Age-related change in speaking tempo: Tracking linguistic experience over time

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Introduction
What is the effect of talker age on speaking tempo? Do older talkers speak more slowly than younger ones?

Empirical background
Corpora of spontaneous speech reveal barely any degree of age-related slowing, non-significant when other determinants of speaking tempo, such as education level, are controlled (Quené, 2008; Horton et al., 2010). This is surprising, given age-related slowing in motor, perceptual, and cognitive processes generally Salthouse, 1991, and given the strong evidence of age-related slowing in read speech e.g. Mysak, 1959.

Theoretical background
"Weaker links hypothesis": Age-of-acquisition effects may be attenuated with age, as late acquired words may catch up with early-acquired words (Gollan et al., 2008).

Some known predictors of word duration in spontaneous speech:
(Cf. Bell et al., 2009; Gahl, 2008, 2010 for review)
- Utterance length
- N-gram probability, other types of predictability
- Fluency
- Word frequency
- Phonological neighborhood density (Gahl, Yao & Johnson, under review)
- Other "lexical" properties

Model
Mixed-effects regression model of word duration in the Switchboard corpus of telephone conversations between strangers (Godfrey et al. 1992):
1. For all talkers,
2. For each age decile separately.

Random effects: Talker, Word, Years of education
Fixed effects:
- Phonemic content (i.e. the sum of a word’s phonemes’ median durations in the ICSI-Switchboard),
- Part-of-speech
- Morphological complexity
- Bigram probability, given previous and following words
- Contextual speaking rate
- Word frequency (Brysbaert et al. SUBTLEX)
- Age of acquisition

Since frequency and age-of-acquisition (AoA) are related variables, AoA was residualized on word frequency.
To further reduce collinearity in the model, continuous variables were centered.
Variables representing (word or segment) duration, probabilities, speaking rate, and frequencies were log-transformed.

Hypothesis
Age-related change affects the relative importance of determinants of speaking tempo, rather than just speaking tempo itself. Changes in the determinants of speaking tempo may mask overall age-related slowing in spontaneous speech.
Here, we focused on age-of-acquisition AoA and word frequency as predictors of word duration.
Both are inherently tied to talkers’ accumulating linguistic usage – and hence, talker age.

Results I:
Talker age does affect word durations: Older talkers speak more slowly than younger ones, when other predictors are controlled.

Results II
Age-of-acquisition emerged as a significant predictor in talkers of all ages. Other things being equal, late-acquired words are longer in duration than early-acquired ones when considering all talkers together, and also in separate models for each age decile (all p < .0001).
Crucially, the effect of age-of-acquisition consistently decreases for each successive decile (beta ~ .043 for the youngest decile vs. .026 for the oldest). Markov Chain Monte Carlo sampling suggests that the difference in coefficients across models is statistically significant.

Conclusions
Talker age does affect speaking rate in spontaneous speech when other determinants of speaking rate are controlled: Older talkers tend to speak more slowly than younger ones.
Moreover, determinants of speaking rate change with talker age, in a manner that is consistent with the “weaker links” hypothesis of effects of age on language production.

References:
Bell, A., Brener, J., Gregory, M., Girard, C., and Jurafsky, D. 2009. Predictability effects on durations of content and function words in conversational English. JML 65, 92-111.

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