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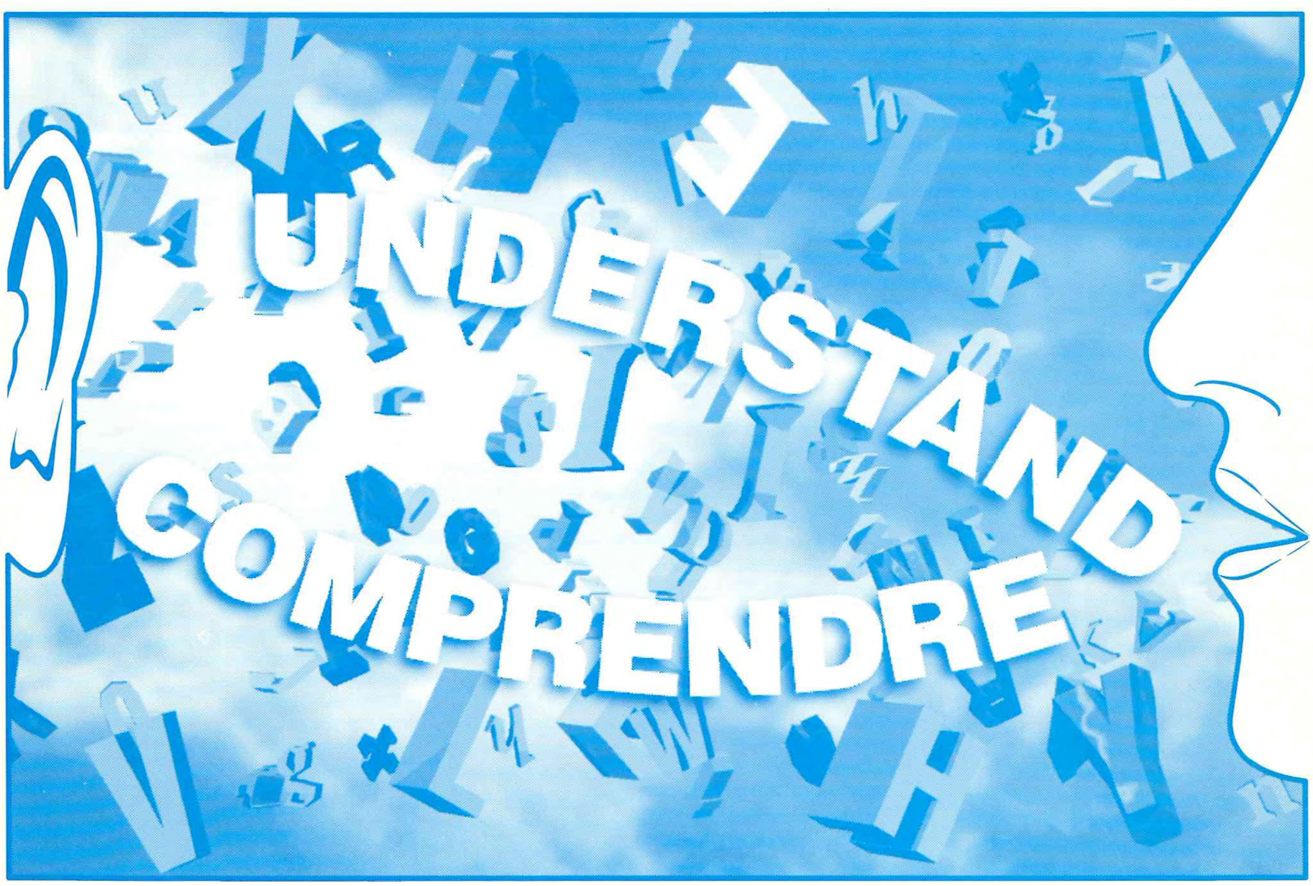

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EDITORIAL

In this issue we publish research articles on speech intelligibility and on the perception of sound.

Also published in this issue are further details concerning Acoustics Week in Canada 1994 to be held in Ottawa. The organizers will be putting on an excellent meeting with interesting courses, exhibition and technical symposium. Get your abstracts in (by June 21!) and reserve your flights. I look forward to seeing you in Ottawa.

Let me end this briefer-than-usual editorial with a note to those interested in reader reaction to the Hétu article published in the March issue. Up to now, it has been light, but positive.

Dans le présent numéro, vous pourrez lire des articles de recherche portant sur l'intelligibilté de la parole et sur la perception des sons.

Vous trouverez par ailleurs de plus amples détails sur la Semaine Canadienne de l'Acoustique 1994 qui se tiendra à Ottawa. Les organisateurs préparent un excellent congrès comportant des cours intéressants, une exposition, ainsi qu'un symposium technique. Préparez votre résumé (pour le 21 juin) et réservez votre vol. J'ai bien hâte de vous rencontrer à Ottawa.

Permettez-moi de terminer cet editorial, plus court qu'à l'habitude, avec une note adressée à ceux qui sont intéressés par les réactions des lecteurs à l'article de Hétu publié dans le numéro de mars. Jusqu'à maintenant, il y a eu très peu de réactions mais elles sont plutôt positives.

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Canadian Acoustics / Acoustique Canadienne 22(2) 3-17 (1994) **Research article / Article de recherche**

OBJECTIVE PREDICATES OF WORD INTELLIGIBILITY

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ABSTRACT

There have been many attempts in the past to systematically attribute the subjective properties of speech to objective and physical characteristics. The aim of this study was to look in more detail at how objective properties interact to contribute to the shape of intelligibility versus presentation level functions for individual words. The interaction of such features as speech level, familiarity and spectral consistency were found to be complex and enlightening. Spectral consistency was measured using the variance of spectral flatness σ and the length of words. These two measures were a novel addition to the standard measures. Although the results shown by no means explain all the variation of speech intelligibility they do provide some insight into the play of factors for the fairly simple case of mono-syllabic words.

SOMMAIRE

Jusqu'à ce jour, de nombreux efforts ont été déployés afin d'attribuer de façon systématique les propriétés subjectives de la parole à des caractéristiques objectives et physiques. Le but de cette étude était de scruter plus en détails comment les propriétés objectives contribuent à la forme d'intélligibilité versus les fonctions du niveau de présentation pour les mots isolés. L'interaction de ces caractéristiques telles que le niveau de la parole, la familiarité et l'uniformité spectrale s'est avérée complexe et révélatrice. L'uniformité spectrale a été mesurée en utilisant la variance de l'égalité spectrale σ et la longueur des mots. Ces deux mesures représentent un ajout innovateur aux mesures classiques. Même si les résultats présentés ne permettent pas d'expliquer toutes les variations de l'intélligibilité de la parole, ils fournissent quelques indices sur le rôle des facteurs pour le cas relativement simple des mots mono-syllabiques.

1. INTRODUCTION

In this paper we seek to assess the relative importance of objective speech measurements in predicting subjective word thresholds and word intelligibility. We use the twelve Boothroyd (1968a and 1968b) lists of words specified by Markides (1978) as our material. Some of the measurements described in this paper were obtained in other studies, the specific sources are described in the text. Here we seek to see how the difficulty of perception of an individual word versus level of presentation is related to properties such as familiarity, energy (speech level) and frequency characteristics.

The analysis in this paper takes the form of correlation of subjective or behavioral data with objective properties. The subjective data was collected in a previous study aimed to identify a subset of words from the Boothroyd lists to be used in an adaptive test (James, 1992b). Some details of the nature of these data are presented herein. The choice and treatment of the objective measurements is based on previous reports in the literature and some further intuitive reasoning by the author. In this case the objective measurements are treated as indicators of the amount of information given to the listener for correct identification of the target word. There are two basic aims of this work: The first is to assess the relative importance of physical measurements and linguistic measurement and how best to treat these properties. The second is to find good objective predictors of the intelligibility characteristics of new speech material.

2. SPEECH MEASUREMENTS

Before embarking on any exploratory statistical analysis, it is useful to discuss the relative importance of the various objective factors in determining the subjective results. We can divide the objective measurements described below into three distinct *types*: those which describe level, spectral characteristics and linguistic usage. We might expect any measure of a certain *type* to be interrelated with other measures of the same *type* and independent of measures of a different *type*. However, it may be deduced that some data of apparently different *types* may be interrelated, for example speech level and mean spectral flatness (see below) are likely to be related measures.

In this study we are relating thresholds of stimulus words (the level at which a word is on average 50% intelligible) and the intelligibility of words at given presentation levels. The relative importance of objective *types* in predicting these subjective characteristics may be inferred by considering the effect of presentation level: It is fairly obvious that small differences in speech signal level will be of little importance at supra-threshold levels. Alternatively, small differences such as these may increase or decrease the level of thresholds, perhaps by the actual difference in speech level. (It is noted here that the manner in which the recording levels were set on the source tape will contribute to measured levels of the words, however these levels were preserved in the subjective study and in the measurements presented here.)

From previous studies (for example, James et al., 1992a), we know that certain Boothroyd words are more robust to degradation than others. This would seem to indicate that certain frequency characteristics are more robust than others. For example, fricative consonants of low intensity will be less audible compared to say the liquids that occur in diphthongs (such as "veil" and "fail."). In these words there are characteristic shifts in the vowel which forms the part of the speech spectrum with the highest energy. There might also be other clusters/structures which prove more robust, or alternatively more fragile to changes in presentation level. We can also state that the degree of consistency of any particular feature will lend to its perception. Here we might expect some interaction of steady state spectral characteristics with their duration and in a limited sense with the word's total duration. It is also true that shorter words will, in general, be of lower total energy.

Finally, we speculate about the importance of familiarity in the perception of speech. This has a history of study, for example Broadbent (1967) and Morton (1969), showing that more frequently used words are of higher intelligibility. Wayland et al. (1989) in addition show the effect of limiting the amount of information available to subjects by gating the test words. We may conclude a similar result for speech level: The further above threshold we get the more acoustic information is available. At higher levels, the effects of familiarity are reduced because the cohort of confusable words is reduced.

2.1. Speech Material

The speech material used in this study was the selection of twelve Boothroyd (1968a and 1968b) lists of ten monosyllabic words, recordings made by ISVR, Southampton. For the purposes of analysis, the words were digitally transcribed and stored in a 12-bit digital format on a Masscomp 5450 computer. The speech data was in a form which enabled use of Audlab signal analysis software and enabled speech to be replayed via a reconstruction filter (Kemo vbf/22) into any external measurement device such as a measuring amplifier or Sound Level Meter (SLM). In this study the relative signal levels to the calibration tone on the original test tape are preserved both for subjective presentation level calibration and for speech level measurements..

2.2. Speech Level

Speech level measurements were obtained in two ways: By calculation from the digitised word samples stored on the Masscomp computer, and by replaying the words via a reconstruction filter set at 8000 Hz cutoff frequency into a Brüel and Kjær SLM (2204), via an in line pre-amplifier (Brüel and Kjær UA0196). Using calculation and an SLM various measures of speech level for a given sample were obtained:

The root mean square power (by calculation) P_{rms}.

$$P_{rms} = \sqrt{\left(\frac{\sum_n P_n^2}{n}\right)}$$

Where P_n are calculated from the square of the voltage of the speech signal.

The mean square power level (by calculation) L_{Prms}.

$$L_{Prms} = \log(P_{rms})$$

The total energy of the speech sample (by calculation) P_{tot}.

$$P_{tot} = \sum_n P_n$$

The total energy level (by calculation) L_{Ptot}.

$$L_{Ptot} = \log(P_{tot})$$

The "A" weighted "Impulse" level (SLM) L_{Aimp}.

The "A" weighted "Fast" level (SLM) L_{Afast}.

2.3. Spectral Analysis

Spectral analysis was in the form of the calculation of normalised Spectral Flatness from the digitised speech samples. More detailed information on the characteristics of particular sections of speech may be obtained using spectral analysis, particularly obtained via the FFT. The spectrum of speech obtained from fourier transform gives us the power-frequency distribution of the signal averaged over a frame of time. Some work has been done on the relation of spectral shape to perception previously by Dubno and Levitt (1981) and more recently by Lee and Dermody (1992) for segments of speech. However these have studied the properties of the discriminability of speech sounds, and the results are not easily translated into the complete word context. Thus here we aim to measure how the signal changes along its duration (see Figure 1). Much of the acoustic information in speech originates from changes in the spectrum and thus it is an important thing to measure. The time-amplitude variation of the various frequency components in speech signals is invariably complicated. We could, perhaps, go into great detail on these variations, however there will be great differences between the frequency characteristics of different articulations of the same word on a microscopic scale, both between speakers and by the same speaker. It is therefore useful to look at the general shape and variation of speech spectrum.

One measure which lends itself to calculation is called Spectral Flatness σ (Jayant and Noll, 1984), this gives us a single measure of the spectral shape of the signal. σ is obtained from a single spectrum and in this case is normalised, a value of 1 would indicate a flat or white noise spectrum and a value of 0 a completely random spectrum.

Spectral Flatness, σ, is defined as the uniformity of the frequency distribution of the signal thus:

$$\sigma_{t-t_0} = \frac{\exp\left(\sum_n [\ln(P_n)]/n\right)}{\sum_n (P_n)/n}$$

Where P_n is the mean power over the frequency interval n, in the duration t-t_0.

With this measure we could use the whole duration of the speech sample or use spectral flatness as indicator of change of spectrum by looking at the flatness between successive frames. The latter is more useful if we wish to look at the variation or consistency of the spectrum of the signal.

An example of spectral flatness analysis is given in Figure 1. The top graph shows the time-amplitude variation for the word "cheese", the lower graph shows the corresponding spectral flatness plotted against time frame. We can see the three distinct regions representing "ch", "ee" and "zz", the first consonant, vowel and final consonant. The most dominant feature is the low spectral flatness over the duration of the vowel, this is due to the strong harmonic structure of the vowel sound. The regions representing the consonants produce much smaller dips in the flatness curve, these are due to the shaped noise characteristics of "ch" and "zz". It is interesting to note that vowel sounds are of low spectral flatness and high energy.

The normalised spectral flatness was calculated for frames of 12.8 ms at 3.2 ms intervals using a version of the Audlab "fft" program (sfm) modified by the author. Thus, between about 160 and 200 data points of spectral flatness were obtained for each word. The mean and variance of these data were then calculated to give the parameters σ_{mean} and σ_{var} for each word. With this approach it was possible to get a measure of both the average shape, and consistency of the shape of the spectrum of individual words. No transformation was applied to σ in the calculations since σ_{mean} and σ_{var} were largely independent (Howell, 1982).

2.4. Duration

The duration t_f for each word was obtained in terms of the number of frames used for each sample in the Spectral Flatness analysis (above).

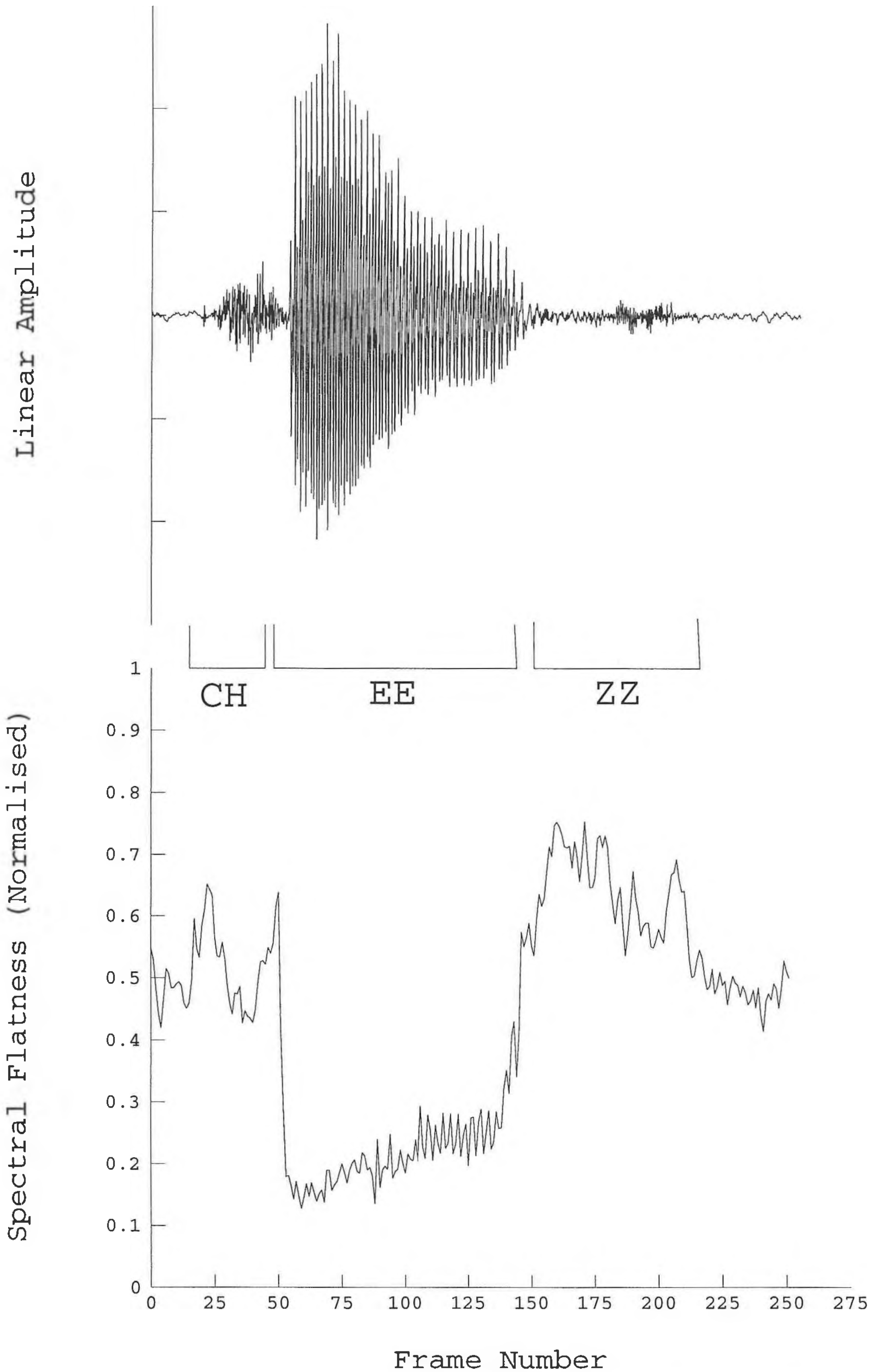

FIG. 1. Spectral flatness σ versus frame for the word "cheese" (lower plot). The upper plot is the corresponding time-domain waveform. Frame length 12.8 ms, frame shift 3.2 ms.

2.5. Familiarity/Frequency of Usage

In most studies of the relationship of word frequency to intelligibility, word counts have been collected from written sources (for example, Rosenzweig and Postman. 1957, Broadbent, 1967, Lyregaard, 1976, and Hood and Pool, 1980) such as those produced by Thorndike and Lorge (1944) and more recently by Francis and Kučera (1982). In this study frequency of usage data was obtained from teletext subtitles (James, 1991), this was data was used because it represents spoken English. Data were collected on the usage of not only the target words, words in the Boothroyd lists, but also for words which were confusable with the target words. Morton's (1969) logogen model supports the idea of "competing" responses, and so some indication of relative familiarity of the target word to other candidates would be useful. The word usage data used here were treated in several ways:

Absolute count of word usage U.

The logarithm of absolute count of word usage $LogU$, as applied by Broadbent, and Lyregaard.

The ratio V_{c1+c2}, where:

$$V_{c1+c2} = \frac{U}{\sum_{c1} U + \sum_{c2} U}$$

i.e. the ratio of the usage of the target word to the sum of usage of the words in the cohort. In this case the response set was defined by all those words which either front rhyme (*c2* confusion, as in cat and cap) or end rhyme (*c1* confusion, as in they and lay).

The logarithm of the ratio V_{c1+c2}, $LogV_{c1+c2}$.

The ratio V_{c1c2}, where:

$$V_{c1c2} = \frac{U}{\sum_{c1c2} U}$$

here the response set $c1c2$ is defined by any words which have a common vowel to the target word (Taken from the dictionary as specified in James 1991).

The logarithm of V_{c1c2}, $LogV_{c1c2}$.

2.6. Word Intelligibility

Seventeen subjects with no history of hearing impairment and between the ages of twenty one and twenty six, were chosen from the local University population. A 6 dB decrement/increment two-by-two paradigm was used to adaptively control the presentation level of 120 Boothroyd words (James, 1992b): The presentation level for the next two words is based on the results from the previous two such that two errors produce a step up in presentation level, one error no change, and no errors a step down. The order of presentation of words was randomised for each subject. The presentation rate was unpaced, a new word only being initiated after the subject's response to the previous one had been recorded. The presentation of each word was cued by a tone followed by a short gap. The subjects were asked to repeat each word as they heard it and told that the words would vary in loudness. Even if they heard only part of a word, or a word that did not make sense, or even a single sound, they were asked to re-iterate it. The response u for each word was recorded as correct (1) or incorrect (-1) by the experimenter. Thus the presentation levels of words are scattered around some overall threshold for each subject.

The data from this subjective experiment are expressed here in terms of Robustness Indices for each word, for several reasons:

> "Intelligibility" versus presentation level functions are to be generated for individual words as opposed to some fractional scoring of a list of items. One can only score a response as correct or as an error for a given item.
>
> The above being the case it seems appropriate to include some measure of the uncertainty of the result (variance) in the expression of the intelligibility function (see below definition of R_L).
>
> Data points u obtained for a word at a given level L are used in obtaining Robustness at other levels. This deviates from the conventional way in which "intelligibility" is obtained. However, this makes more efficient use of the available raw data provided that conditions for the results u are met as specified below.

Robustness Indices R_L were calculated for each word as below for a range of presentation levels L:

$$R_L = \frac{\sum_{k=1}^{n} u_L(k)}{\sum_{k=1}^{n} (u_L(k) - NM_L)}$$

The denominator in is rounded up to 0.01 for all values less than 0.01 for the purposes of computation. The "normalised mean" NM_L is defined:

$$NM_L = \frac{\sum_{k=1}^{n} u_L(k)}{n}$$

and u_L are defined for subject-word results u:

$$\begin{aligned} &If\ u(k) = -1 \quad and \quad L \le L(k) \quad \Rightarrow u_L(k) = -1 \\ &else\ if\ u(k) = 1 \quad and \quad L \ge L(k) \quad \Rightarrow u_L(k) = 1. \end{aligned}$$

Note: If neither of the conditions in above is satisfied then the data point is not used (and is not included in n).

Thus

$$-\infty \ll R_L \ll +\infty$$

For example, in future trials

$$\begin{aligned} R_L > 0 &\Rightarrow p(u_L^+) = 1, \\ R_L < 0 &\Rightarrow p(u_L^+) = 0, \end{aligned}$$

and

$$R_L \equiv 0 \Rightarrow p(u_L^+) = \tfrac{1}{2}.$$

Where $p(u_L^+)$ is the probability of a positive outcome for a subsequent trial with presentation level L. We can plot the "Robustness" R_L versus presentation level L function for each word.

Thus, the more positive the value of R_L the more intelligible the word at level L. A zero value of R_L indicates 50% intelligibility (i.e. either outcome, right or wrong, is indeterminate), and a large and negative R_L low intelligibility.

The Robustness Index R versus presentation level L function for each word was described in a variety of ways. A threshold is obtained at the level at which the Robustness Index is zero, that is where future outcomes have zero predictability. Due to the nature of the functions, graph modelling is applied to the data to obtain measures such as threshold and slope of the graph. Two methods were employed: A straight line fit with intercept and gradient and a Fermi distribution fit with two parameters, midpoint and width. The former and latter correspond in each case to threshold and rate of change of Robustness with level. Two parameters which similarly correspond are *average* and *difference*, these are discussed in more detail in James (1992b), but are also defined below. In addition we look at the Robustness Index for a set of fixed L:

Intercept of linear regression for Robustness versus presentation Level, R_{int}.

Slope of linear regression for Robustness versus presentation Level R_{grad}.

The mid point of the Robustness curve versus level as calculated from a Fermi distribution fit, R_{mid}.

The width of the Robustness curve versus level as calculated from Fermi fit, R_{width}.

The *average* value L_{av}, where:

$$L_{av} = \frac{L_{\max}^{-} + L_{\min}^{+}}{2}$$

where L_{max}^- is the maximum level at which the word was perceived incorrectly across all subjective trials, and L_{min}^+ the minimum level at which the word was perceived correctly across all trials.

The *difference* L_{diff}:

$$L_{diff} = |L_{\max}^{-} - L_{\min}^{+}|$$

The Robustness R of the word at a particular level L, R_L.

3. DATA ANALYSIS

The data were organised into files containing lists of values for each measured parameter. These were ordered according to the original order of the lists and words. This allowed use of various analysis programs to ascertain the degree of interrelation between the different measures. Comparisons, within and between *types*, between measures were made using Linear Regression (Hays, 1963) implemented in the "Unixstat" suite of programs running on a Masscomp 5450 minicomputer. These calculations were also confirmed using the "Minitab" functions "regress" (least squares) and "rregress" (ranked regression) running on a Hewlett Packard 9000s/800 computer. The final regression analysis for prediction of subjective parameters was also performed using the "Unixstat" programs. All these programs provided correlation matrices for any combination of the parameters.

Within the *types* level and word usage there was a large degree of correlation (r > 0.5). This is expected with the level parameters, which have only subtle differences in the treatments of the measurements. The smallest correlations were between L_{Atot} and L_{Aimp} within the level *type* (r = 0.545). It is of interest that the mean spectral flatness σ_{mean} exhibited a degree of correlation to the level parameters (r > 0.4, except for L_{Aimp}). σ_{var} and t_{frame} appeared, to a large degree, to be unrelated to any other *type*, and σ_{mean} and σ_{var} were independent (r < 0.185).

We had hoped by use of the word usage measures $LogU$, $LogV_{cl+c2}$ and $LogV_{clc2}$, to isolate the effects of overall word count from those due to cohorts of the target words. However for these cases $LogU$, $LogV_{cl+c2}$ and $LogV_{clc2}$ are highly correlated (r > .75), thus it is hard to justify the inclusion of V_{cl+c2} and V_{clc2}. above absolute word usage U..

4. RESULTS

4.1. Objective measurements

Summary statistics for a selection of ten objective measures were calculated, these are divided into four *types*; level, spectrum, duration and word usage. There is little to compare about the level and spectrum parameters except to say that the average impulse level L_{Aimp} (indicating peaks) is higher than that obtained with the SLM set on "Fast" (L_{Afast}). The variance in the total power L_{Ptot} is proportionally less than that for L_{Prms} . The longest word "wide" is over twice as long as the shortest word "jot". The highest energy word was "goes" using L_{Prms}, L_{Ptot} and L_{Aimp}, and "dodge" using L_{Afast}. "hutch" was the lowest energy word using both calculated measures and "cheek", "keys" and "shoot" were of lowest level using both SLM settings.

The word with the highest average spectral flatness σ_{mean} was "fish", and with the lowest "veil". Words with highest and lowest variability σ_{var} in spectral shape were "vice" and "hip".

The lowest word count $LogU$ of -0.693 corresponds to a value of $U = 0.5$, that is a zero count word (to the precision of counting). This rounding was also used in calculating the other usage parameters such as $LogV_{cl+c2}$ and $LogV_{clc2}$. This rounding will introduce errors into these values which may have effects in the regressions. (Also of note is that the minimum for $LogV_{clc2}$ is -11.51, unfortunately the lower limit on the precision of the ratio calculation (Minimum V_{clc2} < 0.00001). The zero count words were "haze", "hoof", "thatch", "hutch", "thieve" and "rove", the highest count was for "have" .

4.2. Subjective Parameters

R_{int}, R_{mid} and L_{av} are thresholds related in terms of experimental presentation level, and R_{width} and L_{diff}, express the widths or slopes of the word intelligibility curves. The value R_{grad} may roughly be equated to the width of the intelligibility function in decibels (the limen) if multiplied by 2000 (Robustness range -1000 to 1000).

The word "laze" was measured as having the highest threshold using R_{mid} (57.1 dB) and L_{av} (98.0 dB), and "thighs" the highest using R_{int} (58.6 dB). "Fog" was shown to have the lowest threshold by R_{int}, 16.1 dB, and second lowest by L_{av}. In this case the word with the lowest was "man", 18.0 dB. Using R_{mid}, "bone" had the lowest threshold at 29.0 dB. The words with the flattest intelligibility curves was "poach" by R_{grad} and R_{width}, and "laze" (an old favourite) by L_{diff}. The words with most rapidly increasing intelligibility were "thieve" by R_{grad}, and "will" by R_{width}. Numerous words had L_{diff} equal to zero.

Within the threshold predicting *type* there was high correlation (r > 0.7), R_{grad} and R_{width} were well correlated (r > 0.5). This was not the case within the slope predicting *type*. This is to be expected as the straight line approximates the Fermi fit in this situation. There were various relations between the two *types* and of note is the degree of relatedness between R_{width} and R_{int} (r = 0.513). This may be due to some artifact in the two methods of describing the shape of the intelligibility curves.

Table 1. Summary statistics for the subjective data expressed in terms of Robustness Index R_L at various presentation levels L.

Variable	R_{30}	R_{35}	R_{40}	R_{45}	R_{50}	R_{55}	R_{60}
Minimum	-800	-500	-500	-200	-100	-50	0
Maximum	50	350	750	750	850	850	850
Mean	-344	-93	30	182	351	401	420
Std. Dev.	230	197	237	242	249	231	227

Table 2. Correlation of a selection of subjective parameters versus objective predictors, and total regression taking all selected predictors into account. The stars (*) indicate the degree of significance; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. For the individual objective predictors, a significant result implies that: taking into account all the other predictors, the predictor in question significantly contributes to the overall regression (Hays, 1963).

Variable	Total	L_{Afast}	σ_{mean}	σ_{var}	$LogU$	t_{frames}
R_{int}	***0.518	-0.212	0.295	*0.219	***0.352	0.160
R_{mid}	***0.517	*-0.252	0.271	*0.200	***0.353	0.148
L_{av}	**0.417	-0.213	0.222	0.113	**-0.314	0.094
R_{grad}	0.256	-0.135	0.109	0.077	-0.119	-0.034
R_{width}	0.207	-0.028	0.179	0.112	-0.164	0.051
L_{diff}	0.220	0.218	-0.115	0.120	0.055	0.097

Table 3. Correlation of R_{mid} versus various combinations of a selection of objective predictors, and the total regression taking all selected predictors into account. The stars (*) indicate the degree of significance; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (see text). Note that the removal of certain predictors from the regression not only affects the total regression, but also the importance (significance) of other predictors.

Total	L_{Aimp}	L_{Afast}	σ_{mean}	σ_{var}	$LogU$	t_{frames}
***0.517	-------	*-0.252	0.271	*0.200	***-0.353	0.148
***0.511	-------	***-0.252	-------	**0.200	***-0.353	0.148
***0.494	-------	*-0.252	0.271	**0.200	***-0.353	-------
***0.504	*-0.199	-------	*0.271	*0.200	***-0.353	0.148
***0.472	**-0.199	-------	-------	**0.200	***-0.353	0.148
***0.483	*-0.199	-------	0.271	*0.200	***-0.353	-------
***0.477	-------	-------	**0.271	0.200	***-0.353	0.148

4.3. Summary statistics of *R* versus L data

Table 1 gives summary statistics for Robustness Index R_L (as specified above) over a range of presentation levels L. The greater the value of R_L the more intelligible the word at level L, where a zero value of R_L indicates 50% intelligibility (i.e. either outcome, right or wrong, is indeterminate), and a large and negative R_L low intelligibility. From the means of the data we can deduce that the mean threshold across all words is in the region of 35 to 40 dB. Of note is the comparatively large standard deviation of R_Ls to their ranges and means.

4.4. Regression of subjective versus objective

In this section we list the end results of this study, that is the prediction of subjective parameters by objective measurements. Table 2 shows the correlation between a selection of subjective parameters and a selection of objective predictors. The contributions of objective predictors are combined to give a total prediction for each subjective parameter, the correlation between the combined regression against the subjective parameter is then obtained. The significance of the contribution from each objective predictor is also shown, the hypothesis is: The predictor does not contribute to the overall regression taking into account all other predictors. The stars indicate the degree of significance of the correlations. Thus a significance level of $p < 0.05$ implies that there is only a 5% probability that the predictor in question does not contribute to the overall regression taking all other predictors into account. We can see that *LogU* has the greatest and a unique contribution to the prediction of the subjective parameters indicating threshold, followed by L_{Afast} and σ_{var}.

4.5. Contributions and combinations of objective predictors

Table 3 allows comparison between regressions of R_{mid} using seven different combinations of objective predictors. We can see the overlaps in contributions made to the total regression by different predictors, i.e. L_{Afast} and σ_{mean} do not uniquely contribute to the overall regression when used together. The correlation coefficients are repeated for each combination so one can see how the individual contributions from predictors make up the total regression.

4.6. R_Ls versus objective predictors

The correlation of R_Ls calculated from subjective data versus a selection of predictors is shown in Table 4. These comparisons indicate the relative importance of predictors at different levels. The stars (*) denote significant contributions from individual predictors and the final regression. We can see that in all cases the predictor t_{frames} never makes significant contributions in the presence of the other predictors. L_{Afast}, σ_{var} and *LogU* are significant predictors at all levels except L = 45 dB, most noticeably σ_{var} is not significant (and indicates very little predictive capability) at L = 35 and 40 dB. The least significant ($0.01 > p > 0.001$) total regression was obtained with L = 45 dB, where neither L_{Afast} or σ_{var} are significant predictors (p's > 0.05). Stepping only 5 dB up from this level gave the highest regression coefficient with the three predictors, L_{Afast}, σ_{var}, and *LogU*, all making very highly significant contributions to the multiple regression ($p < 0.001$).

5. DISCUSSION

The object of this study has been to investigate the relative importance or significance of particular objective measures in the prediction of subjective thresholds, and word intelligibility characteristics. Many of the objective measures described in earlier sections of this paper were not used in the final selection used in the results presented above. The criterion for selection as a useful predictor was that the parameter must be either uncorrelated with other parameters, or that a group of correlated parameters produced the most significant prediction. Certain parameters were merely mathematically "treated" versions of others (i.e. L_{Prms}, and P_{rms} etc.) and these were compared within *types* with parameters with similar units (i.e. L_{Prms} with L_{Afast}).

The following discussion is divided into sections by parameter *type*, with a penultimate section bringing all these together. In the final section we look at the multiple regression model obtained with a "good" set of predictors and discuss the properties of particular words which stray from this model.

5.1. Speech level and σ_{mean}

Much attention in the past few decades has been given to the effective measurement of speech levels, and the equalisation of speech levels between words and between sentences used in speech audiometry. Most of the conclusions of these kinds of studies (Fuller and Whittle, 1982, Steeneken and Houtgast, 1979, and Tschopp, 1991a and 1991b) have been that subjective measures are not simply related to speech levels, but that reasonable accuracy may be obtained using measures such as L_{Afast}.

Here we will consider the relative merits of L_{Afast} and L_{Aimp} in the prediction of speech thresholds. We can also bring into the discussion the parameter σ_{mean} which was well correlated with measures of speech level: σ_{mean} was well correlated with L_{Afast} but not so much with L_{Aimp}. We can therefore conclude that when σ_{mean} and L_{Afast} are both included in the multiple regression versus R_{mid} (a subjective threshold) that the significance of their individual contributions will be reduced. In fact the apparent overlapping of contributions from L_{Afast} and σ_{mean} is such that the inclusion of σ_{mean} has very little effect on the total regression (Table 3), this is true to a lesser degree when using L_{Aimp} without σ_{mean}. Removing both direct measures of level still leaves a good total regression. L_{Afast} gives the most significant prediction of threshold measures (Tables 2 and 3) in all situations.

In the treatment of Robustness R at level L, we have used only L_{Afast} as a predictor of the level *type*. The mean threshold of the words used here were judged to be in the region of 40 dB, with a standard deviation of order 5 dB. Table 4 shows the significance of L_{Afast} in predicting mean performance (i.e. R_L) in the range 30 to 60 dB.

Below 40 dB L_{Afast} is not significantly useful in the prediction of performance, for example R_{30} (the value of R at L = 30 dB), this is expected since the standard deviation of L_{Afast} is only 2.6 dB and the range approximately ± 6 dB. The information imparted to the listening individual at this level is going to be severely affected in all cases. Moving up in level, to R_{35} and R_{40} speech level becomes highly significant. This we should expect in the critical region around threshold, since the effects of any factor which marginally affects the amount of information made available will be amplified by the action of lexical contexts (James et al., 1992a).

At L = 45 dB, the speech level again becomes unimportant as all the differences in information giving due to speech level are largely equalised at this listening level. At 50 dB and above the speech level is again significant. This might be due to the perception of those words with little contextual information (perhaps we could term them *fragile*) as being more wholly dependent on the energy of speech features and having low intrinsic context. This idea can be confirmed if the words with high familiarity are separated from those with low familiarity. We will treat this as a probabilistic division and use the simple word count of data as the criterion of division of our sample. That is we will divide the sample into two sets, those with the highest counts and those with the lowest. The words were divided into two sets, the first (a) words with $LogU$ > 3.478, and the second (b) $LogU \leq$ 3.478, where the mean of $LogU$ for the whole sample was 3.478. We now calculate the regression of L_{Afast}, σ_{var}, $LogV_{c1+c2}$ and t_{frames} for the two sets (a) and (b) against R_{40}, R_{45} and R_{50}, the results are shown in Tables 5.

The results for regression against R_{40} for both sets, show that for the high familiarity set (a), $LogV_{c1+c2}$ is the more significant predictor, whereas for the low familiarity set (b), L_{Afast} is more useful. At 45 dB, the correlation L_{Afast} versus R is very low for set (a) but significant for (b). For R_{50}, the importance of speech level is greater for the low context set (b) than for the high context set (a). This confirms the hypothesis that speech energy is much more important for the recognition of low predictability items (b) than for high predictability items (a).

Table 4. Correlation of subjective R_L's versus objective predictors, and total regression taking all selected predictors into account. The stars (*) indicate the degree of significance; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ of individual predictors and for the total regression.

Variable	Total	L_{Afast}	σ_{var}	$LogU$	t_{frames}
R_{30}	***0.477	**0.227	**-0.203	***0.325	-0.134
R_{35}	***0.417	**0.243	-0.065	**0.294	-0.152
R_{40}	***0.394	***0.271	-0.063	**0.253	-0.101
R_{45}	**0.340	0.135	-0.123	**0.272	-0.084
R_{50}	***0.521	***0.230	***-0.263	***0.330	-0.155
R_{55}	***0.494	**0.187	***-0.248	***0.338	-0.156
R_{60}	***0.497	**0.218	**-0.213	***0.351	-0.171

Tables 5. Correlation of subjective R_Ls around threshold versus objective predictors, and total regression taking all selected predictors into account, for (a) words with $LogU > 3.478$, 64 words (top), and (b) words with $LogU \leq 3.478$, 56 words (bottom). The stars (*) indicate the degree of significance; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ of individual predictors and for the total regression.

(a) High usage ($LogU > 3.478$)

Variable	Total	L_{Afast}	σ_{var}	$LogV_{c1+c2}$	t_{frames}
R_{40}	*0.443	*0.175	-0.093	**0.286	-0.151
R_{45}	0.353	-0.016	*-0.250	0.200	-0.081
R_{50}	**0.492	*0.090	***-0.372	0.088	*-0.203

(b) Low usage ($LogU \leq 3.478$)

Variable	Total	L_{Afast}	σ_{var}	$LogV_{c1+c2}$	t_{frames}
R_{40}	*0.421	**0.393	-0.011	0.175	-0.052
R_{45}	0.361	*0.350	-0.062	0.141	-0.105
R_{50}	**0.502	**0.406	*-0.131	0.242	-0.127

5.2. The significance of σ_{var}

The variance of spectral flatness σ_{var} has been described above as a measure of the dynamics of the spectrum, and for this sample is uncorrelated with the mean spectral flatness σ_{mean}. As a predictor of threshold, σ_{var} is a significant predictor of subjective threshold (Tables 2 and 3), in that the lower the variation of spectral shape the lower the threshold. We also surmise that the transmission of finely detailed structure, indicated by high σ_{var}, would more greatly be affected by reduced listening levels, and the correct perception of the word would require the reception of this fine detail.

The correlation of σ_{var} versus R_Ls, indicates that σ_{var} generally works above threshold (L = 50 dB). However, at low levels (i.e. L = 30 dB), the variance of spectrum may provide necessary clues for the perception of high predictability words. In fact for set (a), σ_{var} is a highly significant (correlation coefficient = -0.327 ,p < 0.001) predictor of R_{30}, this is not true for set (b) (correlation coefficient = -0.055, p = 0.337). Unlike speech level, σ_{var} is a significant predictor of performance R just above threshold (L = 45 dB) for high frequency words, becoming very significant at L = 50 dB.

5.3. Word familiarity and word intelligibility

It is clear from Tables 2 to 5 that word usage, represented here by $LogU$ is a very significant predictor of word intelligibility. It is obviously unrelated to any of the other objective parameter *types* since it is in essence not a "physical" parameter of speech. It is interesting to note the differences in word intelligibility characteristics between the sets of words (a) and (b) (as defined in Section 5.1) are due to the effect of probabilistic biases which we might predict from the word counts. In Section 5.1 we used $LogU$ as the criterion measure because it simply indicates a probability of response where information from auditory cues is severely limited. It was seen that for low usage words at low levels (L = 40 dB), speech energy (L_{Afast}) had the greatest effect on identification. However, for high usage words the cohort size measured by $LogV_{c1+c2}$ was significant and speech level only to a lesser degree.

5.4. Word duration t_{frames}

Throughout the regression analysis t_{frames} has been incorporated because we found this parameter largely uncorrelated with every other (except for L_{Ptot}, which we did not use in any of the regressions above). In most examples the duration seems to be a useful predictor but fails to be actually significant in the presence of other "good" predictors in all but one example (Table 5a).

The trend of intelligibility R_L at level L tends to go: Longer word, then lower intelligibility. Since the trend predicted by t_{frame} is relatively weak, it is difficult to justify any particular reasons for the trend. We can take a similar approach to that in Section 5.1, by separating the sample data into two groups on the basis of one parameter. We can now define two new groups; (c) where $t_{frames} > 272$, and (d) $t_{frames} \leq 272$, where the mean of t_{frames} for the whole sample is 272.

Some summary statistics for the two groups of words (c) and (d) are given in Tables 6.

Tables 6 show us that (c) and (d) have similar distributions of characteristics, thus when comparing the two groups further we can rule out effects other than due to the dividing parameter, duration t_{frames}.

In Tables 7 we show the results of linear regressions of R_{mid} versus a set of "good" parameters as previously described. The most striking difference between the two regressions is the relative importance of σ_{var} and t_{frames}. For the longer words (c), t_{frames} gives a significant trend whereas σ_{var} is not such a good predictor. The reverse is true for the short words (d). Though weak, this result suggests that shorter words require greater uniformity in their frequency characteristics (i.e. smaller σ_{var}) than longer words to achieve lower thresholds. It is therefore important to maintain a reasonable information rate whatever the total duration for low thresholds or good intelligibility, or "squashing too much information in too short a time gives higher thresholds".

Tables 6. Summary statistics for some parameters of (c) words with $t_{frames} > 272$, 62 words, and (d) words with $t_{frames} \leq 272$, 58 words. Note that there is little difference between the two sets (c) and (d) in terms of the distributions of R_{mid}, L_{Afast}, σ_{var} and $LogU$.

(c) $t_{frames} > 272$

Variable	R_{mid}	L_{Afast}	σ_{var}	$LogU$	t_{frames}
Mean	42.14	121.6	0.026	3.23	296
Std. Dev.	8.01	2.8	0.008	2.18	17.31

(d) $t_{frames} \leq 272$

Variable	R_{mid}	L_{Afast}	σ_{var}	$LogU$	t_{frames}
Mean	40.26	121.3	0.024	3.74	242
Std. Dev.	5	2.5	0.009	2.17	19.58

Table 7. Correlation of R_{mid} versus objective predictors, and total regression taking all selected predictors into account, for (c) words with $t_{frames} > 272$, 62 words, and (d) words with $t_{frames} \leq 272$, 58 words . The stars (*) indicate the degree of significance; * p < 0.05, ** p < 0.01, *** p < 0.001 of individual predictors and for the total regression.

Variable	Total	L_{Afast}	σ_{var}	$LogU$	t_{frames}
R_{mid} (c)	***0.536	*-0.271	0.122	**-0.404	*0.173
R_{mid} (d)	**0.500	*-0.246	**0.276	*-0.266	0.033

5.5. The combination of predictors

In the discussion Sections 5.1 to 5.4 we examined the relationship between objective and subjective parameters. Using a "good" combination of predictors, L_{Afast}, σ_{var}, $LogU$ and t_{frames} for example, we can calculate a linear regression equation for R_{mid}, where $\hat{R}_{mid}$ is the estimated value of R_{mid}. From this equation we can see that a change in speech level

$$\hat{R}_{mid} = -0.841 L_{Afast} + 229 \sigma_{var} - 1.09 LogU + 0.033 t_{frames} + 132$$

L_{Afast} gives an almost one for one change in word threshold R_{mid}. Given that the range of L_{Afast} was 13 dB, we obtain a predicted range of 11 dB in the subjective threshold R_{mid}. Similarly we can approximate ranges of 9 dB due to σ_{var}, 11 dB due to $LogU$ and 7 dB due to t_{frames} in R_{mid}. This gives us an indication of the magnitude of effects due to contributions from individual predictors.

Figure 2 shows a scatter plot of $\hat{R}_{mid}$ versus R_{mid}. The line $\hat{R}_{mid} = R_{mid}$ is marked giving the line of "perfect" correlation. Points corresponding to particular words are also indicated. Of great interest are those words which deviate most from the line of perfect regression, such as "thumb" and "ways". These are words which conform least to the objective prediction of intelligibility given here. The word "ways" has a much greater subjective threshold R_{mid} than estimated threshold $\hat{R}_{mid}$. It is hard to explain this phenomenon in terms of the quantities we have measured, instead we have to look more closely at the structure of the word. In this case the author was able to look back at the responses recorded in the study described in James (1992a) which looked at word list intelligibility under certain conditions. It was possible to consider the response set for the three plurals included in the sample set of "Boothroyd" words; keys, thighs and ways. Subjects tended to lose the perception of the "zz" in "keys", making "key" and there were also two non-word responses of "keeve". The word "thighs" was commonly confused with "five" or just "thigh". Looking at confusions for "ways", the author found many occurrences of the word "wave", in fact 19 out of a total number of 36 presentations! It is likely under the conditions imposed in that study (and at low presentation levels) that sound of the plural "zz" was lost or masked leaving the subject with an elongated version of "way" (try saying "way" and then "ways", and compare the length!), as this speech sound is too long to "fit" into "way", then it is only natural to attempt an alternative, in this case "wave" seems a reasonable (and popular) alternative.

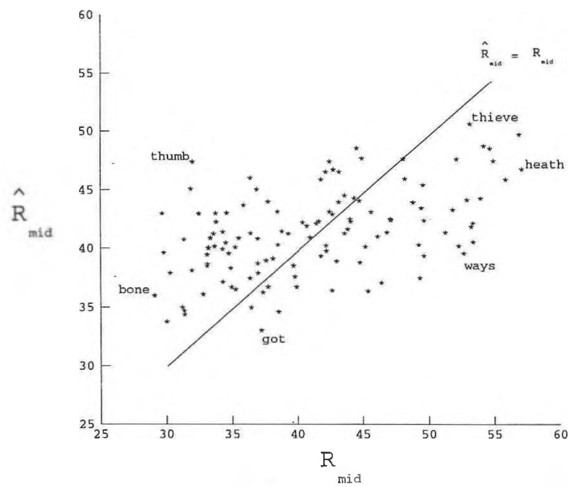

FIG. 2. Scatter plot of $\hat{R}_{mid}$ versus R_{mid}, where $\hat{R}_{mid}$ is the estimation of R_{mid} from regression analysis.

At the other extreme lies the word "thumb" which has a much lower subjective threshold than predicted. To some extent the word "thumb" could be likened to a diphthong (for example "veil"); it has two voiced parts with different tones, the vowel "uh" and the nasal "mm", these features may make it robust. However, if the "um" combination is a "robust" feature, why should "thumb" not still be confused with words within its response cohort (e.g $c1+c2$), such as rhyming words "sum" and "dumb"?

For the two exceptions above we have looked in more detail at the perception of speech features. In the first case we were able to call on experience and use previous results to provide some clues for the deviation of subjective thresholds from those predicted. It must be remembered that from the selection of physical measures we have chosen in this study, there are not likely to be a "best" set of predictors which can explain all the variances of subjective data in all cases. At this point we can apply previously obtained results to the behaviour of the entire test set: we can simply calculate the correlation between the number of incorrect responses for each word from the previous study (James et al., 1992a) and the subjective threshold R_{mid}. Not surprisingly this gives us a very high correlation (coefficient = 0.808), much higher than that obtained from the best multiple regressions listed above. This result gives us insight into the consistency of results between experiments and reliability of the word recognition task. Perhaps the "membership" of response cohorts will be similar in all but a few cases, and those few cases could be assessed by further experiment. Explaining the properties of words which fall furthest from the predictions is not the least difficulty in this kind of study. One could explain, perhaps, the behaviour of all words compared to the "ideal" ones (those on the line of perfect regression), implying that the presence of any particular word used in audiometric material should be justified; i.e. not too unfamiliar, not too familiar, not a plural, not a verb etc. Under these restrictions the compilation of test material such as used in phonemically balanced designs becomes more difficult. At this point we can look back at work done by Hood and Poole (1980) which gives us useful information about the consistency of word intelligibility between speakers and in relation to familiarity as indicated by frequency of occurrence. They state that the effect of the speaker outweighs consideration of familiarity, this is something which we were unable to account for in this study. But they do offer us an olive branch in that measurements with one speaker were generally fairly consistent for many of the words. Inconsistent words are attributed to intra-subject and perhaps subject-speaker-word interaction. Perhaps the time and frequency analysis used here would encompass these causes of variance. Hood and Poole also stated that they and others (e.g. Tobias, 1964) regard such measures as phonetic balance to be unnecessary in the design of speech perception tests, this is now largely accepted.

Thus an alternative to theoretically structured designs then is to use the implicit properties of individual words: if the response set for a given word under given conditions is well defined, then we can define word intelligibility in terms of the size and properties of this response set. Thus we can define speech hearing impairment in terms of "mistakes". This might have some use in the selection and tuning of hearing aids. According to the kind of mistake we can predict the "conditions" imposed by impairment by comparison with response sets from experiments utilising a range of enforced conditions. This is an opened ended approach, unlike forced-choice methods, and by its nature it takes into account all effects of word usage, word confusion, speech spectrum and level.

6. CONCLUSIONS

The trends indicated by the analysis used in this study should apply to mono-syllables outside the sample used here. It is a useful result that word usage *LogU* plays an important part in the prediction of thresholds (i.e. R_{mid}), and therefore it may be used as a guide to selecting test sets in the future, before making recordings of material. Other measurements, for example L_{Afast}, σ_{var} and t_{frames}, may only be made on specific material. It would be interesting to study the general trends for these quantities for a number of different speakers and examples from the same speakers (assuming that they are all trying to make recordings to audiological standards). For example, is the property "speech level" characteristic for a given word or does it only measure level for a given example (as would be expected). Similar arguments could be applied to the other measures used here: One could predict that the speech spectrum and duration would be more characteristic for a given word.

The results presented here pose questions about the most rational method of selecting material for the measurement of speech hearing. Certainly the use of known response sets in the analysis of response errors would be useful. There is also scope for the use of smaller sets of test material with particular properties, as obtained by experiment, aimed at making specific measurements of hearing acuity.

This study has shown that the intelligibility characteristics of individual words can be predicted to a fair degree by objective measurements. Some interaction is apparent between the sources of information, namely physical and linguistic (or contextual). The measure σ_{var} seems to be a useful complement to the other parameters and indicates the importance of information rate or feature rate in speech perception.

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EFFECTS OF METHODOLOGICAL PARAMETERS ON SIGNAL DETECTION AND FREQUENCY DISCRIMINATION

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ABSTRACT

This experiment was undertaken to determine the effects of variation in three methodological parameters, namely paradigm (2IFC vs 4IFC), stimulus duration (50 ms vs 300 ms) and practice (1 vs 6 replications) on the auditory detection threshold and frequency discrimination limen for a 2kHz-pure tone, and the reaction time associated with each. The subjects were three normal-hearing listeners under the age of 30 years. In line with the predictions, an increase in the stimulus duration resulted in a significant decrease in the detection threshold and detection reaction time but did not affect discrimination. Also as expected, paradigm did not affect detection. However, the 4IFC paradigm reduced acuity for a change in frequency, possibly because the problem had changed to one of pattern recognition. Contrary to expectation, practice did not affect either sensory processing or choice reaction time.

SOMMAIRE

Cette étude a pour but de déterminer les effets de la variation de 3 paramètres méthodologiques, à savoir le paradigme (2IFC vs 4IFC), la durée du stimulus (50 ms vs 300 ms) et l'entraînement (1 vs 6 repetitions) sur le seuil de détection auditive, le seuil de discrimination fréquentielle et le temps de réaction associé à chacune de ces tâches. Les trois sujets avaient moins de 30 ans et présentaient une audition normale. En accord avec les prédictions, une augmentation de la durée du stimulus a provoqué une amélioration significative du seuil de détection et du temps de réaction mais n'a pas affecté la discrimination. Tel que prévu, le paradigme n'affecte pas la détection. Le paradigme 4IFC a toutefois réduit l'acuité à un changement de fréquence, parce que le problème est possiblement devenu un problème de reconnaissance de structures. Contrairement aux attentes, l'entraînement n'a pas influencé l'un ou l'autre des processus sensoriels ni le temps de réaction.

1. INTRODUCTION

Auditory perception, particularly within the context of forced-choice signal detection and discrimination tasks, includes both a sensory processing stage and a decision-making stage (Swets, Tanner and Birdsall, 1961). The detection threshold and difference limen reflect sensory acuity. Decision-making may be accessed through such measures as response bias (Green and Swets, 1966) and also response latency (Welford, 1980).

The following experiment was undertaken to study the differential effects of variation in three methodological parameters on the sensory processing and decision-making stages for signal detection and frequency discrimination. The three parameters chosen were stimulus duration, psychophysical paradigm, and practice. The aim was to provide data for use in experimental design.

Stimulus duration has been shown to affect both signal detection and frequency discrimination, within limits. For normal-hearing listeners, increasing duration over the range of approximately 20-100 ms results in a decrease in the detection threshold at the rate of 3 dB/doubling of duration (Garner and Miller, 1947) or 8-10 dB/decade of duration (Florentine, Fastl and Buus, 1988). Below 20 ms, the rate may be as high as 4.5 dB/doubling of duration and from 100 ms - ½ s, as low as 1.5 dB. This psychophysical phenomenon is known as temporal integration. Watson and Gengel (1964) explored the effect of stimulus frequency on temporal integration. Their threshold duration curves spanning the range of 16 -1024 ms were best fit by a negative exponential. As the stimulus frequency increased from 125 Hz to 8 kHz, the time constant decreased.

Like the detection threshold, acuity for a change in frequency (F), as measured by the frequency difference limen (DLF), improves with an increase in stimulus duration (Hall and Wood, 1984). The evidence suggests that the relationship will again depend on the stimulus frequency (Moore, 1973; Sinnott and Brown, 1993). In Sinnott and Brown's study, DLFs were shown to decrease for both 500 Hz and 4000 Hz, as duration increased from 12-400 ms, although less so for 4000 Hz. The effect appeared to level off after 40 ms. The Weber ratio DLF/F for durations equal to or greater than 100 ms at and above 500 Hz is approximately 0.003. Large individual differences due to psychophysical procedure and training have been documented (Green, 1976; Spiegel and Watson, 1984).

Paradigm affects frequency discrimination to a greater degree than it affects detection. Jesteadt and Bilger (1974) and Jesteadt and Sims (1975) compared DLFs obtained using single interval yes/no (Y/N), two-interval forced choice (2IFC) and two interval same/different paradigms. The 2IFC paradigm yielded the smallest and Y/N, the largest, DLF. With respect to detection, the initial focus for research was the possible detrimental effect of clinical vs laboratory procedures. Marshall and Jesteadt (1986), for example, compared the outcomes for the standard audiological method of limits, and 2IFC paradigm in combination with an adaptive variation in intensity. The latter procedure yielded thresholds which were on average 6.5 dB lower than the former. Giguère and Abel (1990) found that thresholds derived from a Bekesy tracking procedure yielded thresholds which were 2-3 dB higher than those from a 2IFC with variation in stimulus intensity across trial blocks.

There is agreement that the 2IFC adaptive procedure will yield lower thresholds than the 2IFC fixed intensity procedure, although this may depend on the targeted probability of correct response used to estimate threshold (Kollmeier, Gilkey and Sieben, 1988; Schlauch and Rose, 1990). The literature suggests that the efficiency of the method, defined in terms of the accuracy and stability of the estimate of threshold, will increase with the number of observation intervals on a trial, 2 vs 3 vs 4IFC (Shelton and Scarrow, 1984; Green, Richards and Forrest, 1989).

Reaction time, which is considered to be a measure of cognition, will also be affected by the number of response alternatives. Simple reaction time is the time needed to respond to the presence of a single stimulus (detection). Choice reaction time, which requires a different response for each of a number of possible stimuli (discrimination), adds the times for identification and response selection (Smith, 1968; Welford, 1980). The time to respond will increase as the discriminability of the alternative stimuli decreases and as the number of alternatives increases and will decrease with practice. Detection reaction time will also decrease to a limited degree, as the stimulus duration (and hence, the total stimulus energy) increases (Brebner and Welford, 1980).

2. EXPERIMENTAL DESIGN

The present experiment was conducted to determine whether and to what extent the auditory detection threshold and frequency difference limen for a 2 kHz-pure tone, and their associated reaction times would be differentially affected by variation in the stimulus duration (50 ms vs 300 ms), psychophysical paradigm (2 vs 4IFC) and practice (1 vs 6 replications), in young, normal-hearing listeners. Based on our review of the literature, and envisioning perception as a 2-stage process of stimulus processing and decision-making, we predicted that an increase in stimulus duration would result in a decrease in the detection threshold and detection reaction time, while an increase in the number of forced-choice alternatives would result in an increase in both detection and discrimination reaction time. Practice was expected to impact positively on all four measures.

Each subject completed the experiment within a two-week period. There were six listening sessions (replications), each lasting approximately one hour. During a session, the detection threshold and frequency difference limen were measured for the four combinations of psychophysical method (2 vs 4IFC) and stimulus duration (50 vs 300 ms). The detection task preceded the frequency discrimination task. Within task, the order of the four combinations of stimulus paradigm and duration was randomly determined.

3. METHODS AND MATERIALS

3.1 Subjects

Three normal-hearing individuals, aged 20 to 26 years, participated in the experiment. All had previously served as subjects in auditory detection but not frequency discrimination studies.

3.2 Apparatus

The experiment was carried out in a double-walled IAC booth. The ambient noise level was less than the maximum allowed for headphone testing (ANSI S3.1-1977). The 2 kHz-pure tone used in the experiment was generated by a Hewlett-Packard Synthesizer/Function Generator (Model 3325A). A custom built attenuator and Luxman integrated amplifier (Model L-210) allowed for variation in amplitude over a range of 90 dB. Stimulus duration and envelope shaping (i.e., 10 ms-rise/decay time) were controlled by means of a Coulbourn Instruments Modular System. The system was controllable from an IBM XT PC via an IEEE-488 interface.

The auditory events on a trial were presented binaurally over a Telephonics TDH-39P matched headset. The stimulus intensities were calibrated using a Bruel & Kjaer artificial ear (Type 4153). Subjects responded by means of a custom-designed hand-held response box which comprised a set of five LEDs to cue the events on each trial and four microswitches for responding. The microswitches were accurate to within 1 ms.

3.3 Procedure

3.3.1 Detection and Discrimination

For the *auditory detection task*, the subject was presented on each trial with a ½ s warning light, a pause of 300 ms followed by two (2IFC) or four (4IFC) listening intervals, separated by 300 ms. The duration of the listening intervals was either 100 ms or 300 ms, depending on whether the stimulus duration was 50 ms or 300 ms. These events were cued by three or five LEDs based on the choice of procedure. The 2-kHz stimulus to be detected was presented in one of the intervals randomly determined from trial to trial. The subject was instructed to depress the microswitch response key corresponding to the LED that was coincident with stimulus, as soon as the last LED in the series was extinguished. A maximum of 5 s was allowed for the response.

The intensity of the stimulus remained constant within a block of 32 trials but was varied across blocks, independently for each subject, so as to generate a psychometric function with the proportion of correct responses, P(C), ranging from 0.50 (chance) to 1.00 (perfect performance) or 0.25 to 1.00 for the 2IFC and 4IFC procedures, respectively. The detection threshold, the intensity that would generate a P(C) of 0.75 or 0.625, for the two procedures, was interpolated from a straight line fit to the data points. These critical values correspond to the midpoints on the theoretical psychometric functions. For either procedure, two data points were considered sufficient, as long as one was between a few percentage points above chance and the threshold P(C), and the other between the threshold P(C) and a few percentage points below perfect performance. In practice, three or four blocks of trials were usually required to satisfy this constraint.

The method for measuring the *frequency discrimination difference limen* was similar to that for detection. On each forced-choice trial, the standard frequency (F) of 2 kHz was presented in either one or three listening intervals, depending on whether the experimental condition specified 2IFC of 4IFC, and a comparison frequency (F + ΔF) was presented in the remaining interval, randomly determined from trial to trial. The comparison stimulus, which exceeded the standard in frequency, remained the same within a block of 32 trials but was varied across blocks, so as to generate a psychometric function with P(C) ranging from either 0.50 to 1.00 or 0.625 to 1.00, depending on the procedure. The frequency difference limen (DLF) was interpolated as that value of ΔF that would result in a P(C) of 0.75 or 0.625, as for the detection threshold.

3.3.2 Choice Reaction Time

The method for obtaining the reaction times associated with correct and incorrect responses for the detection threshold and frequency difference limen is described by Abel and Armstrong (1992). For both tasks, subjects were instructed to respond as quickly as possible without sacrificing accuracy. Guessing was encouraged. For each experimental condition, the P(C) obtained for each block of trials was plotted against each of the median reaction times for correct and incorrect responses, taken separately. These corresponded to the time lag between the termination of the final LED and the microswitch closure signifying the response. The median was used in preference to the mean because of the skewness of the distribution of latencies within blocks. Straight lines were fit by eye to these reaction time psychometric functions. The correct and incorrect reaction times associated with P(C) equal to 0.75 or 0.625, depending on the paradigm, were interpolated to provide values associated with the detection threshold and difference limen.

4. RESULTS

The results of the experiment are presented in Tables 1, 2 and 3. Table 1 shows the detection thresholds and frequency discrimination limens obtained for each of the three subjects for the eight combinations of stimulus duration (50 ms vs 300 ms), paradigm (2IFC vs 4IFC), and replication (1 vs 6). The correct and incorrect reaction times (CRT and IRT) associated with each of these measures are presented in Tables 2 and 3. In the case of subject JT, the results of the detection task obtained on the first day were rejected because of equipment malfunction. These data were replaced by data from the second replication.

Repeated measures ANOVAs were applied to each of the six data sets given in the tables. Although the number of subjects was small, the trends observed for each were similar. In the case of detection, the only significant factor ($p < 0.05$) was stimulus duration. An increase from 50 ms to 300 ms resulted in a decrease in threshold of 6 dB SPL, averaged across paradigm, replications and subjects (see the left panel of Fig. 1). In contrast, the frequency discrimination difference limen was significantly affected by the paradigm ($p < 0.05$). The DLF generated by the 4IFC paradigm was 3.4 Hz greater than the DLF for the 2IFC paradigm, averaged across stimulus duration, replications and subjects (see the right panel of Fig. 1).

With respect to reaction time, the outcomes of the ANOVAs indicated that the values associated with both correct and incorrect trials at the level of the detection threshold decreased with an increase in stimulus duration ($p < 0.05$), as for the detection threshold. The improvement was approximately 106 ms for each of the CRT and IRT, when averaged across paradigms, replications and subjects (see Fig. 2). The IRT associated with the frequency difference limen decreased significantly ($p < 0.05$) for the 4IFC compared with the 2IFC paradigm. As shown in Fig. 2, the difference was on average 35 ms. The CRT did not change significantly as a function of any of the variables manipulated. Two of the subjects showed a decrement for the 4IFC paradigm, and the third subject, an increment.

5. DISCUSSION

Based on our review of the literature, we predicted that increasing the stimulus duration from 50 to 300 ms would result in a decrease in threshold, according to the theory of temporal integration. We did not expect duration to influence frequency discrimination because a number of previous reports had concluded that it was not a significant factor for the range of durations tested. The results of the experiment confirmed the predictions. Across subjects, the threshold decreased significantly by 6 dB, as the stimulus duration increased from 50 ms to 300 ms for both the first and final replications. Duration did not affect the frequency difference limen. The observed value of DLF across the first and final replications, the two paradigms, two stimulus durations and subjects, was 7.8 Hz, yielding a Weber ratio of 0.0039, in line with previous reports.

Paradigm has previously been shown to affect detection, although in comparisons of various forced-choice procedures, the outcome was reported as a change in the stability of the estimates rather than sensitivity. Clinical procedures yield higher DLFs than laboratory estimates. A comparison of the outcomes for 2IFC and 4IFC procedures in the present experiment indicated that the detection threshold was not affected. However, the DLF was significantly greater for the 4IFC paradigm. Averaging across stimulus durations, first and sixth replications and subjects, the observed values for 2IFC and 4IFC were 6.1 Hz and 9.5 Hz, respectively. The smaller value yields a Weber ratio of 0.003, the value quoted in the literature. The larger value yields a Weber ratio of 0.005. One possible explanation for this difference is that the 4IFC paradigm may present the subject with a pattern recognition problem involving sequential processing across listening intervals, rather than a simple comparison of two frequencies.

We expected that practice would improve, that is reduce, both the detection threshold and frequency difference limen. Statistical comparison of the values obtained during the first and final (sixth) replications indicated that there were no differences in either measure. Collapsed across stimulus duration and paradigm, the mean within-subject change in the detection threshold from the first to the final replication was an improvement of 0.9 dB in the detection threshold and 3.5 Hz in the DLF at 2 kHz. For each subject, within each experimental condition, the function relating outcome to replication number, 1 through 6, was always non-monotonic. The lack of a significantly positive outcome may have been due to the fact that all three subjects had had experience as subjects and testers in psychoacoustic experiments, although not with the particular paradigms and measurements under study.

Apart from the traditional psychoacoustic measures of detection threshold and difference limen, the experiment was also designed to evaluate the effect of variation in methodological parameters on decision-making. The measure chosen was the reaction time associated with the same level of performance used to derive the two indices of sensory acuity, i.e., either $P(C) = 0.75$ or $P(C) = 0.625$, depending on whether a 2IFC of 4IFC paradigm had been used. According to the literature, there is some evidence for a decrease in simple reaction time with an increase in duration but only at the low end of discriminability (Brebner and Welford, 1980).

The results of the present experiment showed a significant decrease in both the correct and incorrect reaction times with an increase in stimulus duration for the detection task. The mean within-subject differences in the correct and incorrect reaction times due to duration (without regard to paradigm or replication) were 106 ms and 107 ms, respectively. Across the 24 conditions by subjects, the incorrect reaction time was 45 ms longer than the correct reaction time. We have noted a similar difference in previous studies and have pointed out its comparability to the duration of the alpha half cycle in EEG recordings (Abel, Rajan and Giguère, 1990; Abel and Armstrong, 1992). The average difference observed for the discrimination task was 64 ms.

For the discrimination task, we had expected that the reaction time would increase with number of alternatives, i.e., that the 4IFC paradigm would generate longer values that the 2IFC. A significant difference of 35 ms was observed only for the incorrect reaction time but in the opposite direction. Outcomes across individuals were highly variable. Practice had no effect on reaction time in either task, possibly because the subjects were not experimentally naive.

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Table 1. Detection thresholds (Det) and frequency difference limens (DLF) for a 2 kHz-pure tone. Effects of paradigm, stimulus duration and replication in three subjects.

		Paradigm/Stimulus Duration			
		2IFC		4IFC	
Measure	Sub	50 ms	300 ms	50 ms	300 ms
Det	JT	-1.2 (-0.2)*	-5.6 (-8.6)	-0.3 (0.5)	-4.8 (-6.4)
(dB SPL)	VH	7.9 (5.7)	4.2 (3.5)	8.8 (7.4)	3.7 (1.2)
	FS	10.0 (10.3)	-0.2 (-0.8)	8.6 (7.3)	2.1 (2.6)
DLF	JT	3.4 (3.2)	1.0 (2.0)	7.5 (6.0)	4.0 (2.7)
(Hz)	VH	6.0 (8.4)	6.0 (1.7)	20.0 (10.8)	6.2 (4.2)
	FS	17.4 (8.2)	10.1 (6.0)	19.0 (12.8)	14.3 (6.4)

* First (sixth) replication

Table 2. Correct (CRT) and incorrect (IRT) detection threshold reaction times. Effects of paradigm, stimulus duration and replication in three subjects.

		Paradigm/Stimulus Duration			
		2IFC		4IFC	
Response	Sub	50 ms	300 ms	50 ms	300 ms
CRT (ms)	JT	810 (375)*	600 (385)	800 (485)	600 (275)
	VH	625 (615)	550 (475)	620 (505)	510 (450)
	FS	295 (270)	345 (160)	365 (285)	250 (175)
IRT (ms)	JT	830 (425)	660 (450)	942 (515)	750 (330)
	VH	655 (620)	672 (460)	740 (610)	565 (460)
	FS	327 (319)	395 (150)	365 (245)	230 (190)

* First (sixth) replication

Table 3. Correct (CRT) and incorrect (IRT) frequency discrimination reaction times. Effects of paradigm, stimulus duration and replication in three subjects.

		Paradigm/Stimulus Duration			
		2IFC		4IFC	
Response	Sub	50 ms	300 ms	50 ms	300 ms
CRT (ms)	JT	505 (510)*	520 (350)	380 (350)	330 (225)
	VH	545 (500)	355 (310)	560 (525)	385 (345)
	FS	705 (235)	305 (190)	400 (300)	340 (145)
IRT (ms)	JT	505 (460)	545 (375)	560 (395)	435 (340)
	VH	575 (770)	527 (330)	640 (590)	430 (445)
	FS	715 (250)	325 (260)	475 (390)	325 (190)

* First (sixth) replication

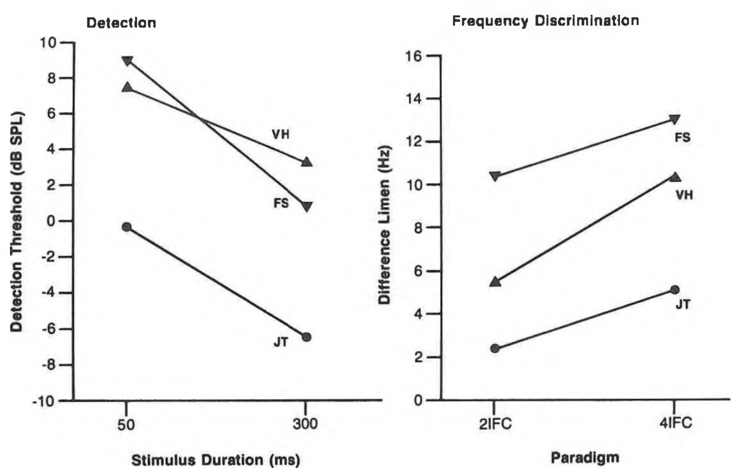

Fig. 1 Detection Threshold and Frequency Difference Limen for a 2-kHz Pure Tone

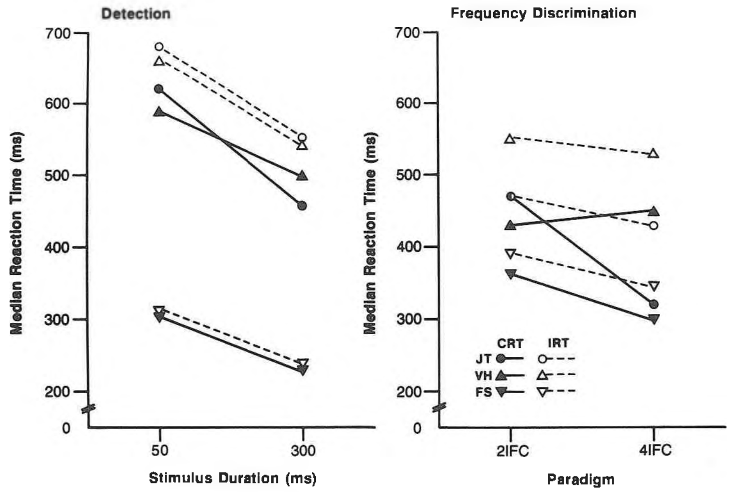

Fig. 2 Correct and Incorrect RTs Associated with the Detection Threshold and Frequency Difference Limen for a 2-kHz Pure Tone

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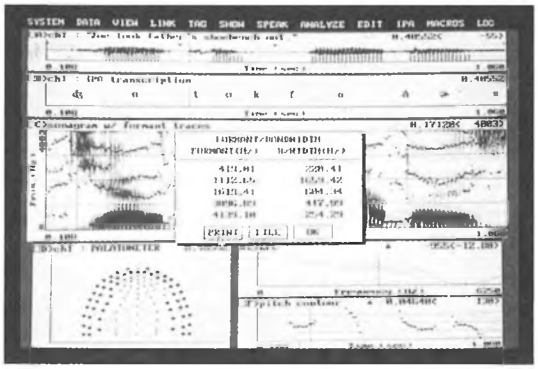

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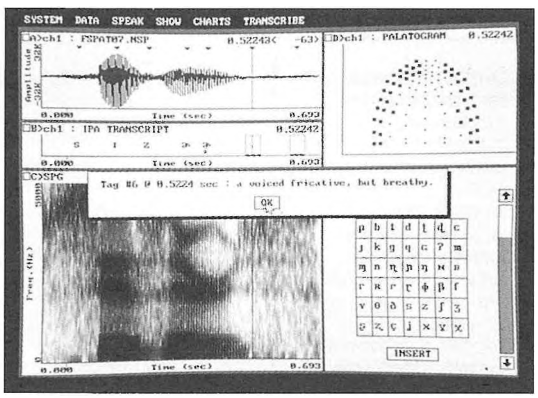

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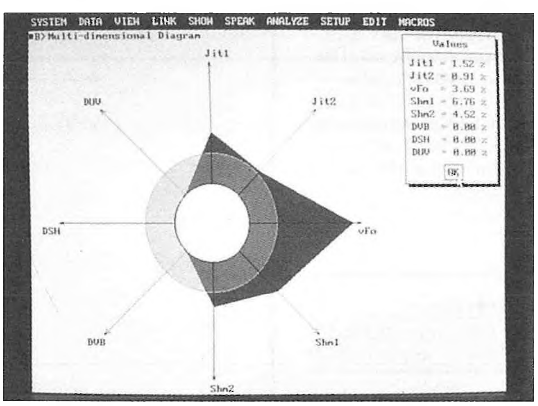

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Vous êtes invités à participer à la Semaine canadienne de l'acoustique, qui aura lieu au Citadel Inn, à Ottawa, du 17 au 21 octobre prochain. Au programme : des séminaires, un symposium, une visite de laboratoire et une réception avec banquet. La première journée, soit le lundi, il y aura un séminaire sur *L'étalonnage et la traçabilité en acoustique*. Deux autres séminaires seront présentés le mardi. Bruel&Kjaer Canada traitera de *La puissance acoustique : mesures et normes applicables*; quant à l'autre séminaire, organisé par Alberto Behar, il portera sur *La protection de l'ouïe et la lutte contre le bruit.*

Le symposium commencera mercredi matin et comportera deux journées complètes de séances organisées sur tous les aspects de l'acoustique. Trois séances simultanées de présentations sollicitées et offertes sont prévues chaque jour. Des repas du midi spécialement préparés par un traiteur et un banquet-réception (mercredi soir) seront servis dans la salle de bal à l'étage supérieur de l'hôtel, qui offre une vue panoramique de la ville. L'assemblée générale annuelle et la remise des prix aux étudiants auront lieu le jeudi après le symposium. Vendredi, des membres du personnel du Laboratoire d'acoustique de l'IRC au Conseil national de recherches du Canada dirigeront une visite de leurs installations et animeront une conférence portant sur lex travaux en cours. Un repas du midi gratuit est prévu à cette occasion.

La Semaine canadienne d'acoustique se déroulera à Ottawa dans l'Hôtel Citadel Inn récemment renové, qui se trouve en plein centre-ville et à quelques pas seulement de la Colline du Parlement et d'autres lieux attrayants. Un grand local d'exposition tout près des salles de conférences a été réservé et c'est là qu'auront leiu les pauses du matin et de l'après-midi. Les participants pourront réserver une chambre d'hôtel à prix réduit (chambre individuelle à 85 $, chambre double à 90 $, petit déjeuner compris) en communiquant directement avec l'hôtel au 1-800-567-3600 et en mentionnant leur participation au congrès de l'Association canadienne de l'acoustique. Nous encourageons les participants à loger à l'hôtel Citadel Inn puisque le tarif des salles de réunion est fonction du nombre de participants hébergés.

Le droit de participation au symposium est de 130 $ par personne pour les membres de l'ACA, de 165 $ pour les non-membres, de 40 $ pour les membres étudiants et de 50 $ pour les étudiants qui ne sont pas membres. Ce prix englobe les repas du midi et le banquet. On pourra s'inscrire au symposium le jour même, tandis que l'inscription aux conférences se fera à l'avance (formulaires dans le numéro de juin).

Président du congrès

Dr Trevor R. Nightingale, téléphone (613) 993-0102

Voyages par avion

Les Lignes aériennes Canadian International sont le transporteur officiel pour notre rencontre nationale à Ottawa. Les délégués pourront épargner jusqu'à 50 % du plein tarif de classe économique, suivant les places disponibles et les restrictions applicables. On pourra réserver une place en communiquant avec Canadian Airlines Conventionair au 1-800-665-5554 et en mentionnant l'événement "5437 à Ottawa".

ACOUSTICS WEEK IN CANADA 1994

Citadel Inn Ottawa

October 17-21, 1994

INVITATION TO PARTICIPATE

You are invited to participate in Acoustics Week In Canada 1994 to be held October 17 through 21 at the Citadel Inn Ottawa. Highlights of the week include seminars, a symposium, a laboratory tour, and entertainment. The week will begin on Monday, October 17 with a seminar on *Acoustical Calibration and Traceability.* Two more seminars will be given on Tuesday. Bruel&Kjaer Canada will address *Sound Power: Measurement and Applicable Standards*, while the other seminar, organized by Alberto Behar, will address *Hearing Conservation and Noise control.*

The Symposium will begin Wednesday morning and will consist of two full days of organized sessions on all aspects acoustics. Each day there will be three simultaneous sessions with invited and contributed papers. Specially catered luncheons for the delegates as well as a Wednesday evening Reception and Banquet will be held in the ballroom atop the Citadel Inn which offers a beautiful panoramic view of the city. The annual general meeting and student awards will be held on Thursday after the close of the symposium. Friday, members of the IRC Acoustics Laboratory at the National Research Council Canada will provide a tour of their facilities and a seminar in which details of current work will be given. Also included in the tour is a complimentary luncheon.

The venue for Acoustics Week In Canada will be the newly renovated Citadel Inn Ottawa located in the heart of downtown, only a short walk from Parliament Hill and other attractions. A large exhibition space central to the lecture rooms has been secured in which morning and afternoon coffee will be served. Discount hotel rates of $85 Single, $90 Double which include free breakfast, are available by telephoning the hotel directly at 1-800-567-3600 and identifying yourself as a CAA conference delegate. Members are encouraged to stay at the Citadel Inn as meeting room charges are determined by the number of guest rooms occupied by our delegates.

The cost of the Symposium will be $130 per person for CAA members, $165 for non-members, $40 for student members, $50 for non-member students. This includes both luncheons and the Banquet. Symposium registration will be conducted at the door, while seminar registration will be done in advance (forms to appear in the June issue).

Conference Chair
Dr. Trevor R. Nightingale, Tel: (613) 993-0102

A Note on Air Travel

Canadian Airlines International has been appointed as the official airline for our national meeting in Ottawa. Savings of up to 50% on full fare economy are available to delegates, pending availability and restrictions. Reservations should be made by calling Canadian Airlines Conventionair at 1-800-665-5554 and quoting event number "5437 in Ottawa."

APPEL DE COMMUNICATIONS

Semaine canadienne d'acoustique 1994

SYMPOSIUM les 19 et 20 octobre

Des présentations sont sollicitées sur tous les aspects de l'acoustique et des vibrations. Le programme englobera trois séances parallèles de présentations sollicitées et offertes. Séances prévues et personnes responsables:

- Acoustique architecturale: John Swallow (416) 789-0522;
- Techniques acoustiques: le prof. Gilbert Soulodre (514) 398-4548 poste 0342;
- Audition en milieu de travail: D^r Chantal Laroche (613) 564-2933;
- Stratégie interdisciplinaire de l'accessibilité auditive:
  D^r Kathy Pichora-Fuller (604) 822-4716;
- Bruits en milieu de travail; prévision, maîtrise et effets:
  D^r Murray Hodgson (604) 822-3073;
- Propagation du bruit extérieur: D^r Mike Stinson (613) 993-3729;
- Parole et perception et production: le prof. Ian MacKay (613) 564-3273;
- Acoustique sous-marine: D^r David Chapman (902) 426-3100.

D'autres séances seront prévues, au besoin, en fonction des communications offertes. Les personnes qui désirent présenter un exposé à une séance particulière sont priés de communiquer avec le responsable de la séance. Toute présentation doit comporter un résumé ne dépassant pas 300 mots, envoyé au responsable technique le 21 juin 1994 au plus tard. Les résumés seront examinés en fonction de la séance appropriée et du contenu, et le responsable technique transmettra les télécopies d'acceptation le 1^er juillet 1994 ou avant. À la suite d'une acceptation, un sommaire de deux pages prêtes à photographier devra être présenté au responsable le 21 juillet 1994 au plus tard. Les présentations acceptées seront publiées dans un numéro compte rendu de la revue *Acoustique canadienne*. On trouvera dans le présent numéro des instructions quant à la préparation des résumés et des communications. Prière de transmettre les résumés et les communications au responsable technique:

D^r John S. Bradley
Institut de recherche en construction, Laboratoire d'acoustique
Conseil national de recherches du Canada
Édifice M-27, chemin Montréal
Ottawa (Ontario) K1A 0R6
Téléphone: (613) 993-9747, télécopieur: (613) 954-1495

Dates: clés

- 21 juin 1994: date limite de réception des résumés;
- 1^er juillet 1994: réponse du responsable technique;
- 21 juillet 1994: date limite de réception du sommaire de la communication, prêt à photographier;
- 19 et 20 octobre: symposium.

Les étudiants sont invités à participer. Des prix en argent seront décernés pour les trois meilleures communications. Les étudiants doivent indiquer leur intention de participer en remplissant le formulaire «Prix annuel relatif aux communications étudiantes» qui figure dans le présent numéro, et en le retournant accompagné d'un résumé.

CALL FOR PAPERS

Acoustics Week In Canada 1994

SYMPOSIUM October 19-20

Contributions from all areas of acoustics and vibration are invited. The programme will include three parallel sessions of invited and contributed presentations. Planned sessions and their organizers are:

- Architectural Acoustics: John Swallow (416) 789-0522;
- Audio Engineering: Prof. Gilbert Soulodre (514) 398-4548 Ext. 0342;
- Hearing in the Workplace: Dr. Chantal Laroche (613) 564-2933;
- Interdisciplinary Approach to Hearing Accessibility:
  Dr. Kathy Pichora-Fuller (604) 822-4716;
- Noise in the Workplace; Prediction, Control, and Effect:
  Dr. Murray Hodgson (604) 822-3073;
- Outdoor Noise Propagation: Dr. Mike Stinson (613) 993-3729;
- Speech and Perception and Production: Prof. Ian MacKay (613) 564-3273;
- Underwater Acoustics: Dr. David Chapman (902) 426-3100.

Other sessions will be created, where necessary, to accommodate contributed papers. Persons wishing to contribute to a special session are encouraged to contact the session organizer. All presenatations require that an abstract no longer than 300 words be submitted to the technical chair on or before June 21, 1994. The abstracts will be reviewed to determine the correct session and suitability of the presentation. The technical chair will fax an acceptance by July 1, 1994. Following acceptance, a two-page camera-ready summary paper is to be submitted to the technical chair no later than July 21, 1994. Accepted papers will be published in the proceedings issue of *Canadian Acoustics*. Instructions for the preparation of abstracts and papers are provided in this issue. Completed abstracts and papers should be directed to the technical chair:

Dr. John S. Bradley
Institute for Research in Construction, Acoustics Laboratory,
National Research Council Canada,
Bldg. M-27, Montreal Road
Ottawa, Ontario. K1A 0R6
Tel: (613) 993-9747, Fax: (613) 954-1495

Summary of Dates:

- June 21, 1994: Deadline for receipt of abstracts;
- July 1, 1994: Response to abstract by technical chair;
- July 21, 1994: Deadline for receipt of camera-ready summary paper;
- October 19-20, 1994: Symposium.

Students are invited to participate. Monetary awards will be given to the three best presentations. Students must signify their intention to compete by submitting the 'Annual Student Presentation Awards' form in this issue along with an abstract.

SEMAINE CANADIENNE DE L'ACOUSTIQUE 1994

Citadel Inn, Ottawa

SÉMINAIRES

L'ÉTALONNAGE ET LA TRAÇABILITÉ EN ACOUSTIQUE

Date : 17 octobre 1994
Présenté par : George Wong, Ph.D.
Endroit: Conseil national de recherches Canada, bâtiment M-36
Pour information : Elizabeth Lambe (613 993-5976, télécopieur 613 952-5113)
Langue : anglais.
Coût : 200 $ (comprend repas et café)

Ce cours d'une journée est destiné aux ingénieurs, scientifiques ou technologues s'occupant d'étalonnage, d'essais ou de normes dans le domaine de l'acoustique. On y traitera de manière informelle :

- des étalons primaires en acoustique
- des systèmes d'étalonnage (sources sonores de référence comme les pistonphones et les systèmes d'étalonnage sur place)
- de la théorie de la mesure acoustique et du choix des appareils : sonomètres, sonomètres intégrateurs-pondérateurs, dosimètres, etc.
- des exigences ISO 9000
- de la philosophie de l'étalonnage en acoustique et des techniques utilisées dans ce domaine

Des informations utiles seront fournies concernant l'étalonnage en acoustique, par exemple en ce qui a trait aux intervalles recommandés et aux exigences minimales à respecter pour obtenir des mesures fiables dont les résultats peuvent être reliés aux étalons primaires conservés au Conseil national de recherches du Canada.

Inscription aux séminaires

L'inscription doit être faite avec Elizabeth Lambe. Les frais d'inscription seront de 250 $ pour les inscriptions reçues après le 1er août 1994. Veuillez noter que les séminaires ne seront présentés que si le nombre d'inscrits, à cette date, est suffisant.

ACOUSTICS WEEK IN CANADA 1994

Citadel Inn Ottawa

SEMINARS

ACOUSTICAL CALIBRATION AND TRACEABILITY

Date: October 17, 1994.
Presented by: Dr. George Wong.
Location: National Research Council Canada, Building M-36.
Information contact: Elizabeth Lambe (613-993-5976, or FAX at 613-952-5113)
Language: English
Cost: $200 (includes lunch and coffee)

This one day event is designed for engineers, scientists and technologists who are involved with acoustical calibrations, tests and standards. It will follow an informal approach and will include discussions on:

- primary acoustical standards
- calibrators (reference sound sources such as pistonphones and field calibrators
- theory and selection of acoustical measuring instruments: sound level meters, integrating-averaging sound level meters, dosimeters, etc.
- ISO 9000 requirements
- acoustical calibration techniques and philosophy

The course will provide answers on acoustical calibrations, such as recommended calibration intervals and minimum requirements to ensure confidence in measurements with traceability to the primary standards maintained at the National Research Council of Canada.

Seminar Registration

Registration should be made through Elizabeth Lambe, the Information contatct. For registrations received after August 31, 1994, the fee will be $250. Please, note that these courses will only be offered if there is sufficient registration by August 31, 1994.

SEMAINE CANADIENNE DE L'ACOUSTIQUE 1994

Citadel Inn, Ottawa

SÉMINAIRES

PROTECTION DE L'OUIE ET LUTTE CONTRE LE BRUIT

Date : mardi 18 octobre 1994
Présenté par : Alberto Behar, Winston Sydenborgh et Bob Pemberton
Pour information : Alberto Behar (416 265-1816)
Langue : anglais
Coût : 100 $

Il s'agit d'un cours pratique d'une journée à l'intention du personnel d'usine faisant partie de programmes de protection de l'ouïe : membres de comités de santé et sécurité, agents de sécurité, infirmières spécialisées en hygiène professionnelle et autres personnes s'occupant de santé et de sécurité au travail.

La première partie du cours portera sur la façon de concevoir les programmes de protection de l'ouïe, de les mettre en oeuvre et de les évaluer, notamment sur le choix des protecteurs d'oreilles appropriés, ainsi que sur la mesure des niveaux de bruit et des expositions à celui-ci. La seconde partie sera consacrée aux aspects techniques de la lutte contre le bruit et au choix des matériaux destinés à abaisser les niveaux de bruit industriel.

PUISSANCE ACOUSTIQUE : MESURE ET NORMES APPLICABLES

Date : 18 octobre 1994
Présenté par: Bruel&Kjaer Canada.
Pour information : Robert Trépanier (514 695-8225)
Langue : anglais
Coût : 175 $

Il est de plus en plus important de certifier la puissance acoustique de sortie des produits. La puissance acoustique des appareils vendus ou exportés en Europe doit être déterminée suivant des méthodes normalisées. Étant donné l'importance croissante du Marché commun européen et la mondialisation des échanges, la capacité de fournir un certificat de puissance acoustique est essentielle aux entreprises qui désirent exporter.

Ce séminaire portera sur les normes que l'on peut utiliser pour en arriver à une mesure de la puissance acoustique qui soit reconnue. Les diverses méthodes acceptées seront comparées aux points de vue fiabilité et facilité de mise en oeuvre. On fera une démonstration de mesure de la puissance acoustique basée sur l'intensité sonore et on montrera que cette technique est simple et fiable dans la plupart de ses applications. La technique de mesure, les indicateurs de contrôle de la qualité et l'interprétation des résultats feront l'objet d'un examen approfondi.

Il faut connaître les grands principes de l'acoustique.

Inscription aux séminaires

Il faut remplir le formulaire d'inscription qui se trouve dans ce numéro et l'envoyer, avec le paiement approprié, d'ici le 31 août prochain. Veuillez noter que les séminaires ne seront présentés que si le nombre d'inscrits, à cette date, est suffisant.

ACOUSTICS WEEK IN CANADA 1994

Citadel Inn Ottawa

SEMINARS

HEARING CONSERVATION AND NOISE CONTROL
Date: Tuesday October 18, 1994.
Presented by: Alberto Behar, Winston Sydenborgh, and Bob Pemberton.
Information contact: Alberto Behar (416-265-1816)
Language: English.
Cost: $100.

This is a practical one day course for plant personnel involved in hearing conservation programmes. This would include members of health and safety committees, safety officers, occupational nurses, and others involved in work place health and safety.

The course content will consider: how to design, implement, and assess hearing conservation programmes, including the selection of hearing protectors, as well as the measurement of noise levels and exposures. The second half of the course will consider engineering noise control issues and the selection of materials to reduce occupational noise levels.

SOUND POWER: MEASUREMENT AND APPLICABLE STANDARDS
Date: October 18, 1994.
Presented by: Bruel&Kjaer Canada.
Information contact: Robert Trepanier (514) 695-8225
Language: English.
Cost: $175.

It is becoming increasingly important to certify the sound power output of products. Equipment sold or exported to Europe must be labeled for sound power in accordance with standardized methods. With the growing importance of the European Community and the global market, the ability to provide a certificate of sound power is key to accessing these markets.

This seminar specifically addresses possible standards that can be used to obtain a recognized measure of sound power. The various accepted methods will be compared for accuracy and ease of implementation. A demonstration of sound power measurement using acoustic intensity is given and shown to be simple and accurate for most applications. Measurement technique, quality control indicators, and result interpretation will be discussed in detail. A basic knowledge and understanding of acoustics are required.

Seminar Registration

The registration form included in this issue should be completed and sent with payment before August 31, 1994. Please, note that these courses will only be offered if there is sufficient registration by August 31, 1994.

SEMAINE CANADIENNE D'ACOUSTIQUE 1994

Citadel Inn Ottawa

SÉMINAIRES

INSTITUT DE RECHERCHE EN CONSTRUCTION, SÉMINAIRES SUR L'ACTUALITÉ TECHNOLOGIQUE DU LABORATOIRE D'ACOUSTIQUE

Date: le 21 octobre 1994.
Presentées par: le Laboratoire d'acoustique, Institut de recherche en construction, Conseil national de recherches du Canada.
Endroit: Conseil national de recherches du Canada, Institut de recherche en construction, Laboratoire d'acoustique.
Contact: Maria Clancy (613-993-2305)
Langue: l'anglais.
Coût: 10 $.

Cette rencontre d'une journée englobera à la fois des exposés et des visites de laboratoire dirigées par des chercheurs du Laboratoire d'acoustique de l'IRC. Les séminaires intéresseront tout particulièrement les praticiens de l'acoustique architecturale et les personnes qui conçoivent, mettent au point et utilisent des matériaux de construction insonorisés.

Au cours des exposés du matin, les chercheurs de l'IRC présenteront de l'information concrète tirée de leurs plus récents projets financés par la clientèle:

- La transmission latérale du son dans les bâtiment à ossature de bois;
- La transmission du son à travers les murs de plaques de plâtre;
- La dégradation de l'insonorisation sous l'effet des prises électriques dans les murs;
- La mesure de la puissance sonore des systèmes CVC et des faibles fréquences;
- Le bruit des avions dans les aéroports canadiens;
- Les techniques de mesure et les essais subjectifs en acoustique des salles;
- La conception et la mise en service d'une nouvelle installation d'essais (transmission par les planchers

Les participants recevront dans la mesure du possible des documents et des tirés à part.

Dans l'après-midi, on pourra visiter les installations du Laboratoire d'acoustique, y compris les locaux d'essais pour murs et planchers, la chambre anéchoïque, les locaux d'essais en acoustique des salles, ainsi que les locaux d'essais de la transmission latérale du son. Cette visite offrira aux participants une excellente occasion d'aborder des questions techniques et des projets futurs avec les chercheurs.

Des autobus feront la navette entre le CNRC et l'hôtel Citadel Inn

Inscription aux séminaires

Il faut remplir le formulaire d'inscription qui se trouve dans ce numéro et l'envoyer, avec le paiement approprié, d'ici le 31 août prochain. Veuillez noter que les séminaires ne seront présentés que si le nombre d'inscrits, à cette date, est suffisant.

ACOUSTICS WEEK IN CANADA 1994

Citadel Inn Ottawa

SEMINARS

INSTITUTE FOR RESEARCH IN CONSTRUCTION, ACOUSTICS LABORATORY TECHNOLOGY UPDATE SEMINARS

Date: October 21, 1994.
Presented by: Acoustics Laboratory, Institute for Research in Construction, National Research Council Canada.
Location: National Research Council Canada, Institute for Research in Construction, Acoustics Laboratory.
Information contact: Maria Clancy (613-993-2305)
Language: English.
Cost: $10.

This one day event will include both seminar presentations and laboratory tours conducted by IRC, Acoustics Laboratory researchers. The seminars will be of particular interest to practitioners of building acoustics as well as persons who design and develop and use acoustically engineered building products.

The morning will include presentations giving applied and practical information from our most recent client funded projects:

- Flanking sound transmission in wood frame constructions;
- Sound transmission through gypsum board walls;
- Degradation of sound insulation due to electrical outlets in walls;
- Sound power measurement of HVAC systems, and of low frequencies;
- Aircraft noise issues at Canadian Airports;
- Room acoustics measurement techniques and subjective testings;
- Design and commissioning of a new floor transmission test facility.

Where possible, handouts and report reprints will be made available to participants.

In the afternoon there will be guided tours of the Acoustics Laboratory facilities which include the wall and floor test suites, the anechoic room, the room acoustics test suite, and the flanking transmission test suite. The tour will provide participants with an excellent opportunity to discuss technical matters and plans for future projects with the researchers.

Buses will provide transportation to and from the Citadel Inn.

Seminar Registration

The registration form included in this issue should be completed and sent with payment before August 31, 1994. Please, note that these courses will only be offered if there is sufficient registration by August 31, 1994.

SEMAINE CANADIENNE DE L'ACOUSTIQUE 1994

Citadel Inn, 101, rue Lyon, Ottawa

RENSEIGNEMENTS ET FORMULAIRE D'INSCRIPTION

SYMPOSIUM

Les droits d'inscription de 130 $ seront perçus à l'entrée; il n'est pas nécessaire de s'inscrire à l'avance.

SÉMINAIRES

Pour tous les séminaires, il faut s'inscrire à l'avance en remplissant ce formulaire.

L'ÉTALONNAGE ET LA TRAÇABILITÉ EN ACOUSTIQUE
Date : le 17 octobre 1994
Inscription: Elizabeth Lambe (613-993-5976, ou télécopieur au 613-952-5113)

LA PROTECTION DE L'OUÏE ET LA LUTTE CONTRE LE BRUIT
Date : le 18 octobre 1994
Coût : 100 $ avant le 31 août 1994, 125 $ après cette date $______

LA PUISSANCE ACOUSTIQUE : MESURES ET NORMES APPLICABLES
Date : le 18 octobre 1994
Coût : 175 $ avant le 31 août 1994, 200 $ après cette date $______

INSTITUT DE RECHERCHE EN CONSTRUCTION, LABORATOIRE D'ACOUSTIQUE, SÉMINAIRES « LE POINT SUR LA TECHNOLOGIE »
Date : le 21 octobre 1994
Coût : 10 $ avant le 31 août 1994, 15 $ après cette date $______

Veuillez noter que les séminaires ne seront présentés que si le nombre d'inscrits au 31 août 1994 est suffisant.

Les formulaires dûment remplis, accompagnés d'un chèque ou mandat (en argent canadien) à l'ordre de l'**ACA 94 Ottawa,** doivent être envoyés à l'adresse suivante :

M. Trevor Nightingale, Ph.D.
Président du congrès ACA 94
Case postale 74068
Ottawa (Ontario) K1M 2H9

HÔTE DU CONGRÈS : LE CITADEL INN

Le Citadel Inn s'est engagé à offrir à nos délégués des chambres au meilleur tarif possible : 85 $ la nuit pour une personne et 90 $ pour deux, petit déjeuner compris. Nous vous conseillons vivement de loger au Citadel Inn, car le coût des salles de réunion dépendra du nombre de délégués de l'ACA qui y descendront. Pour réserver, veuillez composer le 1-800-567-3600 et dire que vous êtes un délégué de l'ACA.

TRANSPORTEUR : LES LIGNES AÉRIENNES CANADIEN INTERNATIONAL

Les Lignes aériennes Canadien international offriront un rabais pouvant atteindre 50 % du plein tarif en classe touriste, selon la disponibilité des places et à certaines conditions. Pour réserver, il faut appeler le service Conventionair de Canadien international (1-800-5554) et donner la référence « 5437 à Ottawa ».

ACOUSTICS WEEK IN CANADA 1994

Citadel Inn Ottawa, 101 Lyon Street, Ottawa

REGISTRATION FORM AND INFORMATION

SYMPOSIUM
Registration fee is $130 and will be collected at the door; pre-registration is not required.

SEMINARS
Registration for all seminars should be done in advance by completing this form.

ACOUSTICAL CALIBRATION AND TRACEABILITY
Date: October 17, 1994.
Registration contact: Elizabeth Lambe (613-993-5976, or Fax at 613-952-5113)

HEARING CONSERVATION AND NOISE CONTROL
Date: Tuesday October 18, 1994.
Cost: $100 before August, 31 1994, $125 after August, 31, 1994. $______

SOUND POWER: MEASUREMENT AND APPLICABLE STANDARDS
Date: October 18, 1994.
Cost: $175 before August, 31 1994, $200 after August, 31 1994. $______

INSTITUTE FOR RESEARCH IN CONSTRUCTION, ACOUSTICS LABORATORY TECHNOLOGY UPDATE SEMINARS
Date: October 21, 1994.
Cost: $10 before August, 31 1994, $15 after August, 31 1994. $______

Please, note that seminars will only be offered if there is sufficient registration by August 31, 1994.

Completed forms should be returned along with a cheque or money order made payable in Canadian funds to **CAA '94 Ottawa** at the address below:

Dr. Trevor Nightingale
CAA '94 Conference Chair
Post Office Box 74068
Ottawa, Ontario K1M-2H9

CONFERENCE HOTEL: CITADEL INN
The citadel Inn, as the conference hotel, has promised to offer our delegates the best available room rate for the days of our conference: $85 single, $90 double per night, including breakfast. You are urged to stay at the Citadel Inn since meeting room costs depend on the number of CAA delegates staying at the hotel. Please make reservations by calling: 1-800-567-3600 and identify yourself as a CAA delegate.

CONFERENCE AIRLINE: CANADIAN AIRLINES INTERNATIONAL
Canadian Airlines International, as the conference airline, will offer savings of up to 50% on full fare economy, pending availability and some restrictions. Reservations should be made by calling Canadian Conventionair at 1-800-5554 and quote event number "5437 in Ottawa."

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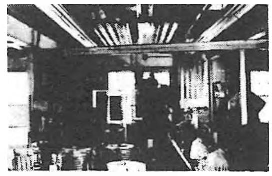
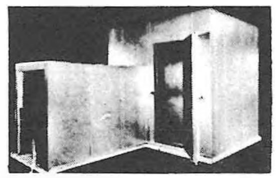


Eckoustic® Enclosures

Modular panels are used to meet numerous acoustic requirements. Typical uses include: machinery enclosures, in-plant offices, partial acoustic enclosures, sound laboratories, production testing areas, environmental test rooms. Eckoustic panels with solid facings on both sides are suitable for constructing reverberation rooms for testing of sound power levels.



Eckoustic® Noise Barrier

- **Noise Reduction Curtain Enclosures**
- **Machinery & Equipment Noise Dampening**

The Eckoustic Noise Barrier provides a unique, efficient method for controlling occupational noise. This Eckoustic sound absorbing-sound attenuating material combination provides excellent noise reduction. The material can be readily mounted on any fixed or movable framework of metal or wood, and used as either a stationary or mobile noise control curtain.

Acoustic Materials & Products for dampening and reducing equipment noise

Multi-Purpose Rooms

Rugged, soundproof enclosures that can be conveniently moved by fork-lift to any area in an industrial or commercial facility. Factory assembled with ventilation and lighting systems. Ideal where a quiet "haven" is desired in a noisy environment: foreman and supervisory offices, Q.C. and product test area, control rooms, construction offices, guard and gate houses, etc.

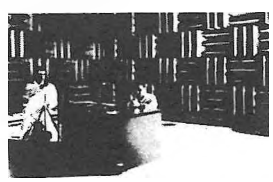
Audiometric Rooms: Survey Booths & Diagnostic Rooms

Eckoustic Audiometric Survey Booths provide proper environment for on-the-spot basic hearing testing. Economical. Portable, with unitized construction.

Diagnostic Rooms offer effective noise reduction for all areas of testing. Designed to meet, within ±3 dB, the requirements of MIL Spec C-81016 (Weps). Nine standard models. Also custom designed facilities.

An-Eck-Oic® Chambers

Echo-free enclosures for acoustic testing and research. Dependable, economical, high performance operation. Both full-size rooms and portable models. Cutoff frequencies up to 300 Hz. Uses include: sound testing of mechanical and electrical machinery, communications equipment, aircraft and automotive equipment, and business machines; noise studies of small electronic equipment, etc.



For more information, contact

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ECKEL INDUSTRIES, INC.

ACOUSTICS WEEK IN CANADA 1994

SEMAINE CANADIENNE D'ACOUSTIQUE 1994

Citadel Inn Ottawa

EXHIBITION

October 19, 20

The Organizing Committee for Acoustics Week In Canada 1994 is pleased to announce that there will be an exhibition of Instrumentation, Software, Materials, as well as Literature related to all aspects of Acoustics, and Noise and Vibration Control. A large room adjacent to the meeting rooms has been made available as an Exhibition space. Companies are invited to exhibit their products and services. The cost will be $275 for an 8-foot table. This includes a partial subsidy of the morning and afternoon conference coffee service that will be held in the exhibition room. Exhibition space will be reserved on a first come, first served basis. You are advised to reserve as soon as possible, as space is limited. A non-refundable deposit of $100 must accompany all reservations, the balance being due on or before October 1, 1994. To reserve space and/or obtain further information, please contact:

Dr. Wing T. Chu
CAA'94 Conference
Post Office Box 74068
Ottawa, Ontario K1M 2H9
Tel: (613) 993-9742, Fax: (613) 954-1495

EXPOSITION

Les 19 et 20 octobre

Le Comité organisateur de la Semaine canadienne d'acoustique 1994 est fier d'annoncer qu'une exposition sur l'instrumentation, les logiciels, le matériel et la documentation relative à tous les aspects de l'acoustique et de la lutte contre le bruit et les vibrations a été prévue dans un grand local tout près des salles de réunion. Les compagnies pourront y exposer leurs produits et leurs services au prix de 275 $ pour une table de 8 pieds, ce prix englobant une subvention partielle des pauses du matin et de l'après-midi qui auront lieu dans le local d'exposition. Puisque le nombre de places est limité, il importe de faire les réservations le plus tôt possible; ces dernières seront traitées au fur et à mesure de leur réception, le solde devant être versé le 1^er^ octobre 1994 au plus tard. Pour tout renseignement ou toute réservation, prière de communiquer avec:

D^r^ Wing T. Chu
Conférence de l'ACA '94
Boîte postale 74068
Ottawa (Ontario) K1M 2H9
Téléphone (613) 993-9742, télécopieur (613) 954-1495

Instructions for the Preparation of Abstracts

1) Duplicate copies of an abstract are required for each meeting paper; one copy should be an original. Send the four copies to the Technical Program Chairperson, in time to be received by June 21. Either English or French may be used. A cover letter is not necessary. 2) Limit the abstract to 300 words, including title and first author's name and address; names and addresses of coauthors are not counted. Display formulas set apart from the text are counted as 40 words. Do not use the forms "I" and "we"; use passive voice instead. 3) Title of abstract and names and addresses of authors should be set apart from the abstract. Text of abstract should be one single, indented paragraph. The entire abstract should be typed double spaced on one side of 8 1/2 x 11 in. or A4 paper. 4) Be sure that the mailing address of the author to receive the acceptance notice is complete on the abstract, to insure timely deliveries. 5) Do not use footnotes. Use square brackets to cite references or acknowledgements. 6) Underline nothing except what you wish to be italicized. 7) If the letter l is used as a symbol in a formula, loop the letter l by hand and write "lc ell" in the margin of the abstract. Do not intersperse the capital letter O with numbers where it might be confused with zero, but if unavoidable, write "capital oh" in the margin. Identify phonetic symbols by appropriate marginal remarks. 8) At the bottom of an abstract give the following information: a) If the paper is part of a special session, indicate the session; b) Name the area of acoustics most appropriate to the subject matter; c) Telephone and fax numbers, including area code, of the author to be contacted for information. Non-Canadian Authors should include country; d) If more than one author, name the one to receive the acceptance notice; e) Overhead projectors and 35mm slide projectors will be available at all sessions. Describe on the abstract itself any special equipment needed.

Instructions pour la Préparation des Résumés de Conférences

1) Deux copies du résumé sont requises pour chaque papier soumis; une des copies doit être un original. Envoyer les quatre copies au Président du Comité technique, suffisamment à l'avance pour qu'elles soient reçues avant le 21 juin. L'anglais ou le français peut être utilisé. Une lettre de présentation n'est pas requise. 2) Limiter le résumé à 300 mots, incluant le titre, le nom et l'adresse du premier auteur; les noms et les adresses des co-auteurs ne sont pas comptabilisés. Les formules en retrait du texte comptent pour 40 mots. Ne pas utiliser la forme "je" ou "nous"; utiliser plutôt la forme passive. 3) Le titre du résumé, les noms et les adresses des auteurs doivent être séparés du texte. Le texte du résumé doit être présenté en un seul paragraphe. Le résumé entier doit être dactylographié à double interlignes sur une face d'une page 8 1/2 x 11 pouce ou du papier A4. 4) S'assurer que l'adresse postale complète de l'auteur qui doit recevoir l'avis d'acceptation est inscrite sur le résumé afin d'assurer une livraison rapide. 5) Ne pas utiliser les notes de bas de page. Utiliser les crochets pour les références et les remerciements. 6) Ne souligner que ce qui doit être en italique. 7) Si la lettre l est utilisée comme symbole dans une formule, encercler la lettre l à la main et écrire "lc ell" dans la marge du résumé. Ne pas introduire la lettre majuscule O dans les chiffres lorsqu'elle peut être confondue avec zéro, mais se cela n'est pas possible, écrire "O majuscule" dans la marge. Identifier les symboles phonétiques à l'aide de remarques appropriées dans la marge. 8) A la fin du résumé, fournir les informations suivantes: a) Si la communication fait partie d'une session spéciale, indiquer laquelle; b) Identifier le domaine de l'acoustique le plus appropié à votre sujet; c) Les numéros de téléphone et de télécopieur, incluant le code régional, de l'auteur avec qui l'on doit communiquer pour information. Les auteurs étrangers doivent indiquer leur pays; d) S'il y a plus d'un auteur, mentionner le nom de celui qui doit recevoir l'avis d'acceptation; e) Des projecteurs à acétates et à diapositives seront disponibles dans chaque session. Indiquer les besoins spéciaux, si nécessaire.

Instructions pour la Préparation des Articles à être Publiés dans le Cahier des Actes du Congrès

Général - Soumettre un article prêt-à-copier d'un maximum de deux pages présenté en deux colonnes. Ne pas inclure de sommaire. Tout le texte en caractères Times-Roman. Disposer les figures dans le haut ou le bas des pages si possible. Lister les références dans un format logique à la fin du texte. Envoyer l'article au président du Programme Technique avant le 21 juillet. Le format optimal peut être obtenu de deux façons:

Méthode directe - Imprimer directement sur deux feuilles 8.5" x 11" en respectant des marge de 3/4" dans le haut et sur les côtés et un minimum de 1" dans le bas. Titre en 12pt, caractères gras, en simple interligne (12pt), centrés sur la page. Le reste du texte en 9pt en 0.75 (9pt) interligne, dans un format en deux colones, avec une largeur de colonnes de 3.4" et une séparation de 1/4". Noms des auteurs et adresses centrés sur la page avec les noms en caractères gras. Les titres de sections en caractères gras.

Méthode indirecte - Dactylographier ou imprimer comme suit, réduire au trois-quart (s.v.p., s'assurer de bonnes photocopies) et assembler l'article sur un maximum de deux pages 8.5" x 11" avec les côtés et un minimum de 1" dans le bas. Titre en 16pt avec 1.33 (16pt) interligne, centré sur la page. Le reste du texte en 12pt avec simple (12pt) interligne. Noms et adresses des auteurs centrés sur la page avec les noms en caractères gras. Titres des sections en caractères gras. Imprimer les colonnes de texte sur quatre feuilles 8.5" x 14" avec une largeur de colonnes de 4.5", une longueur maximum de 12.25", en laissant de la place pour le titre, les noms et les adresses sur la première page.

Instructions for Preparation of Articles to be Published in the Conference Proceedings Issue

General - Submit the camera-ready article on a maximum of two pages in two-column format. Do not include an abstract. All text in Times-Roman font. Place figures at the top and/or bottom of the pages, if possible. List references in any consistent format at the end. Send to the Chairperson of the Technical Programme by July 21. The optimum format can be obtained in two ways:

Direct method - Print directly on two sheets of 8.5" x 11" paper with margins of 3.4" top and sides, and 1" minimum at the bottom. Title in 12pt bold with single (12pt) spacing, centred on the page. All other text in 9pt with 0.75 (9pt) line spacing, in two-column format, with column width of 3.4" and separation of 1/4". Authors' names and addresses centred on the page with the names in bold type. Section headings in bold type.

Indirect method - Type or print as follows, reduce to three-quarters size (please ensure good copies) and assemble article on a maximum of two 8.5" x 11" pages with margins of 3.4" top and sides, and 1" minimum at the bottom. Title in 16pt bold type with 1.33 (16pt) line spacing, centred on the page. All other text in 12pt with single (12pt) line spacing. Authors' names and addresses centred on the page with the names in bold type. Section headings in bold type. Print individual text columns on four sheets of 8.5" x 14" paper with a column width of 4..5", a maximum length of 12.25", and leaving room for the title and names and addresses on the first page.

ANNUAL STUDENT PRESENTATION AWARDS

The Canadian Acoustical Association makes awards to students whose papers are presented at the CAA Annual Symposium. Students contemplating papers for the Symposium should apply for these awards with the submission of their abstract.

RULES

1. These awards are presented annually to authors of outstanding student papers that are presented during the technical sessions at Acoustics Week in Canada.
2. In total, three awards of $500.00 are presented.
3. Presentations are judged on the following merits:
    i) The way the subject is presented;
    ii) The explanation of the relevance of the subject;
    iii) The explanation of the methodology/theory;
    iv) The presentation and analysis of results;
    v) The consistency of the conclusions with theory and results.
4. Each presentation is judged independently by at least three judges.
5. The applicant must be:
    i) a full-time graduate student at the time of application;
    ii) the first author of the paper;
    iii) a member of the CAA;
    iv) registered at the meeting.
6. To apply for the award, the student must send this application simultaneously with the abstract. Multiple authors are permitted, but only the first author may receive an award.

PRIX ANNUELS RELATIFS AUX COMMUNICATIONS ETUDIANTES

L'Association Canadienne d'Acoustique decement des prix aux étudiants qui présenteront une communication au congrès annuel de l'ACA. Les étudiants qui considèrent presenter un papier au congrès doivent s'inscrire à ce concours au moment ou ils soummettent leur résumé.

REGLEMENTS

1. Ces prix sont decernes annuellement aux auteurs de communications exceptionelles presentées par des étudiants lors des sessions techniques de la Semaine Canadienne de l'Acoustique.
2. Au total, trois prix de 500$ sont remis.
3. Les présentations sont jugées selon les critères suivants:
    i) La facon dont le sujet est présente;
    ii) Les explications relatives à l'importance du sujet;
    iii) L'explication de la methodologie;
    iv) La présentation et l'analyse des résultats;
    v) La consistence des conclusions avec la theorie et les résultats.
4. Chaque présentation est evaluée separement par au moins trois juges.
5. Le candidat doit être:
    i) un étudiant à temps plein de niveau gradué au moment de l'inscription;
    ii) le premier auteur du papier;
    iii) un member de l'ACA;
    iv) un régistrant au congrès.
6. Afin de s'inscrire au concours, l'étudiant doit envoyer ce formulaire d'inscription en même temps que son résumé. Plusieurs auteurs sont permis, mais seul le premier auteur peut recevoir le prix.

APPLICATION FOR STUDENT PRESENTATION AWARD AT ACOUSTICS WEEK IN CANADA

FORMULAIRE D'INSCRIPTION POUR LES PRIX DESCERNES AUX ETUDIANTS LORS DE LA SEMAINE CANADIENNE D'ACOUSTIQUE

NAME OF THE STUDENT/NOM DE L'ETUDIANT:________________________
TITLE OF PAPER/TITRE DU PAPIER:________________________
UNIVERSITY/COLLEGE/UNIVERSITE/COLLEGE:________________________
NAME, TITLE OF SUPERVISOR/ NOM ET TITRE DU SUPERVISEUR:________________________
STATEMENT BY THE SUPERVISOR/DECLARATION DU SUPERVISEUR:

The undersigned affirms that the student mentioned above is a full-time student and the paper to be presented is the student's original work./Le sous-signe affirme que l'étudiant mentionne ci-haut inscrit à temps plein et que la communication qui'il présentera est le fruit de son propre travail.

Signature:________________________ Date:________________________

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"The ABC's of noise control"

H.L. Blachford's Comprehensive Material Choices

Noise treatments can be categorized into three basic elements: Vibration Damping, Sound Absorption and Sound Barriers.

Vibration Damping

It is well known that noise is emitted from vibrating structures or substrates. The amount of noise can be drastically reduced by the application of a layer of a vibration damping compound to the surface. The damping compound causes the vibrational energy to be converted into heat energy. Blachford's superior damping material is called **Aquaplas** and is available either in a liquid or a sheet form.

AQUAPLAS DL is a liquid damping material that can be applied with conventional spray equipment or troweled for smaller/thicker application.

It is water-based, non-toxic and provides economical and highly effective noise reduction from vibration.

AQUAPLAS DS is an effective form of damping material provided in sheet form for direct application to your product. Available with pressure sensitive adhesive for ease of application.

Sound Barriers

Sound Barriers are uniquely designed for insulating and blocking airborne noise. The reduction in the transmission of sound (transmission loss or "TL") is accomplished by the use of a material possessing such characteristics as high mass, limpness, and impermeability to air flow. Sound barriers can be a very effective and economical method of noise reduction.

Blachford Sound Barrier materials:

BARYFOL®

Limp, high specific gravity, plastic sheets or die cut parts. Can be layered with other materials such as acoustical foam, protective and decorative facings to achieve the desired TL for individual applications.

Sound Absorption

Blachford's **CONAFLEX** materials provide a maximum reduction of airborne noise through absorption in the frequency ranges associated with most products that produce objectionable noise. Examples: Engine compartments, computer and printer casings, construction equipment cabs, ...etc.

Available with a wide variety of surface treatments for protection or esthetics. Material is available in sheets, rolls and die-cut parts — designed to meet your specific application.

Suggest Specific Material or Design

Working with data supplied by you, or generated from our laboratory, **H. L. Blachford** will make engineering recommendations on treatment methods which may include specific material proposals, design ideas, or modifications to components. Recommendations are backed by documentation which can include written progress reports containing summarization of goals and results, conclusions, data, test procedures and background.

A Quality Supplier

The complete integration of:

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- Advanced engineering
- Quality-oriented manufacturing technology
- Research and development
- Problem solving approach to noise control

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Comprehensive Noise Control Solutions

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Canadian Acoustical Association
L'Association Canadienne d'Acoustique

MINUTES OF THE BOARD OF DIRECTOR'S MEETING

1:00 pm, October 5th, 1993
Delta Chelsea Inn, Toronto

Present:	D. Chapman	M. Roland Mieszkowski	E. Bolstad
	W. Sydenborgh	D. Jamieson	D. Quirt
	T. Nightingale	M. Hodgson	B. Dunn
	J. Hemingway	R. Ramakrishnan	S. Abel
	C. Laroche		
Regrets:	A. Behar	S. Forshaw	D. Whicker

The meeting was called to order at 13:00 hours.

Correction to minutes of the BoD meeting, May 16th, 1993:

Lateness of the June issue of Canadian Acoustics was due to late information regarding advertising material and not as inferred.

The minutes were accepted as corrected.

1) President's Report

Thanks were due to M. Mieszkowski and F. Laville for updating the CAA brochure. M. Mieszkowski has agreed to update the brochure each year after the Annual General Meeting.

The 22nd International Congress on Audiology will be in Halifax in July 1994. Mailing labels of the CAA Membership have already been provided.

The 3rd International Congress on Air- and Structure-Borne Sound and Vibration will be held in Montreal in June 1994. The spring CAA BoD meeting will be held in conjunction with that meeting on Sunday June 12th.

A letter has been received from Hugh Jones suggesting that he represent Canada on the steering committee of the World Conference on Ultrasound (WCU).

Motion: "That Hugh Jones be approved as liaison person to WCU on the understanding that CAA is not prepared to underwrite any financial expenditure."

Proposed: B. Dunn
Seconded: M. Hodgson

Carried

2) Executive Secretary's Report

The paid membership for 1993 stands at 369, which is an increase of 12% over 1992. Final notices were sent to unpaid members in June. All unpaid members were removed from the mailing list on August 1st, which is the deadline for the September issue of the Journal.

After some discussion, it was agreed that the same schedule be followed in 1994.

3) Treasurer's Report

The Association is in good financial health. It was suggested that the BoD consider reducing membership fees or increasing prizes. Student travel subsidies were discussed. Formal student travel guidelines will be prepared by R. Ramakrishnan and A. Behar and presented at the June BoD meeting.

Motion: "That a Student subsidy of $135 be provided for the Toronto conference. The subsidy to be restricted to CAA members registered at the conference who present papers."

Proposed: B. Dunn
Seconded: E. Bolstad

Carried, with 2 abstentions

4) Editor's Report

The Journal continues to be in good shape, in a break-even situation. There continues to be a lack of papers. M. Hodgson agreed to look into the feasibility of forming an editorial board composed of experts in the various fields of acoustics, covering both the east and west, which would solicit papers.

5) Membership/Recruitment

Student members were up by some 35%. The Membership Person requires a budget for posters, and distribution of brochures etc.

Suggestions have been sought from a professional regarding increasing and sustaining membership. These suggestions will be passed on to the succeeding Membership Person.

6) Awards Committee

B. Dunn is resigning from the Awards Committee.

Application forms for prizes will be inserted into the Journal. No posters will be sent to the universities for 1994.

Directors' Awards

This is C. Laroche's last year as a Director. A replacement must be chosen by the BoD.

Science Fair

Thanks to Annabel Cohen, who will continue co-ordination

7) Acoustics Week Reports

Toronto, 1993

A full meeting is expected with a surplus of approximately $2,000.

Ottawa, 1994

J. Bradley to be Technical Co-ordinator.

1995

Quebec or Windsor were suggested.

Motion: "That D. Quirt be accepted as liaison person to International INCE."

Proposed: M. Hodgson
Seconded: W. Sydenborgh
Carried

8) Nomination Committee

Nominations by the Committee are as follows:

President: R. Hetu

Membership: D. Jamieson

Directors: C. Sherry
B. Gosselin
W. Thomson

9) By-Law Review

Only one comment has been received and more input is requested. An updated version will be published in the June issue of the Journal and discussed at the Spring BoD meeting.

10) Brochure

The Brochure will be updated with new Officers and BoD and 2,000 printed.

The Meeting was adjourned at 15:00 hours.

MINUTES OF THE ANNUAL GENERAL MEETING

3:20 pm, October 7th, 1993
Delta Chelsea Inn, Toronto

The Meeting was called to order at 15:30 hours.

1) **Welcome**

D. Chapman, President, welcomed members to the meeting.

On behalf of the Toronto Organizing Committee, M. Osman acknowledged the significant contribution of S. Abel, chairperson, to the conference.

2) **Review of Minutes of Last AGM**

The minutes of the last AGM were accepted as printed.

3) **President's Report**

D. Chapman noted that membership had increased for 1993. Measures were also in hand to improve the Journal. He is stepping down as President, but continuing as Past President.

4) **Executive Secretary's Report**

The paid membership for 1993 stands at 369, which is an increase of 12% over 1992. Members were requested to pay their dues promptly in 1994. All unpaid members will be removed from the mailing list on August 1st, which is the deadline for the September issue of the Journal.

5) **Treasurer's Report**

A printed report was presented by E. Bolstad. The Association is in good financial health. Formalization of the student travel subsidy was suggested rather than building up funds. R. Ramakrishnan is developing a police to guide convenors. It was mentioned that the Post Doctoral Prize was not a grant in itself, but an extra.

6) **Editor's Report**

The Journal continues to be in good shape, in a break-even situation. There continues to be a lack of papers. M. Hodgson is considering the formation of an Editorial Board which would solicit papers. Consideration will also be given to general interest articles, events, new products and problem solving.

7) **Membership/Recruitment**

W. Sydenborgh had agreed to serve as Membership Person for 1 year only. He reported that student members were up by some 35%. Brochures (prepared by M. Mieszkowski and F. Laville) have been sent to the universities. A list of ideas for increasing membership have been obtained from a professional and will be passed on to the new Membership Person.

W. Sydenborgh was personally thanked by the President for serving as membership person for 1 year.

8) **Awards Committee**

There were no applicants for the Eckel Prize. The Bell, Fessenden, Directors', Shaw and Student prizes will be presented at the presentation luncheon on Friday.

T. Neary has run a conference in Banff and passed the proceeds on to CAA. The CAA thanked Terry for his efforts.

Every year applications for student prizes are either not properly filled out or are late. Supervisors are requested to ensure that applications are properly filled out and on time.

On behalf of the students, J. Nicolas thanked those CAA personnel who donated or originated prizes and those who organize their presentation.

9) **Acoustics Week Reports**

Toronto, 1993

A full meeting is expected with 85 papers and 3 plenary sessions. Chairpersons actively solicited papers to ensure a full meeting. Late papers will appear in the next issue of the Journal. There were 103 registrants to the conference. The exhibition collected $4,400 and local consultants donated $2,200. Both exhibitors and consultants were thanked for their contributions.

Ottawa, 1994

The meeting in Ottawa will be from Tuesday October 18th to Friday October 20th. J. Bradley will be Technical Program Co-ordinator and W. Chu, Facilities Manager. Papers will be presented in 3 parallel sessions on Wednesday and Thursday.

1995

Quebec or Windsor were suggested.

It was suggested that the Board of Directors consider holding the meeting every 2 years.

10) **Other Business**

The need to raise the visibility of the CAA on acoustical issues was raised and discussed.

Motion: "That a committee be formed to establish a mechanism whereby issues of concern to members can be discussed and promulgated."

Proposed: J. Hemingway
Seconded: S. Abel

Carried.

J. Hemingway agreed to act as temporary Chairperson. S. Abel, S. Haske, H. Forester, A Behar, M. Mieszkowski and R. Hétu agreed to serve.

A. Behar and W. Sydenborgh will continue with their By-Law review.

11) **Elections**

President: R. Hétu was nominated by the Nominations Committee and acclaimed.

Membership: D. Jamieson was nominated by the Nominations Committee and acclaimed.

Directors: C. Sherry, B. Gosselin and W. Thomson were nominated by the Nominating Committee for the 3 Director positions vacant.

E. Slawinski and M. Cheeseman were nominated from the floor.

A ballot was held and C. Sherry, B. Gosselin and E. Slawinski were elected as Directors.

12) **Adjournment**

The meeting was adjourned at 15:00 hours.

The Canadian Acoustical Association
l'Association Canadienne d'Acoustique

ANNONCE DE PRIX

Plusieurs prix, dont les objectifs généraux sont décrits ci-dessous, sont décernés par l'Association Canadienne d'Acoustique. Quant aux quatre premiers prix, les candidats doivent soumettre un formulaire de demande ainsi que la documentation associée au coordonateur de prix avant le dernier jour de février de l'année durant laquelle le prix sera décerné. Toutes les demandes seront analysées par des sous-comités nommés par le président et la chambre des directeurs de l'Association. Les décisions seront finales et sans appel. L'Association se réserve le droit de ne pas décerner les prix une année donnée. Les candidats doivent être membres de l'Association. La préférence sera donnée aux citoyens et aux résidents permanents du Canada. Les candidats potentiels peuvent se procurer de plus amples détails sur les prix, leurs conditions d'éligibilité, ainsi que des formulaires de demande auprès du coordonateur de prix.

Prix Post-Doctoral Edgar et Millicent Shaw en Acoustique

Ce prix est attribué à un(e) candidat(e) hautement qualifié(e) et détenteur(rice) d'un doctorat ou l'équivalent qui a complèté(e) ses études et sa formation de chercheur et qui désire acquérir jusqu'à deux années de formation supervisée de recherche dans un établissement reconnu. Le thème de recherche proposée doit être relié à un domaine de l'acoustique, de la psycho-acoustique, de la communication verbale ou du bruit. La recherche doit être menée dans un autre milieu que celui où le candidat a obtenu son doctorat. Le prix est de $3000 pour une recherche plein temps de 12 mois avec possibilité de renouvellement pour une deuxième année. Coordonnatrice: Sharon Abel, Mount Sinai Hospital, 600 University Avenue, Toronto, ON M5G 1X6. Les récipiendaires antérieur(e)s sont:

1990	*Li Cheng*	*Université de Sherbrooke*
1993	*Roland Woodcock*	*University of British Columbia*

Prix Étudiant Alexander Graham Bell en Communication Verbale et Acoustique Comportementale

Ce prix sera décerné à un(e) étudiant(e) inscrit(e) dans une institution académique canadienne et menant un projet de recherche en communication verbale ou acoustique comportementale. Il consiste en un montant en argent de $800 qui sera décerné annuellement. Coordonnateur: Don Jamieson, Department of Communicative Disorders, University of Western Ontario, London, ON N6G 1H1. Les récipiendaires antérieur(e)s sont:

1990	*Bradley Frankland*	*Dalhousie University*
1991	*Steven D. Turnbull*	*University of New Brunswick*
	Fangxin Chen	*University of Alberta*
	Leonard E. Cornelisse	*University of Western Ontario*
1993	*Aloknath De*	*McGill University*

Prix Étudiant Fessenden en Acoustique Sous-marine

Ce prix sera décerné à un(e) étudiant(e) inscrit(e) dans une institution académique canadienne et menant un projet de recherche en acoustique sous-marine ou dans une discipline scientifique reliée à l'acoustique sous-marine. Il consiste en un montant en argent de $500 qui sera décerné annuellement. Coordonnateur: David Chapman, DREA, PO Box 1012, Dartmouth, NS B2Y 3Z7.

1992	*Daniela Dilorio*	*University of Victoria*
1993	*Douglas J. Wilson*	*Memorial University*

Prix Étudiant Eckel en Controle du Bruit

Ce prix sera décerné à un(e) étudiant(e) inscrit(e) dans une institution académique canadienne dans n'importe quelle discipline de l'acoustique et menant un projet de recherche relié à l'avancement de la pratique en contrôle du bruit. Il consiste en un montant en argent de $500 qui sera décerné annuellement. Ce prix a été inauguré en 1991. Coordonnateur: Murray Hodgson, Occupational Hygiene Programme, University of British Columbia, 2206 East Mall, Vancouver, BC V6T 1Z3.

Prix des Directeurs

Trois prix sont décernés, à tous les ans, aux auteurs des trois meilleurs articles publiés dans l'*Acoustique Canadienne*. Tout manuscrit rapportant des résultats originaux ou faisant le point sur l'état des connaissances dans un domaine particulier sont éligibles; les notes techniques ne le sont pas. Le premier prix, de $500, est décerné à un(e) étudiant(e) gradué(e). Le deuxième et le troisième prix, de $250 chacun, sont décernés à des auteurs professionnels âgés de moins de 30 ans et de 30 ans et plus, respectivement. Coordonnateur: poste à combler.

Prix de Presentation Étudiant

Trois prix, de $500 chaqun, sont décernés annuellement aux étudiant(e)s sous-gradué(e)s ou gradué(e)s présentant les meilleures communications lors de la Semaine de l'Acoustique Canadienne. La demande doit se faire lors de la soumission du résumé. Coordonnateur: Alberto Behar, 45 Meadowcliffe Drive, Scarborough, ON M1M 2X8.

The Canadian Acoustical Association
l'Association Canadienne d'Acoustique

PRIZE ANNOUNCEMENT

A number of prizes, whose general objectives are described below, are offered by the Canadian Acoustical Association. As to the first four prizes, applicants must submit an application form and supporting documentation to the prize coordinator before the end of February of the year the award is to be made. Applications are reviewed by subcommittees named by the President and Board of Directors of the Association. Decisions are final and cannot be appealed. The Association reserves the right not to make the awards in any given year. Applicants must be members of the Canadian Acoustical Association. Preference will be given to citizens and permanent residents of Canada. Potential applicants can obtain full details, eligibility conditions and application forms from the appropriate prize coordinator.

Edgar and Millicent Shaw Postdoctoral Prize in Acoustics

This prize is made to a highly qualified candidate holding a Ph.D. degree or the equivalent, who has completed all formal academic and research training and who wishes to acquire up to two years supervised research training in an established setting. The proposed research must be related to some area of acoustics, psychoacoustics, speech communication or noise. The research must be carried out in a setting other than the one in which the Ph.D. degree was earned. The prize is for $3000 for full-time research for twelve months, and may be renewed for a second year. Coordinator: Sharon Abel, Mount Sinai Hospital, 600 University Avenue, Toronto, ON M5G 1X6. Past recipients are:

1990	*Li Cheng*	*Université de Sherbrooke*
1993	*Roland Woodcock*	*University of British Columbia*

Alexander Graham Bell Graduate Student Prize In Speech Communication and Behavioural Acoustics

The prize is made to a graduate student enrolled at a Canadian academic institution and conducting research in the field of speech communication or behavioural acoustics. It consists of an $800 cash prize to be awarded annually. Coordinator: Don Jamieson, Department of Communicative Disorders, University of Western Ontario, London, ON N6G 1H1. Past recipients are:

1990	*Bradley Frankland*	*Dalhousie University*
1991	*Steven D. Turnbull*	*University of New Brunswick*
	Fangxin Chen	*University of Alberta*
	Leonard E. Cornelisse	*University of Western Ontario*
1993	*Aloknath De*	*McGill University*

Fessenden Student Prize in Underwater Acoustics

The prize is made to a graduate student enrolled at a Canadian university and conducting research in underwater acoustics or in a branch of science closely connected to underwater acoustics. It consists of $500 cash prize to be awarded annually. Coordinator: David Chapman, DREA, PO Box 1012, Dartmouth, NS B2Y 3Z7.

1992	*Daniela Dilorio*	*University of Victoria*
1993	*Douglas J. Wilson*	*Memorial University*

Eckel Student Prize in Noise Control

The prize is made to a graduate student enrolled at a Canadian academic institution pursuing studies in any discipline of acoustics and conducting research related to the advancement of the practice of noise control. It consists of a $500 cash prize to be awarded annually. The prize was inaugurated in 1991. Coordinator: Murray Hodgson, Occupational Hygiene Programme, University of British Columbia, 2206 East Mall, Vancouver, BC V6T 1Z3.

Directors' Awards

Three awards are made annually to the authors of the best papers published in *Canadian Acoustics*. All papers reporting new results as well as review and tutorial papers are eligible; technical notes are not. The first award, for $500, is made to a graduate student author. The second and third awards, each for $250, are made to professional authors under 30 years of age and 30 years of age or older, respectively. Coordinator: position vacant.

Student Presentation Awards

Three awards of $500 each are made annually to the undergraduate or graduate students making the best presentations during the technical sessions of Acoustics Week in Canada. Application must be made at the time of submission of the abstract. Coordinator: Alberto Behar, 45 Meadowcliffe Drive, Scarborough, ON M1M 2X8.

INSTRUCTIONS TO AUTHORS PREPARATION OF MANUSCRIPT

Submissions: The original manuscript and two copies should be sent to the Editor-in-Chief.

General Presentation: Papers should be submitted in camera-ready format. Paper size 8.5" x 11". If you have access to a word processor, copy as closely as possible the format of the articles in Canadian Acoustics 18(4) 1990. All text in Times-Roman 10 pt font, with single (12 pt) spacing. Main body of text in two columns separated by 0.25". One line space between paragraphs.

Margins: Top - title page: 1.25"; other pages, 0.75"; bottom, 1" minimum; sides, 0.75".

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Abstracts: English and French versions. Headings, 12 pt bold, upper case, centered. Indent text 0.5" on both sides.

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Page numbers: In light pencil at the bottom of each page.

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DIRECTIVES A L'INTENTION DES AUTEURS PREPARATION DES MANUSCRITS

Soumissions: Le manuscrit original ainsi que deux copies doivent être soumis au rédacteur-en-chef.

Présentation générale: Le manuscript doit comprendre le collage. Dimensions des pages, 8.5" x 11". Si vous avez accès à un système de traitement de texte, dans la mesure du possible, suivre le format des articles dans l'Acoustique Canadienne 18(4) 1990. Tout le texte doit être en caractères Times-Roman, 10 pt et à simple (12 pt) interligne. Le texte principal doit être en deux colonnes séparées d'un espace de 0.25". Les paragraphes sont séparés d'un espace d'une ligne.

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Auteurs/adresses: Noms et adresses postales. Lettres majuscules et minuscules, 10 pt à simple (12 pt) interligne. Centré. Les noms doivent être en caractères gras.

Sommaire: En versions anglaise et française. Titre en 12 pt, lettres majuscules, caractères gras, centré. Paragraphe 0.5" en alinéa de la marge, des 2 cotés.

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