Army Research Laboratory

Comparison of Acoustic Properties of Two USMC Helmets

by Paula Henry, Jim A. Faughn, Timothy J. Mermagen

ARL-TR-4383 February 2008

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Comparison of Acoustic Properties of Two USMC Helmets

Paula Henry, Jim A. Faughn, Timothy J. Mermagen
Human Research and Engineering Directorate, ARL

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14. ABSTRACT

The United States Marine Corps (USMC) has recently replaced an older Combat Vehicle Crewman (CVC) communications headset (the MK1697/G) with a newer version (Enhanced CVC headset [ECVCH]) manufactured by the same company (Sonetronics). A communications headset consists of two earphones and a microphone with the capability to receive and transmit communications across a radio or intercom. The ECVCH headset provides improvements in situational awareness through the addition of a talk-through microphone, in hearing protection through thicker ear pads, and in greater field ruggedness. A set of evaluations was conducted to determine if the ECVCH showed improvements in attenuation and speech intelligibility over the MK1697/G headset. There was no improvement in sound attenuation with the ECVCH. The ECVCH showed a decrement in speech intelligibility, although this decrement was not large enough to impact operational performance. The difference in performance can be explained by the differences in frequency responses between the two headsets.

15. SUBJECT TERMS
hearing protection; helmets; speech intelligibility

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1. Introduction

Communication in military settings must be clear and understandable to avoid possible fatal accidents and mistakes. Effective speech communication requires three components: clear speech by the talker, a non-distorting communications channel to transmit the speech from talker to listener, and good hearing and speech comprehension by the listener.

Speech intelligibility is the overall quality of speech that makes it comprehensible. Speech intelligibility can be predicted with the use of various objective measures, but its ultimate indicator is the percentage of speech units that can be correctly identified during specific operational conditions. The speech units can range in size and complexity from phonemes, syllables, or words to phrases, sentences, or passages. The most common speech unit used for testing intelligibility is words. The transmission effectiveness of a system can be determined through calculation of the percentage of words correctly identified by the listener (Syrdal, Bennett, & Greenspan, 1994).

Speech intelligibility depends on the properties of the three components of the communication system: the talker, the communications channel, and the listener. These components can be assessed individually or as a group. The objective of the current study is to evaluate the differences in speech intelligibility through the two communication headsets connecting a talker with a listener through an intercommunications system. Therefore, all three components of the system were included in the evaluations, with the headset as the only component changing.

In order to measure the effects of communication headsets on speech intelligibility, the talkers and listeners must have normal speech and hearing and must be familiar with the test material. This study used the Modified Rhyme Test (MRT) as the speech material. The MRT is one of three American National Standards Institute (ANSI) standardized word tests authorized for measuring speech intelligibility over communication systems (ANSI, 1999).

In addition to providing radio or intercommunications signals, communications headsets provide the user with hearing protection. The amount of hearing protection provided must be evaluated separately from speech intelligibility. The headsets in combat vehicle crewman (CVC) systems protect the wearer from potentially hazardous noise levels by reducing the amount of environmental sound that reaches the ears. Sound attenuation measurements determine how much the headsets reduce the listener's exposure to the surrounding noise. One method of measuring sound attenuation is through real-ear attenuation at threshold (REAT) (ANSI, 2002) whereby hearing thresholds are measured with and without the hearing protection (in this case, the CVC helmets), and the calculated differences constitute the amount of attenuation.

The purpose of this study was to conduct auditory measurements to compare the attenuation and speech intelligibility obtained through two of the United States Marine Corps (USMC) CVC systems used for mounted operations. The older system was referred to by two names: the MK1697/G (referring to the headset-microphone kit) or the DH132B (referring to the shell). The older CVC system consists of a sized liner (in sizes small, medium, or large) with the embedded headset and the DH132B shell. The newer CVC system is called the enhanced CVC helmet (ECVCH). It consists of a universally sized liner with the embedded headset and either the DH132B or another CVC shell. The communications system used in this evaluation was the AN/VIC-3(V) vehicle intercommunications system (VIC-3). The AN/VIC-3(V) is the most common intercommunications system used on tracked vehicles. Both headsets are manufactured by Sonetronics Corporation based in New Jersey. For the purposes of this report, the old and new headsets are referred to as the MK1697/G and ECVCH, respectively. The USMC sponsored and provided funding for this effort. The voluntary, fully informed consent of the persons used in this research was obtained as required by 32 Code of Federal Regulations (CFR) 219 (OSD, 1999) and Army Regulation (AR) 70-25 (HQDA, 1990). The investigator has adhered to the policies for the protection of human subjects as prescribed in AR 70-25 (HQDA, 1990).

2. Methods

The study was composed of an objective measures portion comprised of acoustic measures on a manikin and a subjective measures portion comprised of participant testing of speech intelligibility and attenuation. The objective manikin measures consisted of frequency response measures to determine the sound output from the headphones of the two headsets. The objective participant measures consisted of speech intelligibility and sound attenuation testing made with human participants. Some participants who completed the speech intelligibility portion of the study also completed the sound attenuation portion.

A CVC system consists of a liner, a communications headset, and a hard protective shell (see figure 1). The headset is embedded in the liner and is comprised of headphones (which provide sound attenuation and communications from radios and intercoms), and a microphone (DA, 1997). The Department of Defense has several technical manuals pertaining to the use and wear of the CVC systems. None of the documents reviewed by the investigators provides information about how to properly fit the system to the wearer's head. The manuals state that the helmet should have a "tight fit" (DA, 1997, p. 1 through 8), that wearers should "adjust tension [using adjustable straps] so that the ear seal is tight against your head" (DA, 1997, p. 2-33), and that the wearer should "select the proper size for the individual's use" and "adjust the chinstrap securely" (USACHPPM, 2006, p. 57). Written instructions provided by the USMC with the ECVC helmets included a statement that the helmet should be placed on the head so that the brow pad rests "two fingers above the nose".

As stated earlier, the MK1697/G liner comes in three sizes: small, medium, and large. The ECVCH has a universal liner that is intended to be adjustable to fit all heads through the use of hook and loop straps on the sides and nape of the liner. The ballistic shells used for both helmets come in two sizes: small/medium and large. Two samples of the MK1697/G helmet were received for the evaluation, one sized small and one sized large. Five samples of the ECVCH were received for the evaluation. The determination of the appropriate size of the MK1697/G helmet for each participant was made, based on the participant's reported comfort while wearing a particular size. The ECVCH was adjusted on each participant's head for comfort. For both helmet models, the chin strap was secured and the helmet rested firmly on the participant's head.

Figure 1. From left to right: CVC liner; CVC ballistic shell, assembled helmet with embedded headset.

2.1 Measurement of Frequency Response of Headsets

Objective measures of the headsets were conducted to determine the frequency response of the output of the headphones for each of the CVC helmets. These measures were conducted to determine if differences existed between the different samples of the same helmet and between the old and new versions. For each measurement, a headset was placed on the Knowles Electronics Manikin for Acoustic Research (KEMAR) without the ballistic shell. The KEMAR is a manikin designed to represent the anatomical structure of the average adult male head and torso. It includes two pinnae, DB-100 Zwislocki couplers to simulate ear canals, and Etymotic Research, Inc., ER-11 microphones situated at the positions of the eardrums. Recording through the microphones of the KEMAR emulates recording at the eardrums of a human listener. The headsets were placed on the KEMAR with care to center the headphones over the manikin's pinnae, and the chin strap was secured as it would be when worn by a human. Figure 2 shows a photograph of the KEMAR test apparatus with a CVC helmet.

A maximum length sequence (MLS) signal was played out of the headphones of the CVC helmets and recorded through the microphones mounted inside the KEMAR. Both presentations of the MLS signal and recordings from the microphones were made through the 01dB[1]

[1]01dB is a trademark of Metravib.

Symphonie[2] two-channel sound card and accompanying software. The results of the measurements revealed that the five samples of the ECVCH headset were nearly identical in frequency response. The two samples of the MK1697/G headset were also nearly identical in frequency response. Slight differences were noted in the frequency responses between the MK1697/G and the ECVCH headsets. Figure 3 shows the average frequency response from three of the ECVCH headsets along with the average frequency response from the two MK1697/G headsets. Recordings from the two headphones (left and right) were averaged to show a single response curve for the headset. As shown in the figure, the frequency responses of the two headsets were very similar except for the area between 800 and 1250 Hz where the ECVCH headset has a higher response than the MK1697/G headset. Since no large differences in frequency response were seen for the five samples of the ECVCH headset, three of the ECVCH headsets were arbitrarily selected for use in the study. Since the two samples of the MK1697/G were different sizes, both were used in the evaluation to accommodate participants with different head sizes.

As mentioned previously, both of the headsets in the evaluation are manufactured by Sonetronics, Inc. In a telephone conversation with Sonetronics, an engineer indicated that several changes had been made in transitioning from the MK1697/G to the ECVCH. The changes that were relevant to this study included higher output sensitivity in the earcup, larger earcup volume, and thicker earcup padding. The increase in output sensitivity was designed to improve speech intelligibility in higher levels of background noise. The larger earcup volume and thicker earcup padding were designed to improve the amount of attenuation provided by the helmet. The microphones on the two helmets are identical. Testing was only conducted on the headphones of the systems rather than on both the microphone and headphones since no change was made in the microphone on the newer helmet.

[2]Symphonie is a trademark of 01dB.

Figure 2. KEMAR with CVC headset for frequency response measurements.

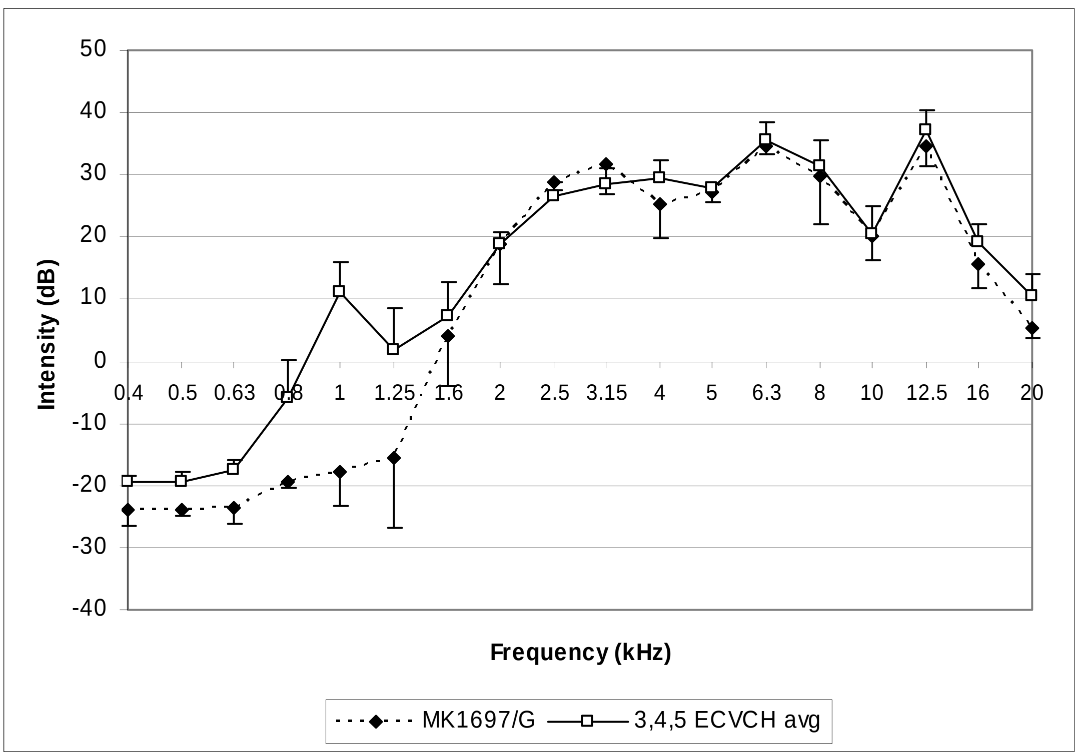

Figure 3. Frequency responses of the two headsets. (Responses were averaged across ears within each headset. Open symbols represent the average of the two samples of the MK1697/G headset. The closed symbols represent the average of the three samples of the ECVCH headset used in the present study. Error bars indicate one standard deviation.)

2.2 Sound Attenuation

Ten civilian volunteers between the ages of 27 and 56 (mean = 41.8) participated in the sound attenuation measurements through the REAT procedure (ANSI, 2002). Five of the volunteers were male and five were female. None of the participants had extensive prior experience using CVC helmets. All participants had normal hearing sensitivity defined as pure-tone hearing thresholds of ≤ 20 dB hearing level (HL) at audiometric frequencies from 125 through 8000 Hz (ANSI, 2004). Volunteers' ears were examined with an otoscope at the time of audiometric testing and were found to be free of wax or abnormalities. None of the participants showed obvious signs of irritation or infection in the areas of the head or ears that would be contacted by the headphones and helmets (ANSI, 2002). Normal middle ear status was verified through use of a Grason-Stadler GSI-37 tympanometer.

Instrumentation included the CVC helmets, an Interacoustics AC40[3] audiometer, three Electro-Voice[4] SX[5] 500+ loudspeakers, two Crown 605 amplifiers and a response button. The participant was seated in the center of a reverberant chamber. Pulsed one-third octave narrow bands of noise were presented at the seven octave frequencies 125 through 8000 Hz. The stimuli were presented over the loudspeakers through the audiometer. The loudspeakers were arranged in the room to create a diffuse stimulus presentation. Thresholds were obtained to the nearest 5-dB increment via an adaptive 10-down, 5-up methodology. Unoccluded (open ear with no helmet) and occluded (both helmet conditions) were tested with the ordering of systems and occluded/ unoccluded conditions counterbalanced across listeners. Each pair of unoccluded ear and headset trials was repeated once in accordance with the ANSI standard method of measurement (ANSI, 2002). Investigators manually recorded the participant's threshold for each test stimulus. Participants were allowed to take breaks between helmet conditions. Participants depressed the response button to indicate when a sound was heard. The measurement of each pair of thresholds took approximately 20 minutes to complete for a total of 40 minutes for both CVC helmets.

The helmets were fitted on the participants according to comfort since there are no specific sizing requirements (DA, 1997). Participants removed all earrings and eyeglasses before donning the helmet. The liner was fit to the person first, with adjustments made to the straps to ensure a tight fit. Based on information received from USMC, the brow pad of the helmet was aligned on the participant's head to be "two fingers above the nose". The ballistic shells for the CVC were then placed on top of the liners and pushed down into place by the participant. Each of the three ECVCH models was worn by 4 of the 12 participants.

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[3]Not an acronym.
[4]Electro-Voice is a trademark of Bosch Communications Systems.
[5]Not an acronym.

REAT was calculated for each of the seven third-octave frequency bands as outlined in ANSI S12.6. Attenuation was calculated as the difference between the unoccluded (no helmet) and occluded (with helmet) thresholds with the two attenuation values averaged for each CVC. Individual two-trial averages were averaged across participants, and the standard deviation of the average attenuation value for each CVC model was calculated for each frequency as the difference between the average attenuation of each participant's two trials and the mean attenuation of the entire panel of participants.

2.2.1 Anthropometric Measures

In accordance with ANSI standard S12.6, two anthropometric measures were taken from participants in the attenuation portion of the study: bitragion width with a spreading caliper and head height with an anthropometer[6]. Table 1 shows the anthropometric measurements.

Table 1. Anthropometric measures for the participants in the sound attenuation portion of the study.

Participant Number	Sex	Bitragion Width (cm)	Head Height (cm)
1	F	12.6	12.3
2	M	13.6	13.1
3	M	14.8	13.5
4	M	13.5	12.2
5	F	12.6	12.2
6	F	12.5	12.2
7	F	14.0	12.3
8	F	12.8	12.4
9	M	14.3	12.9
10	M	13.6	12.6
	AVG	13.43	12.57
	F	12.90	12.28
	M	13.96	12.86

2.3 Speech Intelligibility

Twelve civilian volunteers between the ages of 26 and 51 (mean = 37.5) participated in the speech intelligibility portion of the study. Six of the volunteers were male and six were female. None of the participants had extensive prior experience using CVC helmets. All participants had normal hearing sensitivity defined as pure-tone hearing threshold levels ≤ 20 dB hearing level (HL) at audiometric frequencies from 125 through 8000 Hz. Volunteers' ears were examined with an otoscope at the time of audiometric testing and were found to be free of ear wax or other abnormalities. None of the participants showed obvious signs of irritation or infection in the areas of the head or ears that would be contacted by the headphones and helmets (ANSI, 2002). Normal middle ear status was verified through use of a GSI-37 tympanometer. All participants had American English as their native language.

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[6]The spreading caliper and anthropometer were made by GPM (not an acronym) of Zurich, Switzerland.

Instrumentation for the speech intelligibility measurements included the two CVC helmets, clipboards, writing implements, response sheets, chairs for the participants, four PSB[7] International loudspeakers, a background noise file, a compact disk player to play the background noise file, a Crown[8] Macro-Tech[9] 2400 amplifier, a Dell desktop computer that controlled the playing of the speech recordings, a Symetrix[10] SX204 headphone amplifier, and a specially wired cable to interface the CVC helmets with the headphone amplifier. Background noise consisted of a 7-minute recording of the interior of a moving (10 mph) M113 armored personnel carrier played at 105 dB A-wtd. All practice and test trials were conducted in an acoustically treated room.

Test material consisted of recordings of the 300 items of the MRT. The test consists of 50 six-word groups of monosyllabic English words (House, Williams, Heker, & Kryter, 1965). The six words in each group have the same vowel and differ by initial or final sound. An MRT list is a subset of the 300 words, consisting of 50 words, one from each group of six. Six lists, which between them contain all 300 words, comprise a full MRT set. Participants respond by marking on a paper form with a pen which word they heard. Participants completed one practice set along with two test sets, one for each of the two helmet models.

Recordings of the MRT were made before testing. An expert male talker was used to create two recordings. For use in the practice trials, the talker recorded one ordering of the MRT in a quiet sound-treated chamber. For use in the test trials, the talker recorded a different ordering of the MRT item set in the presence of the M113 background noise played at 105 dB A-wtd. The same CVC microphone was used for both recordings. The carrier phrase used for the recordings was "Mark the _______ now" in which the MRT item was inserted into the blank within the phrase.

The output of the microphone for the CVC headset was routed through the VIC-3 intercommunications system and recorded to a Dell personal computer. The recordings were played back to the listeners through the same Dell personal computer routed through a Symetrix SX204 headphone amplifier to the headphones of the CVC headsets. In this way, the CVC microphone and the VIC-3 intercommunications system were constant components of the test paradigm without the need to have a live talker.

Both helmets were properly fitted on each participant in the same manner as previously stated for the sound attenuation portion of the study. The volume control on the headphone amplifier was adjusted by all participants to be at a comfortable volume before the test portions of the study. For practice and test trials, listeners heard the MRT items played over the headsets and selected which word from the given six-word group was presented, using a paper and pen methodology.

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[7]Not an acronym.
[8]Crown is a registered trademark of Crown Audio Incorporated, a Harman International Company.
[9]Macro-Tech is a registered trademark of Crown Audio, Incorporated, a Harman International Company.
[10]Symetrix is a trademark of Symetrix, Inc.

Participants were familiarized with the MRT items before the start of data collection by completing a practice list of the MRT items recorded in quiet. Participants were seated in a sound-treated booth and wore the headset that would be worn for the first set of test trials. Participants listened to the items presented through the headset with no background noise presented. Four loudspeakers were positioned in the room to output background noise during the test trials. The loudspeakers were approximately 1 m from the position of the listener and were directed toward the listener's chair. The background noise consisted of a 7-minute recording of an M113 armored personnel carrier played at a level of 105 dB A-wtd, which was identical to that used in the recordings. The order of the two helmets was counterbalanced across participants. Each of the three ECVCH models was worn by 4 of the 12 participants.

During data collection, all 300 MRT words were used once for each set divided into six 50-word lists. A full set of 300 words took approximately 20 minutes to complete. After a full MRT set was completed, a short (about 5-minute) break was taken and helmets were changed as needed. Longer breaks were taken at the discretion of the participants. Total participant time was approximately 1.5 hours.

The dependent variable of interest in this study was the listener's performance in each condition. Data analysis includes descriptive statistics (means, standard deviations) and a paired samples t-test. Before data analysis, two transformations of the data were made. First, the adjusted percent correct scores were transformed to rationalized arcsine units (rau) (Sherbecoe & Studebaker, 2004; Studebaker, 1985). The rau transformation puts the proportion data into an interval form which is more appropriate for statistical analysis. Second, all individual transformed scores were adjusted for the probability of getting a correct response by chance. The adjustment for chance or guessing was calculated as

$$Tc = (ATu - 100)/(A - 1) \tag{1}$$

in which *Tc* is the adjusted score, *Tu* is the uncorrected score in rau, and *A* is the number of alternate choices per item (6) (Sherbecoe & Studebaker, 2004).

3. Results

3.1 Sound Attenuation

The Department of Defense has outlined attenuation requirements for the CVC helmet (DoD, 1986). Table 2 shows the minimum attenuation values outlined in MIL-H-44117A along with the average REAT values and corresponding standard deviations obtained for each of the two headsets across the seven frequency bands in the present study. The values reported by the manufacturer are also included in the table. Comparisons between the MIL standard and the helmets show that both meet the minimum requirement, except at 2 kHz. Furthermore, comparisons between the REAT values obtained in the present study with the helmets indicate that they provide very similar attenuation. The attenuation values obtained for the ECVCH are 3 to 10 dB less than those reported by the manufacturer.

Table 2. Real-ear attenuation (in dB) and standard deviations (SD) as a function of frequency obtained in the present study for the MK1697/G and ECVCH headsets. (The table also contains the criterion values from MIL-H-44117A and values reported by Sonetronics.)

	REAT Values for Each One-Third Octave Band (Hz)						
	125	**250**	**500**	**1k**	**2k**	**4k**	**8k**
MK1697/G	14.50	17.50	21.25	27.50	26.00	35.75	33.25
SD	4.56	4.44	5.59	5.26	3.08	2.94	3.35
ECVCH	17.00	18.50	20.75	25.00	23.25	38.00	34.25
SD	3.40	4.89	6.34	5.38	4.38	4.97	5.68
MIL-H-44117A	14	16	21	23	28	35	30
ECVCH data from Sonetronics	27	28	30	33	33	44	37

3.2 Speech Intelligibility

Figure 4 shows the speech intelligibility scores (corrected for chance performance and converted to rau) averaged across participants for each of the three conditions: practice (in quiet), the MK1697/G, and the ECVCH headset. The raw data are provided in appendix A. As shown in the figure and as expected, performance was best in the practice condition. The introduction of noise in the test conditions resulted in reduced speech intelligibility performance, regardless of the headset worn. Between the two headsets, participants performed better on average with the MK1697/G than with the ECVCH.

A paired samples t-test between the two headset conditions indicated a statistically significant difference in speech intelligibility $t(11) = 2.484$, $p < .05$, indicating that the performance with the MK1697/G headset was significantly better than with the ECVCH.

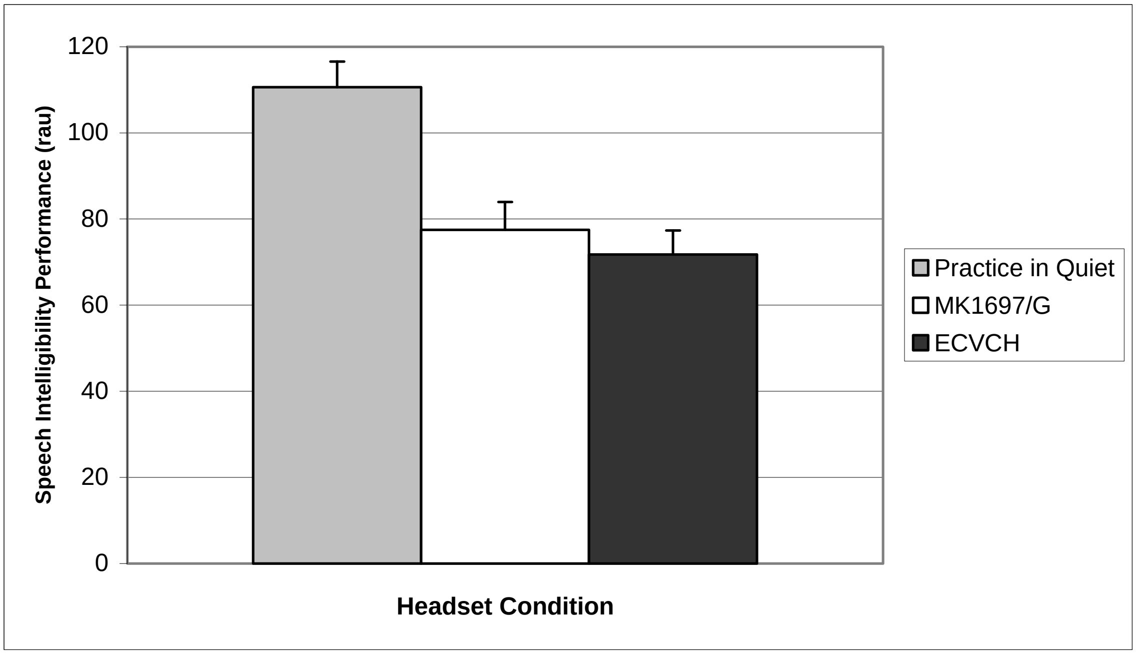

Figure 4. Average speech intelligibility performance for each of the three test conditions. (Speech intelligibility performance is shown in rationalized arcsine units corrected for chance. The gray bar indicates average performance in quiet [practice], the open bar indicates performance with the MK1697/G headset, and the solid bar indicates performance with the ECVCH headset. Error bars indicate +1 standard deviation.)

4. Discussion

Frequency response measurements of the MK1697/G and ECVCH showed essentially equivalent responses except in the region between 800 and 1250 Hz. In this area, the ECVCH showed a higher response (providing more information to the listener in this frequency region).

As expected, speech intelligibility performance was shown to be best in quiet and poorer with the addition of background noise. Recall that the practice list was conducted with either headset, depending on which headset was the first to be tested in noise for that participant. It has been well documented that speech intelligibility is degraded in noise as compared to quiet environments. A comparison of the speech intelligibility between the two headsets shows that performance is poorer with the ECVCH than with the MK1697/G helmet. The differences seen in the frequency responses between the two headsets may have contributed to the differences seen in the speech intelligibility portion of the study. The differences in frequency response result in differences in audibility of the speech signal to the listener. One would think that providing a broader frequency range would improve speech intelligibility, but this is not always the case. When low frequency energy is increased in a broadband stimulus, its energy has the potential to mask the energy at higher frequencies. This phenomenon is called "upward spread of masking" (Moore, 1997). Speech intelligibility, particularly in noise, relies on the listener's ability to extract high frequency consonant information from the signal. The additional mid-frequency energy that was present in the ECVCH headset that was not present in the MK1697/G may have contributed to poorer performance because of upward spread of masking (e.g., Stelmachowicz et al., 1990).

Participants were allowed to adjust the volume control on the headphone amplifier separately for each test condition. It is possible that all participants set the output of the MK1697/G headset higher than the ECVCH headset, which would result in better speech intelligibility; however, there is no way to determine this since the volume control settings were not recorded for each participant.

Note that although the statistical analysis revealed a significant difference between the performances with the two helmets, the actual speech intelligibility difference was very small (5%) and is within expected variability of such speech tests. Furthermore, this small difference would not likely be meaningful in a real-world scenario. The testing conducted in this study involved the speech intelligibility of individual words embedded in a carrier phrase. The contextual advantage of phrases and sentences typically allows for higher speech intelligibility than with individual words. Therefore, a 5% difference in intelligibility of individual words is not likely to impact operational performance with connected speech.

Sound attenuation measured through REAT showed that the two headsets provide essentially the same attenuation in this test environment, but the measured sound attenuation values are less than those reported by the manufacturer. Both headsets meet the minimum sound attenuation criteria outlined in MIL-H-44117A except at the 2-kHz one-third octave band. The failure to meet the criteria at 2 kHz and the lower attenuation values seen in the present study as compared to those provided by the manufacturer are most likely attributable to suboptimal fitting of the helmet or other abnormality in the test environment rather than a true failure of the headsets.

5. Conclusions

Slight differences exist in the frequency responses of the headphones from the two headsets. Sound attenuation values as measured through REAT between the two headsets were essentially the same. Individual listeners were allowed to adjust the volume control on the headphone amplifier to a comfortable listening level and these settings were not recorded. Slight differences were seen in the speech intelligibility performance between the two headsets. These differences were likely attributable to the difference in the frequency responses between the two headsets and possibly differences in output through changes in the headphone amplifier volume control.

Although the differences in speech intelligibility were statistically significant, the difference was too small to be meaningful in real-world applications and falls within the expected variability for the test. The ECVCH headset showed an increase in the low frequency response when compared to the MK1697/G headset. The evaluation demonstrates that the ECVCH headset is operationally no different than the MK1697/G.

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Appendix A. Raw Data From the Speech Intelligibility Portion of the Study

	Number of Items Correct				Number of Items Incorrect		
Part #	Practice	MK 1697/G	ECVCH		Practice	MK 1697/G	ECVCH
1	272	259	240		28	41	60
2	250	235	230		50	65	70
3	299	250	242		1	50	58
4	299	252	225		1	48	75
5	297	237	219		3	63	81
6	296	211	235		4	89	65
7	294	250	201		6	50	99
8	299	262	249		1	38	51
9	295	233	243		5	67	57
10	295	257	239		5	43	61
11	296	251	232		4	49	68
12	297	219	213		3	81	87

	Adjusted % Correct				rau without chance corr				rau corrected for chance		
Part #	Practice	MK 1697/G	ECVCH		Practice	MK 1697/G	ECVCH		Practice	MK 1697/G	ECVCH
1	88.80	83.60	76.00		93.93	87.64	79.79		92.72	85.17	75.75
2	80.00	74.00	72.00		83.78	77.89	76.05		80.54	73.47	71.26
3	99.60	80.00	76.80		116.53	83.78	80.57		119.84	80.54	76.68
4	99.60	80.80	70.00		116.53	84.61	74.24		119.84	81.53	69.09
5	98.80	74.80	67.60		112.98	78.64	72.13		115.58	74.37	66.56
6	98.40	64.40	74.00		111.62	69.39	77.89		113.94	63.27	73.47
7	97.60	80.00	60.40		109.3	83.78	66.07		111.16	80.54	59.28
8	99.60	84.80	79.60		116.53	89.01	83.36		119.84	86.81	80.03
9	98.00	73.20	77.20		110.41	77.15	80.96		112.49	72.58	77.15
10	98.00	82.80	75.60		110.41	86.75	79.41		112.49	84.10	75.29
11	98.40	80.40	72.80		111.62	84.19	76.78		113.94	81.03	72.14
12	98.80	67.60	65.20		112.98	72.13	70.07		115.58	66.56	64.08
avg	96.30	77.20	72.27		108.89	81.25	76.44		110.66	77.50	71.73
sd	5.90	6.45	5.60		9.92	6.20	5.04		11.90	7.44	6.05

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