss findings from 4 areas in bold

Age Differences with Different Types of Distracters

- Task: recall simple sentences
- Listening condition
  - Quiet
  - Low level distracter (Signal-to-noise ratio (0 dB)
  - Higher level distracter (Signal-to-noise ratio (-6 dB)
- Type of competing speech sound
  - One competing speaker
  - Two competing speakers
  - Multitalker babble

(Representative data for all studies discussed)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>YOUNGER</th>
<th>OLDER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>18.6</td>
<td>71.2</td>
</tr>
<tr>
<td>*Education (years)</td>
<td>14.0</td>
<td>16.5</td>
</tr>
<tr>
<td>*Vocabulary</td>
<td>42.6</td>
<td>72.5</td>
</tr>
<tr>
<td>Health (self-rated)</td>
<td>1.1</td>
<td>1.3</td>
</tr>
<tr>
<td>Hearing (self-rated)</td>
<td>0.7</td>
<td>0.9</td>
</tr>
<tr>
<td>*Pure-tone average (PTA)</td>
<td>97.8</td>
<td>48.1</td>
</tr>
<tr>
<td>*Word recognition</td>
<td>87.8</td>
<td>96.3</td>
</tr>
<tr>
<td>*Digit symbol substitution</td>
<td>67.6</td>
<td>66.8</td>
</tr>
<tr>
<td>*Forward digit span</td>
<td>6.1</td>
<td>5.8</td>
</tr>
<tr>
<td>*Backward digit span</td>
<td>6.4</td>
<td>5.8</td>
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</tbody>
</table>

*Pure-tone average (PTA)
*p<.05 between groups
Recall of Sentences in Noise


Waveform of a target sentence (top panel) and three types of sound used as distractors.

Varying Listening Situation
- Listen to and recall passages on familiar topics (providing good contextual support)
- Predictability (consistency) of distracter
  - Study 1: One distracting speaker (consistent, predictable situation with same target speaker and distracter speaker throughout)
    - Shows no effect of distraction for either young or older adults
    - For either free recall or multiple choice comprehension questions
  - Study 2: Different distracting speakers (less predictable; same target speaker, vary competing speakers)
    - Young show no effect of distraction, old recall less with competing speakers than in quiet
    - However, no age difference in distraction on comprehension questions (shows that often less sensitive than free recall)

Predictors of “cost” of distraction

<table>
<thead>
<tr>
<th>Predictor</th>
<th>$R^2$</th>
<th>$R^2$ Change</th>
<th>$p$</th>
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<tbody>
<tr>
<td>Complex processing</td>
<td>.18</td>
<td>.18</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Speed</td>
<td>.25</td>
<td>.07</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>Memory span</td>
<td>.26</td>
<td>.01</td>
<td>n.s.</td>
</tr>
<tr>
<td>Hearing</td>
<td>.29</td>
<td>.03</td>
<td>n.s.</td>
</tr>
<tr>
<td>Age</td>
<td>.31</td>
<td>.02</td>
<td>n.s.</td>
</tr>
</tbody>
</table>
Effect of semantic content of distracter

- Are meaningful distracters more difficult for older adults than younger adults?
  - Informational masking
  - Reading distraction task shows differences for adults depending on semantic content (Connelly, Hasher, & Zacks, 1991)

Distraction by meaningless and meaningful speech

Effects of semantic content when target & distracter do not overlap

- Do we see age differences in older and younger adults’ memory when distracters are interpolated, not concurrent?
- Are older adults affected more by semantically related material?
- Clearest test of effects of semantic content on listening
- Age differences would make the strongest case for distraction effects at a higher cognitive/attentional level

Task: listen to 300-word stories about familiar topics, then answer true-false questions (latency and accuracy recorded)

(Tun, Little & Wingfield, in preparation)

Results

- No significant age differences in accuracy on factual questions, or questions about unrelated distracters
  - No differences with neutral, related, unrelated distracters
- For related lure questions, older adults less accurate than young only when they heard a related distracter
- Response latencies show a similar pattern; old are slower than young, but differentially slower on related lure questions with related distracters
- Demonstrates that older adults had more difficulty with semantically related distracters (inhibitory deficit?)

"Tom and Barb’s canasta club is meeting at their home tonight. There are three other couples, so there are two tables for playing doubles..."
Qualitative age differences in memory

- May depend on semantic as well as acoustic factors
- May include differences in recall or response latency, as well as false memory
- Whether age differences in the effects of distracting speech are seen may depend on where you look...

Two scenarios for age differences in distraction...

- Optimal listening situation (e.g. at home)
  - Stories on familiar topics
  - One competing voice
  - Predictable, consistent listening situation
  - Unrelated distracter

- Challenging listening situation: (e.g. doctor’s office)
  - Unfamiliar to-be-remembered material; little context
  - Multiple competing voices
  - Unpredictable listening situation
  - Related distracter topics
  - Effortful, self-initiated memory task

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References
