

Respirator Speech Intelligibility Testing with a Highly Trained Speaker

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The Modified Rhyme Test (MRT) is used by the United States' National Institute for Occupational Safety and Health (NIOSH) to assess speech intelligibility of commercial chemical, biological, radiological and nuclear (CBRN) air-purifying respirators (APRs). The MRT requires listeners to correctly identify single-syllable words spoken by a respirator wearer. Sound output level, enunciation, accent, and pronunciation of the respirator wearing test speaker may adversely affect the sound conveyance and speech intelligibility scores of a given respirator. It was postulated that a highly trained speaker who had participated in many speech intelligibility trials might induce higher intelligibility scores than a less trained speaker. A modified version of the NIOSH MRT was conducted to evaluate this hypothesis. A total of 13 male participants aged 23.2 ± 5.7 years participated. All volunteers were healthy, native English speakers and had normal hearing. One experienced male volunteer without a regional accent served as the speaker for all trials. Listener panels consisted of three male volunteers. Volunteers were trained according to the NIOSH test procedures. Background noise during all trials was set at 60 ± 2 dBA. The speaker read the MRT word lists with a speech sound level between 75 and 85 dBA. Twelve NIOSH-certified CBRN APRs that were evaluated previously using the standard NIOSH test method to obtain performance ratings were used. The speaker read one word list while wearing each of the twelve masks and one word list without the respirator to the same panel of listeners. All twelve respirators were tested on four separate test days with a different group of listener volunteers for each test day. Performance ratings for each mask were determined by dividing the corrected MRT score for the mask by the MRT score for the no mask condition. A Two Way Analysis of Variance was performed at the $p = 0.05$ level to determine if there were differences in performance ratings among respirators and between test methods. There were statistically significant differences among the respirators and between the methods, but there were no significant interactions between the two factors. The MSA Millenium (91.5%), 3M FR-M40 (89.7%), Scott M110 (88.4%), Scott M120 (87.9%), MSA Ultra Elite (85.7%), Avon C50 (85.5%), Avon FM12 (85.2%), North 5400 (84.7%), and Peltor-AOSafety M-TAC (83.6%) had statistically significantly higher scores than the FR-7800B (76.6%). The Millenium, FRM-40, and M110 scored significantly higher than the Drager CDR 4500 (81.1%). The Millenium also scored significantly higher than both the Survivair Optifit (83.2%) and the M-TAC. Performance ratings with the single trained speaker ($86.5\% \pm 0.6\%$, mean \pm standard error of the mean) were statistically significantly higher than those for the NIOSH method ($84.0\% \pm 0.6\%$). However, the average performance rating across all respirators by listener during the trials with the highly trained speaker ranged from $78.2\% \pm 9.6\%$ to $93.5\% \pm 7.3\%$. So, while a highly trained speaker will yield a small increase (2.5%) in performance, there is still a large amount of variability in listener performance even though speaker variability was controlled as much as possible.