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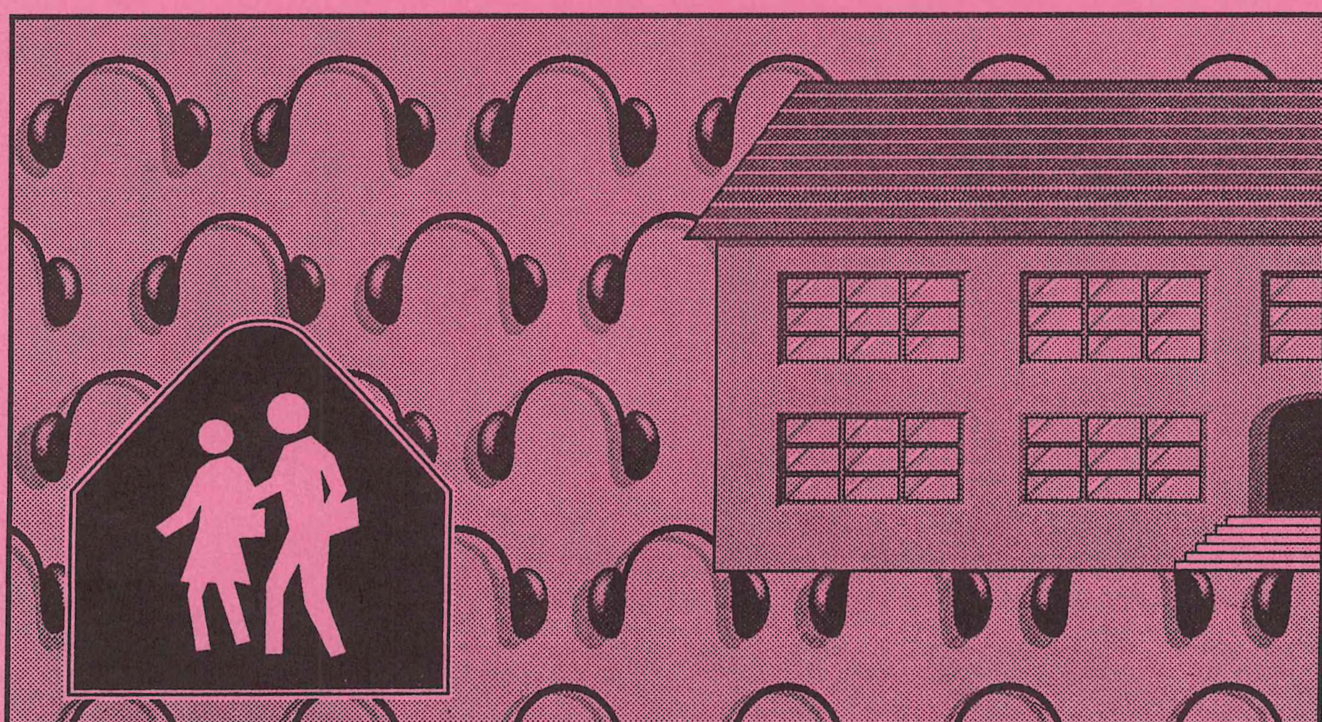

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EDITORIAL

UN PERIODIQUE SCIENTIFIQUE OU UN BULLETIN DE LIAISON ?

L'Acoustique canadienne existe depuis une quinzaine d'années déjà. Une certaine tradition s'est donc implantée dans la communauté de l'acoustique au Canada.

Cette publication assume deux rôles, l'un d'information aux membres de l'Association, l'autre de moyen formel de communication scientifique. La vitalité et l'intérêt d'une telle publication dépend, pour une large part, de son contenu scientifique, en termes de données nouvelles ou de synthèses originales de connaissances. Dans un contexte multi-disciplinaire comme c'est le cas de l'acoustique, on doit aussi considérer la transmission de connaissances peu accessibles parce que publiées dans des périodiques disciplinaires hautement spécialisés. De plus, la communication scientifique entre chercheurs(euses) et professionnels(les) canadiens(nes) contribue à accroître les interactions dans un pays où les distances favorisent l'isolement. En somme, le caractère scientifique de notre périodique est essentiel. Pour l'alimenter, il a besoin d'un *support actif* des chercheurs(es) et professionnels(les) membres de notre Association.

A SCIENTIFIC JOURNAL OR A NEWSLETTER?

Canadian Acoustics has been published for fifteen years now. Thus, a tradition exists in the acoustic community of Canada. Such a publication fulfills two roles, one of providing information to the members of the Association, and anotherone of formal scientific communication. The vitality and the interest of such a publication relies, for a major part, on its scientific content in terms of new data or original reviews. In a multi-disciplinary context as is the case for Acoustics, one must also consider the transfer of knowledge that is less accessible because of being originally published in highly specialized disciplinary journals. Moreover, scientific communication between canadian researchers and professionnals contributes to increase interactions in a country in which distances favor isolation. To sum up, the scientific character of our journal is essential. In order to feed it, there is a need for an *active support* from researchers and professionnals who are member of our Association.

EFFET SUR L'AUDITION DE L'EXPOSITION AU BRUIT PENDANT LA FORMATION SCOLAIRE

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SOMMAIRE

Afin de vérifier l'hypothèse que l'exposition au bruit dans les ateliers professionnels est suffisamment élevée pour affecter l'audition, une comparaison des seuils auditifs de 327 élèves du secteur professionnel et 370 du secteur général a été effectuée. La moyenne des seuils des deux oreilles est utilisée pour l'analyse de variance qui cherche à expliquer la variation des seuils à 4kHz. Le modèle d'analyse tient compte des antécédents médicaux, de l'utilisation d'armes à feu, de l'exposition au bruit pendant les loisirs , le travail et pendant l'apprentissage scolaire. Les variables utilisées pour définir l'exposition pendant l'apprentissage scolaire comprennent la dose cumulée d'exposition au bruit, le profil d'exposition, le type d'atelier fréquenté et le secteur d'orientation. Tout en tenant compte de l'ensemble des variables influençant l'acuité auditive, le secteur d'orientation est la seule variable expliquant de façon statistiquement significative la variation des seuils à 4kHz. A cette fréquence, les élèves du secteur professionnel ont des seuils auditifs systématiquement plus élevés de 1 dB que ceux du secteur général. Malgré leur jeune âge, les élèves du secteur professionnel accusent déjà une légère différence d'acuité auditive reliée à leur apprentissage scolaire.

ABSTRACT

Students enrolled in vocational courses are suspected of having poorer hearing acuity than other students in regular (non vocational) courses due to noise exposure during training. This study compares hearing thresholds of 327 students in vocational courses to those of 370 students of regular courses. The mean of the thresholds in the two ears is used for analysis of variance. This analysis is used to determine which variables explain the variation of thresholds at 4 kHz. Factors analysed were: health history, exposure to noise during leisure activities or work, experience with fire arms and career orientation at school. Variables describing this last item are: total noise dose, pattern of exposure, type of workshop and training group. Considering all variables influencing hearing acuity, the only one that shows statistical significance is the group training. At 4 kHz, students of vocational courses show thresholds 1 dB higher than those of students of regular courses. Thus, in spite of their age, students of vocational courses already have slightly poorer hearing which appears related to their school training.

INTRODUCTION

L'exposition à des niveaux élevés de bruit au travail est reconnue comme nocive pour l'audition. L'apprentissage professionnel en milieu scolaire comporte des conditions similaires à celles du milieu de travail: mêmes machines et mêmes opérations, potentiellement aussi bruyantes à l'école qu'en usine. Quelques études ont traité des effets de cette exposition sur l'acuité auditive des écoliers. Woodford et O'Farrel (1) ainsi que Duclos et coll. (2) concluent à la nocivité de l'exposition au bruit durant la formation professionnelle des élèves. Cependant on note certaines limites méthodologiques à ces études. Ainsi aucune d'entre elles ne comporte de traitement statistique des données. L'étude de Duclos et coll. compare l'audition de garçons de 14 à 18 ans exposés au bruit à l'école à celle de filles de 18 à 22 ans sans démontrer que ces deux groupes sont effectivement comparables au point de vue de leur exposition para-scolaire au bruit. Woodford et O'Farrel ont analysé la diminution de l'acuité auditive des élèves sans distinction des fréquences où se situe cette baisse d'acuité. D'autre part Axelsson et coll. (3) ont étudié l'audition d'adolescents fréquentant des ateliers professionnels mais en ne considérant que leur exposition au bruit durant leurs loisirs. Par conséquent, ces études ne permettent pas de déterminer sans équivoque la contribution de l'exposition au bruit durant la formation scolaire à l'état de l'audition des jeunes.

Notre étude a pour objectif de vérifier s'il y a une association entre l'exposition au bruit pendant la formation scolaire et l'acuité auditive des élèves. Le rapport détaillé de l'étude (4) rend compte d'un second objectif, non traité dans cet article, qui visait à décrire les seuils auditifs des adolescents.

METHODOLOGIE

Approche expérimentale

Nous avons planifié une étude comparative de l'audition d'élèves de deux groupes qui ne différeraient que sous le rapport de leur exposition en milieu d'apprentissage scolaire. L'un de ces groupes est exposé au bruit à l'école (formation professionnelle); l'autre ne l'est pas (formation générale). La similitude des sujets quant aux autres facteurs influençant l'audition n'est connue qu'à posteriori. Le contrôle de ces facteurs est effectué lors de l'analyse statistique.

Population

Au total 944 sujets ont été examinés: 471 du secteur professionnel et 473 du secteur général. Les programmes professionnels visés étaient la menuiserie, l'hydrothermie, l'équipement motorisé et l'ajustage mécanique. Les sujets provenaient de trois niveaux d'étude caractérisés par un temps d'exposition au bruit plus ou moins long soit de la dernière année du cours régulier (durée: 2 ans), du cours supplémentaire (durée: 3 ans) ou du cours intensif (durée: 1 an).

L'analyse a porté sur 327 sujets du secteur professionnel et 370 du secteur général. Les autres sujets ont été exclus pour les raisons suivantes: une exposition au bruit dans les 14 heures précédant l'examen, un tympanogramme anormal, une atteinte auditive non compatible uniquement avec une exposition au bruit, un dossier incomplet, une expérience de service militaire. Les sujets étaient des garçons âgés de 16 à 20 ans (X : 17 ans 5 mois au professionnel et 16 ans 8 mois au général). Ils fréquentaient huit écoles situées en milieu urbain, suburbain et rural.

Procédure

Le protocole d'examen consistait en un questionnaire complété lors d'une entrevue, un examen tympanométrique et un examen audiométrique. Le questionnaire identifiait pour chaque sujet le profil scolaire antérieur et actuel, les expériences de travail bruyant, le service militaire, les activités bruyantes de loisirs et les antécédents médicaux pouvant avoir un effet sur l'audition (maladies, antécédents familiaux de surdité...). L'examen audiométrique a eu lieu en milieu insonorisé. La recherche des seuils de 500 Hz à 6 000 Hz était effectuée avec des audiomètres automatisés (méthode ascendante Hughson-Westlake).

Des relevés sonométriques (sonomètre intégrateur de type I) ont été réalisés aux différents postes de travail en atelier. Le temps d'exposition annuelle à ces postes était établi d'après des informations recueillies auprès des enseignants. Ces données ont permis d'établir les doses d'exposition annuelle (L_{Aeq}-2000h) pour tous les niveaux d'étude des différents programmes et l'exposition cumulée (E_A) au cours de l'ensemble de l'apprentissage scolaire (5).

RESULTATS

Exposition au bruit à l'école

La figure 1 présente l'exposition au bruit cumulée durant l'ensemble de l'apprentissage scolaire. Cette exposition varie de 74 à 98 dBA (moyenne 82,5 dBA). Il y a une grande variation du E_A selon le type de programme, le niveau d'étude d'un même programme et l'école fréquentée. C'est dans l'atelier de menuiserie d'une des écoles que l'on retrouve l'exposition la plus élevée soit 98 dBA. La dose de bruit cumulée varie de 74 à 98 dBA pour ceux qui suivent le cours régulier, 75 à 89 dBA pour ceux qui font le cours supplémentaire ou le cours intensif.

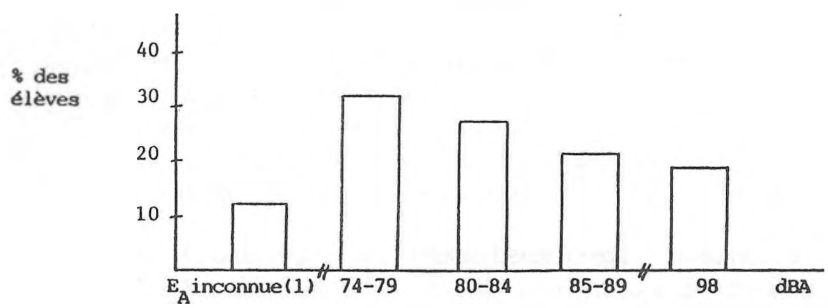

Figure 1. Répartition des élèves du secteur professionnel selon la dose d'exposition au bruit cumulée en cours d'apprentissage scolaire (E_A)

(1) inclus les élèves du profil mixte et du profil marginal (voir tableau 3)

Exposition au bruit à l'extérieur de l'école

Les élèves du secteur professionnel rapportent proportionnellement plus d'expériences de travail bruyant soit 60% comparativement à 47,5% au général. Elles sont moins bruyantes que celles des élèves du général mais de plus longue durée. Le E_A lié au travail est donc plus élevé chez les élèves du professionnel.

L'exposition au bruit durant les loisirs a engendré un E_A moyen de 91,8 dBA (s = 4,5) pour les élèves du secteur professionnel et de 89 dBA (s = 9,3) pour ceux du général. Pour le tir d'armes à feu, on retrouve une plus grande proportion d'élèves du professionnel pour chaque catégorie de nombre total de cartouches tirées.

Antécédents médicaux

Les sujets des deux secteurs d'apprentissage ont très peu d'antécédents médicaux susceptibles d'affecter leur audition. Plus de 70% des élèves des deux groupes n'en rapportent aucun. L'ensemble de l'histoire médicale des sujets a été traité sous forme d'indice numérique en accordant un poids à ces antécédents selon leur risque d'affecter l'audition (4).

Exposition au bruit et seuils à 4 kHz

Afin de dégager l'effet du bruit en milieu scolaire sur l'audition des élèves, l'analyse de variance (modèle linéaire généralisé) a été utilisée. L'analyse a porté sur les seuils à 4 kHz définis comme la moyenne des seuils des deux oreilles. Les variables indépendantes sont les suivantes: la présence ou l'absence d'expérience de travail bruyant, la dose d'exposition au bruit dans les loisirs (E_A) les catégories de nombre de cartouches tirées et les indices d'antécédents médicaux. La variable identifiant l'exposition au bruit en cours d'apprentissage est définie de quatre façons soit selon 1-le secteur d'apprentissage (professionnel, général), 2- le programme d'apprentissage (général, hydrothermie, ajustage mécanique, menuiserie, équipement motorisé), 3- la catégorie d'exposition au bruit cumulée durant la formation (E_A scolaire), et finalement 4- le niveau ou profil d'études comprenant le cours régulier, le cours intensif, le cours supplémentaire de même que le profil mixte (élèves ayant été inscrits dans un programme non visé par l'étude ou présentement au secteur régulier après un apprentissage au professionnel) et le profil marginal (élèves dont la durée de formation est supérieure à la formation professionnelle de base).

A 4 kHz, on observe une différence de 1 dBHL entre les seuils auditifs des élèves du professionnel et ceux des élèves du général, les premiers ayant le seuil moyen le plus élevé (tableau 1). Pour un intervalle de confiance de 95%, la différence entre les seuils moyens des deux groupes se situe entre 0,2 et 1,8 dBHL. Il existe donc une différence réelle entre l'acuité auditive des deux groupes.

Seul le secteur d'apprentissage (professionnel vs général) explique de façon statistiquement significative la variation des seuils à 4 kHz (p=0,02) (tableau 2). La variable identifiant l'exposition au bruit en cours d'apprentissage sous les trois autres formes soit le programme d'apprentissage, le E_A scolaire et le niveau ou profil d'études n'est pas statistiquement significative. Néanmoins, définie comme niveau ou profil d'études, celle-ci s'approche du seuil de la signification. Le tableau 3 décrit les seuils à 4kHz pour les différents niveaux ou profils d'études.

Tableau 1. Seuils auditifs (dBHL) à 4kHz selon le secteur d'orientation

Secteur	n	$\bar{X}$	s	Minimum	Maximum
Académique	370	1,91	5,8	- 10	35
Professionnel	327	2,91	5,6	- 10	20

Tableau 2. Résultats de l'analyse de la variance du seuil à 4 kHz en tenant compte des variables travail bruyant, antécédents médicaux, tir d'armes à feu, loisirs bruyants et secteur d'apprentissage scolaire

Souce de variance	Degré de liberté	Somme des carrés	F	P
Travail	1	0,52	0,02	0,900
Antécédents	8	120,95	0,46	0,884
Tir d'armes à feu	6	183,66	0,93	0,472
Loisirs	1	0,03	0,00	0,976
Secteur d'apprentis-sage	1	181,03	5,50	<u>0,019</u>

Tableau 3. Seuils à 4kHz selon les profils d'études professionnelles

Profil	n	$\bar{X}$	s	Minimum	Maximum
Cours régulier	174	2,50	5,5	- 10	20
Cours intensif	43	2,93	5,5	- 8	18
Cours supplémentaire	68	3,85	6,1	- 10	18
SOUS-TOTAL	285	2,89	5,7	- 10	20
Profil mixte (1)	27	2,70	4,8	- 5	15
Profil marginal (2)	15	3,80	6,0	- 5	15

(1) Elèves ayant été inscrits dans un programme non visé par l'étude ou présentement au secteur académique après un apprentissage professionnel.

(2) Elèves dont la durée de formation est supérieure à la formation professionnelle de base.

Une analyse de variance a aussi été réalisée en incluant l'âge comme autre variable concomittante. Cependant, nous n'avons pas mis en évidence de différence statistiquement significative en prenant en compte cette variable. Etant donné que l'âge est jusqu'à un certain point relié à l'exposition au bruit durant l'apprentisage, dans les loisirs et au travail (les élèves plus vieux ayant plus de chance d'avoir une plus grande dose cumulée), les autres analyses ne comprenaient pas cette variable.

DISCUSSION

Les résultats montrent que les élèves du secteur professionnel ont des seuils auditifs à 4 kHz plus élevés que ceux des élèves du général. Cet état est lié à leur exposition au bruit en cours d'apprentissage et non à des facteurs tels que l'exposition au bruit dans les loisirs et au travail ou aux antécédents médicaux. Bien que la différence soit faible, elle apparaît être systématique pour les différents centiles de la distribution des seuils. La différence entre les deux groupes n'est donc pas le fait des valeurs extrêmes les plus élevées.

Si les résultats indiquent que le fait d'appartenir au secteur professionnel constitue un risque d'atteinte auditive, nous ne pouvons pas cependant isoler un indice de risque plus spécifique à l'exposition, par exemple la dose d'énergie cumulée (E_A scolaire), le mode temporel d'exposition (niveau ou profil d'études) ou le programme d'études. Une étude de type cas-témoins pourrait sans doute contribuer à cerner de façon plus explicite le facteur de risque associé au fait d'être élève au secteur professionnel. A ce stade-ci, l'hypothèse selon laquelle le risque soit davantage lié au mode temporel d'exposition qu'à la dose cumulée pourrait être envisagée. En effet, l'analyse de variance indique une valeur au seuil de la signification statistique pour la variable "niveau ou profil d'apprentissage" ($p=0,06$) et les résultats ont tendance à associer une augmentation des seuils auditifs à une augmentation du temps total d'exposition. Le mode temporel d'exposition influencerait la récupération du décalage temporaire du seuil auditif (6). Ainsi une période de production intensive (fin d'un projet, ou d'un stage) surtout si elle s'accompagne d'une exposition au bruit extérieure à l'apprentisage (loisirs, travail) pourrait représenter une exposition excessive pour les élèves du professionnel et, en agissant sur le mode de récupération, pourrait augmenter le risque d'atteinte permanente.

D'un point de vue pratique les résultats obtenus montrent la nécessité de la réduction du bruit dans les ateliers professionnels. A cause du caractère particulier de la situation d'apprentisage, de nouveaux moyens sont à développer pour améliorer l'environnement sonore. L'emploi de protecteurs auditifs de façon généralisée n'est sans doute pas indiqué pour des élèves et des enseignants qui, dans cette situation d'éducation, doivent forcément communiquer verbalement.

D'autre part les niveaux élevés de bruit mesurés dans les ateliers professionnels dépassent les niveaux sonores maxima généralement admis pour que la communication puisse être efficace (7,8). De plus, exposés à ces niveaux sonores, il est possible que les élèves présentent des signes de fatigue auditive (9) et qu'ainsi leur aptitude à suivre un cours théorique après une période en atelier puisse être sérieusement affectée (10). Il serait intéressant d'étudier ce phénomène.

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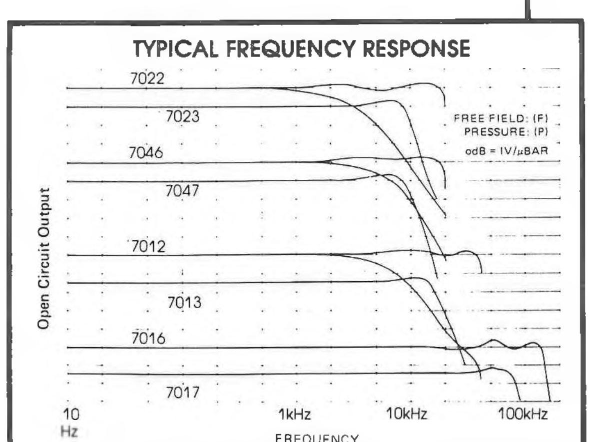

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THE RELIABILITY OF PERSONAL NOISE DOSIMETERS UNDER STEADY-STATE AND VARIABLE NOISE EXPOSURE

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ABSTRACT

Three groups of l5 industrial workers were identified according to their pattern of exposure to noise: a) steady-state, b) periodically fluctuating and c) randomly variable. A personal dosimeter was worn by each worker for three consecutive days. The long term exposure was also assessed by means of sound level meter sampling procedure. The standard error of measurement of the dosimetry was ± 1.10, ± 1.56 and ± 2.86 dB for the three types of exposures respectively. Dosimetric and SLM data acheived the same result within 0.5 dB for the first 2 groups. An average difference of 3.4 dB was obtained with the third group.

SOMMAIRE

Trois groupes de l5 travailleurs industriels ont été recrutés en fonction de la configuration temporelle de leur exposition professionnelle au bruit. Il s'agissait a) de bruits stables, b) de bruits dont le niveau subit des variations périodiques et c) de bruits dont le niveau varie de manière aléatoire. Chaque travailleur a porté un dosimètre individuel durant trois jours consécutifs. L'exposition à long terme a également été évaluée par échantillonnage sonométrique. L'erreur-type de mesure dosimétrique atteignait respectivement ± 1.10, ± 1.56 et ± 2.86 dB pour les trois types d'exposition. Les mesures dosimétriques et sonométriques ont donné le même résultat à 0.5 dB près pour les deux premiers types d'exposition. Un écart moyen de 3.4 dB, en faveur des mesures sonométriques, a été obtenu pour le groupe de travailleurs dont l'exposition était aléatoire.

The widespread use of personal dosimeters have been justified by the need to measure directly the exposures to fluctuating noise, and more especially for noise fluctuations that depend on motions of the individuals in different worksites. The meaningfulness of the measure in terms of risk of hearing loss is a function of its reliability: it must represent an accurate estimate of the long-term exposure [1]. Sources of error have been identified for personal exposure meters: the microphone location [2-3], and its interaction with the nature of the sound field [4-5], the accuracy of the frequency response complying to Type 2 sound level meter tolerances limits [6], the limited dynamic range of the device [7] and its response to high level impulses [8-10]. The variability of the exposure to be measured has also been considered [11] but few studies have attempted to quantified the actual contribution of this source of error. In a study on mining operations, the 95 % confidence interval of the mean of 10 dosimetric results was estimated to be 10% for jobsites involving relatively stable noise levels and 45 % for sites involving highly variable exposures [12]. Overall, the mean for 5 dosimeter results on the same sites and occupations layed, to 95 % confidience, within ±3 dB of the true mean.

The aim of the present investigation was to assess the reliability of personal dosimetry for different patterns of exposures in industry. Three categories of exposures were defined for the purpose of this study:
- category I (C1): job assignments that involve constant daily exposure to steady-state noise without motion in space;
-category 2 (C2): job assignments involving displacements in different noisy area that are predictible in space and time, or exposure to time-varying noise, the variations being determined and predictable for a workday an repeated from one day to another;
-category 3 (C3): job assignments that are partially or totally unpredictible, involving varying exposures within a workday and from one day to another.

It was hypothesized from previous results [12] that the dose measurements over a workday would be highly reliable for the first two categories and relatively unreliable for the third one.

METHODS

Selection of the industrial settings

In order to minimize the possible influence of other sources of variation, the plants selected had to meet the following criteria: absence of audible discrete impact/impulse noises or predominantly high frequency noise (above 3 kHz). A weaving mill and a food processing plant were found to meet these criteria.

Subjects

For each of the three categories of exposure, a group of I5 volonteer workers was selected. Their job assignment and pattern of noise exposure had to fit the definitions given above. Subjects in group C1 were production workers. Group C2 comprised production workers and maintenance personnel assigned to a restricted area in the production line. Workers belonging to group C3 were responsible for the general maintenance in the factory .

Equipment

Ten Dupont MK1 dosimeters were used. They were submitted to a thorough verification and calibration prior to the experiment. The calibration was checked before and after every day of measurement. They were set to operate with a 5 dB exchange rate and a threshold of 80 dBA. A Bruel and Kjaer integrating sound level meter (model 2225), equiped with a BK-4175 microphone, was also used for a parallel assessment of the exposures of the 45 subjects.

Procedure

Each subject worn the same dosimeter for a full 8-hour work shift during three consecutive days. They received instructions to prevent artifact in the measurements. The microphone, attached to the clothing, was located at the shoulder.

Exposure measurements with the sound level meter involved the following steps: the worker was first met to obtain a detailed description of his work organization and schedule, then measures of L_{eq60s} were obtained for each activity or job performed during a representative workday. For the subjects belonging to group C3, a list of assignments within a "typical" week or month period was first obtained; the sampling of the noise exposure levels was then performed accordingly.

RESULTS

Table 1. Mean, standard deviation (s), minimum and maximum dose in dBA (time weighted average) for three consecutive days (8-hour periods) for three categories of exposures. The corresponding results obtained with the sound level meter (SLM) are also given.

	Mean	S	min.	max.
Group C1				
day 1	94.96	6.58	86.4	106.4
day 2	94.50	6.41	85.9	105.9
day 3	94.25	6.13	86.8	103.9
SLM	94.15	6.47	85.9	103.1
Group C2				
day 1	87.92	7.47	77.2	101.5
day 2	88.01	7.31	73.5	101.6
day 3	88.49	6.44	81.0	101.2
SLM	88.08	6.68	79.1	101.2
Group C3				
day 1	85.78	6.06	74.4	98.1
day 2	84.32	8.52	69.7	100.0
day 3	86.28	7.04	71.9	97.4
SLM	89.32	4.26	82.9	99.2

The mean results presented in Table I are in agreement with our assumption: for exposures to steady-state noise (C1) and to predictable fluctuating noise (C2), the average dosimetric readings for a group were highly reproducible from one day to another and they were very similar to those obtained with a SLM. For relatively unpredictable time-varying noise (C3), the daily mean doses showed variations; the standard deviations are also more variable and tend to be higher than in the other groups. The range of doses extend from much lower minimum values to approximately the same maximum values. Moreover, there is a clear disagreement between the dosimetric and SLM results. These observations are confirmed by the results of the analysis of variance (randomized block design) on the factors "repetition of measurements" and "method of measurement" as shown in Table 2.

Table 2. Results of one-way analysis of variance on the effect of the repetition of measurements with dosimeters and method of measurement, for each category of exposure.

Source of variation	Mean square	F	Probability	Degrees freedom
Repetition of meas.				
Group C1	1.95	1.63	0.21	2,28
Group C2	1.38	0.51	0.61	
Group C3	15.56	1.41	0.26	
Method of meas.				
Group C1	1.67	4.96	0.04	1,14
Group C2	0.01	0.03	0.86	
Group C3	84.81	8.40	0.01	

The results from Table 2 demonstrate that there was no systematic variation in daily noise dose measurements. But one will note that the variability (in dB squared) was much higher for group C3. When comparing SLM results with the logarithmic average of the dosimeters results, significant differences are obtained for categories C1 and C3. In the first case, the mean difference is equal to 0.5 dB in favor of the dosimetric readings. This is explained by a very slight but systematic overestimation of the time spent away from the noise (e.g. in the lunch room) when interviewing the workers about their work schedule. This small bias was probably present for the other two categories, but it would have been outweighted by the higher intra-individual variability in the exposure along the day. The effect of the mode of measurement with category C3 is explained by the fact that with the SLM method, the exposures were estimated over 40-hour and l60-hour periods and then converted to daily 8-hour doses. The limited 3-day dosimetric sampling did not take into account some of the most severe exposures occuring over a typical week or month interval.

In the absence of any systematic daily variation in dosimetric results, the random error was further analysed by computing the standard error of measurement: it is based on the reliability coefficient as indicated in the following equation [l3]:

$$S_e = S (l - R_{xx})^{1/2} \quad (1)$$

where S_e = standard error
S = standard deviation
R_{xx} = reliability coefficient

Table 3. Reliability coefficients, standard error and 95% confidence intervals of time weighted averages obtained from dosimetric measurements in dB for the three categories of exposures.

Group	R_{xx}	S_e (dB)	$\pm 1.96\ S_e$ (dB)
C1	0.97	1.10	±2.16
C2	0.95	1.56	±3.06
C3	0.82	2.86	±5.61

Assuming that the measurement error is independant of the magnitude of the measure and that it is normally distributed, the values given in Table 3 represent estimates of the variability of individual results; this allows to define confidence intervals of individual exposure levels measured by means of personal dosimeter. Thus, for 95% of the cases in group C1, the results obtained is within ± 2.2 dB of the true dose. For group C2 and C3, the margin of error extends over 6.2 and 11.2 dB respectively. It implies for example that a dosimetric result of 90 dB-8hour means that the true exposure level is somewhere between 87.8 and 92.2 dBA in group C1, between 86.9 and 93.1 dBA for a worker in group C2 and between 84.4 and 95.6 for an individual belonging to group C3.

DISCUSSION

Our hypothesis is confirmed by the present results obtained with group C3: unless it is conducted on a homogeneous group of workers [14], personal dosimetry is relatively unreliable when evaluating daily exposures that are partially or totaly unpredictable. An appropriate identification of the exposure variables is necessary to accurately assess representative daily doses. Repeating the measurement over three consecutive days was not sufficient to achieve this accurate estimation: averaging the doses over three days of measurement would only reduce the variablility by a factor of l.7 (that is the square root of 3). The margin of error of the average would be ± 3.2 dB, a range of values that cannot be considered as negligeable. Consequently, at least for this category of exposures, a systematic analysis of the work organization within the appropriate time scale combined with an adequate sampling of the noise levels with a precision SLM is probably more reliable. Furthermore, it was less time consuming to perform direct measurements at several sites and for several activities than repeating personal dosimetry over three days (which were insufficient to achieve a representative estimate of the individuals long-term exposure levels).

However, the reliability of the SLM survey method should also be assessed for this type of unpredictable exposures; independant estimates of the long-term exposure of general maintenance personnel may turn out to be relatively variable, unless considerable time is devoted to the survey of the exposure of each worker. This is suggested by the results of a study conducted on foundry workers [15]. Dosimetric measurements were performed over the number of days necessary to acheive a long term representative dose at a level of precision of ±2 dB for a 95 % condfidence interval. It required up to 23 days of measurements for some jobsites like maintenance. Then, sound level meter measurements were conducted over five days selected at random. The difference in microphone location (shoulder vs free-field) was taken into account by means of a uniform correction factor for all comparisons. The 5-day samples of SLM measurements underestimated the long term dose by as much as 7 dB in the case of jobs involving subtantial movements, working in confined spaces and tasks where the operator works close to the noise source and frequently changes position relative to the source.

The results obtained in the present experiment with exposure categories C1 and C2 did not confirm our hypothesis at the level of individual measurements. Despite a careful selection of the workers in accordance with the definition of our exposure categories, only group estimates can be said to be reliable. The individual readings are subject to a significant daily variation; even if they are averaged over three days of measurement, their margin of error is still significant: ± l.2 dB for group C1 and ± 1.8 dB for group C2. Considering that, using the SLM, it takes only a few minutes to obtain several measures of exposure of a worker belonging to group C1, it certainly represents a more valid and pratical method of dose assessement. But it is also the case for workers belonging to group C2, even though the sampling of the noise levels for differents activities require more time; attaining a higher degree of reliability can be achieved in less survey time using an intergrating sound level meter and analysing the work organization than undergoing personal dosimetry over several days with the same workers.

Considering the influence of the variability of exposure and the other sources of error of personal dosimetry [l-l0], one can conclude that this approach to noise exposure measurement is of limited use in industrial settings [l6].

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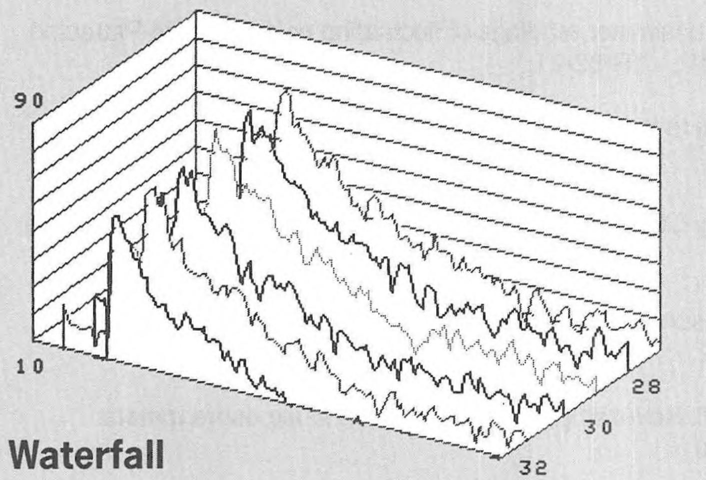

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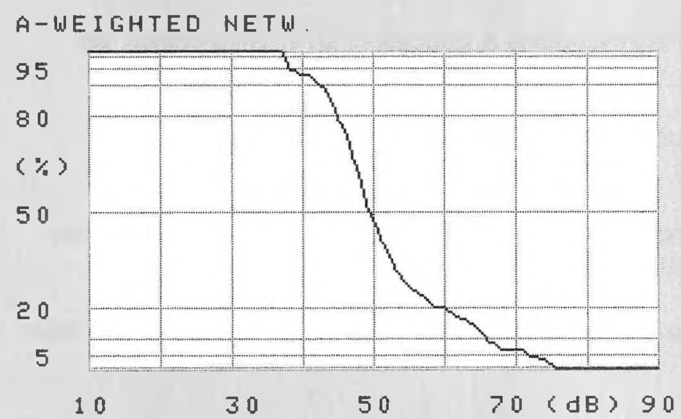

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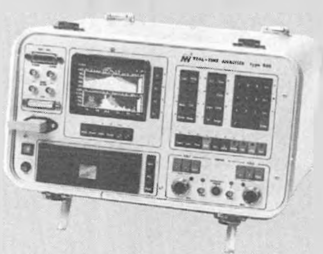

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POINT DE VUE / VIEW-POINT

by Murray Hodgson, Editor, Canadian Acoustics

The future of Canadian Acoustics

On assuming the role of editing Canadian Acoustics it was inevitable that I would have to give some thought to its future. This was prompted by a need to try to avoid problems experienced by the previous editors and to respond to 'complaints' fittering down the acoustic grapevine, and to a sincere desire to make the journal better serve its readers. What, then, should become of Canadian Acoustics?

There seem to me to be three main options. First, it could become exclusively a newsletter, aimed at informing and interconnecting Canadian acousticians. Such is the approach of the British Acoustics Bulletin. Secondly, it could become a full-pledged scientific journal, referred to by acousticians world-wide. This is the approach of the French Revue d'Acoustique. Thirdly, it could become a combination of the above options. This has been the Canadian approach up to now. Inevitably there are arguments for each option. Which option would best satisfy the wishes of, and serve the needs of, Canadian acousticians?

Certainly, it is important for us to be informed of events and news of significance to us. Further, given the vast distances separating us and our diverse interests, there is a place for a means for inter-communication between ourselves - if we're interested in doing so.

Establishing a high quality Canadian acoustics journal to rival JASA or JSV would be a lofty objective, presumably of utmost importance to the nationalists amongst us. But does the world need another acoustics journal? Whatever, it is certain that this option would require a sufficiently high rate of submission of sufficiently high-quality papers. Shortage of papers has been a complaint of Canadian Acoustic's editors since its conception. Are we numerous enough, and do we produce sufficiently good research to support such a journal? A perusal of the proceedings of the 12th ICA held in Toronto last year reveals that

Canadians presented 81 papers on an impressively vast range of topics. With the current 'publish or perish' mentality, I assume most of this work will inevitably be published in a journal. Are we interested in publishing it in a Canadian journal? Not to date, it seems. Frankly, it amazes me that we don't take more advantage of the editor's frequent invitations to, for example, reproduce conference papers in Canadian Acoustics. What easier way to add a publication to our C.V.'s.

Or are we saving the work for another journal? For me a chicken-egg situation exists here. If Canadian Acoustics were of sufficiently high quality and reputation to carry weight in the eyes of, for example, promotion and grant-giving bodies I would publish there. Until then, I can't afford to! How then would we make the transition from the status quo to the ideal? First of all, as trite as it sounds, we would have to decide collectively that we want to do so, and then do it! It won't happen if we sit back and wait for someone else to start the process. We would have collectively to submit good publications, to be subjected to stringent peer review and, hopefully, publication. We would also have to accept the inconvenience of the transient stage.

Personally I see no reason why Canadian Acoustics could not, and good reasons why it should, remain a combination newsletter/scientific journal. It is the ideal vehicle for expressing our viewpoints, advertising our activities and publishing our research. I don't understand why we haven't take more advantage of Canadian Acoustics in the past. Will we in the future?

* * * * * * * * * * *

As for all other viewpoints, the editors welcome discussion of the above opinions as well as points of view on any other subjects of interest to Canadian acousticians.

NEWS / INFORMATIONS

DOCUMENTS AVAILABLE FROM

Transport Canada - PNRP
Air Navigation System Requirements
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I. *Vancouver International Airport Aircraft Noise Monitoring System Selection of Remote Monitoring Sites*
Reference # TP 6686E
Publishing date: July l985

2. *Helicopter Noise Level Tests Vancouver Harbour - Gastown, B.C.*
Reference # TP 6934E
Publishing date: November 1985

3. *Aircraft noise levels measured during the trial SID2 procedure Vancouver International Airport, Canada*
Reference # TP 7374E
Publishing date: February l986

4. *Concorde noise measurements Vancouver International Airport July and August l986*
Reference # TP 8158E
Publishing date: April l987

NEWS ON CONFERENCES

Following are three conferences Sponsored by the Institute of Acoustics (25 Chambers Street, Edinburgh, EH1 1HU)

- REPRODUCED SOUND 3
Windermere Hydro Hotel, 5-8 November 1987

- INDUSTRIAL NOISE
Windermere Hydro Hotel, 26-29 November 1987

- UNDERWATER COMMUNICATION AND POSITION FIXING
University of East Anglia, 17-18 Dcember 1987

INTER-NOISE 88
Sponsored by the International Institute of Noise Control Engineering (INCE), will be held at Avignon (France) Aug. 30 - Sept. 1st.

Inter-Noise Secretariat's adress is : BP 23, 60302 Senlis Cedex, France.

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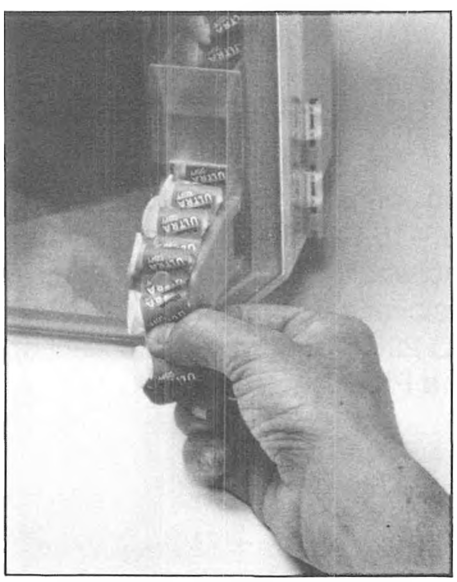

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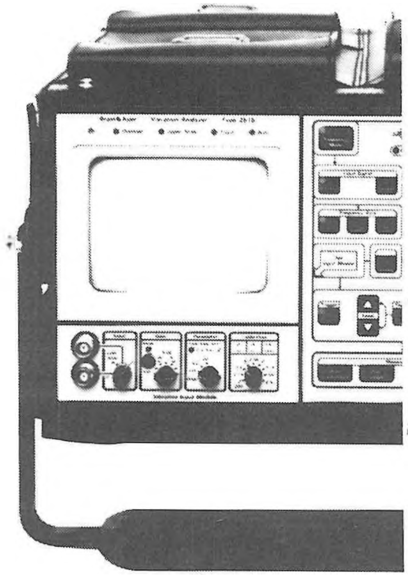
The course registration fee is $75.00 for government employees and $150.00 for other participants. Early registration is advisable as the number of participants is limited. To register respond by letter to the Registration Secretary, Ministry of the Environment, Training and Certification Section, 135 St. Clair Avenue West, Toronto, Ontario, M4V 1P5. Phone (416) 456-0266.



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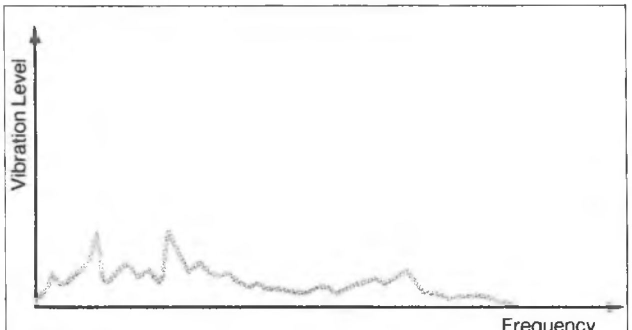

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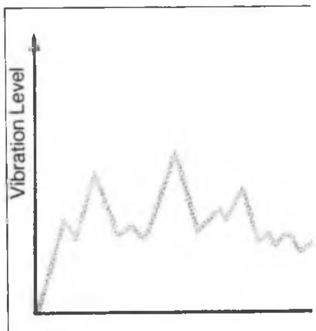

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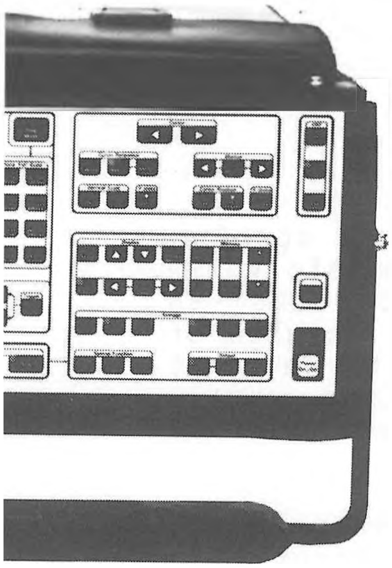

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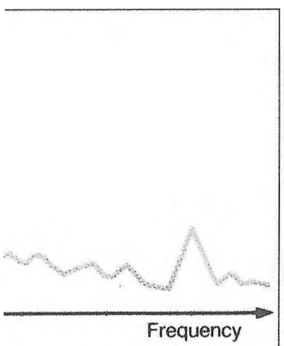

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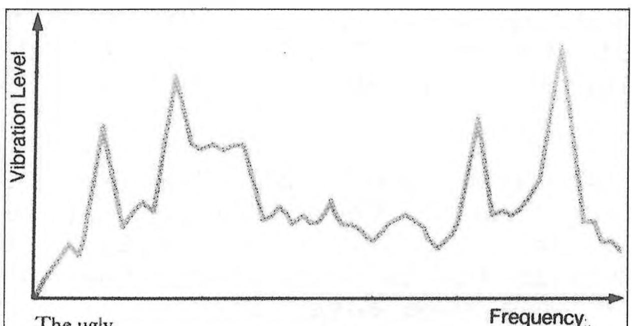

The ugly
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CAA - MEMBERSHIP UPDATE

Sharon M. Abel, Ph.D.
President, CAA

Last January Annabel Cohen, Moustafa Osman and I spent a Sunday afternoon in my lab catching up on local gossip while stuffing over five hundred envelopes with invoices for 1987-88 membership dues. What follows is an analysis of the results of the mailing. We received a total of 373 replies (with cheques) by mid-May. I subsequently undertook an analysis of the country of origin, membership category and interests of those who had replied.

Figure 1 provides a breakdown of the total membership. Seventy-three percent (73%) are full members, six percent (6%) are students, seventeen percent (17%) hold subscriptions, the category by which we identify libraries and companies, and four percent (4%) hold sustaining memberships, the category representing advertisers in Canadian Acoustics. Table 1 shows the number of Canadians verses non-Canadians in our Society. We see that fourteen percent (14%) of the total reside outside Canada. Most of those (i.e., 68%) are members and twenty five percent(25%) are subscribers.

The distribution of the Canadian membership across the ten provinces is given in Table 2. Ontario leads under the categories of members, subscribers and sustaining, but Quebec heads the group in terms of students (thanks Nicole and Chantal). We also have good representation in British Columbia, Alberta, Manitoba and Nova Scotia.

Table 3 shows the distribution of the non-Canadian membership by category and country. More than half (i.e., 69%) are from the U.S.A., but as you can see, we are well represented internationally with members as far away as Hong Kong, Australia and Brazil. We have yet to find some advertisers.

Overall, the picture looks bright for the Canadian Acoustical Association. No doubt our numbers in the Atlantic provinces will rise, when Annabel moves to Halifax this Fall. And I hear that Tim has been busy telephoning potential advertisers. Presently, we're analyzing your interests (as checked off on the yellow invoice). This information will shortly be passed along to our Editor for use in establishing publication guidelines. Why not ask a colleague to join us. Better still give a subscription to our Journal to a friend abroad for Christmas. Congratulations Raymond on a wonderful new look!

Acknowledgement

Many thanks to Mrs. Dolly Razack for her substantial help with database management.

Figure 1 DISTRIBUTION OF CAA MEMBERSHIP (05/15/87)

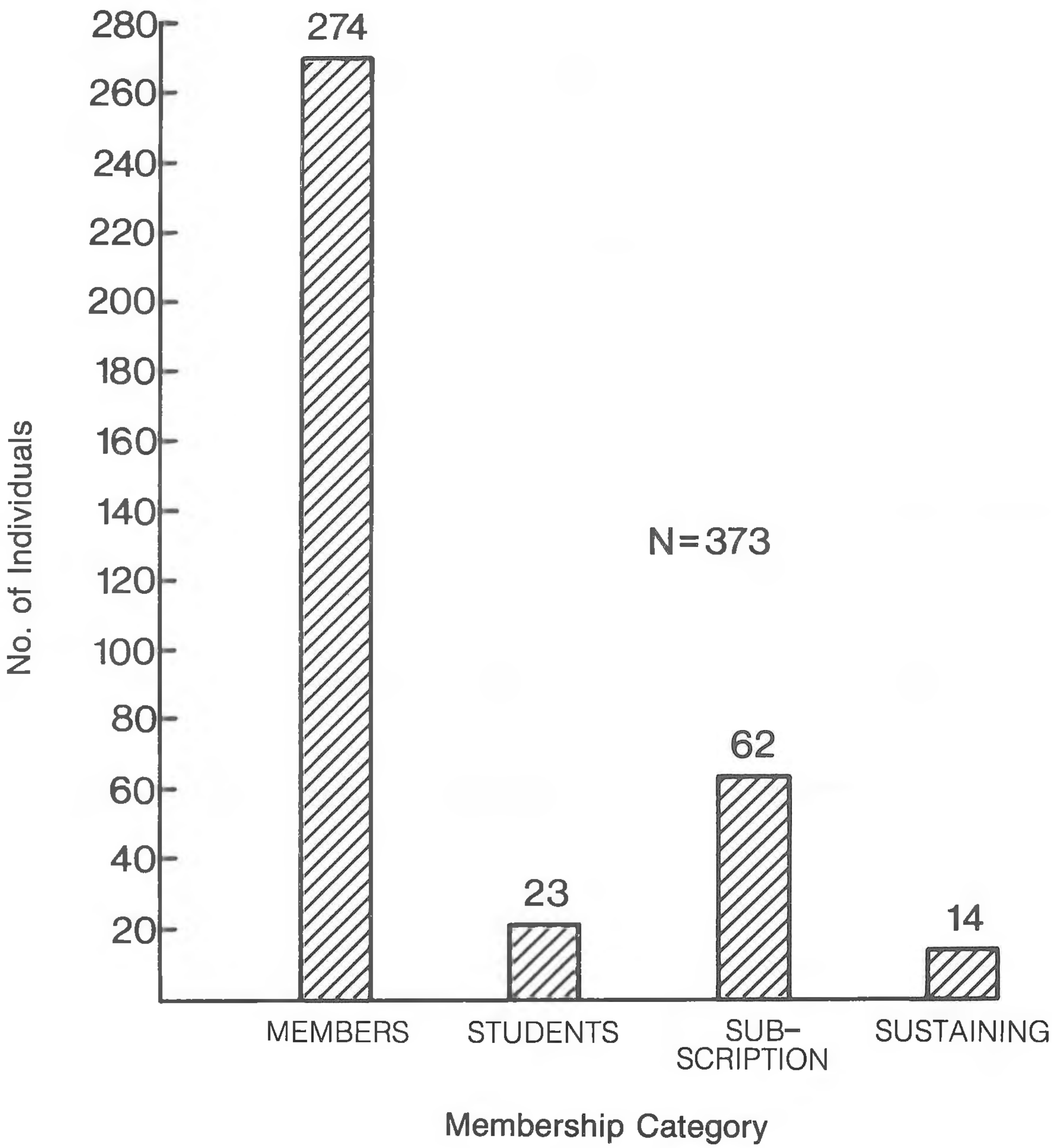

TABLE 1 CANADIAN VS NON-CANADIAN CAA MEMBERSHIP (05/15/87)

	Member	Student	Subscription	Sustaining	Sub-Total
Canadian	239	20	49	14	322
Non-Canadian	35	3	13	Nil	51
Sub-Total	274	23	62	14	373

TABLE 2 DISTRIBUTION OF CAA MEMBERSHIP BY PROVINCE (05/15/87)

	Member	Student	Subscription	Sustaining	Sub-Total
British Columbia	17	2	8	0	27
Alberta	20	0	5	2	27
Saskatchewan	0	0	1	0	1
Manitoba	11	0	3	0	14
Ontario	136	5	25	8	174
Quebec	44	10	6	2	62
New Brunswick	2	1	0	0	3
Nova Scotia	9	1	1	2	13
P.E.I.	0	0	0	0	0
Newfoundland	0	1	0	0	1
Sub-Total	239	20	49	14	322

TABLE 3 DISTRIBUTION OF NON-CANADIAN CAA MEMBERSHIP (05/15/87

	Member	Student	Subscription	Sustaining	Sub-Total
U.S.A	25	3	7	0	35
U.K.	2	0	2	0	4
France	2	0	1	0	3
Germany	0	0	2	0	2
Scandinavia	2	0	0	0	2
Netherlands	1	0	0	0	2
Hong Kong	1	0	0	0	1
China	0	0	1	0	1
Brasil	1	0	0	0	1
Australia	1	0	0	0	1
Sub-Total	35	3	13	Nil	51

Membership Directory / Annuaire 1987

The numbers that follows each entry refer to the areas of interest as coded below.
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