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Effect of Face Mask on Speech Communication during COVID-19

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The virus's widespread transmission can be linked to particles in the air and droplets, making the use of personal protective equipment (PPE) crucial to preventing viral transmission.[1] Face masks are used to prevent pathogen transmission via droplets and/or aerosols.[2] As a result, N95 respirators and surgical facemasks are widely utilized in medical settings across the world.[3] Even traditional respiratory PPE, particularly full-face or partial-face masks, has been shown to diminish voice clarity and, as a result, communication efficiency.[4] Using a face mask reduces the distinctness of both messages: materials intended to reduce pathogen and other airborne particle transmission influence mouth mobility and sound delivery, and face masks often occlude the talker's mouth, obscuring key visual speech cues.[5] Both noise and the mask's limited vision would be labeled as communication barriers.[6]

Aside from several public health concerns, recent rises in the use of face masks have presented a huge obstacle to our regular communication tactics because face masks can impair both auditory and visual speech generated by a speaker.[5] Also, various kinds of face masks cause variable amounts of disturbance, every style of face mask reduces speech intelligibility if presented in presence of background noise.[5] Listeners are stronger at combining auditory and visual signals, with as much as a 26% improvement over the audio condition alone.[6] Masks conceal the mouth, making it difficult to collect information from the lip and facial expressions to enhance auditory comprehension. Lip reading is extremely useful in noisy environments because these gestures give temporal cues and raise understanding of linguistic aspects. Specifically, information concerning spoken consonants is supplied.[7] When the face is visible, the speech reception threshold (SRT) in the presence of background noise improves by 3 by 5 dB.[8] Access to lip-reading signals improves speech interpretation in background noise, particularly for those with hearing impairment.[6]

The use of face masks can obscure speech sounds, particularly for higher frequencies that help to distinguish between identical sounds. The acoustic impact of a speaker with a face mask is equal to the listener suffering from a mild high-frequency hearing loss.[9] A surgical mask decreased the speech perception threshold in the presence of noise by 1.6 dB on average across all noise sources, whereas an N95 mask lowered it by 2.7 dB.[10] In acoustic measurements, mask tissue affects the amplitude by lowering up to 8 dB for frequencies higher than 1 kHz, but not below.[10] In the high-frequency region of 2,000 to 7,000 Hz, simple medical masks, which are often used in operating theaters, lower the level of spoken language by 3 to 4 dB, while N95 masks decrease the level by roughly 12 dB.[11] There is a considerable dampening in frequency information from 1 to 8 kHz, with a larger reduction detected with N95 masks (5.2 dB) and surgical masks (2.0 dB) as compared with unmasked speech.[12] In one of the studies in which the authors compared the speech intelligibility in five different conditions and found intelligibility was the highest when the speaker did not wear a face mask, the surgical mask outperformed all others, trailed by the cloth mask without a filter, then the transparent mask, and lastly the cloth mask with a filter.[5]

Masks act as a low-pass filter having a cut-off frequency of 2 kHz for the surgical mask similarly at 1 kHz for the N95 mask to modify effective sound transmission. A low-pass filter, such as that induced by face masks, will limit the audibility of high-frequency parts of spoken speech, such as consonants and sibilants, or at the very least increase listening effort. Face masks raise the amount of effort required of the speaker, resulting in vocal fatigue, discomfort, and a lack of synchronization of speaking and breathing.[13] Also, the

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occlusion effect of the face mask produces a positive feedback effect on voice volume, causing one to speak in a soft tone than usual.[14] Factors such as temperature stress, hearing, and visual impairments, and mobility restriction enhance physical and attentional tiredness when wearing personal protective equipment.[15] An N95 mask's increased effort of breathing may create anxiety in certain people. Asthmatic clinicians may feel anxiety-related dyspnea.[16] Industrial respirators that are uncomfortable in fitting have been demonstrated to produce psychological stress, particularly in individuals who suffer from anxiety.[17]

The majority of masks block visual exposure of the speaker's lips, resulting in a communication barrier. This can make communication difficult to understand, especially in noisy situations or when the audience has a hearing problem.[18] It has been proposed that to achieve 90% accuracy in speech interpretation, the signal should be given at a level 10 to 15 dB above the noise source.[19] The World Health Organization (WHO) recommended the use of surgical masks in lower-risk situations whereas respirators in high-risk contexts.[1] Many people with hearing loss rely on visual clues from the mouth to understand speech; masks may impair speech communication efficiency. There is an additional challenge that occurs when there is background noise present in the healthcare environment. Hence, transparent surgical masks will help people with normal hearing and hearing loss communicate better because the mask's transparency allows for the required visual signals from the mouth to be present for speechreading.[20]

Conflict of Interest
None declared.

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