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Session 2pSCb: Speech Intelligibility (Poster Session)

2pSCb17. The effects of surgical masks on speech perception in noise
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Surgical masks and blood shields worn by anesthesiologists and surgeons in hospital operating rooms may negatively impact speech communication and put patients at needless risk. Young adult subjects listened to sentences from the Speech Perception in Noise Test (SPIN) recorded by a male and female talker. All eight SPIN lists were recorded under three different speaking conditions: 1) speaking normally without any obstruction, 2) wearing a typical surgical mask, and 3) wearing a surgical mask with an attached blood shield. Multi-talker babble was mixed with the SPIN sentences at several signal-to-noise ratios to simulate conversation in noisy environments. Speaker gender and recording conditions were counterbalanced across listeners to control for learning and fatigue effects. SPIN test scores for each of the three types of recordings and both talker genders were compared in order to determine the degradation that blood-shields and surgical masks may have speech communication in the operating room. [Research supported by research grants from the Division of Social and Behavioral Sciences and a scholarship from the College of Arts and Sciences at The Ohio State University.]

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INTRODUCTION

Anesthesiologists and surgeons at Nationwide Children’s Hospital in Columbus, OH have expressed serious concerns about speech communication in the operating rooms in which they work. These professionals have reported that it is sometimes difficult to hear one another during surgeries, which could put patients at risk. One factor that may contribute to speech communication problems in surgery is the surgical masks and blood shields that surgeons and anesthesiologists must wear. These procedure masks cover the lower portion of the face, the mouth and nose, and serve to prevent the transmission of bacteria and fluids between the patient and the health professional, protecting both. While medically important, these masks may alter the speech produced by person who is wearing the mask. This obstruction could result in quieter or distorted speech sounds reaching the listener’s ears.

Murthy et al. (1995) analyzed the detrimental effects of operating room noise levels on measures of mental performance. They found that exposure to noise levels equivalent to that of an operating room resulted in deterioration in mental efficiencies and short-term memory. Kracht et al., (2007) measured the noise levels of operating rooms during specific surgeries at Johns Hopkins Hospital. Sound pressure levels at Johns Hopkins Hospital were found to average between 55 and 70 dB(A) with significant sound peaks (some of great intensity) during surgical procedures. Mendel et al., (2008) measured the effect of surgical masks on speech perception in a dental office environment. Individuals with normal hearing and those with hearing impairments served as listeners. Test material was a digital recording of a subset of the stimuli from the Connected Speech Test (Cox, et al., 1987) prepared by a professional radio broadcaster. Mendel et al., reported that the presence of a surgical mask did not have a detrimental effect on speech understanding for either the normal hearing or hearing-impaired listeners. There are substantial differences between the dental office and hospital operating rooms, and Mendel, et al. did not test mask with blood shields.

The purpose of this study is to test the effect that the surgical masks and blood shields worn by anesthesiologists and surgeons in operating rooms have on speech communication. We hypothesize that the surgical masks and blood shields worn by health professionals with normal hearing in operating rooms may be an impediment to speech communication. Specifically, we expect listener performance on a standard test of speech perception in noise to be poorer when the speaker is wearing the surgical mask or both the surgical mask and blood shield than when nothing covers the speaker’s mouth and face.

METHODS

Subjects

Six young adults (ages 18-38) with normal hearing served as listeners for this study. Normal hearing was established by standard audiometric testing (thresholds ≤ 20 dB for audiometric test frequencies from 250 to 8000 Hz). Listeners were compensated for participation in the study.

Speech test materials

Two professional speakers (one male and one female) recorded the sentences of the Speech Perception in Noise (SPIN) test for each of the talking conditions: Unmasked, Masked, and Mask plus Shield. The SPIN test is made up of eight lists of 50 different sentences (Bilger et. al., 1984). After each sentence is played, the listener is prompted to repeat the last word they heard in the sentence. For 25 of the sentences, the last word is somewhat predictable from the context of the sentence. For the remaining 25 sentences, however, the last word is unrelated to the rest of the sentence. Each key word appears in a “high context” and “low context” sentence. Multi-talker babble from the original recording of the SPIN test was dubbed onto the second channel to serve as the masker. Six audio CDs, each containing the eight SPIN lists recorded for each talking condition and both talkers were burned for use in the listening experiment. A 1 kHz calibration tone was recorded on the first track of both channels. Before playback through the audiometer, the level from each channel was adjusted to 0 VU.
Listening Experiment

After completing the informed consent documents, each listener was seated in a sound-treated booth wearing TDH-43P headphones. Air conduction thresholds were measured with standard audiometric test procedures using an Interacoustics AC-33 clinical audiometer to determine that the listener had normal hearing thresholds. After audiometric testing, the listener was given a practice run of the SPIN sentences masked by multi-talker babble to familiarize him- or herself with the test.

After the practice session, testing with a full set of 50 SPIN sentences began with a randomly selected combination of talker gender and talking condition. Based on pilot work, the playback level for the SPIN sentences was set to 64 dB HL and the multi-talker babble was set to 60 dB HL. For each listener, the order of testing was counter-balanced to offset practice or fatigue effects. A different SPIN list was used for each gender by talking condition combination. Responses were marked by the experimenter as correct or incorrect, and if the response was incorrect the response (if any) of the listener was recorded on the answer form.

RESULTS

Percentage of correct responses was calculated for each talker-gender by talking-condition presentation. Performance on high context and low context presentations was tallied separately for each of the six SPIN lists used for a given listener. Results averaged for the six listeners are shown in Figure 1.

![Effect of Surgical Masks on Intelligibility](image)

**FIGURE 1.** Percentage of correct responses for the SPIN sentences averaged for six listeners with normal hearing. Talking conditions (unmasked, masked or mask plus shield) are grouped together. Talker gender and context cues are indicated by the shading of each bar.
In general, percentage of correct responses, P(C) was highest for the unmasked condition, followed by the
masked condition, and the mask plus shield condition. Across the three talking conditions, P(C) for the male talker
is lower than for the female talker. Finally, performance on the low context sentences is poorer than for high
context.

DISCUSSION

This report should be considered as preliminary. From the testing of these first six listeners, it appears that the
signal-to-masker ratio was set a bit too high leading to performance in the unmasked condition that nears the ceiling
at 100%. While there are obvious reductions in listener performance with the masked and masked-plus-shield
conditions, the variability in those conditions is large enough to cast doubt on the statistical significance of the
difference. Further testing at a lower signal-to-masker ratio will be conducted and reported in the presentation.

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