The effect of musical training on ecological cocktail party listening

Anneliese Schulz, Brian B. Monson
Department of Speech and Hearing Science, College of Applied Health Sciences, University of Illinois at Urbana-Champaign

Introduction

Many studies have suggested that experience, such as musical training, has an impact on listener performance for speech comprehension in challenging auditory environments (1, 2). However, some studies have failed to reveal any musician advantage (3, 4).

Because the typical recording procedure for speech materials involves using a microphone located directly in front of a talker, most studies examining speech-in-speech listening (the "cocktail party" problem) simulate an unnatural scenario in which the target talker and maskers are all facing the listener (Figure 1A). Our study design was more representative of ecological cocktail party listening, in which the target talker faced the listener while co-located maskers had head orientations (a.k.a. facing angles) facing away from the listener (45° or 60° relative to the listener, Figure 1B).

It is generally assumed that extended high frequencies (EHF; > 8 kHz) are not valuable for speech comprehension, but recent evidence from our lab and others suggests otherwise (Figure 1C, Figure 2).

Head Orientation of Maskers

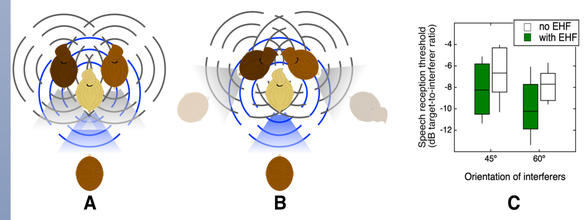

Figure 1. (A) The unnatural scenario typically simulated when evaluating cocktail party listening. (B) The more ecologically valid scenario simulated in the present study. (C) Previous findings of the effects of masker head angle and access to EHF energy in the speech signal.

In a previous study measuring the speech reception threshold (SRT; the target-to-masker ratio necessary to achieve 50% accuracy of identification of words in a sentence), it was found that masker head orientation impacts listener performance in a speech-in-speech listening task (5). Listeners performed better in the 60° condition compared to the 45° condition. Furthermore, listeners performed better with access to EHFs.

Aim

- To determine whether musical training may improve speech comprehension in challenging, more ecologically valid listening situations.
- To determine whether EHFs provide cues for target speech comprehension in a speech-in-speech listening task for musicians.

Extended high-frequency characteristics

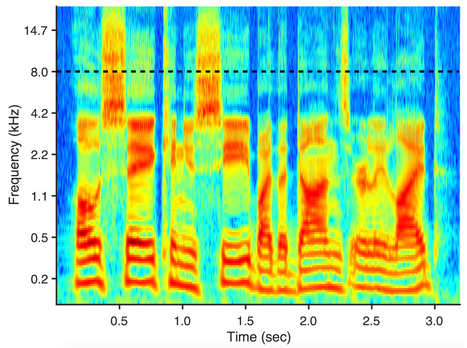

Figure 2. High-frequency characteristics of the phrase "Oh say can you see by the dawn's early light". There is considerable energy above 8,000 Hz.

- Extended high-frequency hearing is defined as hearing beyond 8 kHz.
- Extended high-frequency hearing aids in sound localization and is a unique mammalian trait of vertebrates (5).

Method

Stimuli:

- Masker: two-female-talker babble stimulus created using previous recordings with microphones positioned at 45° and 60° relative to the talkers (6).
  - To decrease predictability of the maskers, a semantically unpredictable speech signal was used for the maskers.
- Target: female talker, recorded in a sound-treated booth at 0° relative to talker.
  - BKB sentences.
  - Type I microphone, 44.1-kHz sampling rate, 16-bit precision.
- Low-pass filtered condition: all stimuli low-pass filtered with 32-pole Butterworth filter, cutoff frequency of 8 kHz.

Method (continued)

Subjects:

- Musicians: 13 participants with normal hearing, 10+ years of musical training.
  - Musical training included private lessons and/or group ensembles.
- Non-musicians: 11 participants with normal hearing and 0 years of musical training.

Procedure:

- Stimuli presented to listeners seated in a sound-treated booth at 1 m over a KRK Rokit 8 G3 loudspeaker with good high-frequency response.
- Masker level set at 70 dB SPL at 1 m
- Target talker level (*i.e.*, signal-to-noise ratio; SNR) was adaptively varied.
- One-down, one-up adaptive rule.
- Both adaptive tracks started with a signal level of 4 dB SNR. SNR initially adjusted in steps of 4 dB, but switched to an adjustment of 2 dB after the first reversal.
- Brief training block consisting of 16 sentences.
- Four conditions tested in separate blocks:
  - With EHF *vs.* without EHF
  - Masker head orientation of 45° *vs.* head orientation of 60°.
- Block order randomized across participants.

Results

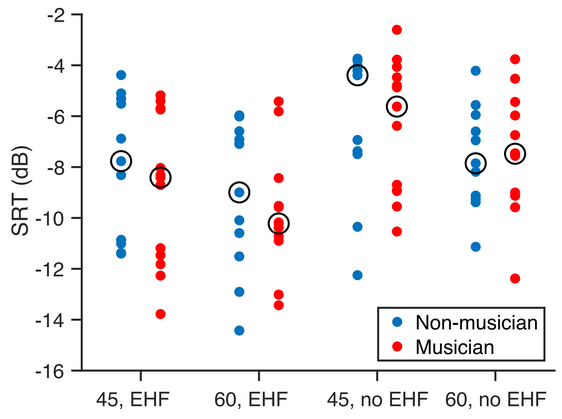

Figure 3. Non-musician and musician SRT with and without EHF at 45° and 60° masker head orientation. Black circles indicate the median of each condition.

Results (continued)

- No difference between musicians and non-musicians ($p = 0.7$).
- Significant improvement with access to EHF ($p<0.001$).
- Significant improvement in 60° condition ($p<0.001$).
- Non-musicians improved 1.7 dB with access to EHF.
- Musicians improved 2.5 dB with access to EHF.
- No interaction between musicianship and EHF access.
- No interaction between musicianship and head angle of maskers.

Conclusions

- Under our ecological cocktail party listening conditions we did not observe a musician advantage.
- Acoustical energy above 8,000 Hz is useful for cocktail party listening.
- Ecological study design and other factors (*e.g.*, noise exposure) may play a role in diminishing musician advantage.
- Limitation: small sample size.
- Data collection is ongoing until we reach our target number of musicians and non-musicians (N=20).

References

1. Slater, J., Skoe, E., Strait, D. L., O'Connell, S., Thompson, E., & Kraus, N. (2015). Music training improves speech-in-noise perception: Longitudinal evidence from a community-based music program. *Behavioral Brain Research,* 291, 244-252.
2. Parbery-Clark, A., Tierney, A., Strait, D.L., Kraus, N. (2012). Musicians Have Fine Tuned Neural Distinction of Speech Syllables. *Neuroscience,* 219, 111-119.
3. Skoe, E., Camera, S., Tufts, J. (2018). Noise exposure may diminish the musician advantage for perceiving speech in noise. *Ear and Hearing.*
4. Swaminathan, J., Mason, C. R., Streeter, T. M., et al. (2015). Musical training, individual differences and the cocktail party problem. *Sci Rep*, 5, 11628.
5. Monson, B. B., Rock, J., Schulz, A., Hoffman, E., and Buss, E. (submitted). Ecological cocktail party listening reveals the utility of extended high-frequency hearing.
6. Heffner, H.E., Heffner, R.S. (2008). High-frequency hearing. In: Dallos, P., Oertel, D., Hoy, R., (Eds.), Handbook of the senses: Audition. Elsevier, New York. pp. 55-60.
7. Monson, B. B., Hunter, E. J., and Story, B. H. (2012). Horizontal directivity of low- and high-frequency energy in speech and singing. *J. Acoust. Soc. Am,* 132, 433–441.

ILLINOIS