Effects of age and musical expertise on perception of speech in speech maskers in adults

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Background

Perceiving speech in the presence of concurrent speech, or speech-on-speech (SoS), relies on perceptual mechanisms such as discriminating mean fundamental frequency (F0) and vocal-tract length (VTL) **[1]**, and on cognitive mechanisms such as directed attention and working memory **[2]**.

Aging effects. Older adults may be less sensitive to F0 differences, possibly affecting their ability to perceive different speakers **[3]**. Age-related cognitive changes may lead to difficulties in attention direction and inhibition **[4]**.

Musical expertise. Compared to non-musicians, musicians are reported to possess enhanced processing of acoustic features such as F0 **[5]**, as well as enhanced cognitive abilities such as auditory attention skills **[6]** and working memory **[7].** While this intuitively could lead to a musician advantage for SoS perception, reports of musicians outperforming non-musicians on SoS tasks are inconsistent across both younger- **[8,9,10]** and older- **[11,12]** adults. Differences in SoS paradigms across the literature have made it difficult to directly compare musicianship advantages in SoS perception in younger- and older adults, or to clarify related underlying mechanisms.

Objectives

O1 To investigate the extent to which voice differences aid SoS perception in older- compared to younger adults

O2 To investigate whether a musician advantage in SoS perception exists for older adults

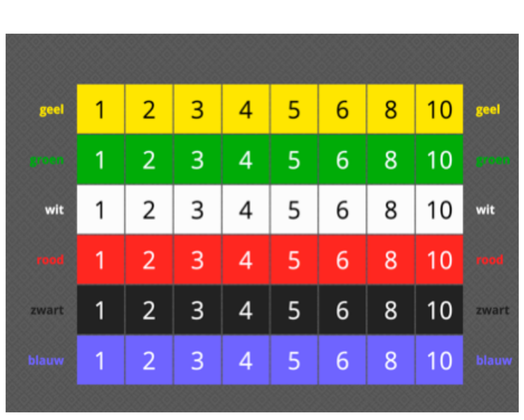
Design and Methods

Participants

- **O1:** 32 younger adults (18-32 years) and 25 older adults (60-79 years), recruited through flyers, via conservatories and orchestras.
- **O2**: 5 younger and 11 older participants were excluded because they were musically active but did not meet the musician criteria.
- Musician inclusion criteria: 10+ years of formal training, start of training before the age of 7, continued musical practice within the previous 3 years **[14].**
- Participants who met none of the musician criteria were considered as non-musicians.
- Four experimental groups for **O2**: younger musicians and non-musicians (9 YM, 19 YNM) and older musicians and non-musicians (5 OM, 9 ONM).
- All participants native Dutch speakers with self-reported normal hearing.

Materials and experimental parameters

- Dutch version of the Coordinate Response Measure (CRM) procedure **[13]**.
- Sentences with a call sign and color-number coordinate, e.g., *"Laat de [hond] zien waar de [blauwe] [zes] is." ("Show the [dog] where the [blue] [six] is.")* **[15]**.
- Target and single-talker masker sentences were produced by the same female speaker, but had a different call sign (dog vs. cat).
- Gibberish maskers created by shuffling masker sentence chunks from 150 to 300 ms.
- Three masker voice conditions: ΔF0/ΔVTL = 0 semitone (st)/0 st, -6 st/+1.8 st, and -12 st/+3.6 st.
- Three target-to-masker ratios (TMR) : -8, -4, and 0 dB.



▲ **Fig. 1 –** Interface for the CRM

References [1] Darwin et al., *JASA*, **2003**, 114. [2] Zekveld et al., *JASA*, **2013**, 134. [3] Vongpaisal & Pichora-Fuller, *JSLHR*, **2007**, 50. [4] Goossens et al., *Hear. Res.*, **2017**, 344. [5] Micheyl et al., *Hear. Res*., **2006**, 219. [6] Strait et al., *Hear. Res.,* **2010**, 261. [7] Kraus et al., *ANYAS*, 2012, 1252. [8] Başkent & Gaudrain, *JASA*, **2016**, 139. [9] Kaplan et al., *Front. Psychol.*, **2021**, 12. [10] Boebinger, et al., JASA, **2015,** 137. [11] Zhang et al., *Ear Hear.,* **2021,** 42. [12] Mussoi, *J. Speech Lang. Hear. Res.*, **2021,** 29. [13] Bolia et al., *JASA*, **2000**, 107. [14] Fuller et al., *Front. Neurosci.*, **2014**, 8. [15] Nagels et al., *JASA*, **2021**, 149. [16] Rachman et al., Under review [17] Harding et al., NeuroImage, 2019, 96.

Preliminary data

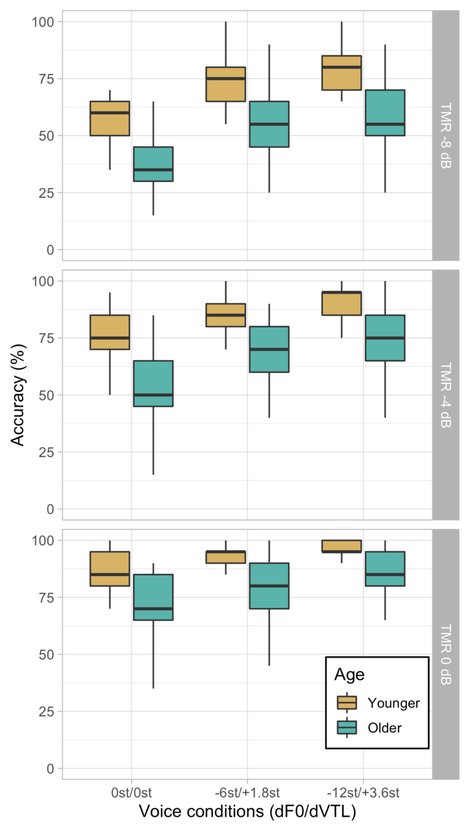
O1 – General age effect (Fig. 2)

Accuracy scores were analyzed with a mixed-effects 2x3x3 ANOVA with age group (younger, older) as between-subject factor and voice condition (0st/0st, -6st/+1.8st, -12st/+3.6st) and TMR (-8, -4, 0 dB) as within-subject factors.

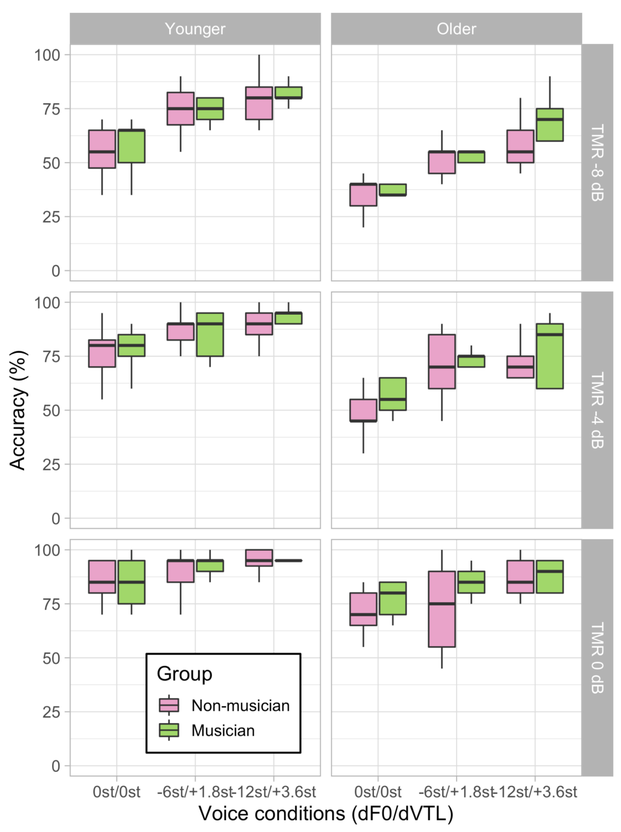
- Significant main effect of age group [$F(1,56)=51.8$, $p<.001$],
- Significant interaction between age group and voice condition [$F(2,112)=3.2$, $p<.05$].
- Significant interaction between age group and TMR [$F(2,112)=6.6$, $p<.01$].
- Significant interaction between voice condition and TMR [$F(4,224)=8.5$, $p<.001$].

O2 – Musician advantage in older adults (Fig. 3)

As data collection is still ongoing and current experimental groups are too small for a preliminary analysis, a proper analysis will follow when data collection has been completed.



▲ **Fig. 2 –** Accuracy (in %) shown for the younger and older adults for the three voice conditions. Three panels present from top to bottom TMRs of -8, -4, and 0 dB.



▲ **Fig. 3 –** Accuracy (in %) shown for O2 participants, separated into the younger (Left panels) and older (Right panels) musicians and non-musicians.

Discussion

- Preliminary results for **O1** showed a general effect of age, supporting earlier findings (e.g. **[4]**) of older adults having more difficulties in perceiving masked speech than younger adults.
- Results further showed that overall performance increased when voice differences between target and masker voice became larger, suggesting that both younger and older adults are able to use F0 and VTL cues to separate target from masker speech.
- The interaction between age and voice condition suggests that younger and older adults benefit from voice difference to different degrees, but ceiling performance may play a role for the younger participant group. A detailed analysis of the benefit from voice cues in the different age groups will follow once data collection has been completed.
- Because F0 and VTL were manipulated together, we could not infer from these data if perception of F0 or VTL, or both, is affected by aging (as shown for F0 in some studies **[3]** but not for VTL **[16]**), and that this contributed to the age effect on speech on speech perception.
- Future studies should manipulate F0 and VTL cues independently to assess their individual benefit to older listeners.
- In next steps, while we plan to first compare groups with strict musician and non-musician criteria as in **[8]**, we will also explore continuous metrics such as years of musical training **[17]**.

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