

EVALUATION OF AIDED AND UNAIDED AUDITORY FUNCTIONS FOR ROYAL CANADIAN MOUNTED POLICE (RCMP) MEMBERS

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1. INTRODUCTION

Functional hearing involves activities such as sound detection, recognition, localization, and speech perception, which typically occur in noise and depend on binaural hearing [1]. Like many agencies, the RCMP currently uses the audiogram to classify hearing [2]; however, its relationship to functional hearing ability is limited [2-3]. RCMP would therefore like to establish new, scientifically-based, hearing criteria founded on a complete functional hearing assessment – a lengthy process involving the consideration of numerous work-related aspects [3].

This paper reports on the functional hearing assessment of 57 RCMP members facing operational restrictions due to hearing thresholds exceeding current health policy criteria. The primary objective was to assist RCMP in making more informed decisions regarding fitness-to-work in members wearing hearing aids, prior to the establishment of new hearing criteria. A second objective was to verify if hearing aids can improve performance, allowing members to carry out auditory functions required to safely perform their job. It was also hoped that results, together with a description of the hearing aid parameters used, could help identify best practices in hearing aid fittings for optimal functional hearing abilities in the RCMP work environment.

2. METHOD

2.1 Procedures

Members were first required to visit their audiologist to ensure proper hearing aid fit and function, and to gather useful information (settings, amplification strategy, number of programs, microphones, noise reduction algorithms, program used in work environment, etc.) by means of a questionnaire. Following at least one month of regular use, the functional hearing evaluation was performed with the hearing aid program and settings used on a regular basis in the workplace. The testing protocol included a basic audiological evaluation, in addition to unaided and aided measurements of: 1) binaural free field detection thresholds, 2) speech perception in quiet and in noise, using the Hearing in Noise Test – HINT [4-5], and 3) sound localization of a 65-dBA broadband noise (0.25-8 kHz).

Adaptive measurement of speech reception thresholds (SRT) were performed in either English or French, the native or preferred language of members, in quiet and in three conditions of 65-dBA speech spectrum noise: 1) speech in quiet (Quiet), 2) noise from the front (NF), 3)

noise from the right (NR), and 4) noise from the left (NL). A Noise Composite score was also computed $[(2 \cdot NF + NR + NL)/4]$ to represent overall functional ability for speech perception in noise under binaural listening conditions. Sound localization was assessed in three conditions, with twelve loudspeakers placed behind, to the right and to the left, thereby assessing horizontal localization in the left/right and front/back dimensions. For each condition, the number of left-right or front-back confusions was calculated.

2.2 Data Analysis

Since no scientifically-based hearing standards have yet been established, the following interim criteria were adopted: 1) SRT in quiet no greater than 40 dBA (the level of typical whispered speech at one meter), and 2) noise composite score and number of localization errors no worse than the 5th percentile performance for normal hearing individuals tested with the same protocol, in the same sound field. Individuals meeting the interim criteria were deemed operationally fit; for others, restrictions were maintained until empirically-based hearing standards are established.

In addition to individual data, group data was preliminarily analyzed to meet the second objective. It was anticipated that hearing aids would typically improve speech recognition, but could potentially hinder sound localization by disrupting important localization cues.

3. RESULTS

3.1 Hearing Aid Profile

Since individual RCMP members were evaluated with their own hearing aids, a variety of hearing aid styles, makes and models was seen. Binaural amplification was most prominent (n = 50), with CICs and open-fit BTEs being highly represented (Figure 1).

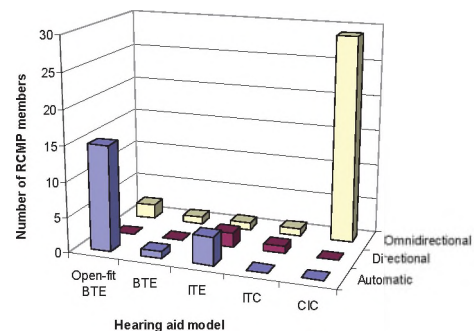


Figure 1. Hearing aid profile for the 57 RCMP members. (BTE: Behind-the-ear; ITE: In-the-ear; ITC: In-the-canal; CIC: Completely-in-the-canal)

3.2 Individual and Group Data

Individual data relative to interim criteria, summarized in Table 1, highlight a key issue for the design and fitting of hearing aids. While they can provide adequate benefits in speech recognition (the SRT in quiet and the noise composite score of 13 and 10 members, respectively, were improved to meet interim criteria), hearing aids significantly hindered front/back localization abilities in 16 cases, altogether changing the outcome from pass to fail. In contrast, left/right localization was not appreciably altered. Such findings are further evident in group data (Figure 2).

Table 1. Summary of unaided vs aided performance.

Task	Performance measure	Aided	Unaided	
			Pass	Fail
HINT	SRT in Quiet	Pass	40	13
		Fail	0	4
	Noise Composite	Pass	27	10
		Fail	0	20
Localization	# of L/R errors (Behind)	Pass	53	2
		Fail	0	2
	# of F/B errors (Side)	Pass	20	1
		Fail	16	20

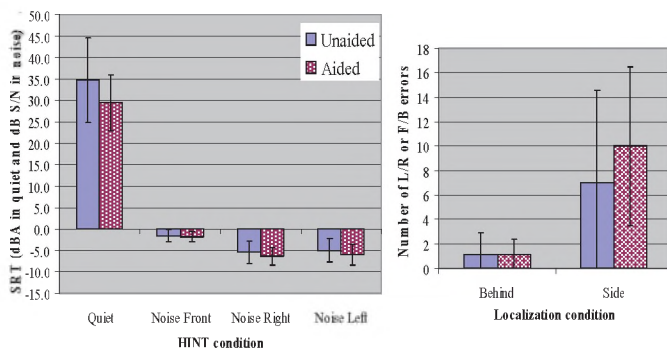


Figure 2. Mean SRTs (left panel) and number of L/R and F/B errors (right panel). Error bars show ± 1 standard deviation.

A 3-way mixed design ANOVA was performed independently for HINT results, and for the number of localization errors. Hearing aid model, the grouping variable, was sorted into five categories: automatic BTEs, omnidirectional BTEs, omnidirectional custom, automatic custom, and directional custom. The repeated measures variables were the use of hearing aids (unaided vs aided) and the testing condition (Quiet, NF, NR, NL for HINT; behind and side for sound localization).

For both hearing abilities, the analyses revealed a significant main effect of condition, main effect of hearing aid use, and interaction between both variables. No significant effect of grouping variable was found, even when analyses were repeated by grouping into two categories (auto + directional vs omni for speech; BTE vs custom for localization).

Apart from NR and NL, all HINT conditions were found to be significantly different from one another. HINT performance was generally better with hearing aids;

however, improvement from unaided to aided was most noticeable in Quiet, and smallest in NF. Localization accuracy was best when speakers were behind and, in contrast to speech recognition, was better without hearing aids, with greater increases in errors from unaided to aided in the side conditions.

4. DISCUSSION

In this sample, hearing aids: 1) improved SRTs; the effects being most prominent in Quiet and least considerable in NF, 2) neither significantly improved nor impeded L/R localization, and 3) in some cases substantially increased F/B errors in localization. Localization was generally better for sources behind than to the side, with fewer L/R than F/B errors, a result consistent with previous research [6]. Combined with previous findings [7], results indicate that hearing aids can considerably affect localization abilities. Additional analyses (not reported here) also point to the limited ability of audiometric data to predict functional abilities, and the need for individual assessments, both unaided and aided, for fitness-to-work purposes.

As members were tested using their own hearing aids, fitted and adjusted independently from this study, makes, models, styles and settings covered a wide range, making it difficult to identify optimal characteristics. Further work is needed to identify best practices in hearing aid fittings for optimal functional hearing abilities, and to develop empirically-based hearing standards for the RCMP.

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