Age differences in language production: The neural correlates of semantic interference, phonological facilitation, and target picture frequency

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**PURPOSE**

The goal of the current study was to examine the neurological basis of age-related differences in language production using a picture word interference paradigm.

**BACKGROUND**

- **Picture Word Interference (PWI):** Presenting a distracting word with a target picture influences response latencies for the target.
- **Categorically related distractors** activate a network of related items, slowing target production.
- **Phonologically related distractors** activate phonemes that are part of the target word, speeding production.
- **Inhibition Deficit Theory:** Older adults are less able to control what information enters working memory. All distracting information should be processed to a greater extent.
- **Transmission Deficit Theory:** Weakening of the connections within the phonological system results in retrieval failures.
- Older adults display greater semantic interference than younger adults, but no age differences are found for phonological facilitation.

**SUBJECTS**

- 20 healthy younger adults between 20 and 31 years old (M=23.70)
- 20 healthy older adults between 60 and 79 years old (M=76.25)

**MATERIALS AND PROCEDURE**

- 240 color images with a written distractor superimposed
- Target pictures vary on frequency (log-HAL), ranging from 2.30 to 12.44 (M=7.48, SD=1.91)
- Target and distractor frequency were uncorrelated
- Participants were asked to name the target quickly and accurately

**RESULTS**

**Increased Semantic Elaboration in Older Adults**
Older adults showed increased activation in regions associated with early perceptual processing, semantic organization, and elaboration compared to younger adults during production with a categorical distractor.

**Decreased Phonological Processing in Older Adults**
Older adults showed decreased activation in regions associated with language processing and articulation compared to younger adults during production with a phonological distractor.

**Target Frequency Modulates Brain Activity Differently for Older and Younger Adults**

- **Negative Correlations Between Frequency and Activation**
  - Older Adults > Younger Adults: Phonological > Neutral
  - Bilateral Pre & Postcentral Gyrus
  - Lateral Occipital Cortex & Lingual Gyrus

  For older adults, lower frequency targets presented with phonological distractors were associated with increased activation in regions associated with articulation and early visual processing. This relationship was absent for younger adults.

- **Positive Correlations Between Frequency and Activation**
  - Younger Adults > Older Adults: Categorical > Neutral
  - Right Inferior Temporal Gyrus

  For younger adults, higher frequency targets presented with categorical distractors were associated with increased activation in the right inferior temporal gyrus, a region associated with semantic processing. This relationship was absent for older adults.

**Method**

**Subjects**

- 20 younger adults between 20 and 31 years old (M=23.70)
- 20 older adults between 60 and 79 years old (M=76.25)

**Materials and Procedure**

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**Results**

- **Increased Semantic Elaboration in Older Adults**
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  - Older adults showed decreased activation in regions associated with language processing and articulation compared to younger adults during production with a phonological distractor.

**Conclusions**

- **Categorical Distractors:** Older adults’ semantic networks were activated to a greater extent than younger adults’ when categorical distractors were presented. Results are consistent with the Transmission Deficit Theory.
- **Phonological Distractors:** Even when provided access to the phonology of the target, older adults showed deficits in regions that support production. Results are not entirely consistent with either Transmission Deficit or Inhibition Deficit theories.

- **Low Frequency Targets:** When older adults were presented with a phonological distractor, increased activation in the auditory-motor speech coordination network was associated with lower frequency targets.
  - Phonological cues aided articulation for words that were most difficult for older adults to access.
  - Results are partially consistent with the Transmission Deficit Theory.

- **High Frequency Targets:** When younger adults were presented with a categorical distractor, increased activation related to semantic processing was associated with higher frequency targets.
  - Increased semantic elaboration was not sensitive to target frequency for older adults, suggesting a more highly connected or redundant semantic network.
  - Results are consistent with the Transmission Deficit Theory.