

Development of a Hearing Performance Standard for Law Enforcement Officers

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Abstract

A hearing performance standard for new police officer candidates in the State of Michigan was developed by a task force consisting of the authors and four members of the Michigan Law Enforcement Officers Training Council. Ratings of the importance of hearing sensitivity and speech intelligibility in performing each of 135 specific job tasks formed the basis for pass-fail criteria. The standard, described in this report, includes specifications for unaided and aided hearing performance, types of hearing assessment measures, hearing measurement procedures, and the appropriate examining professional. The authors believe that the standard provides an appropriate accommodation to hearing-impaired law enforcement officer candidates with respect to The Americans with Disabilities Act.

Key Words: Americans with Disabilities Act, hearing loss, hearing standard, law enforcement

The monitoring of hearing levels for the purpose of hearing conservation is commonplace in the US, particularly in industrial work settings. Essentially, these hearing conservation programs monitor and ascertain the presence of hearing loss within designated occupational groups, and attempt to foster working conditions that minimize risks to the occurrence or progression of hearing loss.

Programs that foster employment opportunities for hearing-impaired persons, and the continuity of employment once hearing loss develops, are much less common. A major implication of Title I of The Americans with Disabilities Act (Public Law 101-336; Equal Employment Opportunity Commission, 1992) is that hearing impairment should not unduly diminish employment opportunities in comparison to those available to persons with normal hearing. It is reasonable, therefore, that efforts be made to minimize employment inequities likely to arise as a consequence of hearing

impairment. We report in this article on the process of developing a hearing standard applicable to new law enforcement officer candidates in the State of Michigan, and on the substance of the standard.

Studies on the prevalence of hearing impairment among police officers have revealed mixed findings. For example, Cohen et al (1970) found no difference in the prevalence of hearing loss in police officers and nonofficers, while Pierson and Mahe (1973) found hearing loss to be more prevalent in a small sample of highway patrol officers than among their nonofficer peers. More recently, Hughes and Lankford (1992) sampled 55 male police officers from seven different departments across six communities. The younger officers in their study exhibited essentially normal hearing, with older officers showing greater high-frequency sensorineural hearing loss with increasing age. Overall, the loss of hearing in the officer group was greater than in a normative age-matched sample.

As stated by Hughes and Lankford (1992), effective communication is an essential element in law enforcement. The communication requirements of a police officer's routine duties are such that the officer's life may depend on the ability to hear, localize, and understand a variety of environmental and speech sounds, including soft sounds. As part of the methodology in developing a hearing standard for Michigan's law

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enforcement officers, therefore, we necessarily concerned ourselves with the importance of these various auditory capabilities in performing law enforcement job functions. Our larger concern was with balancing the potentially high risks of hearing loss to the safety of the officers and the public with assurances that the standard would afford the officers reasonable employment opportunities.

METHOD

Task Force

A Hearing Standard Task Force was convened by the Michigan Law Enforcement Officers Training Council in the fall of 1991 to formulate a hearing performance standard for new police officers in Michigan. Three audiologists, the authors, served on the task force; our backgrounds collectively represented diverse professional experiences in academic, research, administrative, and clinical settings. In addition, the task force consisted of four members of the training council staff representing the Field Services and Employment Standard Sections. Each of these four individuals held long-standing administrative posts on the training council, with responsibilities for establishing and maintaining selection criteria for employment of law enforcement officers in Michigan. These selection criteria encompass medical and educational standards, as well as standards of physical agility. Each of these training council members had substantial personal experience as a police officer.

Criteria Used in Task Force Deliberations

Prior to the time of the task force deliberations, the Michigan Administrative Code required that police officer candidates possess "normal hearing." The code did not define the term audiometrically, and did not recognize an individual with hearing impairment as one who might be qualified to serve as a police officer.

While numerous scientific studies have documented the auditory abilities of humans with normal and disordered audition under many experimental and empirical conditions, relatively few have explored the relationship between auditory function and job performance. Those few, conducted in conjunction with evaluations of self-assessment hearing handicap scales for adults (Alpiner and Schow, 1993), did not provide

a useful direction with respect to the development of the type of hearing performance standard of concern to the task force. As a result, the task force utilized an approach based on expert opinion rather than a formal validation approach in developing the standard.

In deriving elements of the hearing performance standard, some general principles outlined by Chial (1985) in a document prepared for the Michigan State Police were used as pragmatic guidelines in the initial stage of development of the standard:

- (1) An officer should hear well enough to avoid undue risk to bystanders and to protect innocent citizens from harm,
- (2) An officer should hear well enough not to be at a personal disadvantage...the combined effects of ability, training, experience, and technology should constitute a strategic advantage favoring the officer, not his or her adversary, and
- (3) An officer should hear well enough to contain or restrain hostile adversaries, (and) to perform other necessary police duties. (p. 36)

The deliberations of the task force were based on an analysis of critical job performance tasks, first identified by a job analysis conducted by the training council in 1978, and re-evaluated by the Hearing Standards Task Force in 1991. Careful consideration was given to the variety of critical and hazardous job functions required of police officers, and to the relative importance of auditory communication in executing these functions. The analysis included the evaluation of situations involving (a) the use of firearms, in which clear and effective communication or detection of environmental sounds could affect the safety of human lives; (b) first-aid applications; (c) in-car radio communications during normal and pursuit situations; (d) emergency situations involving car accidents and road hazards; (e) criminal arrests; (f) the serving of legal papers; (g) the provision of legal testimony; and (h) a variety of other tasks in which varying degrees of verbal communication are involved. Each of 135 specific job tasks, across 27 job categories, was rated by task force members with respect to the importance of both hearing sensitivity and speech understanding on a 3-point rating scale (not important, important, and critically important). Although auditory localization was not rated as a separate auditory function, the task force considered the general contribution of symmetrical hearing

sensitivity to localization as the ratings were applied to the various job tasks.

Results of this scaling procedure suggested that essentially normal hearing sensitivity and speech understanding are critical in a majority of the job tasks performed by police officers. Using the results of this preliminary appraisal, the task force next derived pass-fail criteria.

Four audiologic principles were agreed to by the task force in providing a foundation for use of the ratings in generating the hearing standard: (1) an officer's speech understanding may be assumed to be satisfactory if hearing sensitivity is normal; (2) in cases of borderline-normal hearing sensitivity, speech recognition scores must be measured directly as evidence of the individual officer's ability to perform job tasks requiring speech understanding, and speech recognition scores in noise must be measured directly to obtain an estimate of the officer's ability to perform communication tasks in the presence of competing environmental sounds; (3) aided hearing must meet performance criteria identical to those for unaided hearing; and (4) audiologic criteria must be based on measures that can be obtained by the use of procedures and equipment routinely employed in audiology clinics. The first two of these four principles became the basis for delineating unaided criteria I and II. Unaided criteria I requires only pure-tone threshold testing when hearing sensitivity meets a relatively rigorous standard, while unaided criteria II requires that word recognition scores be measured in both quiet and noise as a result of an officer's failure to pass the more rigorous hearing sensitivity standard. In keeping with the third principle above, aided criteria are identical to unaided criteria II, except that test procedures are administered under aided conditions.

Although there have been no standards established for the measurement of speech recognition in noise, the members of the task force concluded that such a measurement is necessary to establish an officer's performance in real-life, or field, conditions. These conditions may include crowd noises, sirens, road traffic, gunfire, and a variety of other noises. The major underlying limitation regarding this measure is that no single measure currently exists that accurately predicts communication performance in such a variety of noisy conditions. Of course, inherent limitations of the specified measure relate to score differences resulting from the type of noise used and the relative separation, azimuth, and levels of the signal and noise. The task force members agreed that a measure of this kind

was important to include and that the recommended test protocol must meet the fourth basic principle stated above. Finally, in this regard, there appears to be insufficient data for predicting the range of scores that might result for a sizable population. This is an issue the authors expect to monitor for the purpose of future data analysis.

Additionally, data relevant to the articulation index (AI) (French and Steinberg, 1947; Kryter, 1962; ANSI, 1969; Mueller and Killion, 1990) were reviewed and considered in developing the standard. The task force concerned itself particularly with those aspects of the AI related to the prediction, in normal-hearing listeners, of speech recognition scores in quiet and in background noise, as measured with conventional lists of monosyllabic words (see, for example, Wilson et al, 1990). A discussion of the rationale for the selected speech recognition criteria follows a description of the standard.

Hearing Performance Standard

The developed standard consists of the following criterion levels:

Unaided criteria I: Pure-tone thresholds measured under audiometric earphones shall not exceed 20 dB HL in either ear at any of the following frequencies: 500, 1000, 2000, 3000, and 4000 Hz. Candidates whose hearing levels fail to meet these requirements must be evaluated using unaided criteria II.

Unaided criteria II: For either ear, pure-tone thresholds measured under audiometric earphones shall not exceed a four-frequency average (500, 1000, 2000, and 3000 Hz) of 25 dB HL, threshold at none of these single frequencies shall exceed 35 dB HL, and threshold at 4000 Hz shall not exceed 45 dB HL. In addition, speech recognition scores shall be 90 percent or better in each ear at 50 dB HL in quiet, using full lists of recorded, age-appropriate, monosyllabic words presented under earphones. (Although not required, it is recommended that the lists of Northwestern University Test No. 6 be used for speech recognition testing, to achieve consistency across clinical settings.) Furthermore, speech recognition scores measured binaurally in sound field shall be 70 percent or better at a +5 dB signal-to-noise (S/N) ratio, when a full list of recorded monosyllabic words is presented at 50 dB HL. For this measurement, both the word list and competing speech noise shall be presented at 0° azimuth. Candidates whose hearing levels

Table 1 Acceptable Hearing Levels and Speech Recognition Scores under Unaided Criteria I, Unaided Criteria II, and Aided Criteria of the Hearing Performance Standard

	<i>Hearing Sensitivity</i>		<i>Speech Recognition</i>	
	<i>Stimuli</i>	<i>Pass-Fail Criteria</i>	<i>Stimuli</i>	<i>Pass-Fail Criteria</i>
Unaided Criteria I	Pure tones	20 dB HL at 1000, 2000, 3000, and 4000 Hz, in each ear; failure requires evaluation under unaided criteria II	NA	NA
Unaided Criteria II	Pure tones	25 dB HL, four-frequency average at 500, 1000, 2000, and 3000 Hz; 35 dB at 500, 1000, 2000, or 3000 Hz; and 45 dB at 4000 Hz, in each ear	Recorded monosyllabic words (full lists)	90% in quiet (under earphones), in each ear, and 70% in noise (in sound field)
Aided Criteria	Narrow-band noise or warble tones	25 dB HL, four-frequency average at 500, 1000, 2000, and 3000 Hz; 35 dB at 500, 1000, 2000, or 3000 Hz; and 45 dB at 4000 Hz, in each ear	Recorded monosyllabic words (full lists)	90% in quiet, and 70% in noise (in sound field)

NA = not applicable.

or speech recognition scores fail to meet the requirements of the unaided hearing standard may elect to be evaluated with a hearing aid in one or both ears, as necessary to meet the aided criteria.

Aided criteria: For either ear, narrow-band or warble-tone thresholds measured in a calibrated sound field at 0° azimuth shall not exceed a four-frequency average (500, 1000, 2000, and 3000 Hz) of 25 dB HL, threshold at none of these single frequencies shall exceed 35 dB HL, and threshold at 4000 Hz shall not exceed 45 dB HL. Measurements shall be made monaurally in an audiometric sound field with the unaided (nontest) ear plugged or, when necessary, effectively masked. (Measurements of aided threshold may also be expressed as real-ear aided response, using probe-microphone measurements, with sound pressure levels appropriately converted to hearing levels.) In addition, speech recognition scores in sound field shall be 90 percent or better in each aided ear (with the nontest ear plugged or appropriately masked), using full lists of recorded, age-appropriate, monosyllabic words presented at 50 dB HL in quiet at 0° azimuth. Furthermore, monaurally or binaurally aided speech recognition scores measured in sound field shall be 70 percent or better at a +5 dB S/N ratio, when a full list of recorded monosyllabic words is presented at 50

dB HL. Both the word list and competing speech noise shall be presented at 0° azimuth.

Table 1 summarizes recommended stimuli and acceptable hearing levels and speech recognition scores under the separate hearing performance standard criteria.

Speech Recognition Performance in Quiet and Noise

Quiet. A unique aspect of this hearing performance standard is the inclusion of specific criteria with respect to speech recognition performance. The standard stipulates that all police officer candidates not meeting the more rigorous pure-tone requirements of unaided criteria I must demonstrate minimally acceptable speech recognition performance under both quiet and noisy background conditions. Because of the critical nature of speech understanding in the overall performance of police officers, as suggested by the ratings from the scaling procedure, we adopted as a first approximation a rather stringent criterion recognition score (in quiet) of 96 percent. Rather than using this value as the pass-fail criterion for the standard, however, we reasoned that the use of a 90 percent criterion would at least partially account for the fact that there is not a true difference

between a score of 96 percent and one of 90 percent. In fact, for a 50-item test, there is no difference between a speech recognition score of 96 percent and any score between 86 percent and 100 percent, the limits of the 95 percent critical differences for an obtained score of 96 percent (Thornton and Raffin, 1978).

Another way to view the 90 percent cutoff score in our application is that scores of < 90 percent (i.e., 88%) would differ from an idealized score of 96 percent at a confidence level of 0.147 (Raffin and Thornton, 1980, Table 2), as opposed to, for example, a more traditional 0.05 level. Raising the probability of a type I error to 0.147 is tantamount to acknowledging, in effect, that in one of about seven times, a score of < 90 percent will not differ from one of 96 percent, even though our implicit assumption is that it does differ. For our application, this was considered an acceptable risk. Based on this combination of empirical data and logic, we concluded that a speech recognition score of 90 percent or higher, obtained in quiet on a 50-word list, was a sufficiently high standard of performance to protect police officers and the public adequately, and at the same time to satisfy the broader intent of The Americans with Disabilities Act.

In addition to representing a relatively high performance standard, the 90 percent minimum criterion in quiet is consistent with the level of recognition performance to be expected when pure-tone sensitivity reflects worst-case conditions. With reference to Table 1, an audiogram showing hearing thresholds of 20 dB at 500 and 1000 Hz, 25 dB at 2000 Hz, and 45 dB HL at 4000 Hz illustrates such a worst-case scenario under either unaided criteria II or the aided criteria. When this audiogram (for which the four-frequency average would be around 25 dB HL) is superimposed on the count-the-dot audiogram form of Mueller and Killion (1990), the calculated AI value is 0.73. This AI value is equivalent to a speech recognition score (for monosyllabic words) of about 90 percent. This observation, therefore, leads to an assurance of an internal consistency between the standard's pure-tone sensitivity and speech recognition criteria.

Noise. There is general agreement in the literature that speech recognition scores worsen substantially in the presence of noise and reverberation. The problem for the task force was to choose listening conditions and permissible test score values that had some rational basis in the literature. Unfortunately, the available literature could not be used to resolve completely the

problem at hand. The data that we regarded most relevant to our deliberations were those reported by Finitzo-Hieber and Tillman (1978) and Mueller and Killion (1990, Fig. 2). Finitzo-Hieber and Tillman (1978) studied the effects of noise, reverberation, and the use of hearing aids singly and in combination on speech recognition scores. They reported that a mean recognition score of 71 percent was obtained by normal-hearing listeners (children) at a reverberation time of 0.4 sec and an S/N of +6 dB. A mean score of 80 percent was obtained at an S/N ratio of +6 dB and a reverberation time of 0 sec (no reverberation). Mueller and Killion (1990) reported the empirical relationship among S/N ratio, AI, and percent intelligibility for syllables, monosyllabic words, and sentences. A mean score of approximately 82 percent was obtained by normal listeners at a +6 dB S/N ratio, presumably in the absence of any notable reverberation. If these data are directly compared, therefore, an intelligibility decrement of about 10 percent is attributable to the presence of moderate reverberation at a +6 dB S/N ratio.

It was our judgment that the acoustic conditions of the Finitzo-Hieber and Tillman study are relatively common in the work environment of the typical police officer, and thus that an intelligibility score of about 70 percent on a test conducted under moderately reverberant conditions would be nearly ideal as a minimum criterion. Because audiologic tests of speech recognition are almost always conducted under nonreverberant conditions, however, a criterion based on data gathered in the absence of reverberation was clearly more appropriate. We decided to adopt a criterion recognition score based on the use of an S/N ratio of +5 dB, for audiometric applications, at which typical performance could be expected to be about 80 percent. Using reasoning similar to that described above for the speech recognition criterion in quiet, we chose a 70 percent criterion, implicitly acknowledging that there is no statistically significant difference between a score of 80 percent and one of 70 percent. For a 50-item test, the limits of the 95 percent critical differences for an obtained score of 80 percent (Thornton and Raffin, 1978) are 64 to 92 percent. The use of a 70 percent cutoff score means that scores < 70 percent (i.e., 68%) would differ from an idealized score of 80 percent at a confidence level of 0.177 (Raffin and Thornton, 1980, Table 2), resulting in scores of < 70 percent not actually differing from a score of 80 percent in one of about six cases. We concluded, therefore, that a speech

recognition score of 70 percent or higher, obtained under nonreverberant audiometric conditions on a 50-word list at an S/N ratio of +5 dB, was a sufficiently high standard for the purpose at hand.

Recommendations to the Training Council

Though not part of the formal standard, the following recommendations (A–J) were transmitted in a separate report as advisory to the Michigan Law Enforcement Officers Training Council with respect to implementation of the hearing performance standard. The expectation was that, over a reasonable period of time, the recommendations might be incorporated into the administrative rules accompanying the standard. Because these rules provide the legal authority and responsibility for personnel to behave in ways that conform with the rules, such action would effectively mean that the recommendations would become part of the hearing standard.

- A. Throughout the standard, the intensity of auditory stimuli shall be expressed in decibels relative to normal hearing level as defined by the American National Standards Institute S3.6-1989 (ANSI, 1989), or applicable current standard.
- B. The testing shall be performed by (1) an audiologist who is employed in a hearing clinic accredited by the Professional Services Board of the American Speech-Language-Hearing Association (ASHA), or (2) an audiologist who has an ASHA Certificate of Clinical Competence in Audiology (CCC-A). The audiologist shall be professionally licensed by the state, if applicable. (At the time of this writing, the State of Michigan does not have a professional licensing requirement for audiologists.)
- C. While only minimum audiometric testing is required for candidates who satisfy unaided criteria I, it is recommended that the first test for all candidates be a pure-tone air-conduction audiogram that documents hearing sensitivity thresholds at the octave frequencies 250 Hz through 8000 Hz and the interoctave frequency 3000 Hz.
- D. It is recommended that each of the Michigan police agencies establish an ongoing hearing conservation program designed to meet Michigan Occupational Health Standards Commission regulations.
- E. As part of a hearing conservation program, it is recommended that departments test the hearing of all entry-level law enforcement officers, using basic pure-tone air- and bone-conduction audiometry and speech audiometry to establish baseline measures. This will permit the monitoring of hearing proficiency of the officers over time and promote the prevention of progressive hearing loss.
- F. In cases in which an agency employs officers who use hearing aids in the performance of their jobs, periodic monitoring of the effectiveness of their aided performance is critical, and is strongly recommended as part of an ongoing hearing conservation program.
- G. It is incumbent on the examining audiologist to keep detailed documentation of assessment procedures and results relevant to individual hearing aid fittings.
- H. Aided criteria must be met no sooner than 30 days subsequent to the initial hearing aid fitting, to allow for adjustment to the device(s).
- I. It is recommended that hearing aids fitted for police officers employ frequency-dependent input compression circuitry with short attack times to minimize the impact of impulse noise.
- J. Several aspects of the hearing performance standard require validation. The task force encourages independent and cooperative clinical research efforts to validate and improve the effectiveness of the standard. (Although not specifically mentioned in the recommendations, the authors believe that useful information would result from efforts to determine whether officer candidates who meet the sensitivity criteria of unaided criteria I also meet the speech recognition criteria required in unaided criteria II in quiet and noise. Furthermore, the necessity of measuring speech recognition might be examined by prospective or retrospective analysis of calculated AI values in this population.)

The Law Enforcement Officers Training Council accepted the standard and implemented it on April 9, 1992. It has become part of the Administrative Rules of the State, and legislative action approving the rules into Administrative Law occurred in 1995. The implementation is as written and includes recommendations A through E. The remaining recommendations (F through J) have not been acted upon to date. There have

been no legal or professional challenges as of this writing.

Finally, the cost of implementation, which consists primarily of the fees associated with administering the hearing tests, are borne by each of the local agencies as necessary. In cases where hearing aids are required, the individual officer candidates are responsible for the purchase of the instruments.

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