Talker identification in three types of background noise

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Summary

- Perceiving speech in the presence of background noise (i.e., masking) requires listeners to distinguish and attend to one talker from among competing talkers.
- Young adults with normal hearing learned to identify five talkers by the sound of their voice in quiet.
- Talker identification accuracy was tested in quiet and masking by speech-shaped noise, multi-talker babble, and a single competing talker.
- Performance was best in quiet and fell as a function of SNR for all masker types.
- The change in accuracy as a function of SNR was greatest for multi-talker babble.
- Trained sentences facilitated identification compared to untrained sentences.
- Individual variability in performance appeared unrelated to listeners' pure-tone hearing levels, speech perception in noise, or phonological awareness/memory.

Methods

Participants

Native English-speaking young adults (N = 30; 25 female, 5 male; age 18-30) with a self-reported history free from speech, language, and hearing problems.

Target Talkers and Sentences

Participants learned to identify 5 female native speakers of American English from their recordings of 30 “Harvard Sentences” (IEEE, 1969). Listeners trained on 15 of the sentences and tested on all 30. Training/testing sentences were counter-balanced across participants.

Masking Noise and Speech

- Speech-shaped noise was extracted from track 69 of the Quick Speech-in-Noise Test (QuickSIN; Killion *et al.*, 2004).
- Four-talker babble was extracted from tracks 24-35 of the QuickSIN.
- Single competing talkers (N = 4, female native speakers of American English) recorded 26 additional “Harvard Sentences”.
- Combined RMS amplitude of targets and maskers was held constant at 68dB across the different test SNRs (Inf, +5dB, 0dB, -5dB).

Procedure

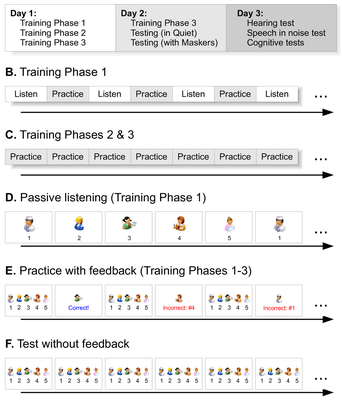
(A) Three visits for talker identification training/testing and cognitive / audiological assessment.

(B) Phase 1: Passive familiarization of talkers blocked by sentence **(D)**, followed by active practice with feedback **(E)** (Day 1).

(C) Phase 2: Further active practice with feedback blocked by sentence **(E)** (Day 1); Phase 3: Further active practice with feedback with random sentence order **(E)** (Day 1 & 2).

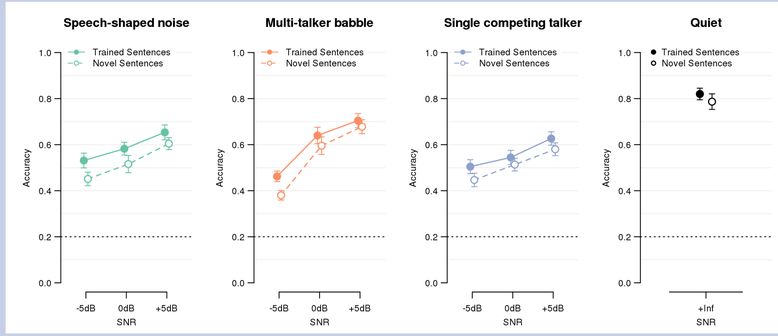
(F) Talker identification test with no feedback, first in quiet, and then in the three types of masking noise (SSN, MTB, SCT; counterbalanced) (Day 2).

Day 3: Pure-tone hearing (Carhart *et al.*, 1959), speech-in-noise (QuickSIN), and cognitive tests (CTOPP; Wagner *et al.*, 2013).



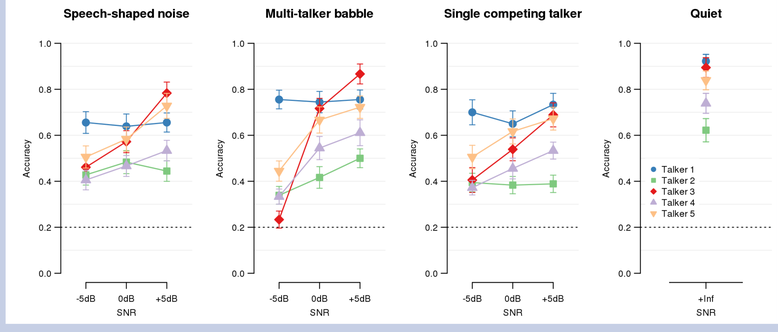
Results: Masking Conditions

Talker identification accuracy as a function of SNR across noise types



- Marginal effect of masker type such that overall talker identification accuracy in background babble (57.7%) was somewhat better than in speech-shaped noise (55.6%) or a single competing talker (53.6%) [$F_{2,58}$ = 2.73, p = 0.073].
- Significant effect of SNR such that overall talker identification accuracy differed as a function of SNR [$F_{1,29}$ = 167.86, p = 1.38×10^{-13}].
- Participants were most accurate in the most favorable SNR, and accuracy fell as SNR decreased (+5dB: 64%; 0dB: 57%; -5dB: 46%).
- Facilitatory effect of SNR varied across noise type [condition by SNR; $F_{2,58}$ = 9.52, p = 2.65×10^{-4}] such that multi-talker babble had the steepest slope for talker identification accuracy.
- Overall talker identification accuracy for trained sentences (60.7%) was significantly better than for novel sentences (55.5%) [$F_{1,29}$ = 28.05, p = 1.1×10^{-5}].
- Facilitatory effect of trained versus novel sentences did not differ across masker type [$F_{2,58}$ = 0.37, p = 0.69] nor SNR [$F_{1,29}$ = 1.98, p = 0.17].
- No three-way interaction between condition, SNR, and sentence familiarity was observed [$F_{2,58}$ = 0.36, p = 0.70].

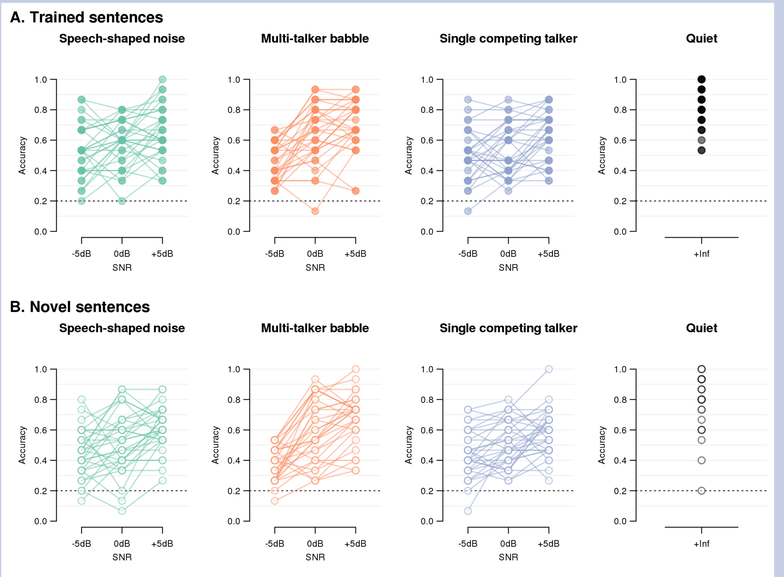
Talker identification accuracy depending on target speaker



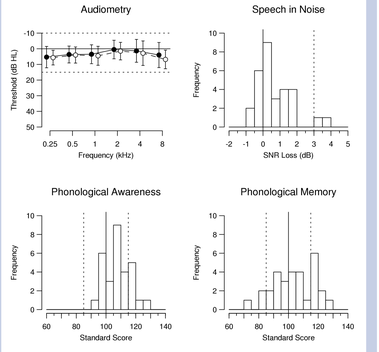
- There was substantial variability in talker identification accuracy across speakers.
- While some remained unaffected by background noise (Talker 1), others varied across both noise type and SNR (most notably, Talker 3).
- The most identifiable talker at +5dB was poorly identified at -5dB SNR (Talker 3).

Results: Individual Variability

Variability in talker identification accuracy across participants



Supplemental assessments



- Individual performance varied considerably across participants.
- Correlation between talker identification accuracy in quiet and in masking was significant (SSN: r = 0.78, p < 4×10^{-5}; MTB: r = 0.81, p < 5×10^{-8} ; SCT: r = 0.67, p < 5×10^{-5}).
- After controlling for accuracy in quiet, no significant correlations were found between talker identification accuracy with masking and the supplemental assessments ($|r|$ = 0.03 – 0.28).
- Decrement in accuracy in babble from +5dB to -5dB was marginally correlated with the phonological awareness (r = 0.44, p < 0.02) and phonological memory (r = 0.45, p < 0.02) subtests of the CTOPP.

References

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