1pSCc11. Age effects of pitch-shifted auditory feedback on reflexive and volitional voice F0 control

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BACKGROUND

- Pitch-shift reflex is a corrective voice F0 response to an auditory feedback pitch "error" (Burnett et al., 1998; Xu et al., 2004).
- Many reflexes increase in latency and decrease in magnitude with age.
  - Jaw-jerk reflex (Kossioni & Karkazis, 1998)
  - Deep tendon reflexes (Baloh, Ying, & Jacobson, 2003)
- Volitional motor reaction time often increases with age.
- Voice fundamental frequency (F0) is often less stable in the elderly than in younger individuals (Linville & Fisher, 1985; Benjamin, BJ, 1981).

RESEARCH QUESTIONS

Q1: Does normal aging increase voice F0 response latency…
- of the pitch-shift reflex?
- of voluntary voice F0 responses?

Q2: Does normal aging reduce pitch-shift reflex magnitude?

Q3: Does pitch-shift stimulus magnitude affect pitch-shift reflex magnitude?
- Is there an interaction between age group & pitch-shift stimulus magnitude?

METHODS

Participants

- 32 adults from three age groups with age-appropriate hearing acuity and voice quality

Age Group	**Young**	**Middle-aged**	**Elderly**
Age Range (avg.)	19 — 29 (22.3)	45 — 63 (58.4)	65 — 79 (70.8)
n (M:F)	12 (1:11)	10 (4:6)	10 (4:6)

Experiment Set-up

- Acoustic signals were anti-alias filtered at 2 kHz and digitally recorded at 10kHz
  1. voice output
  2. voice auditory feedback
  3. 200 Hz pure tone, pitch shifted the same time and direction as voice auditory feedback

Tasks and Stimuli

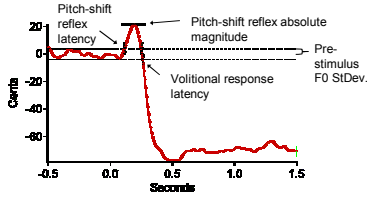
- Participants sat in a sound-dampened room wearing circumaural headphones w/ a boom microphone 1" from lips.
  - Auditory feedback intensity equaled voice output intensity (~ 80 dB SPL).
- An LED cued participant to vocalize /u/ steadily at comfortable pitch for 5 sec.
  - LED cue repeated every 10 sec. for a total of 180 trials.
- Participants were warned they would hear a sudden brief shift in voice pitch once per vocalization

	Task	***Pitch-shift stimulus***	*n*
Sustain	Vocalize /u/ at a steady pitch, ignoring the pitch shift	**20 or 100 cents**; 100 ms; Up or Down	120
Follow	Vocalize /u/ at a steady pitch, then change voice F0 in same direction as pitch shift	**100 cents**; 100 ms; Up or Down	60

Data Analysis

- Extracted F0 in Praat (Boersma & Weenink, 2007)
- Smoothed with 3-point window filter
- Time aligned individual trials to the onset of the pitch shift stimulus
- Averaged trials to create one F0 contour per person per condition (see below)
- Calculated mean and 2nd standard deviation value in 500 ms pre-stimulus period
- Automatically marked F0 deviations that exceed 2SD of the pre-stimulus mean
- Checked data for normality & log transformed if positively skewed

Avg F0 Contour for 1 Elderly Female in Follow task



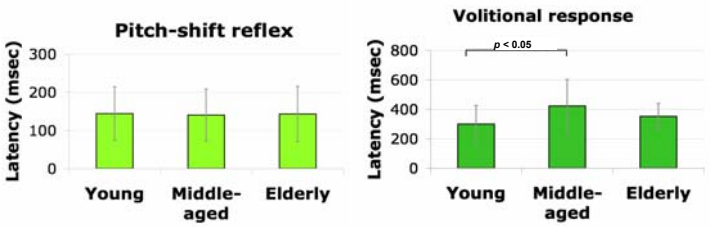
Dependent variables:

- **pre-stimulus voice F0 StDev (cents)**
- **pitch-shift reflex latency (msec.)**
- **pitch-shift reflex absolute magnitude (cents)**
- **volitional voice F0 response latency (msec.)**

RESULTS

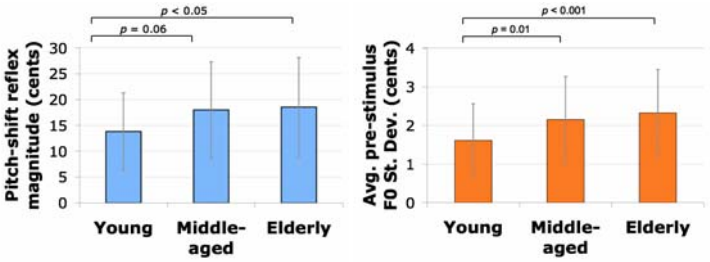
Effect of age on voice F0 response latency

- No effect on pitch-shift reflex latency
- Decreased volitional voice F0 response latency for middle-aged



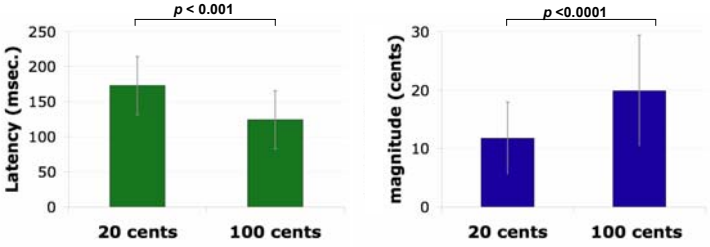
Effect of age on pitch-shift reflex magnitude

- Near-significant increase in pitch-shift reflex magnitude with age.
  - *Voice F0 variability increased with age*
  - *Voice F0 variability correlated with pitch-shift reflex magnitude*



Effect of pitch-shift stimulus magnitude on pitch-shift reflex

- Shorter pitch-shift reflex latency with larger magnitude stimulus
- Larger pitch-shift reflex magnitude with larger magnitude stimulus



- No interaction between age + stimulus magnitude for pitch-shift reflex latency or magnitude.

SUMMARY

1. **Volitional F0 response latency increases with age.**
2. **Pitch-shift reflex magnitude is affected by age, but latency is not.**
3. **Voice F0 stability is reduced with age.**
4. **Pitch-shift reflex latency is shorter and magnitude is greater with greater pitch-shift stimulus magnitude.**

IMPLICATIONS

- **The pitch-shift reflex is robust across age span in healthy adults**
- **Increased pitch-shift reflex magnitude may be a cause of or a response to increased voice F0 variability.**

Acknowledgements

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