



# Listening Effort and Speech Perception Performance Using Different Facemasks

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## Introduction

Facemasks can negatively impact social interaction and introduce difficulties in understanding spoken language. Various types of masks decrease the vocal signal by attenuating high frequencies as much as 2 to 12 dB between 2 and 7 kHz depending on mask type (Corey et al, 2020). This attenuation pattern has been compared to a pseudo hearing loss, as it mimics the effects of a high-frequency hearing loss.

Much of the literature examining the effects of facemasks on acoustic information and speech perception has not focused on speech understanding with facemasks in varying background noise levels, nor how these effects impact listeners with hearing loss. In addition, few studies have examined how listening effort is affected by facemask use.

## Objective

The purpose of this study was to investigate the relationship between speech perception and listening effort under different signal-to-noise ratios (SNRs) and various mask conditions for listeners with normal hearing and hearing loss. The goal was to address the disparities in previous studies by manipulating both mask type and background noise levels as well as examine listening effort to obtain a more complete picture of the effects of facemasks on speech perception.

## Method

### Participants (N=40 Adults)

- Normal Hearing (NH)
  - N=18 (10 females, 8 males; mean age 37 years)
  - PTA  $\leq$  15 dB HL
- Slight Hearing Loss (SHL)
  - N=11 (5 females, 6 males; mean age 52 years)
  - PTA between 16 and 25 dB in both ears
- Mild Hearing Loss (MHL)
  - N=11 (6 females, 5 males; mean age 48 years)
  - PTA > 25 dB in at least one ear
- Normal middle ear function
- Normal cognitive function

## Stimuli

- Mini-Mental Status Examination (MMSE)
- Quick Speech in Noise (QuickSIN)
  - Two sentences recorded in each mask condition by a female talker

## Mask Conditions

- No Mask (NM)
- Surgical Mask (SM)
- N95
- KN95
- Transparent mask/small visual opening (TM1)
- Transparent mask/large visual opening (TM2)
- Cloth mask with 2 layers (CM2)
- Cloth mask with 3 layers (CM3)
- Face shield+cloth mask & 3 layers (SHCM3)

## Procedure

- Cognitive Screening
- Audiometric Testing
  - Otoscopy
  - Tympanometry
  - Pure tone thresholds
- QuickSIN
  - 2 lists presented per mask condition
  - Signal at 50 dB HL; SNR varied from +25 to 0 dB
  - Sound field with listener 6 feet from speaker
- Listening effort rated after each sentence

Listening Effort	
1	No Effort
2	Very Little Effort
3	Little Effort
4	Moderate Effort
5	Considerable Effort
6	Much Effort
7	Extreme Effort

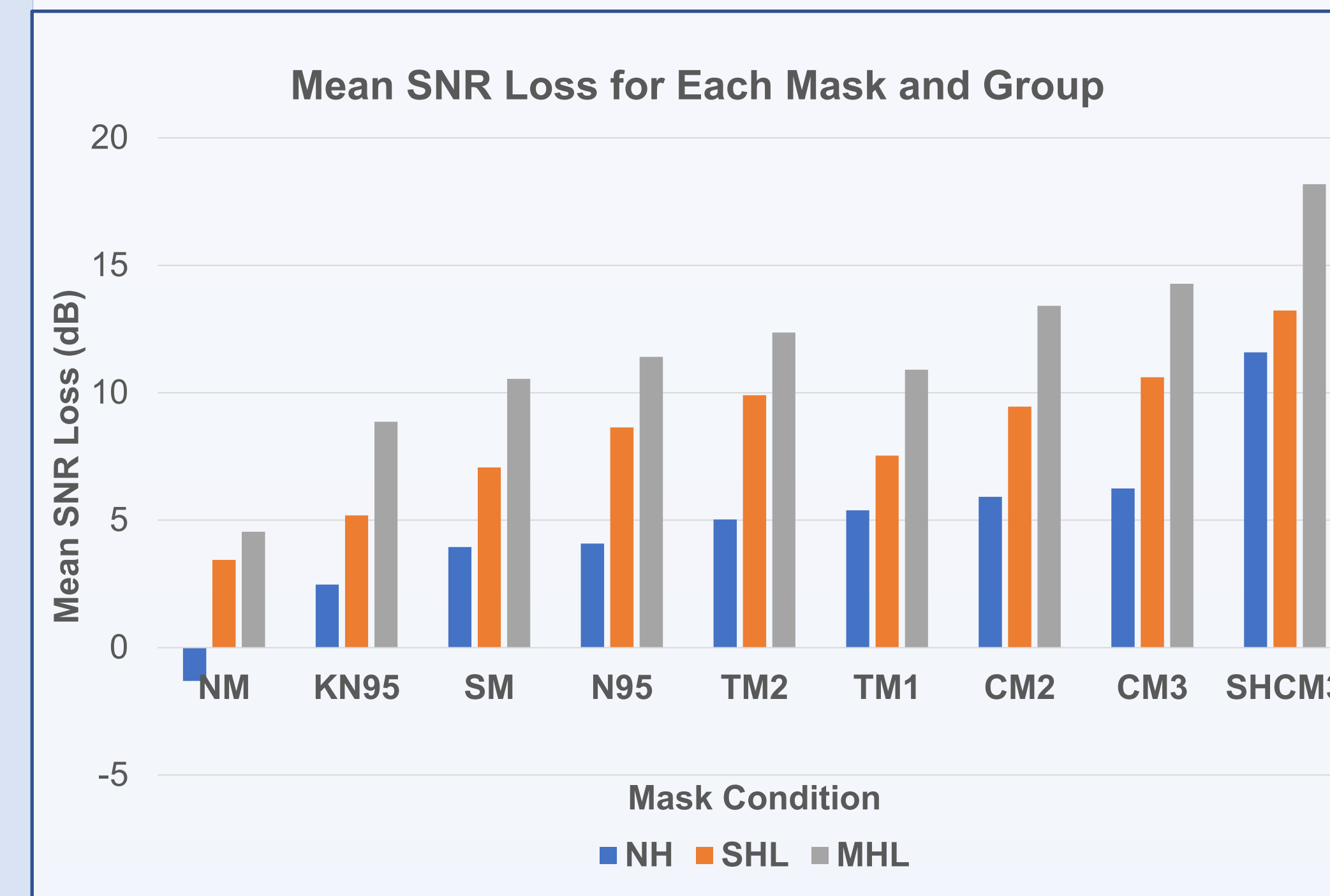
## Results

### SNR Loss

- Listeners with normal hearing demonstrated a mild SNR loss (5.05 dB).
- Listeners with slight (8.09 dB) and mild (11.60 dB) hearing loss demonstrated a moderate SNR loss.

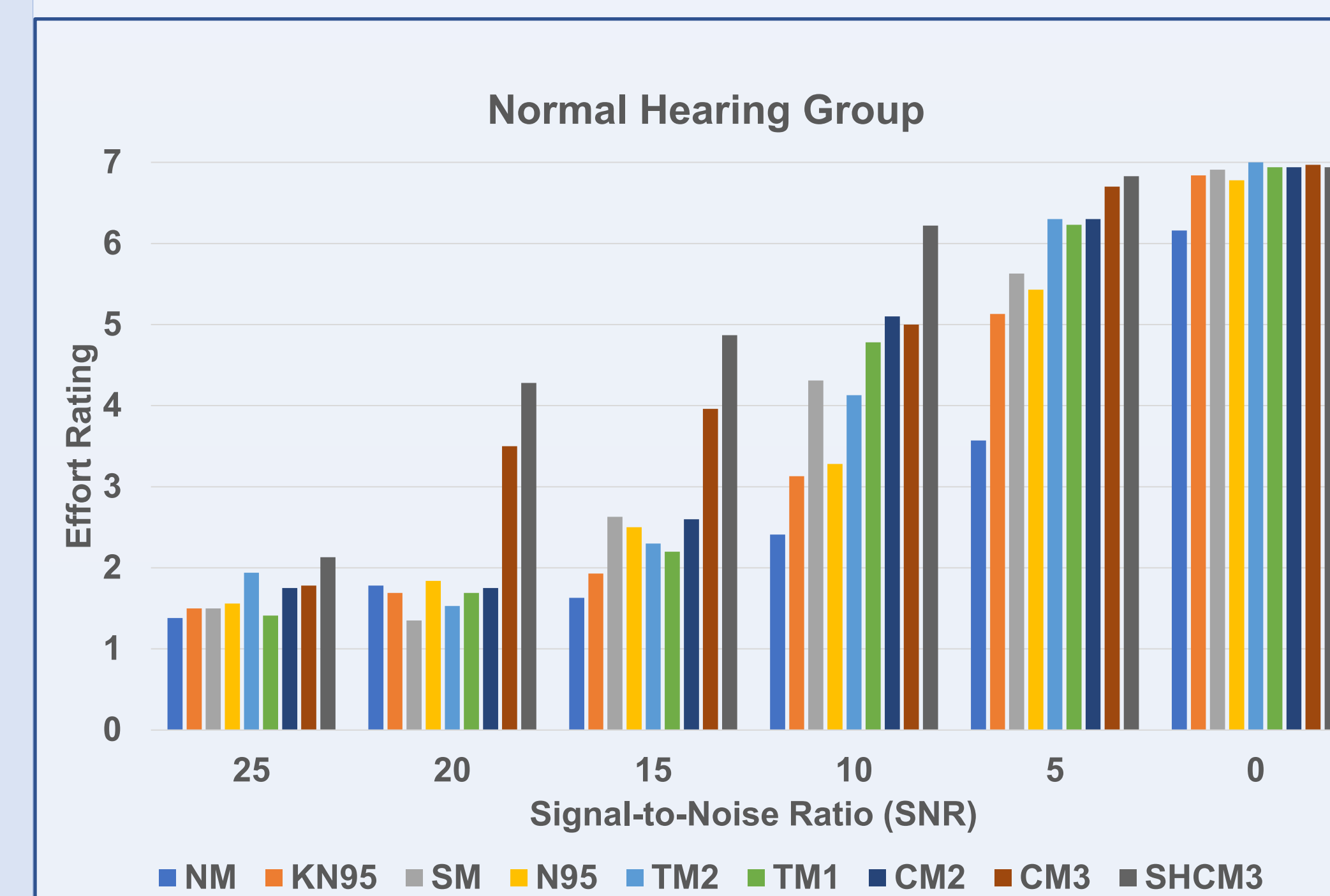
## SNR Loss Results Cont.

- Performance in the NM, KN95, and SM conditions was significantly better than in the CM3 and SHCM3 conditions for all groups ( $P < 0.05$ ).
- Best to worst performance: NM, KN95, SM, N95, TM2, TM1, CM2, CM3, SHCM3.



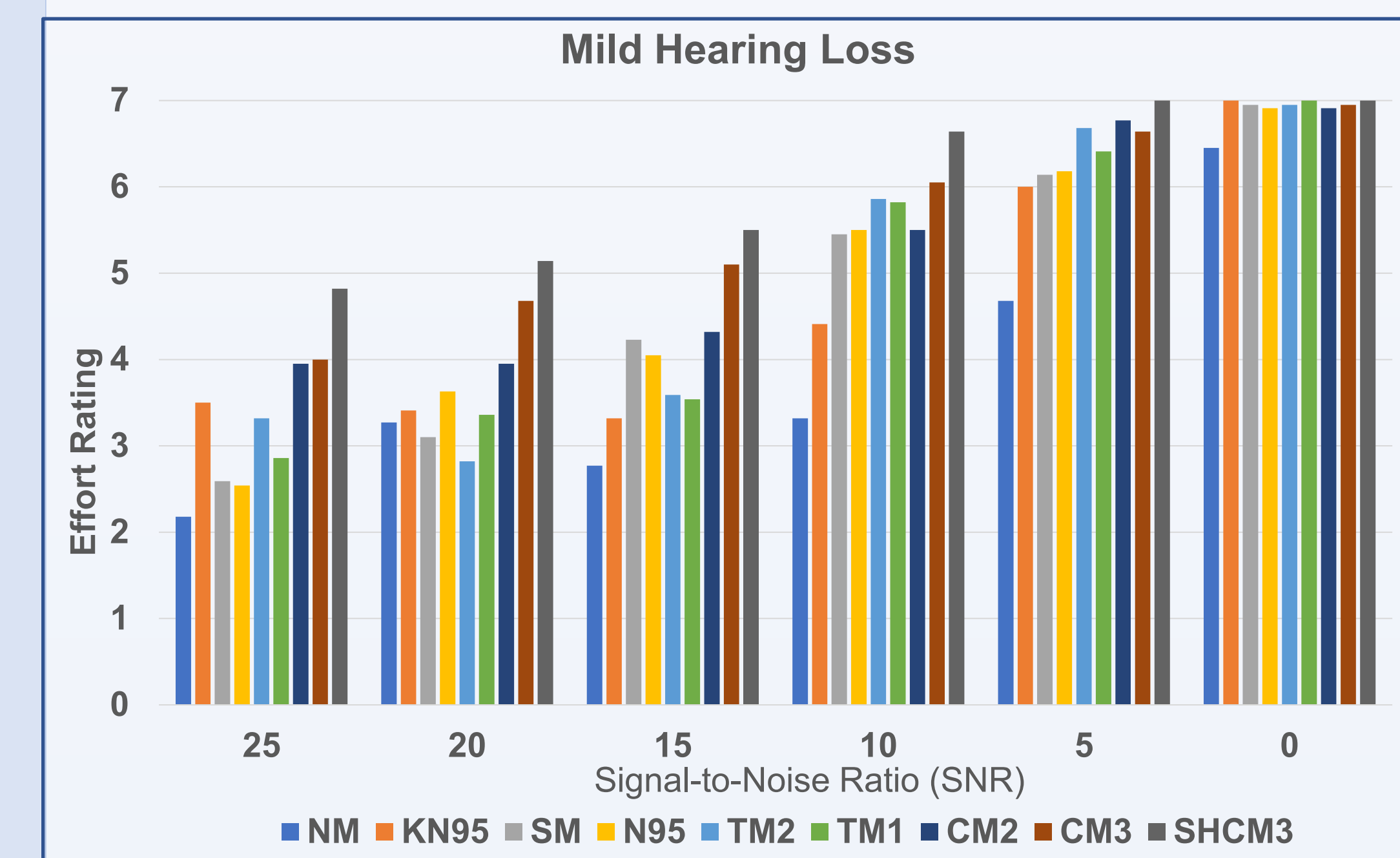
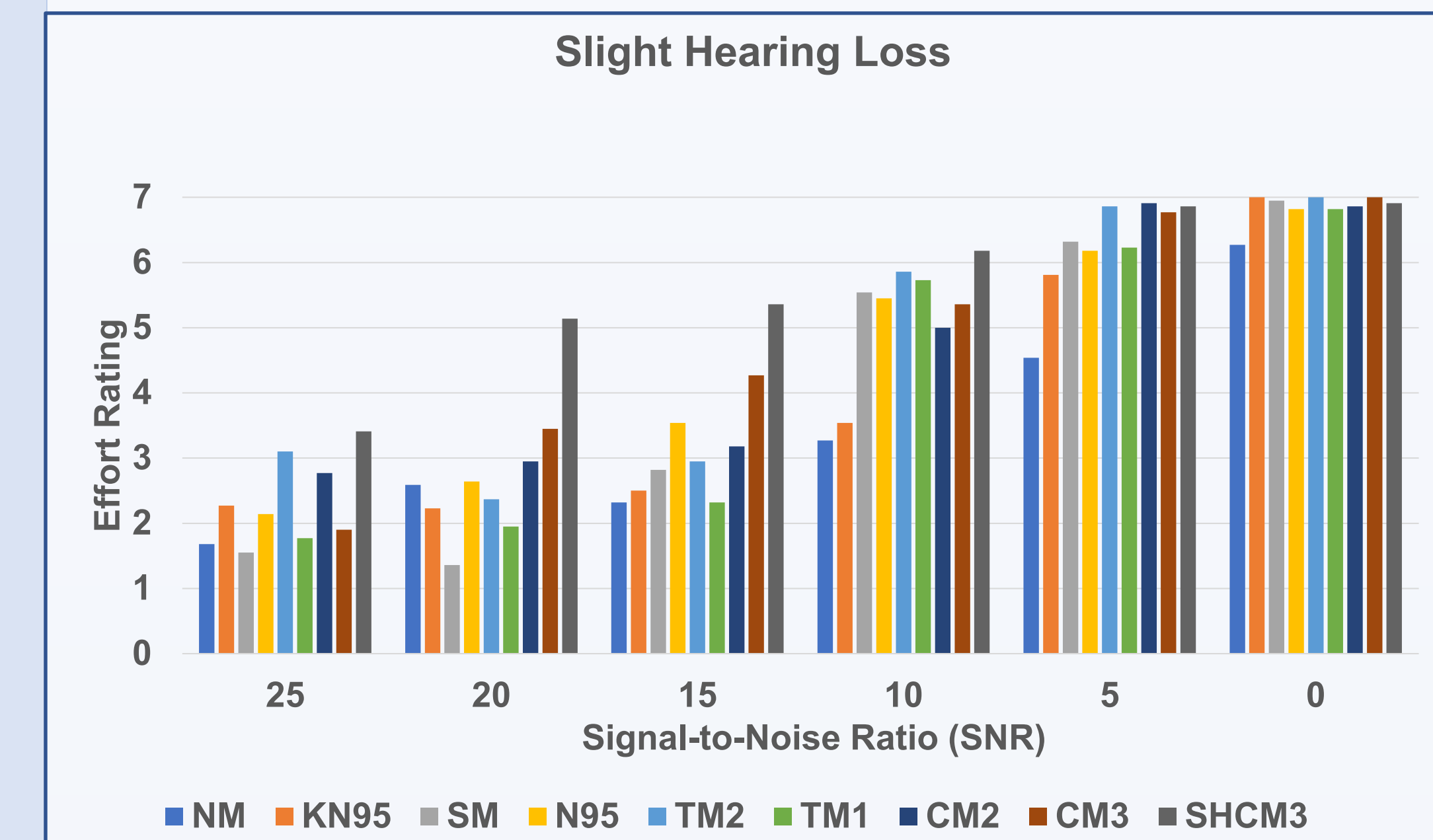
## Listening Effort - NH

- Less listening effort required in the easier mask conditions and more favorable SNRs.
- Greater listening effort required in the more difficult mask conditions and poorer SNRs.
- For the normal hearing group, effort ratings at +25, +20, and +15 dB SNR were very low for all mask conditions except at +20 and +15 dB SNR for the CM3 and SHCM3 masks.



## Listening Effort – SHL / MHL

- Higher overall effort was exhibited in the slight and mild hearing loss groups in all mask conditions and SNRs.



## Conclusions

- All listeners demonstrated an SNR loss worse than expected when masks were used including the NH group.
- Listening effort increased and speech perception performance decreased at poor SNRs and in the more difficult mask conditions.
- No mask, KN95, and surgical masks had the least impact on performance while cloth masks, especially those with 2 or 3 layers and a face shield (CM2, CM3, and SHCM3), posed a significant detriment to communication.
- An SNR of at least +15 dB when listening in noise is recommended when a mask is used in a background of noise.

## Reference

Corey, R.M., Jones, U., & Singer, A.C. (2020). Acoustic effects of medical, cloth, and transparent face masks on speech signals. *The Journal of the Acoustical Society of America*, 148(4), 2371-2375.