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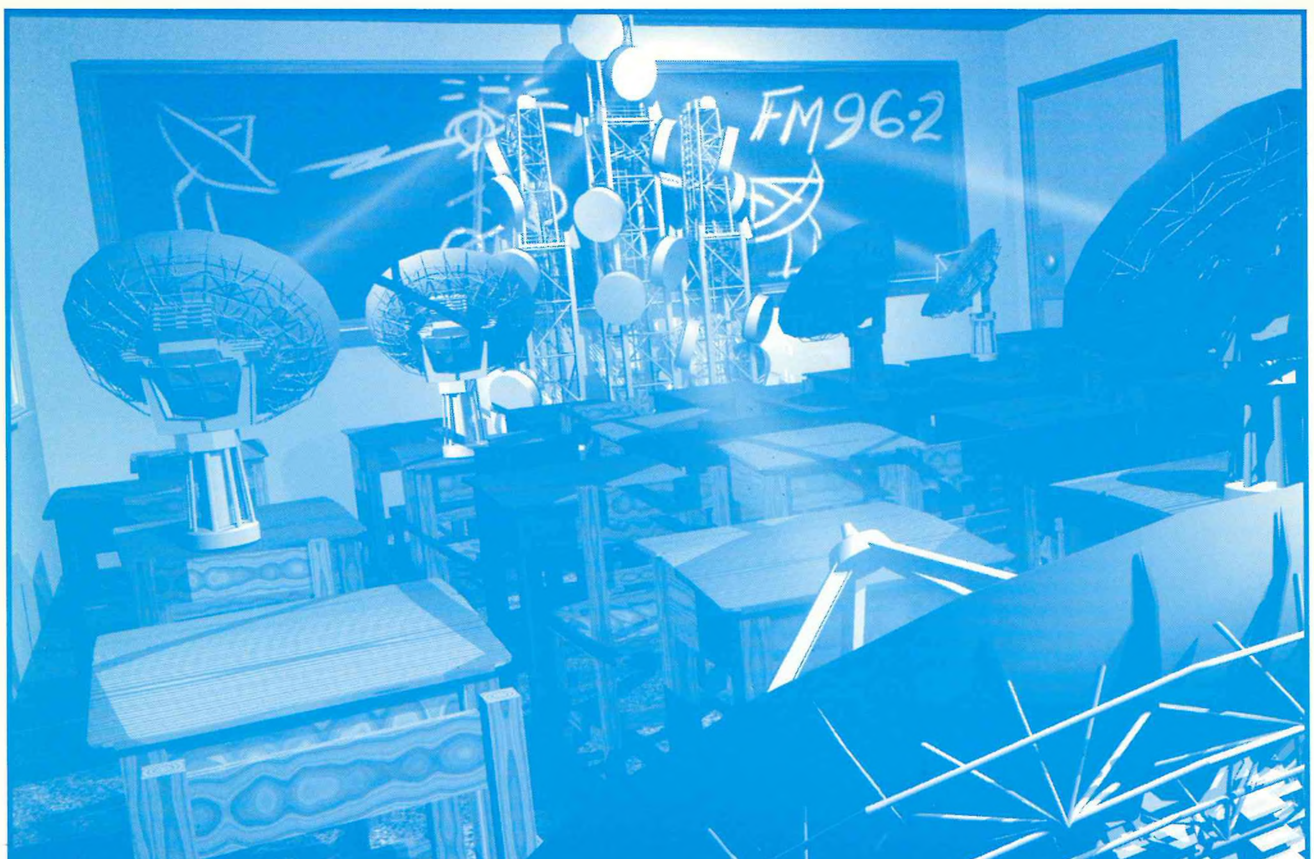

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ÉDITORIAL / EDITORIAL

Dans ce numéro, vous trouverez des articles de recherche portant sur les bénéfices des systèmes d'amplification auditive FM dans les salles de classe, sur la localisation auditive et sur la perception des phonèmes de la parole.

Dans le numéro de juin 1995 de l'*Acoustique Canadienne*, j'ai publié le rapport final du groupe de travail du I-INCE sur la réglementation du bruit de travail. Lors de la réunion de directeurs de l'ACA en juin, l'on a remarqué que quelques controverses sont associées aux rapports des groupes de travail de I-INCE. Les pays membres de I-INCE sont appelés à voter pour entériner ces rapports. Cependant, les pays membres de I-INCE, qui sont aussi membres des organismes de normalisation tel que ISO, peuvent se retrouver en conflit d'intérêts s'ils jugent que les rapports sont en contradiction avec les normes. L'ACA est dans cette situation et sollicite la réaction de ses membres sur ce qui devrait être fait. Consultez la page 31 pour plus de détails.

Enfin, il n'est pas trop tard pour soumettre un résumé pour la Semaine canadienne d'acoustique 1997. Un second appel de communications est publié aux pages 33. Nous vous invitons à faire parvenir votre résumé, si vous ne l'avez pas déjà fait.

Published in this issue you will find research articles on the benefits of FM sound-amplification systems in classrooms, on sound localization and on the perception of speech phonemes.

In the June 1995 issue of *Canadian Acoustics*, I published the report of the I-INCE Working Group on occupational-noise regulation. At the recent CAA Directors' meeting it was noted that some controversy has arisen with respect to this and subsequent similar reports. Member countries of I-INCE are asked to vote on 'accepting' these reports. However, member countries which are also members of standards organizations, such as ISO, can find themselves in a conflict of interest if they judge that the reports conflict with standards. Canada and the CAA are in this position. The CAA is therefore sollicting members' reactions to this problem. Consult page 31 for more details.

It is not too late to submit a paper to Acoustics Week in Canada 1997. A second Call for Papers is included in this issue on page 35. I invite you to submit a paper if you haven't done so already.

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CLASSROOM USE OF FM SYSTEMS WITH HEADSETS BY CHILDREN WITH MILD, FLUCTUATING, OR UNILATERAL HEARING LOSS

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ABSTRACT

Twenty school-age children with hearing loss that was minimal (16 to 25 dBHL) to mild (26 to 40 dBHL), fluctuating conductive, or unilateral were fit with personal FM systems with lightweight headsets for a two-month trial period in their classrooms. At the end of the trial period, the classroom teacher evaluated change in the child's classroom performance. This measure was used to evaluate the success of the trial. Prior to the trial period, the classroom teacher completed an evaluation of the child's classroom performance, and the children were tested by an audiologist in the soundbooth in unaided and aided conditions. The pre-trial measures were considered for their possible value in predicting which children would be successful users of the equipment. The FM system with headset was found to be beneficial for about 80% of the children. However, there was no single pre-trial indicator or combination of indicators that could be used to predict who would or would not be a good candidate for long-term use of the equipment. These findings suggest that before making a final decision regarding the suitability of an FM system with headset for use by a child, it is necessary to consider pre-trial factors (type of classroom, classroom behavior, academic performance, audiometric results, and personal factors), as well as evidence gathered during a trial period. Furthermore, since most children showed some benefit from the signal-to-noise enhancement provided by the equipment, another long-term strategy may be to design classrooms which are less acoustically hostile. A cost-benefit analysis of these alternatives should be undertaken.

ABRÉGÉ

Vingt enfants d'âge scolaire ayant une perte auditive conductive fluctuante, ou une perte unilatérale allant de minimale (16 à 25 dBHL) à légère (26 à 40 dBHL), furent équipés de systèmes individuels à modulation de fréquence et d'écouteurs légers pour une période d'essai de deux mois dans leurs classes. À la fin de la période d'essai le professeur évalua les variations de la performance en classe de chaque enfant. Avant le début de la période d'essai, le profeseur évalua également la performance scolaire de l'enfant et un test auditif, avec et sans amplification, fut administré à chaque enfant par un audiologiste. Pour prédire quels enfants pourraient bénéficier de l'usage de cet équipement il a été tenu compte du potentiel prédictif des mesures préalables à l'essai. Le système à modulation de fréquence avec écouteurs s'est révélé bénéfique pour environ 80% des enfants. Par contre il a été impossible de trouver un seul indicateur préalable à l'essai, ou un groupe d'indicateurs, qui permette de prédire qui pourrait être ou non un bon candidat pour utiliser cet équipement. Ces résultats suggèrent qu'il est nécessaire de tenir compte aussi bien des facteurs préalables à l'essai (genre de classe, comportement en classe, performance scolaire, résultats audiométriques et facteurs personnels), que des preuves amassées durant la période d'essai avant d'établir une décision finale sur le bien fondé de l'utilisation par un enfant d'un système à modulation de fréquence et écouteurs. Étant donné que la plupart des enfants ont bénéficié de l'amélioration du signal par rapport au bruit, il est suggéré qu'une autre stratégie serait de concevoir des salles de classe moins hostiles sur le plan acoustique. Il serait bon d'entreprendre une étude des coûts par rapport aux bénéfices apportés par cette autre solution.

1. INTRODUCTION

There are hearing-impaired children in schools today for whom hearing aids and traditional FM systems would not usually be recommended. These include children with the following kinds of hearing loss: minimal or slight hearing loss (16 to 25 dBHL); unilateral hearing loss; and fluctuating conductive hearing loss. Due to the nature of their hearing problems, these children may experience little difficulty in ideal listening conditions; however, they may have difficulty understanding speech in the unfavourable listening conditions typical of classrooms.

In classrooms, communication is primarily auditory-verbal, with visual information supplementing spoken information. Information is presented in spoken language with the presumption that students can hear what the teacher says. It has been noted that children spend at least 45% of the school day engaged in listening activities (Berg, 1987). Listening is often mentioned by teachers as a crucial skill for classroom success (Flexer, Wray & Ireland, 1989). In addition, children are expected to participate in interactive communication activities where difficulties in listening are likely to jeopardize the appropriateness and acceptability of their contributions.

In a recent study by Crandell (1993), children with minimal sensorineural hearing loss obtained poorer sentence recognition scores than normal-hearing children in most listening conditions. As listening conditions became more adverse, the performance of both groups declined, but the decline was more marked for those with minimal hearing loss. Therefore, we would expect that even children with only a minimal hearing loss will experience difficulty understanding speech in noisy conditions. Furthermore, it has been noted by Bess (1986) that a mild or unilateral hearing loss can cause significant academic problems.

Berg (1993) points out that in a typical classroom it is not uncommon for background noise levels to reach 55 to 75 dBA when a teacher and 25 or more students are present. He further states that for students to hear effectively, the noise levels for an occupied classroom should not exceed 40 to 50 dBA. Besides background noise, other factors, such as signal-to-noise ratio, reverberation time, and the distance between the listener and the talker may further undermine the quality of transmission of the speech signal, with listeners consequently experiencing further difficulty understanding speech.

Preferential seating, or having the child sit as close to the talker as possible, has often been recommended as a means to overcome the poor listening conditions of the classroom. Such preferential seating, however, is insufficient to overcome the adversity of the acoustical conditions in the classroom. Flexer and her colleagues (1989) stated that although a hearing-impaired child may detect the teacher's voice and perceive the teacher's intonation patterns, the fine detail of individual speech sounds may still not be heard clearly enough to allow the child to differentiate one word from another. The negative effects of a typical classroom environment on the integrity of the speech signal have been demonstrated by Leavitt and Flexer (1991). Using the Rapid Speech Transmission Index (RASTI) System to measure the effect of a quiet listening environment on a speech-like signal, they obtained results indicating that, even when a child is seated in a front-row seat, the loss of critical speech information can be significant.

In the absence of architectural solutions to improve classroom acoustics, the use of assistive listening devices, such as a personal FM system, offers a way to enhance signal transmission for a listener. Historically, FM systems have been fit on children with severe-to-profound hearing loss and used as either a primary source of amplification or as a supplement to a personal hearing aid fitting. Recently, personal FM systems with lightweight headphones have been recommended for use in the classroom by children with minimal, fluctuating, or unilateral hearing loss (Crandell, 1993; Cargill & Flexer, 1991; Kopun, Stelmachowicz, Carney & Schulte, 1992; Maxon, 1992).

When an FM system is used in a classroom situation, the teacher wears a microphone that picks up his or her voice at close range. The acoustic speech signal is converted to an FM signal that can be transmitted across the room to a child wearing an FM receiver. The received signal is then converted back to a sound signal that is delivered over the headset. There are two advantages of using an FM system: the amount of speech energy that is lost due to transmission of the signal over distance is minimized, and the FM-transmitted signal is not degraded like an acoustic signal would be degraded during transmission through a noisy and highly reverberant classroom. Note that the FM systems in question differ from traditional FM systems because they provide little or no amplification of the signal. Moreover, in contrast to traditional FM fittings, FM systems with headsets do not eliminate the listener's reception of signals from other sources (Kopun et al., 1992). For example, the teacher's voice can be transmitted from the other side of the classroom by the FM unit while, at the same time, the child is still able to hear the voice of a nearby classmate.

A study was undertaken in Spring 1994 in the Lower Mainland area of British Columbia to assess the use of personal FM systems with headsets by hearing-impaired school-aged children who were not considered, according to existing provincial ministry guidelines, to be candidates for either hearing aids or traditional FM systems. Some children had previously tried amplification and rejected it.

The objectives of the study were to determine: 1. whether students would demonstrate improvement with the equipment on measures of classroom performance based on teacher observations; 2. whether benefit could be predicted from pre-trial measures obtained from teacher evaluations or audiologic measures; and 3. to make recommendations regarding the possible inclusion of FM with headset into an established protocol within the Auditory Training Equipment Program of the provincial Ministry of Education.

Table 1. Profile information about the children who participated in the study and the equipment fit on them

Child	Age	Grade	First Language	Hearing Loss	Exceptionality	Equipment
1	6	K*	English	permanent conductive		Telex
2	5	K*	English	mixed bilateral		Phonic Ear
3	5	K*	English	fluctuating conductive		Telex
4	7	1	English	fluctuating conductive	Down Syndrome	Phonic Ear
5	6	1	English	unilateral sensorineural		Telex
6	6	1	Chinese	bilateral sensorineural		Telex
7	6	1	Chinese	bilateral sensorineural		Telex
8	7	2	English	bilateral sensorineural	"gifted"	Phonic Ear
9	8	2	English	unilateral sensorineural		Phonic Ear
10	8	2	English	fluctuating conductive		Telex
11	9	3	English	mixed bilateral	Down Syndrome	Phonic Ear
12	8	3	English	fluctuating conductive	Down Syndrome	Telex
13	9	4	English	bilateral sensorineural	"gifted"	Phonic Ear
14	10	4	English	bilateral sensorineural		Phonic Ear
15	12	5	English	unilateral sensorineural	Vision Deficit	Telex
16	10	5	English	bilateral sensorineural		Telex
17	11	6	English	bilateral sensorineural	Learning Disabled	Phonic Ear
18	12	7	English	fluctuating conductive		Phonic Ear
19	13	7	English	permanent conductive		Telex
20	13	8	Chinese	bilateral sensorineural		Phonic Ear

* Kindergarten

2. METHOD

2.1 Participants

Twenty hearing-impaired elementary school children participated in the study (Table 1). Criteria for participant selection were: 1. bilateral minimal-to-mild hearing loss from .500 to 3 kHz, a fluctuating mild-to-moderate or unilateral hearing loss; 2. no current use of any amplification or assistive listening device in the classroom or at home; 3. consent of the child, parents, and teacher. Any child seen for an educational audiology assessment at the Burnaby, Simon Fraser, or Vancouver Health Units within the one-month intake period of the project who met the selection criteria was included. Ages ranged from 5 to 13 years and grades ranged from kindergarten to grade 8. Three of the children were learning English as a second language and five had additional disabilities, including Down Syndrome, visual impairment, and learning disabilities. Two children were identified by their teachers as being "gifted". The heterogeneity of the group is representative of the children with the kinds of hearing loss of interest who were enrolled in elementary schools in the district.

2.2 Equipment

Two commercially available personal FM systems, a Phonic Ear Easy Listener (PE300T transmitter, PE300R receiver with AT606 Walkman-style headset), and a Telex Sound Enhancement System (TW6AA transmitter, AAR-10 receiver with GenEXXA HP-110 light-weight headphones) were used for aided performance measures in the soundbooth and for the classroom trials. Both systems were set to provide signal enhancement but not amplification. The Phonic Ear system was set with output compression having a kneepoint of 78 dBSPL such that no compression was expected for normal speech input. The Telex system was set with the compression off. Two different brands of FM systems with headsets were used because our intention was to evaluate the general type of system and not to evaluate any one brand or to compare brands.

2.3 Design of the Study

All children were recruited and underwent a pre-trial audiologic evaluation at one of the three participating clinics within a one-month intake period at the beginning of the final term of the school year. The regular classroom teacher of each child completed a pre-trial evaluation of the child's classroom performance. The children then underwent a two-month trial with one of the two brands of FM system with headset[1]. An equal number of each of the two brands were fit, with the brand being randomly assigned to the child (Table 1). Benefit from the use of the device was evaluated post-trial based on the teacher's subjective rating of change in the child's classroom performance.

2.4 Procedures

Pre-trial Soundbooth Clinical Procedures. Children were evaluated by routine methods in one of the government audiology clinics in the Greater Vancouver Regional District. Special procedures to evaluate the performance of the children with the FM system with headset included a comparison of their unaided and aided speech reception thresholds (SRTs) and their unaided and aided speech discrimination scores measured in the soundfield in conditions of competing noise.

SRTs for spondee words presented in noise (with competing 8-talker babble presented at 65 dBHL) were obtained by determining the level of presentation of the speech at which the words were heard 50% of the time. The stimuli were those described by Cheesman (1992).

Speech discrimination scores, the percentage of monosyllabic words in a list that were correctly identified by the listener, were obtained unaided in the soundfield under two conditions of competing noise: 1. at a signal-to-noise ratio (S:N) of +10 dB (speech presented at 75 dBHL; noise presented at 65 dBHL); 2. at a S:N of 0 dB (speech presented at 65 dBHL; noise presented at 65 dBHL).

The sources of signal and babble were arranged to simulate diotic rather than dichotic listening conditions. Specifically, the speech signal always originated from a loudspeaker located at 0^0 (directly in front of the child) and the competing babble always originated from another loudspeaker located either over the child's head or at 180^0 (directly behind the child). Whenever possible NU6 word lists were employed; however, some young children and children with minimal English were tested using the PBK-50 (Haskins, 1949) or NU-CHIPS (Elliott & Katz, 1980) word tests. The vocabulary used in the latter tests is simpler because the words have been selected to be age-appropriate for younger children[2].

FM-aided soundfield measures were obtained with the volume control of the FM unit set at the user's comfort level. The microphone for the FM system was placed at a calibrated spot in front of the loudspeaker from which the signal emanated. To locate the calibrated spot, the following steps were followed: 1. a 1-kHz warbled pure tone was presented through the loudspeaker with the audiometer set at a dial reading of 65 dBHL; 2. a measurement was taken with a sound-level meter at the position of the child's head; 3. the sound level was measured at positions closer and closer to the loudspeaker until a 20 dB increase over the level measured at the position of the child's head was achieved. By placing the microphone of the FM unit at this spot, it would pick up the signal at a level 20 dB higher than the level arriving at the child's ear, thereby approximating the FM advantage when the lapel microphone is placed within 6 to 8 inches of a talker's mouth (Maddell, 1992).

FM-aided soundfield SRTs were measured in noise using the same procedures that were used in the unaided condition described above, except that the child wore the FM unit (the microphone was placed at the calibrated spot). FM-aided speech discrimination scores were obtained with the speech and competing babble both set to 65 dBHL on the dial of the audiometer (for one child, due to tester error, speech discrimination was not tested in the aided condition). Since the FM microphone was placed nearer to the loudspeaker delivering the speech and farther from the loudspeaker delivering the competing babble, the input to the microphone was at least +20 dB S:N.

Pre-trial Subjective Ratings by Teachers. Prior to the trial with the FM units, the classroom performance of each child was rated by his or her regular classroom teacher using the Screening Instrument For Targeting Educational Risk (SIFTER; Anderson, 1989). The purpose of the SIFTER is to provide a valid method by which children with hearing problems (either known or suspected) can be educationally screened. The SIFTER has been demonstrated to have good content validity for this purpose based on information from the literature, initial teacher review, and two years of teacher evaluation of content areas and question items; based on an evaluation of over 500 students with hearing loss, it was also found to have moderate content reliability (Anderson, 1989). Our interest in administering the SIFTER was to determine if it could be used to predict whether or not a child would benefit from an FM system with headset and to guide initial recommendations regarding equipment use.

The SIFTER (Anderson, 1989) is a 15-item questionnaire which provides a performance rating for five content areas (academic, attention, communication, participation, behaviour). The teacher rates the child's performance against classroom peers for each item using a five-point scale. The total score for each content area, based on three questions per area, is categorized as "pass", "marginal", or "fail". Anderson recommends that children be evaluated by an educational audiologist if they fail in the attention and/or class participation content area in combination with failures on any of the other content areas. She suggests that children falling into the "marginal" area are at risk and should be monitored or assessed depending on additional information.

Post-trial Subjective Ratings by Teachers. An evaluation was carried out immediately following the conclusion of the FM classroom trial using a fifteen-item FM Evaluation Questionnaire that was completed by the classroom teacher. The questionnaire was designed in-house for the project. The questions were formulated by eight audiologists based on clinical experience discussing with teachers how FM systems were used by children in classrooms and using similar existing questionnaires (e.g. the MARRS Project Questionnaire, Sarff, 1981). The FM Evaluation Questionnaire was used to determine whether or not teachers noticed any change in performance that might be attributable to use of the FM system with headset. Teachers were asked for a numerical rating from 1 to 5 (none to very) on eleven items, indicating degree of change in classroom behaviour and academic performance (Appendix A). Qualitative comments on the reactions of fellow students, the child's own reactions, problems understanding or operating the equipment, and general impressions were also gathered.

3. ANALYSIS

Prior to implementing the study, the investigators arrived at a consensus that, in their professional judgement, an average rating of 3.0 ("some improvement") or greater on the FM

Evaluation Questionnaire would be considered to be a clinically or educationally significant indication of benefit (see Green & Kreuter, 1991 for a discussion of standards of acceptability in program evaluation, p. 218). The children who achieved an average rating of 3.0 were considered to have benefited enough from the device that a recommendation for continued use would be warranted.

We also considered how well the pre-trial measures might serve us in trying to predict which children would benefit from long-term use of an FM system. We decided that we would take an improvement of 10 dB or more on the SRT in noise measure, or an improvement of 20% or more on the speech discrimination measure, as evidence that a child was deriving enough signal enhancement from the device in the conditions tested in the soundbooth that it was reasonable to hope for improvements if the device were worn in a classroom situation. According to Berg (1993), even in a relatively good classroom with ambient noise at a level of 55 dBA, it would still be advisable to have a 5 to 15 dB enhancement of signal-to-noise ratio; a 10 dB improvement would fall midway in this range. Differences between speech discrimination scores may be significant if they reach between 4 and 30%, depending on factors such as the number of words in the list and the baseline score (Skinner, 1988, p. 296). Given these guidelines, for our materials and subjects, a difference in speech discrimination scores in quiet was not considered to be significant until it reached 20%. Measures that would help in predicting benefit could be incorporated into any new protocols that might be recommended to the Ministry of Education.

4. RESULTS

4.1 Post-trial FM Evaluation Questionnaire

FM Evaluation Questionnaires were completed for 18 children. One child refused to complete the trial. The teacher of another student did not feel that there had been enough opportunity to observe the child's performance with the FM system although she commented that she felt the child would benefit and that the trial should be continued. Fourteen (78%) of the 18 children who were evaluated achieved an overall rating of 3.0 ("some improvement") or greater on the questionnaire. The overall mean total score for the eleven items rated on the five-point scale was 3.5 (<u>SD</u> = $\pm$ 0.7), with the mean score on all but one of the items being at least 3.0 (Table 2).

There were an additional four questions asking for the teachers' and students' qualitative comments about their impressions and experiences with the FM system. For example, for all but one of the children, a comment was provided in response to Item 12, relating to the reaction of fellow students to the device, and only one of the 18 comments suggested a negative reaction. A typical comment was "Students were all quite impressed and C seemed to like being a bit of a celebrity (he's normally quite shy)."

Item 13, which concerned the child's own reaction to using the unit, also evoked favourable comments from 16 of 18 respondents. Two children, although finding some benefit in using the devices, felt that they would not want to use a device on a full-time basis. Both children were identified as "gifted" and were doing very well in school despite their hearing problems.

Of the 17 teachers who responded to Item 14, none found the equipment difficult to understand or operate, although there were some complaints about the physical quality of the lightweight headsets. Three teachers complained that the headsets were of questionable quality, broke easily, and were a poor fit on small heads.

Of the 17 teachers reporting general impressions in response to Item 15, 15 were strongly in favour of the use of FM systems in the classroom, and the two who taught the "gifted" children were supportive but found it difficult to evaluate the contribution of the device because the children were already at the "top of their class". Comments like the following were common "E.... loved the unit. She became a lot happier and animated in class. She smiled a lot when I was talking just to her. I hope she has access to the unit next year. It was a very rewarding experience for both of us."

4.2 Pre-trial Soundbooth Clinical Measures

<u>SRT in Noise</u>. The mean SRT in noise in the aided condition was 34.7 dBHL (<u>SD</u> = $\pm$ 7.7 dBHL); for the unaided condition it was 48.2 dBHL (<u>SD</u> = $\pm$ 7.9 dBHL). Thus, the average improvement was 13.5 dB. Fourteen (70%) of the children showed improvements of at least 10 dB (Table 3). Furthermore, the improvement in group performance was shown to be significant by a t-test for matched pairs [$t(18) = -7.06$, $p < .001$].

Of the 14 children who showed an improvement of at least 10 dB on the SRT in noise measure, 11 achieved a rating of at least 3.0 on the FM Evaluation Questionnaire, two others were not rated, and one achieved a rating less than 3.0. The one who showed an improvement of at least 10 dB on the SRT in noise measure, but who achieved a rating less than 3.0 on the FM Evaluation Questionnaire, was a child with learning disabilities. There were also three children who achieved a rating of at least 3.0 on the FM Evaluation Questionnaire who did not show an improvement of at least 10 dB on the SRT in noise measure; two of these three were very young children who did not speak English as their native language.

<u>Speech Discrimination in Noise</u>. The mean score for speech discrimination measured in the aided condition (equivalent to +20 dB S:N) was 92.3% (<u>SD</u> = $\pm$ 7.8%). The mean score for speech discrimination measured in the two unaided conditions was 89.8% (<u>SD</u> = $\pm$ 11.2%) in the +10 dB S:N condition, and 81.8% (<u>SD</u> = $\pm$ 13.5%) in the 0 dB S:N condition (Table 3). The difference between the mean scores obtained in the aided condition and in the two unaided

Table 2. Mean improvement in children's' performance as rated by teachers on the post-trial FM Evaluation Questionna

Question	Rating (mean ± SD)	Number of respondents
1	3.8 ± 0.8	18
2	3.6 ± 0.8	18
3	3.7 ± 1.2	18
4	3.2 ± 0.9	17
5	3.3 ± 0.9	10
6	3.2 ± 0.6	17
7	3.2 ± 1.2	17
8	4.2 ± 0.9	18
9	3.0 ± 1.0	12
10	3.2 ± 1.0	18
11	2.9 ± 1.5	15
Total	3.5 ± 0.6	18

Table 3. Comparison of pre- and post-trial measures for individual children

	FM evaluation	SIFTER	Unaided-aided differences in soundbooth measures	
Child	Overall rating	Recommendation	SRT in noise (dB)	Speech discrimination score (%)
1	3.4*	monitor	18*	24*
2	4.2*	monitor	11*	7
3	4.2*	intervention	10*	5
4	3.8*	not rated	17*	16
5	3.2*	intervention	20*	-8
6	3.3*	monitor	8	8
7	3.7*	intervention	3	20*
8	2.6	no intervention	5	4
9	3.3*	monitor	16*	0
10	3.6*	intervention	2	4
11	4.0*	intervention	22*	24*
12	3.1*	intervention	15*	25*
13	2.5	no intervention	4	-4
14	4.0*	no intervention	12*	20*
15	2.8	intervention	0	0
16	not rated	no intervention	10*	12
17	2.3	intervention	19*	18
18	4.4*	monitor	11*	8
19	did not complete trial	intervention	28*	not tested
20	4.8*	monitor	30*	20*

* Children who demonstrated a clinically significant difference.

conditions were 2.9% and 10.5% respectively. Only when aided performance was compared to performance in the 0 dB S:N condition was improvement shown to be significant by a t-test for matched pairs [$t(18) = 4.32$, $p < .001$].

Six children (32%) showed improvements of 20% or greater when the aided speech discrimination score was compared to unaided performance in the noisiest condition. Of these six, all achieved a rating of at least 3.0 on the FM Evaluation Questionnaire. Five of the six also showed an improvement of at least 10 dB on the SRT in noise measure, and the one who did not was learning English as a second language. There were, however, eight children who achieved a rating of at least 3.0 on the FM Evaluation Questionnaire who did not show an improvement of at least 20% on speech discrimination in noise; there does not appear to be any particular subject characteristic common to these children.

4.3 Pre-trial Subjective Ratings by Teachers

The SIFTER was completed for 19 of the 20 children in the study. One child with Down Syndrome was not rated because the teacher felt that the child's level of function in the classroom was too low for it to be appropriate to make a comparison between this child and other children in the class[3]. The number of children who fell into the "fail" or "marginal" categories prior to the trial with the FM system were as follows: 11 (58%) in the academic area; 14 (74%) in the attention area; 14 (74%) in the communication area; 9 (47%) in the participation area; 10 (53%) in the behaviour area. Following Anderson's (1989) recommendations, follow-up by an educational audiologist was indicated for eight (42%) of the children, monitoring was indicated for an additional seven (37%), and no further intervention was

Table 4. SIFTER ratings by teacher of child's classroom performance

Child	Content Area				
	Academic	Attention	Communication	Participation	Behaviour
1	Pass	Marginal	Marginal	Pass	Marginal
2	Fail	Marginal	Marginal	Marginal	Marginal
3	Fail	Fail	Pass	Marginal	Fail
4	Not Rated				
5	Fail	Fail	Fail	Fail	Fail
6	Pass	Marginal	Marginal	Pass	Pass
7	Fail	Marginal	Fail	Pass	Pass
8	Pass	Pass	Pass	Pass	Pass
9	Pass	Pass	Marginal	Pass	Pass
10	Pass	Marginal	Fail	Pass	Fail
11	Fail	Fail	Fail	Fail	Fail
12	Fail	Fail	Fail	Marginal	Fail
13	Pass	Pass	Pass	Pass	Pass
14	Marginal	Pass	Pass	Pass	Pass
15	Marginal	Marginal	Fail	Fail	Marginal
16	Pass	Pass	Pass	Pass	Pass
17	Fail	Fail	Fail	Fail	Fail
18	Marginal	Marginal	Marginal	Marginal	Pass
19	Marginal	Fail	Marginal	Pass	Marginal
20	Pass	Marginal	Marginal	Marginal	Pass

indicated for the other four children (21%). Individual profiles on the SIFTER can be seen in Table 4.

Of the 14 children who received an overall rating of at least 3.0 on the FM Evaluation Questionnaire, following Anderson's (1989) recommendations, six would have received intervention, six would have been monitored, one would have received no intervention, and one child who had Down Syndrome would not have been rated. Of the four children who did not satisfy the criterion for success on the FM Evaluation Questionnaire, according to Anderson's (1989) recommendations, two should have received intervention, and two should have received none.

5. DISCUSSION

Our first objective was to determine if the children who participated in the study would benefit from wearing an FM system in the classroom. Benefit, as measured subjectively using the teacher's rating of improvement in classroom performance over the trial period, was demonstrated by the majority (78%), but not all, of the children who participated in the study. Furthermore, on pre-trial, objective, audiologic measures, 14 children (70%) showed at least a 10 dB improvement in SRT in noise, and six children (32%) showed improvements of at least 20% in speech discrimination scores in noise when the FM system with headset was worn.

These results provide evidence that the majority of students with minimal-to-mild, fluctuating conductive, or unilateral hearing loss can be expected to benefit from wearing an FM system with headset in the classroom. Although conventional hearing aids or traditional FM systems were not indicated for these cases according to existing provincial ministry guidelines, the potential usefulness of an assistive listening device such as an FM system with headset is supported by both subjective and objective measures of performance.

Our second objective was to determine if pre-trial audiometric measures or teacher ratings could be used to distinguish between children who would or would not be likely to benefit from wearing an FM system with headset.

Of the 14 children who were rated post-trial and who did receive an overall rating of at least 3.0 on the FM Evaluation Questionnaire, 11 showed an improvement of at least 10 dB on the SRT in noise measure and six showed an improvement of at least 20% on the speech discrimination test. Of the four children who were rated post-trial and who did *not* receive an overall rating of at least 3.0 on the FM Evaluation Questionnaire, only one (the child with learning disabilities) showed an improvement of at least 10 dB on the SRT in noise measure, and none showed an improvement of at least 20% on the speech discrimination in noise test.

Of the audiometric measures, SRT in noise seems to be more useful than speech discrimination for identifying those who will benefit from an FM system with headset. Had a criterion of a 10 dB improvement in SRT in noise been adopted to determine which children would receive a trial with the FM system with headset, 14 would have been correctly categorized: 11 children who benefited would have been fit, and three (# 8, # 13, # 15) who did not benefit would not have been fit. However, four children would have been incorrectly categorized: one child (with learning disabilities, # 17) would have been fit who did not benefit, and, of greater concern, three children who did benefit would not have been fit. Of the three who would not have been fit, two (# 6 and # 7) were young children who did not speak English as a native language. There is no obvious explanation for why the other child (# 10) did not show an improvement on SRT in noise even though the teacher felt that the child had shown improvement in classroom performance. Perhaps the teacher of this child was influenced by expectations regarding the usefulness of the equipment. Overall, we concluded that pre-trial measures of SRT in noise could be used to identify most children who would benefit from wearing an FM system; however, audiometric measures based on speech perception should not be used to decide against a trial with an FM system with headset for very young children who are learning English as a second language. Such audiometric measures may also not be sufficient to ensure benefit in the case of children, such as the child with a learning disability, who have conditions other than hearing loss that affect their classroom performance.

It is noteworthy that most of the children had pre-trial classroom difficulties, as reported by the teachers on the SIFTER, in one or more areas (academic, attention, communication, participation, behaviour). The pre-trial classroom profiles that were reported by the teachers would have triggered intervention for nine children (47%), monitoring for six (32%), but no intervention for four (21%).

Had we used the SIFTER to decide which children would receive a trial with an FM system with headset, adopting a decision rule to fit all of the students for whom Anderson (1989) would recommend intervention *or* monitoring, then 15 would have been correctly categorized and three would have been incorrectly categorized. Using this decision rule, 13 of the 14 children who benefited from wearing the FM system with headset would have received a trial, but devices would also have been fitted on two children who did not benefit from them. In one of these cases (# 15), the child did not meet the criteria for change in SRT in noise; and the other case (# 17) was the child who likely did not benefit from the FM system because of a learning disability. Only one child who benefited would not have been given a trial (# 14). Note that this child would have been fitted with an FM system with headset if we had based our decision on change in SRT in noise. In addition, we would have correctly decided *not* to try the FM system with headset on two children (# 8 and # 13) whose teachers rated them as not benefiting from the device, both of whom were considered by the teachers to be "gifted" students and both of whom showed less than a 10 dB improvement on SRT in noise.

Overall, decisions based on the SIFTER and the SRT in noise measure were both helpful but not perfect for determining who would or would not be likely to benefit from the use of an FM system with headset. The objective SRT in noise measure and the subjective SIFTER measure had similar test sensitivity and specificity. Decisions based on the SIFTER would have resulted in slightly more devices being fit, including more on those who showed post-trial benefit and those who did not. In contrast, decision based on the SRT in noise are would have been more conservative and resulted in fewer devices being fit, both on those who showed no post-trial benefit and those who did. Those *not* likely to benefit from an FM system with headset because they are already excellent students, would have been correctly identified on the basis of either measure. It could be argued that such students may indeed benefit from an FM system, but that it is difficult to assess their benefit using either teacher ratings or audiometric measures because they are performing so well unaided. The only subject who did not benefit from the FM system with headset, and who would not have been identified as a poor candidate by the subjective or objective measures, was a child with a learning disability; neither measure was useful in predicting if benefit would be achieved by this child. It is possible that it is difficult to appreciate benefit in a case like this one because the child is performing at floor due to other problems that are unsolved by assistive listening devices. Not surprisingly, because the SRT in noise measure uses speech materials, it was not as helpful as the SIFTER in predicting benefit from the device for very young children who were learning English as a second language. In contrast, other children with special needs, such as the children with Down Syndrome, and older children learning English as a second language, did benefit from the FM system with headset and there was agreement between audiometric and teacher ratings for these cases.

It is interesting that there was a lack of any significant correlation between the objective or subjective pre-trial measures and the post-trial measures, indicating that the assessment instruments used in this study with these participants were not predictive of degree of benefit. Subjects who showed good benefit in the soundbooth did not always receive proportionately high ratings for improved performance in the classroom. Conversely, while good performance in the soundbooth did not guarantee success with the device, relatively good performance on the SIFTER did not prohibit success. For example, teachers judged that performance improved significantly for all subjects who performed well enough on the SIFTER to be recommended for monitoring rather than intervention. Clearly, individual differences in the personalities of the children, their academic performance, their exceptionalities, and the specific classroom settings all played a role in the outcomes of the trials. The impact of these factors could not be precisely predicted by the SIFTER or soundbooth evaluations and only became apparent during the actual trial in some cases. Especially in the cases of the exceptional children, a trial period would clearly be needed in addition to pre-trial measures. Although the sample size studied is small, the results highlight the importance of taking all factors into consideration when audiologists and teachers contemplate the fitting of an FM system.

It seems that FM systems with headsets can provide effective assistance in the classroom for many children who suffer from lesser degrees of hearing loss and for whom conventional amplification is inappropriate and preferential seating insufficient. Based on our findings, we recommended that FM systems with lightweight headsets be included as an option in the Auditory Training Equipment Program of the British Columbia Ministry of Education. Nevertheless, the recommendations were not implemented largely due to lack of available funding for the equipment.

Finally, because almost all of the children with these lesser degrees of hearing loss seem to benefit from the enhancement of signal-to-noise ratio provided by the equipment, we wonder if we would find that children with normal hearing would also benefit. Since classrooms are often acoustically hostile, and because spoken communication is so integral to classroom education, it seems important to consider that, for the long-term, it might be more cost-effective to improve classroom acoustics, or at least to build new classrooms with superior acoustical characteristics, than to purchase and maintain equipment for a large number of children who would not need assistance in more favourable listening conditions. In order to determine the best long-term solution, it would be necessary to conduct a cost-benefit analysis of the alternatives.

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7. FOOTNOTES

1. One child refused to complete a trial following assessment. A three-week strike by the teachers in one school district caused a disruption in the trials for approximately half of the children; however, all children did use the equipment for at least two months.
2. While the use of different tests would be unacceptable in tightly controlled experimental conditions, our purpose was to determine if the best available clinical measures could be used to determine benefit from the FM systems with headset. For each child, the same test was used in both aided and unaided conditions.
3. Teachers were comfortable rating all of the other children as required by the SIFTER.

8. ACKNOWLEDGEMENTS

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APPENDIX A

FM Evaluation

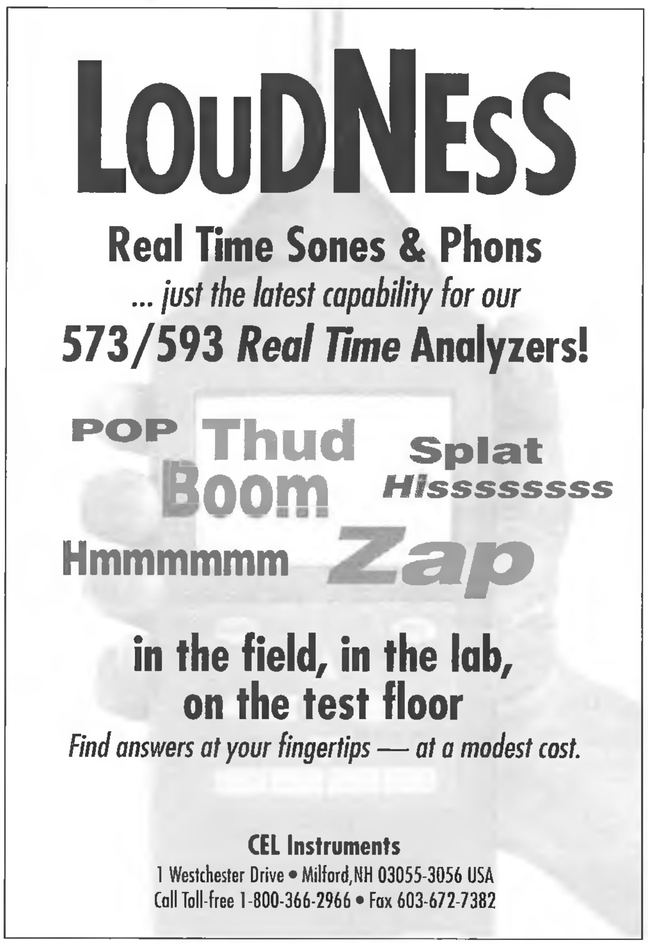
Student: ____________________ Date: ____________________

Equipment: ____________________ Class Size: ____________________

Teacher: ____________________ School: ____________________

Item	Question	None 1	2	Some 3	4	Very 5
1.	Helpful in improving student attention (i.e. listening to instructions)					
2.	Helpful in improving on task behaviour (i.e. following instructions)					
3.	Helpful in improving concentration of student during oral presentations					
4.	Helpful in improving class participation					
5.	Helpful in improving student test performance and achievement					
6.	Helpful in increasing the pace of instruction (i.e. less re-instruction)					
7.	Helpful in improving student attitude					
8.	Helpful in reducing teacher voice fatigue					
9.	Helpful in overcoming problem of interfering classroom noise					
10.	Helpful in classroom management (i.e. fewer problem behaviours)					
11.	Have you noticed any change in the student's attitude? (i.e. enthusiasm for school)					

12. Reactions of fellow students:
13. Student's own input:
14. Any problems understanding or working equipment?
15. Comments/General impressions:



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INDIVIDUAL DIFFERENCES IN, AND A COMPARISON OF, IDENTIFICATION AND SIMILARITY JUDGMENTS OF CONTEXT-CONDITIONED /S/ AND /ʃ/ PHONEMES

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ABSTRACT

Speech segments strongly influence the perception of adjacent speech segments. Such context effects provide interesting evidence of the interaction of acoustic information in the perceptual system. Studies that have dealt with such phenomena have focused on the effect of context on the label assigned to a phoneme, so that little is known about the **within-class** perception of context-conditioned phonemes. In the present study, the effect of vowel context on the perception of synthetic /s/- and /ʃ/-like frication noises was examined in two experiments. A two-alternative forced-choice identification task confirmed that identification of the fricative in a set of consonant-vowel syllables was influenced by the vowel context. In a second experiment, the perceptual similarity of pairs of fricatives whose identity was influenced by the vowel was estimated in a triadic comparison task. INDSCAL analyses provided three dimensions that could account for 80.9% of the observed variance. However, individuals differed greatly on the contribution of each dimension to their similarity judgments. For some listeners, judgments of perceptual similarity were strongly related to their identification judgments. For other listeners, similarity of the fricatives was related to the physical differences between the fricatives, regardless of whether the fricatives had been identified as the same consonant or not. These results indicate that listeners differ in their abilities to perceive differences between phonemes that have been assigned the same label.

SOMMAIRE

Des segments de discours influencent fortement la perception des segments de discours adjacents. De tels effects de contexte produisent une intéressante mise en valeur de l'interaction de l'information acoustique dans le système perceptif. Les études portant sur un tel phénomène se sont concentrées sur l'effet du contexte sur l'étiquette collée à un phonème, de telle sorte que l'on en sait peu à propos de la perception des phonémes conditionnés par le contexte à l'intérieur de la classe. Dans la présente étude, l'effet du contexte vocalique sur la perception des sons fricatifs tels que /s/ et /ʃ/ synthétiques a fait l'objet de deux expériences. Le travail d'identification d'un choix binaire a confirmé que l'identification de la fricative dans un éventail de syllabes consonne-voyelle était influencé par le contexte vocalique. D'après une seconde expérience, la similarité de perception des paires de fricatives dont l'identité était influencée par la voyelle a été estimée dans un projet de comparaison ternaire. Les analyses de l'INDSCAL ont mis en évidence trois dimensions qui pouvaient comptabiliser 80,9% de la variance observée. Cependant, les individus ont différé énormément pour la contribution de chaque dimension à leurs jugements de similarité. Pour certains auditeurs, les jugements de similarité de perception étaient fortement liés à leurs jugements d'identification. Pour d'autres auditeurs, la similarité des fricatives était liée aux differérences physiques entre les fricatives, qu'elles aient été identifiées comme la même consonne ou non. Ces résultats indiquent que les auditeurs diffèrent dans leurs capacités à percevoir des différences entre les phonèmes auxquels on a assigné la même étiquette.

The acoustic information that characterizes a phoneme varies with the context of the other phonemes surrounding it. For example, the phoneme /d/, when produced at the onset of a syllable, contains a brief noise burst and periodic energy. When the following vowel has a high-frequency second formant (F_2), the F_2 transition rises at the onset of the syllable (e.g., in /di/). When the vowel has a low F_2 (e.g., in /du/), the initial F_2 transition falls. The onset frequency and extent of the transitions can serve as reliable cues to the identity of the consonant (Liberman, et al., 1967). This dependence of the acoustic characteristics of a phoneme on the context in which it occurs is called context-conditioned variability.

As a consequence of the variability in the acoustic content of speech segments, it is often impossible to predict the phonemic identity of a particular acoustic pattern without also knowing the acoustic information (context) that precedes or follows the segment. Because a given phonemic distinction may be cued by several types of acoustic information distributed in time, two acoustic cues may compensate for one another; a change in one cue may be "cancelled" by a change in the other, thereby maintaining a constant phonetic percept.

Over a limited range of values, such cancellation effects have been demonstrated with a number of speech contrasts. For example, the "say" - "stay" distinction may be cued both by the duration of silence following the fricative /s/ and by the frequency of the first formant at the onset of voicing. When either of these cues is ambiguous, the other will cue the presence of /t/. However, a lengthening of the silent interval in a word that is perceived as "say," which normally would change what a listener hears to "stay," can be compensated by increasing the onset frequency of the first formant (F_1) so that the perception of "say" persists (Best, et al., 1981). Likewise, for a limited range of F_1 values and silent intervals, a higher F_1 will not produce the "stay" percept if the silent duration is shortened.

Phonetic context effects have been studied extensively in identification tasks in which phonemes are labelled in a forced-choice task (Repp, 1982, provides a review of these studies). With such tasks, listeners must select from a limited set of phoneme labels for their identification responses, even if the labels are not particularly appropriate to the phonemes. Because of the limited set of responses permitted in the identification task, listeners may adopt response strategies that assign the same labels to phonemes that are perceptually noticeably dissimilar. Little is known regarding the degree of perceptual similarity (or dissimilarity) among phonemes that have been assigned the same (or different) labels. The question arises whether the effect of systematically changing the phonemic context along an acoustic continuum is to create a perceptual continuum, which is then artificially partitioned because of the nature of the forced-choice task used to study it. Alternatively, the underlying percept may indeed be categorical and phonemes labelled as belonging to one phonemic category may indeed be perceptually more similar than stimuli that lie in opposite sides of a category boundary. If this is indeed so, it would have interesting ramifications for theories of speech perception because stimuli on either side of a phonemic boundary could clearly be acoustically more similar than within-category stimuli.

Support for the latter hypothesis, that context-conditioned phonemes within a category are perceptually more similar than across category phonemes, comes from studies of the discriminability of context-dependent phonemes (Bailey, et al., 1977; Oller, et al., 1991; Repp, 1981). In these studies, discriminability of phonemes is usually better for phoneme pairs that cross category boundaries than for those that lie within a category. Such results lend support to the notion that within-category stimuli are more similar than between-category stimuli. However, Repp (1981) identified two subgroups of listeners that performed differently in a fricative discrimination task. One group demonstrated the good cross-boundary and poor within-category discrimination reported in earlier studies. The other, smaller, group of listeners demonstrated good discrimination of within-category stimuli. Repp postulated that this group of listeners who did not respond to the fricatives in a categorical manner were able to listen to these stimuli as auditory, rather than phonetic objects.

In the present paper, the context-conditioning of phonemes was studied using both a traditional forced-choice identification task and a triadic comparison procedure that yielded a direct measure of perceptual similarity. The effect of vowel context on the perception of /s/ and /ʃ/-like frication noises was studied.

1. PERCEPTION OF /S/ AND /ʃ/

The perception of context-conditioned /s/ and /ʃ/ segments has been studied by a number of investigators (Abbs & Minifie, 1969; Kunisaki & Fujisaki, 1977; Mann & Repp, 1980; Mann, et al., 1985; Nittrouer & Studdert-Kennedy, 1987; Repp, 1981; Whalen, 1981; Yeni-Komshian & Soli, 1981). Kunisaki and Fujisaki (1977) used synthetic syllables produced by combining a frication-noise continuum (representative of /s/- and /ʃ/-like frication) with /a, e, o, u/ vowels. Japanese listeners labelled the consonants as either /s/ or /ʃ/. The boundary between /s/- and /ʃ/-labelled stimuli was at different fricative frequencies for different vowel contexts. The boundary shifted to lower fricative frequencies before rounded vowels, which contain lower second and third formants than do unrounded vowels. These results have been replicated with English-speaking adults (Mann & Repp, 1980; Repp, 1981; Whalen, 1981), with children as young as three years of age (Nittrouer & Studdert-Kennedy, 1987), and with vowel contexts that do not occur in the listeners' native language (Whalen, 1981).

The context-dependent perception of /s/ and /ʃ/ segments provides an ideal stimulus set to investigate the relationship between identification and similarity judgments. Not only have the acoustic variables that influence the perception been extensively studied, but also individual differences in the ability to discriminate fricatives embedded in different vowel contexts have been described (Repp, 1981). Stimuli can be created that vary along the two independent acoustic dimensions of frication frequency and vowel quality; within a range of each of these acoustic dimensions, identification of the fricative will be dependent on both of these acoustic dimensions. The phoneme categories will therefore be bounded by stimuli that contain acoustically-identical fricatives on one or the other dimension. A comparison of the perceptual similarity of stimuli that span the boundary, yet contain identical frication noises, versus stimuli that lie to one side of the boundary therefore can be made.

2. TRIADIC COMPARISONS

Triadic comparison procedures have been used to estimate the perceptual similarity of musical intervals (Levelt, et al., 1966), of timbres (Plomp, 1970), and of vowels (Beck, et al., 1988; Pols, 1970; Pols, et al., 1969; Rakerd & Verbrugge, 1985). In this procedure, sets of three stimuli (triads) are compared by the subject, who must decide which two stimuli are **most similar** and which two are **most dissimilar**. This comparison is made for all possible triads of the stimulus set. The number of times that each pair of stimuli is selected as more similar than other pairs yields an index of the perceptual similarity of stimulus pairs.

An advantage of the triadic comparison task is that, unlike verbal scaling procedures, triadic comparisons do not force subjects to use verbal categories in order to obtain a similarity metric. Rather, the task permits the use of a simple instruction set that allows subjects to set their own criteria for similarity (Levelt, et al., 1966).

A disadvantage of the procedure is the rapid increase in the number of trials that is needed as the number of stimuli is increased. In order that every possible pair of stimuli is compared with all other pairs of stimuli, all possible stimulus triads must be included in the design. The total number of triads that can be created from N stimuli is N(N-1)(N-2)/6. Thus, for 45 stimuli, 14,190 triads can be formed; for 12 stimuli, there are 220 triads.

3. PURPOSE

In the present study, a set of synthetic fricative-vowel stimuli was constructed to demonstrate the effect of vowel context on fricative perception. A two-dimensional continuum was constructed, with frication-noise frequency comprising one dimension and vowel context the second dimension. These two dimensions were combined factorially to construct the stimulus set. In Experiment 1, identification data were obtained with this stimulus set to confirm that the vowel F_2 and F_3 frequencies did systematically affect the identification of the fricatives. In the second experiment, the perceptual similarity among the fricatives in a subset of 12 of the synthetic fricative-vowel syllables was estimated from the results of a triadic comparison task. This second stage of data collection provided perceptual similarity judgments and allowed a comparison to be made among: (a) the perceptual space occupied by the synthetic stimuli, (b) the labels assigned to these syllables in Experiment 1, and (c) their acoustic characteristics.

4. EXPERIMENT 1: IDENTIFICATION

4.1 Method

Stimuli. A synthetic, frication-noise continuum was paired with a synthetic /i/ - /u/ continuum to form a set of 45 consonant-vowel (CV) syllables (9 noises x 5 vowels). The fricative and vowel sounds were created separately and concatenated. All synthesis was performed with 12-bit resolution at a 14-kHz sample rate.

The synthetic fricatives were 150-ms noises; this duration is slightly longer than fricative durations in natural sentence production (Klatt, 1974), and is slightly shorter than the 175-ms durations for these fricatives produced in isolated CV syllables (Behrens & Blumstein, 1988).

The fricatives were synthesized with ILS (Interactive Laboratory System, Version 4.0) software. A wideband, flat-spectrum noise was created digitally. The noise waveform had a linear rise time of 75 ms from silence to full amplitude and a 30-ms linear fall from full to half-amplitude. This frozen noise was digitally filtered to form a continuum of nine noises (C_1 - C_9) in which the low-frequency cut-off increased from 1800 to 4000 Hz and the high-frequency cut-off increased from 3950 to 4950 Hz in equally-spaced steps. The filters were elliptical, third-order filters, which provided 40-dB attenuation in the stopbands.

The five vowels (V_1-V_5) were synthesized with an implementation of the Klatt cascade formant synthesizer (Jamieson, et al., 1989; Klatt, 1980). The vowels were 300 ms long. F_1 was fixed at 250 Hz. F_2 and F_3 contained transitions that increased in both duration and frequency from V_1 (/u/) to V_5 (/i/). Further details of the formant transitions are provided in Table 1.

Instrumentation. Stimulus generation and data collection were controlled with an IBM/AT computer and a DT2801A I/O board, followed by a Hewlett-Packard passive attenuator, a Kemo VB/25 programmable filter, and a Charybdis programmable attenuator (Model D). Stimuli were output at a digital-to-analog conversion rate of 14 kHz and low-pass filtered at 6 kHz with a rejection rate of 96 dB/octave.

Table 1
F_1 and F_2 Synthesis Parameters for the Stimuli Used in Experiment I

	F_2 transition			F_3
Vowel	Start (Hz)	Finish (Hz)	Duration (ms)	Freq (Hz)
V_1	1450	850	300	2200
V_2	1650	1200	240	2400
V_3	1850	1550	180	2600
V_4	2050	1900	60	2800
V_5	2250	2250	0	3000

Note: Entries are the centre frequency and the duration of the F_2 transitions, and the F_3 (stationary) centre frequency. Transition durations were selected to maintain perceptual continuity of the fricative with the vowel. For more /u/-like vowels, longer transitions were required.

The synthetic stimuli were presented monaurally via a TDH-49 earphone in an MX41/AR cushion while the subject was seated in a double-walled IAC sound-attenuating test booth. Stimuli were presented at a level at which the continuous, steady-state portion of one of the synthetic vowels, V_3, measured 65 dB SPL at the earphone in an NBS-9A coupler. Instructions were presented to the subject using a colour monitor, and the subject responded by pressing "keys" on a template placed over a Koala digitizing pad interfaced to the computer.

Subjects. Twelve adults, aged 20 to 41 years, served as subjects (S1 - S12). All had some phonetic training. All listeners had pure-tone thresholds better than 20 dB HL (ANSI, 1989) at 250, 500, 1000, 2000, 4000, and 6000 Hz in the test ear.

Procedure. Identification data were collected in a two-alternative forced-choice task. Subjects were instructed to indicate, after each stimulus presentation, whether the consonant sounded more like an /s/ or /ʃ/ by pressing one of two buttons labelled "ss" or "sh". Twenty identification judgments were made for each synthetic stimulus. Stimuli were presented in 20 blocks of 45 stimuli each; within each block, the order of stimulus presentation was randomized without replacement.

4.2 Results

Individual subjects' responses are displayed in Figure 1. The percentage /ʃ/ responses made for each stimulus is plotted as a function of the frication-noise portion (C_1-C_9) of the stimulus. The parameter is the vowel (V_1-V_5) with which each fricative was paired. Each point in these identification functions is based on 20 identification responses.

For all subjects and in each vowel context, subjects responded /ʃ/ for lower-frequency fricatives and /s/ for higher-frequency fricatives. The effect of the vowel on the identification of the

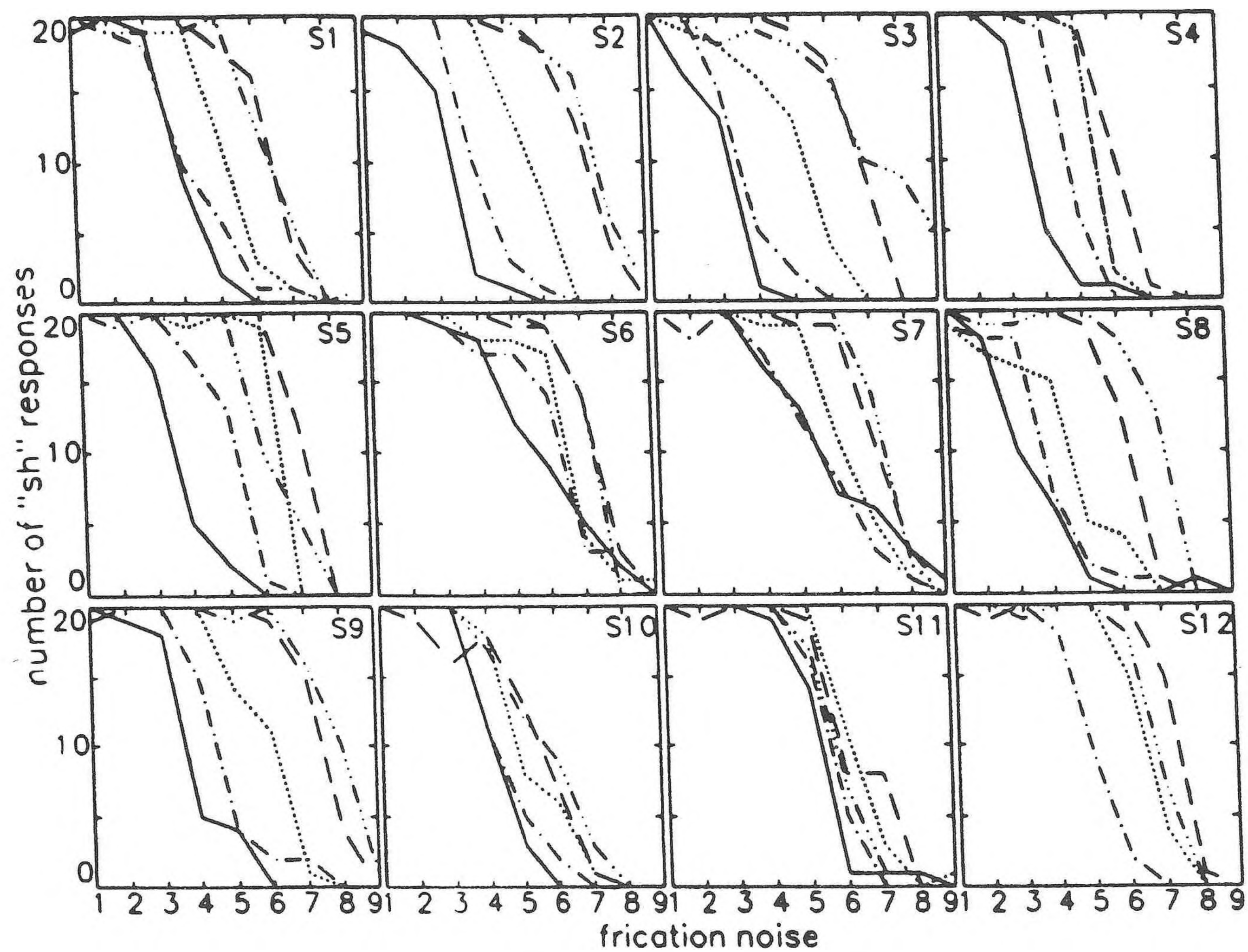

Figure 1. Identification responses for each of the 12 listeners as a function of frication noise and vowel quality obtained in Experiment 1. Each point represents the responses lon 20 stimulus presentationsl. Solid line (V_1-/u/), dash-dot line (V_2), dotted line (V_3), dashed line (V_4), dash-dot-dot line (V_5-/i/).

fricative is shown by the shift of the identification functions to the right as the F_2 and F_3 frequencies increased from V_1 (/u/) to V_5 (/i/). The category boundary, as defined by the point at which there were 50% /s/ and /ʃ/ responses, shifted to higher-frequency noises as the vowel context changed from V_1 to V_5. Over the range of fricatives where this shift occurred, the same frication noise was labelled differently before different vowels. For example, Subject 1 labelled C_5 as /ʃ/ only 10% of the time when it was followed by V_1, yet identified the same frication noise as /ʃ/ 100% of the time when it was followed by V_5.

There were large individual differences in the fricative identification functions both in the location of the /ʃ/ - /s/ identification boundary and in the magnitude of the vowel context effect. For some subjects, the effect of increasing the formant frequencies did not extend across all vowels. Four subjects (S1, S3, S6 and S10) had shifts in the fricative identification boundaries for V_1-V_4 only. Four others (S4, S5, S11 and S12) showed an effect of the vowel context that was non-monotonic; the increase in second and third formant frequencies from V_4 to V_5 shifted the /ʃ/ - /s/ identification boundary back to lower-frequency fricatives. Such non-monotonic changes in identification functions for these context-conditioned phonemes have been observed by Mann and Liberman (1983) and may be influenced by perceptual "magnet" effects (Kuhl, 1991).

The effect of the vowel context and frication noise on the identification of the fricatives was examined using a repeated-measures analysis of variance. A significant effect of vowel (F=39.0, df=4,44, p<.001) and frication noise (F=271.6, df=8,88, p<.001) was obtained, as well as a significant interaction between these two factors (F=22.1, df=35,352, p<.001).

In summary, the effect of vowel context on the perception of fricatives, as reported by Mann and Repp (1980), Repp (1981), and Whalen (1981), was replicated with a set of synthetic fricative-vowel syllables. For all subjects, some fricatives were labelled as /ʃ/ when followed by vowels that had high F_2 and F_3 values and as /s/ when followed by vowels with lower formant frequencies, although there were substantial individual differences in the extent of the vowel influence.

5. EXPERIMENT 2: PERCEPTUAL SIMILARITY JUDGMENTS

5.1 Method

Stimuli. The stimulus set was selected from the set of synthetic syllables used in Experiment 1. Syllables that contained the five fricatives (C_{1-3} and C_{8-9}) whose identi-fication was not strongly influenced by the vowel context were not included. Two of the vowels were eliminated from the stimulus set in order to reduce the number of stimuli to be used in the triadic comparison task. Post-hoc analyses of the data from Experiment 1 indicated that V_4 and V_5 did not differ with respect to the number of /s/ and /ʃ/ responses that each elicited and, for some subjects, V_5 created a non-monotonic shift in the identification boundaries (cf. Figure 1). V_5 was therefore eliminated in favour of V_4 and V_2 was eliminated arbitrarily, to reduce further the stimulus set. The 3 vowels ($V_{1,3,4}$)that had transition durations of 300, 180, and 60 ms and a systematic effect on the perception of the frication noise were included. After eliminating these stimuli, a set of twelve syllables remained for the triadic comparison task (Roskam, 1979); those stimuli produced by combining C_{4-7} and $V_{1,3,4}$. The stimulus set was sufficiently small that a completely-balanced triadic comparison procedure could be completed in a single experimental session of reasonable duration.

The twelve syllables were combined to form all possible sets of three different syllables, or 220 triads. For the purpose of analysis, each triad can be treated as three pairs of stimuli, from which the subjects selected the most similar pair and the most dissimilar pair. Within the set of 220 triads, each stimulus occurred 110 times, and each pair of stimuli occurred 10 times.

Procedure. Instrumentation and subjects were as described for Experiment 1. Subjects participated in Experiment 2 during a second test session.

Each trial of the triadic comparison task consisted of an initial stimulus presentation sequence in which each of the three stimuli to be compared (Stimuli A, B and C) was presented once. A section of a video monitor corresponding to each stimulus and labelled "A", "B" or "C" was flashed in reverse video as each stimulus was presented. A 500-ms interval followed each stimulus presentation.

After the initial presentation sequence, subjects could listen repeatedly to any of the stimuli by pressing the labelled buttons on a touch-sensitive digitizing pad. Subjects were instructed to indicate which pair of consonants was most similar and which pair was most dissimilar by pressing the button on the digitizing pad that was labelled with the chosen stimulus pair. Stimuli could be repeated as many times as required in order to make a decision.

Ten practice trials were completed prior to starting the 220 trials. The order of the triads and the order of the stimuli within the triads were random.

5.2 Results

In order to generate a similarity matrix that included the entire stimulus set, the three possible pairwise combinations of stimuli within each triad were first rank-ordered with respect to similarity. Within each triad, a score of 2 points was assigned to the pair selected as the most similar (it was judged to be more similar than the two other pairs). Zero points were assigned to the pair selected as most dissimilar. One point was assigned to the pair that was not selected (it was judged to be more similar than one of the other pairs and less similar than the other). The points assigned to a pair were then summed over the 10 occurrences of that pair within the 220 triads, to yield a composite score indicating the number of comparison pairs that were judged to be less similar than that pair — that is, the **similarity value** of the pair.[1] The maximum similarity value that can be obtained with this procedure is 20 (i.e., when a pair was selected as the most similar every time that it was presented, regardless of the other stimulus in the triad) and the minimum is 0 (when a pair was selected as most dissimilar on every trial). Completely random responding yields an expected similarity value of 10 for each pair.

The obtained similarity values indicated that subjects were not responding randomly: the full range of possible similarity values (0-20 across different stimulus pairs) was obtained for several subjects and the smallest range of similarity values was from 1-18 (for subject 9). The summed similarity matrix for all 12 subjects is presented in Table 2. Each entry in the matrix is the similarity value for a pair of stimuli — that is, the total number of times that a stimulus pair was chosen as more similar than other pairs — summed across all 12 subjects.

Table 2

Summed similarity matrix for 12 subjects in the triadic comparison task. Each entry indicates the total number of times that each pair of stimuli was selected as more similar than other pairs. The maximum attainable value was 240; the minimum was 0.

		C4			C5			C6			C7		
		V1	V3	V4	V1	V3	V4	V1	V3	V4	V1	V3	V4
C4	V1		155	144	164	159	138	92	96	102	73	49	57
	V3			213	93	209	169	45	109	123	36	60	65
	V4				83	173	210	49	72	135	37	38	77
C5	V1					119	111	194	127	105	141	115	102
	V3						189	65	160	157	51	71	79
	V4							66	103	196	51	48	104
C6	V1								149	105	213	190	149
	V3									167	132	185	151
	V4									79	79	97	172
C7	V1											201	157
	V3												190
	V4												

[1] An alternative, ordinal-level interpretation of the similarity value is that the value comprises the sum of the ranks assigned to each pair in all occurrences in different triads. The most similar pair was given a rank of 2, the pair that was not selected was given a rank of 1 and the least similar pair was given a rank of 0.

Some general observations can be made concerning the patterns of similarity values observed. First, similarity values were generally smallest when the physical differences between two fricatives were the greatest (C_4 vs. C_7). This is indicated by the relatively small values contained in the upper right corner of the summed similarity matrix. Second, similarity values were generally largest when the fricatives were either identical or differed by just one step. This result is revealed in the large entries occurring near the main diagonal of Table 2. Thus, the physical distance between the fricative portions of two stimuli was inversely related to the subject's similarity judgments, regardless of other stimulus parameters, including vowel spectrum and consonant identity.

Fricative labels and perceptual similarity. To examine the relation between the labelling and similarity judgments, each stimulus was first classified as /s/ or /ʃ/ on the basis of the label given to it more than 50% of the time in Experiment 1. Table 3 presents mean similarity values for two groups of stimuli: (1) pairs of syllables that were labelled as the same fricative (either both identified as /s/ or both as /ʃ/) and (2) pairs of syllables that were labelled as different fricatives (one /s/ and the other /ʃ/).

Table 3

Comparison of the perceptual similarity values for pairs of syllables that had been assigned the same vs. different fricative labels in Experiment 1. Entries are: (1) the number of stimulus pairs included in each calculation, (2) the mean similarity value and (3) the standard deviation of the similarity values.

Subject	Same Label			Different Label		
	N	Mean	SD	N	Mean	SD
S1	31	12.55	5.2	35	7.74	4.4
S2	30	14.73	3.0	36	6.06	3.4
S3	31	13.26	4.4	35	7.11	4.3
S4	31	12.88	4.9	35	7.46	4.4
S5	31	11.77	5.5	35	8.42	5.2
S6	39	11.08	5.1	27	8.44	5.8
S7	39	11.36	4.6	27	8.04	4.0
S8	34	11.76	5.1	32	8.13	4.3
S9	31	12.10	4.4	35	8.14	3.8
S10	34	12.71	4.3	32	7.13	4.2
S11	31	13.48	3.9	35	6.91	4.6
S12	31	12.71	5.1	35	7.60	4.5
Mean SD		32.8 3.17	12.53* 1.01		33.3 3.17	7.60* 0.71

* A matched-pairs t-test between the overall means indicated a significant difference ($t(11)=10.047$, $p<.001$).

Although the intersubject variability of these values was relatively large, in general judgments of perceptual similarity were related to the perceptual identity of the consonants, in that consonants that were labelled the same were judged to be perceptually more similar than consonants that were labelled differently.

The comparison made in Table 3 included two types of stimulus pairs: (1) stimuli in which the fricatives were physically different, and (2) stimuli in which the fricative portion was fixed, but the vowel portion differed. Because the interest in this study was to examine the perceptual context effect and because perceptual similarity judgments were related, in part, to the physical similarity of the consonants, it was important to isolate the relationship between the fricative label and the perceptual similarity, particularly in those cases where the fricatives were identical (so that it was the vowels that influenced the label). To achieve this isolation, the perceptual similarity analysis described above was repeated, restricting the data set to the cases where both stimuli in a pair contained the same frication noise.

Table 4 presents the results of this analysis, based on the 12 pairs that contained the same fricative noises in both stimuli of the pair (i.e., the 12 stimulus pairs that lie nearest the main diagonal in Table 2). It can be seen that mean similarity values for these stimuli are higher than those in the inclusive analysis in Table 3, indicating that, as expected, stimuli were judged to be more similar when the fricative portions of the stimuli within the pair were more similar, physically. Again, it can be seen that, on average, fricatives that were given the same label had higher similarity values than those that were given different labels, reflecting the fact that, for some subjects, similarity was judged on the basis of whether the fricatives belonged to the same phoneme class.

Although the pattern described above holds for the summarized results, there were large individual differences in response patterns. Tables 5 and 6 compare the similarity matrices for two subjects (S2 and S6) who responded quite differently. S6 obtained high similarity values for all stimulus pairs that were included in this analysis. For this subject, similarity judgments apparently were based on the physical differences among the fricatives, rather than on how the signals were labelled. A similar but less extreme dependence on physical differences was shown by subject 11, who also had very high similarity values for all stimulus pairs included in this analysis.[2]

Table 4

Comparison of the perceptual similarity values for pairs of syllables that had been assigned the same vs. different fricative labels in Experiment 1. Only pairs of syllables in which the frication components were physically identical (and the vowels differed) have been included. Entries are (1) the number of stimulus pairs included in each calculation, (2) the mean similarity value, and (3) the standard deviation of the similarity values.

Subject	Same Label			Different Label		
	N	Mean	SD	N	Mean	SD
S1	6	15.33	1.5	6	12.33	3.7
S2	4	14.75	3.6	8	7.13	2.2
S3	6	13.66	2.4	6	8.33	1.4
S4	6	17.00	2.5	6	12.17	3.9
S5	4	17.25	1.3	8	12.25	4.2
S6	8	17.50	1.4	4	18.75	1.9
S7	8	12.88	4.8	4	9.75	3.9
S8	6	11.33	4.8	6	8.00	3.8
S9	4	14.75	2.2	8	9.88	3.4
S10	10	15.70	3.3	2	11.50	2.1
S11	10	17.50	1.3	2	16.00	1.4
S12	4	17.00	1.4	8	10.00	5.1
Mean		6.3	15.39*		5.67	11.34*
SD		2.23	2.01		2.23	3.35

* A matched-pairs t-test between the overall means indicated a significant difference ($t(11)=5.888$, $p<.001$).

For the remainder of the subjects, judgments of perceptual similarity were related, at least partially, to how the fricatives were labelled, in the identification task of Experiment 1. Subject 2 was the most extreme of these subjects, showing a mean similarity rating of just 7.13 when the fricatives of the pair were labelled differently, vs. 14.75 when the fricatives were labelled the same. Other subjects fell between S2 and S6 in terms of the relative dependence of their similarity judgments on the physical differences between the signals and on the labels assigned to stimuli.

Multidimensional scaling of similarity data. In order to study further the dimensional structure of these perceptual similarity judgments, the data were subjected to nonmetric multidimensional scaling. SPSS-X ALSCAL (v.3.1) routines produced a three-dimensional solution which accounted for 80.9% of the variance. Adding a fourth dimension contributed little to the goodness of fit, accounting for just 1.0% more of the variance.

The three-dimensional solution is illustrated in Figure 2. Dimension 1 corresponds to the physical (acoustical) differences among fricatives and accounts for 49.5% of the variance. Dimension 2 accounts for 24.7% of the explained variance and appears to correspond to the perceptual identity of the fricative.

[2]Subjects 6, 7 and 11 reported that they were making similarity judgments based on the "pitch" of the fricatives. This is consistent with comments of Repp's (1981) non-categorical subjects. The data from subjects 6 and 11 suggest that they were making the judgment independently of the vowel context.

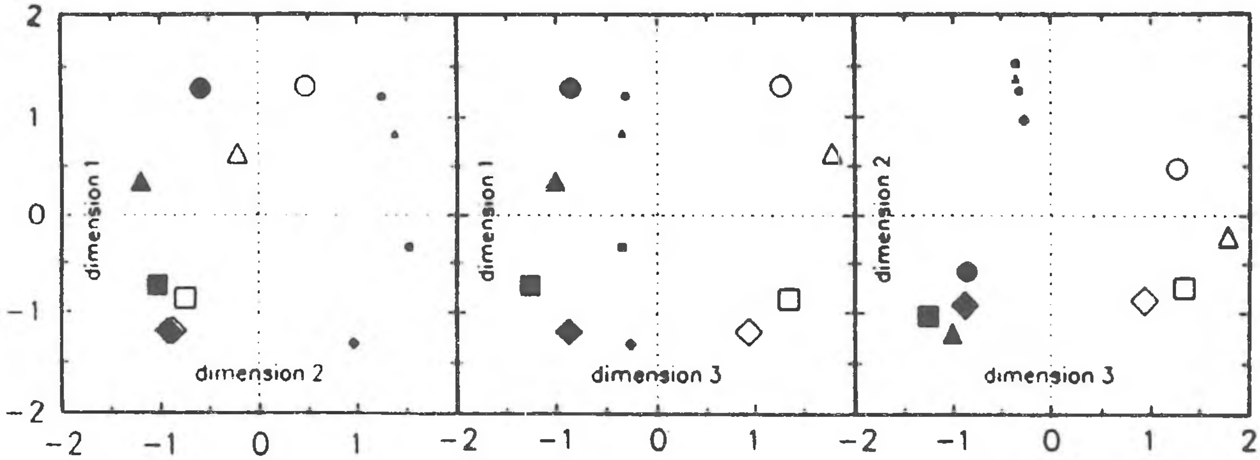

Figure 2. Three-dimensional scaling solution for similarity judgments obtained in Experiment 2. Each point represents the location of an individual stimulus in space. The solution accounted for 80.9% of the observed variance in the similarity judgments

Table 5

Perceptual similarity matrix for S2. Each entry indicates the total number of times each pair of stimuli was selected as more similar than other pairs. The maximum attainable value was 20; the minimum was 0.

		C4			C5			C6			C7		
		V1	V3	V4	V1	V3	V4	V1	V3	V4	V1	V3	V4
C4	V1		6	8	16	9	8	11	12	9	11	10	7
	V3			18	5	19	16	1	10	15	3	5	13
	V4				3	15	17	1	4	16	1	3	14
C5	V1					6	5	19	9	3	19	14	7
	V3						14	3	15	13	4	6	13
	V4							5	11	19	4	3	17
C6	V1								10	6	18	16	6
	V3									12	11	15	14
	V4										6	5	15
C7	V1											17	6
	V3												8
	V4												

Table 6

Perceptual similarity matrix for S6. Each entry indicates the total number of times each pair of stimuli was selected as more similar than other pairs. The maximum attainable value was 20; the minimum was 0.

		C4			C5			C6			C7		
		V1	V3	V4	V1	V3	V4	V1	V3	V4	V1	V3	V4
C4	V1		17	19	12	11	9	7	4	5	3	0	3
	V3			18	11	15	10	5	7	6	3	1	2
	V4				10	13	15	4	6	4	1	5	2
C5	V1					19	15	14	14	12	8	5	6
	V3						16	9	12	15	6	5	5
	V4							12	9	13	3	6	6
C6	V1								20	16	15	15	14
	V3									18	11	12	12
	V4										10	9	13
C7	V1											18	19
	V3												20
	V4												

Stimuli which were primarily labelled as "sh" were weighted negatively, and stimuli that were perceived as "ss" were weighted positively in this analysis. The third dimension, which distinguishes among the three vowels that were paired with the consonants, identifies the remaining 6.7% of the explained variance.

The differences between subjects are most visible in Figure 3, where the weights given by each subject for each dimension are displayed. This solution is consistent with the observation that the relative contribution of vowel and fricative information to perceptual similarity judgments varied from listener to listener. For several listeners (6, 10[shown by the symbol A in Figure 3] and 11[shown by B in Figure 3]), the first dimension (related to the physical properties of the frication noise) is weighted very highly, and dimension 2 (related to the mean group identification of the fricative) received little or no weight. For most other subjects, dimension 2 was weighted substantially, as was dimension 1.

A further reduction of the data for the two subjects (S2 and S6) who differed dramatically in the three-dimensional solution is presented in Figure 4. Figure 4a and 4b show the obtained perceptual similarity score for every pair of stimuli plotted as a function of the probability that the pair had been assigned the same fricative labels ($p["ss"]_{STIM1} * p["ss"]_{STIM2} + p["sh"]_{STIM1} * p["sh"]_{STIM2}$), for Subjects 2 and 6 respec tively. Figure 4c and 4d present the obtained perceptual perceptual similarity

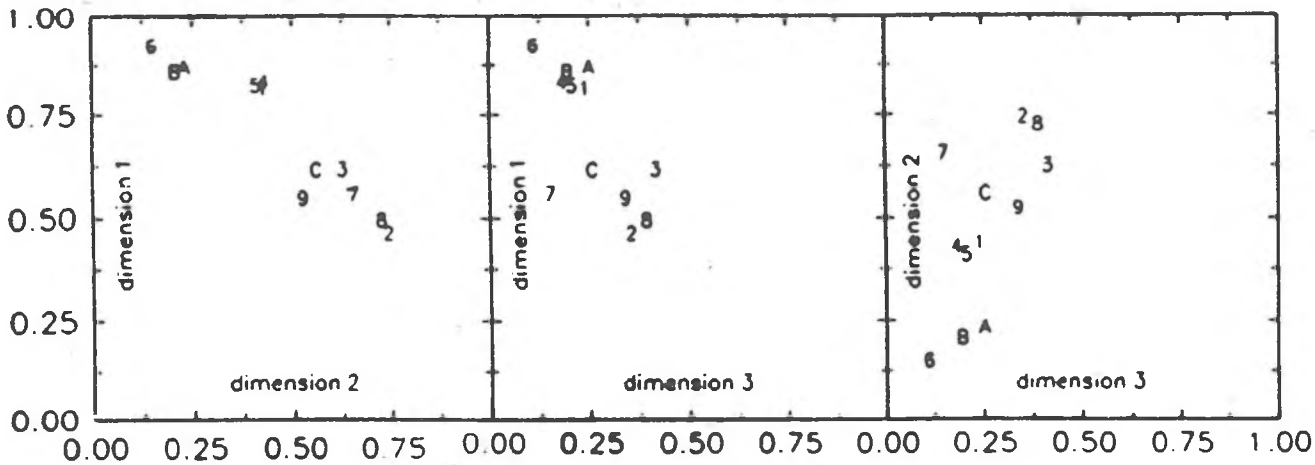

Figure 3. Three-dimensional scaling solution for similarity judgments. Individual listener's values for each dimension are indicated by subject numbers (S1-S9) and by A, B, and C for S10, S11, and S12 respectively.

score for every pair of stimuli plotted as a function of the difference in the centre frequency of the frication noise, again for Subjects 2 and 6, respectively. For S2, similarity judgments were related to the **labelling judgments** (r = 0.88; cf. Figure 4a) and not to the physical differences between the frication noises (r = -0.17; cf. Figure 4c). On the other hand, for S6, similarity judgments were strongly related to the **physical differences** between the consonants (r = -0.94; cf. Figure 4d), rather than to the labels that were assigned to stimuli (r = 0.30; cf. Figure 4b). The other subjects were distributed between these two extremes — making more or less use of both physical differences between the fricative portions of the signals and the labels given to the signals.[3]

6. GENERAL DISCUSSION

In these experiments the effect of vowel context on the perception of a preceding fricative consonant was studied using two experimental paradigms: a labelling task, in which listeners were forced to make a binary labelling decision, and a comparison task, in which listeners rated the perceptual similarity of pairs of fricatives. The results of the labelling task (Experiment 1) confirm the reliable occurrence of context-conditioning, where the label assigned to each stimulus reflected **both** the acoustic properties of the fricative sound and the acoustic vowel context in which the fricative information was presented. Listeners differed in the extent of the influence of vowel context on the perception of the fricatives, but all listeners showed the systematic influence of the vowels on the consonant identification over a range of frication frequencies. The results confirm those of Mann and Repp (1980) and Whalen (1981), with a new set of entirely synthetic syllables.

[3]These factors are, of course, not completely independent, because identification itself was dependent on the frication frequency as shown in the results of Experiment 1.

The results of the triadic comparison task (Experiment 2) showed that reliable patterns of similarity judgments could be obtained with context-conditioned signals. These similarity judgments were compared to: (a) the physical (acoustical) similarity of the fricative stimuli, and (b) the **predicted** similarity — derived from the identification (labelling) data obtained in Experiment 1. There was a continuum formed by the way in which individual listeners combined the two types of available information in making their similarity judgments. For **some** listeners, similarity judgments were made almost independently of the labels that were assigned to the fricatives; for other listeners, judged similarity was substantially a function of the fricative labels. Two subjects — S2 and S6 — bounded the extremes of this continuum, with S2's similarity responses being strongly linked to the labels assigned and S6's responses to the acoustical differences between the fricative portions of the signals.

Listeners who made greater use of the pitch of the fricative in making similarity judgments may be less strongly influenced by the vowel context in their identification judgments (for example S6 showed relatively small shifts in the phonemic boundary as a function of vowel context); alternatively, such subjects may be more "analytical" listeners than others and better able to "tune" their listening to one portion of the syllable while ignoring the rest. The former hypothesis is not supported by the data of Repp (1981) who did not observe a relation between the magnitude of the context effect and the ability of listeners to discriminate between within phone class fricatives.

The present findings seem to extend the traditional notion of "categorical perception" of phonemes (e.g., Liberman, et al., 1967), to view the perception of speech as being a continuum of abilities. Certainly, an extreme categorical view is not

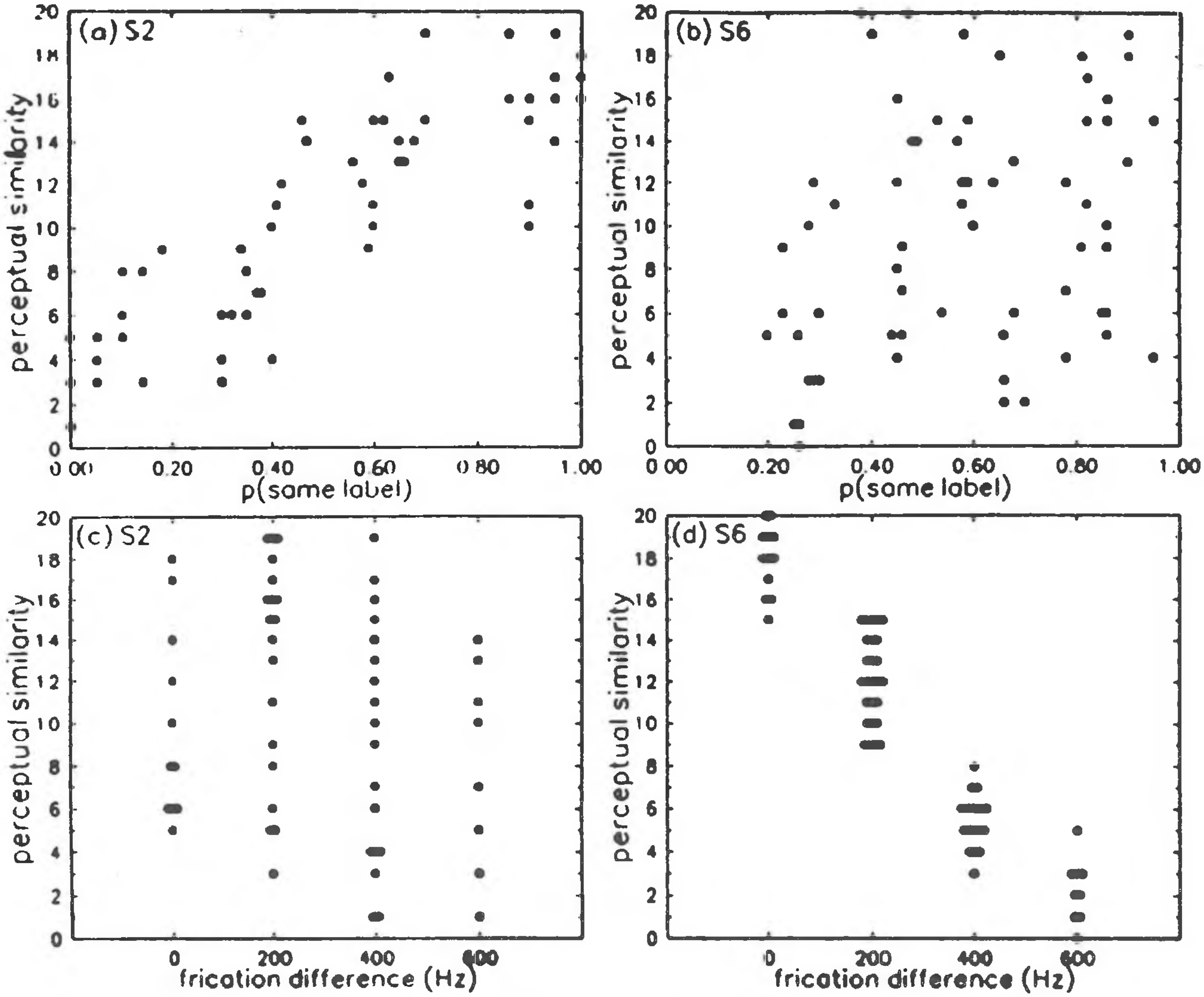

Figure 4. Judged similarity vs labelling similarity and fricative differences. In panels (a) and (b), perceptual similarity values are plotted as a function of the probability that a pair of fricatives would be assigned the same label for S2 and S6. In panels (c) and (d), perceptual similarity is plotted as a function of the difference in the centre frequency of the frication noises in each pair of consonants for S2 and S6. Horizontal jitter has been introduced to the data points in order that multiple data points do not mask each other.

consistent with these data: many of the listeners were more sensitive to differences between stimuli than a simple, binary-labelling view would admit. Indeed, some subjects clearly were able to make similarity judgments on the basis of physical similarities between the fricative noises, with little reference to the labels assigned to the stimuli. Implicit in this ability is the capacity to discriminate between phonemes that belong to the same identification category. Moreover, the continuous nature of the difference among subjects in the extent to which they relied on stimulus labels seems inconsistent with a view that subjects were responding in either a "speech" or an "auditory" mode (Liberman & Mattingly, 1985).

Of considerable interest is the origin of the individual differences in performance on the two tasks. One clear possibility is that, with further practice on the triadic comparison task, or with re-instruction to focus the listener's attention on the auditory as opposed to phonemic (linguistic) cues, the patterns of similarity judgments shown by a few listeners in the present study might be shown by all listeners.

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AUTHOR NOTES

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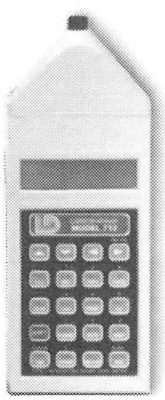

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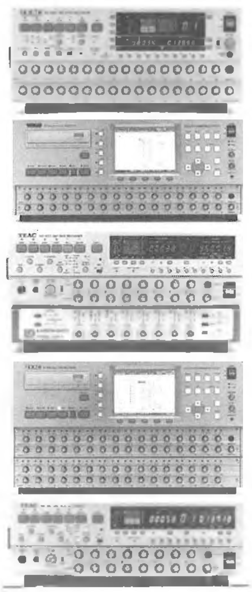

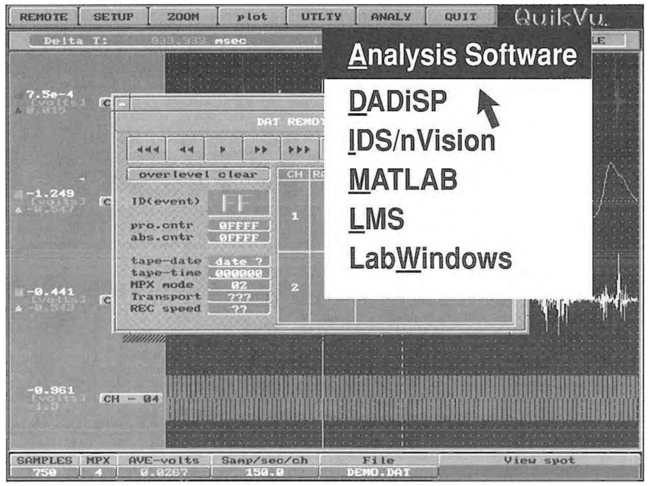

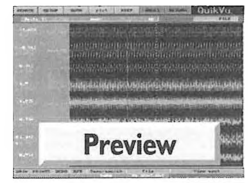

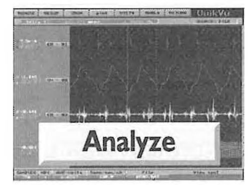

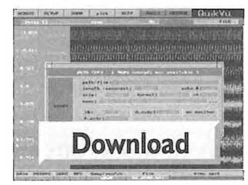

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ACCURACY IN SOUND LOCALIZATION: INTERACTIVE EFFECTS OF STIMULUS BANDWIDTH, DURATION AND RISE DECAY

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ABSTRACT

This study investigated the effects of stimulus bandwidth/centre frequency (broadband noise vs one-third octave bands, centred at 500 Hz and 4000 Hz), in interaction with stimulus duration/rise decay time (50/10, 300/10, 300/50 and 380/50 ms) on sound localization. The experiment was conducted in a semi-reverberant sound proof booth. Twelve normal-hearing subjects were tested using a single array of six loudspeakers positioned 60 deg apart in the horizontal plane. Each was presented one block of 120 forced-choice speaker identification trials for each for the twelve listening conditions. Subjects achieved 100% correct in localizing broadband noise, regardless of duration/rise decay. Scores were significantly lower for the one-third octave bands. There was no difference due to frequency for the three longer durations. For the short duration/short rise decay, a relative improvement was observed for the low frequency and a decrement for the high frequency. The results were interpreted with reference to the precedence effect.

SOMMAIRE

Cette étude avait pour but d'évaluer l'influence de la largeur de bande et de la fréquence centrale (bruit à large bande, bruits en bande tiers d'octave centré sur 500 Hz et 4000 Hz) sur la localisation auditive, et l'interaction de la durée/temps de montée-descente des signaux acoustiques (50/10, 300/10, 300/50 et 380/50). L'expérience s'est déroulée dans une chambre semi-réverbérante et comprenait un ensemble de six haut-parleurs espacés de 60 deg dans le plan horizontal. Douze sujets avec audition normale ont participé. Chaque sujet devait répondre à une série de 120 essais d'identification de haut-parleur avec choix forcé pour chacune des douze conditions expérimentales. Les sujets ont répondu correctement à 100% des essais dans le cas du bruit à large bande, quelque soit la durée et le temps de montée-descente du signal. Les résultats étaient significativement inférieurs dans le cas des bruits en bande tiers d'octave. Les résultats ne dépendaient pas de la fréquence centrale aux trois durées les plus longues. À la durée la plus courte, une amélioration de la capacité de localization a été observée à la fréquence centrale de 500 Hz et une détérioration à la fréquence centrale de 4000 Hz, par rapport aux trois durées les plus longues. Les résultats expérimentaux sont interprétés en fonction de l'effet de préséance.

1.0 INTRODUCTION

The precedence effect, as described by Wallach, Newman and Rosenzweig (1949), refers to the importance of the direct wave at the onset of the stimulus (first wavefront), relative to delayed reflections from the ongoing portion of the stimulus, in determining the perception of direction in rooms. Tobias and Schubert (1959) studied the relative weighting of these two parameters by means of a sound lateralization paradigm. A noise burst was presented binaurally over a headset, and for a range of interaural onset disparities, the corresponding values of opposite interaural ongoing disparities that centred the acoustic image were measured. The transient onset disparity lost its effectiveness when stimulus duration exceeded 150 ms. For shorter sounds, ongoing disparity was always the more dominant cue, by a factor which was proportional to duration.

In contrast, Kunov and Abel (1981) showed that, for pure tone stimuli, when interaural onset and ongoing fine structure (phase) cues were in opposition, onset completely determined the percept when the rise decay (RD) was brief, i.e., 5 ms. The influence of onset gradually diminished, as RD increased. Not until RD had reached 200 ms, was the perceived laterality of the sound image completely determined by the ongoing phase disparity. The duration of peak amplitude of the stimulus

(25 ms vs 200 ms) was not a significant factor (Abel and Kunov, 1983). Neither onset nor phase was effective for the lateralization of frequencies at or beyond 1500 Hz, except for the shortest RD (i.e., 5 ms). Similiar effects have been shown for localization of pure tones in a sound field. Rakerd and Hartmann (1986) found that onsets as long as 100 ms affected the localization in a semi-reverberant room. RD interacted with the peak intensity of the stimulus, suggesting that the critical variable was onset rate, the increase in sound pressure per unit time.

In a recent study, Giguère and Abel (1993) compared the localization of one-third octave noise bands in absorbent and reverberant rooms. Reverberation compromised accuracy for frontal and lateral speaker arrays, independent of stimulus centre frequency or RD. In contrast to pure tones, the benefit of a short RD was relatively small and limited to the low frequency. A possible explanation was that ongoing random envelope fluctuations in the noise band stimulus diminished the importance of onset.

The present experiment was designed to further investigate the interactive effects of stimulus rise decay and duration, in combination with stimulus bandwidth and centre frequency, on horizontal plane sound localization. The effects of variation in these parameters on the utilization of both binaural and spectral cues in judging directionality were studied.

2.0 EXPERIMENTAL DESIGN

Sound localization was investigated in normal-hearing subjects by means of a single array of six loudspeakers, surrounding the subject at ear level in the horizontal plane. Speakers were positioned 60 deg apart i.e., at azimuth angles of 30, 90, 150, 210 (-150), 270 (-90) and 330 (-30) deg, at a distance of 1 m from the subject's centre head position. The stimuli were broadband noise and one-third octave bands, centred at 500 Hz and 4000 Hz, chosen to allow an assessment of the effectiveness of binaural and spectral cues (Giguère and Abel, 1993).

For each stimulus, four combinations of duration and rise decay time were presented: 50/10 ms (50 ms, including a 10 ms RD), 300/10 ms, 300/50 ms, and 380/50 ms. These contrasted total duration with RD held constant, RD with total duration constant, and duration of peak amplitude with RD constant. The three longer durations were presented at a level of 75 dB SPL and the shortest duration at a level of 82 dB SPL, in an attempt to maintain equal loudness (Miller, 1948; Papsin and Abel, 1988).

3.0 METHODS AND MATERIALS

3.1 Subjects

The subjects were eight male and four female volunteers, aged 21-37 years. Several had previously participated in studies of auditory perception, including sound localization. All had normal hearing bilaterally, with headphone hearing thresholds less than 15 dB HL at 500 Hz and 4000 Hz. Within subject, the difference in threshold between ears was no greater than 6 dB, minimizing the possibility of a right/left bias in sound localization. The experiment was completed in one 2-hr session. Subjects were paid $10 for their participation.

3.2 Apparatus

The apparatus has been described previously (Giguère and Abel, 1993). Subjects were tested individually, while seated in the centre of a 3.5 m (L) by 2.7 m (W) by 2.3 m (H) semi-reverberant sound proof chamber (IAC series 1200) that modelled a real-world listening environment (Giguère and Abel, 1990; Abel and Hay, 1996). Reverberation times for the test stimuli were 0.4 s. The ambient level was less than the maximum allowed for headphone testing (ANSI-S3.1, 1991). Subjects responded by means of a laptop response box comprising an array of six microswitches in the same circular configuration as the speaker array.

3.3 Procedure

One block of 120 forced-choice speaker identification trials, comprising 20 random presentations of the stimulus from each loudspeaker in the array, was given for each of the twelve listening conditions. The order of conditions was counterbalanced across subjects to cancel the effects of practice and/or fatigue. Prior to the start of each block, the subject was given a series of six familiarization trials, comprising one stimulus presentation through each speaker.

A trial began with a 1/2 s warning light on the response box, followed by a brief pause and then the presentation of the stimulus. To minimize the effects of head movement, subjects were instructed to fixate a straight-ahead visual target, to keep the head steady and to sit squarely in the chair, each time the warning light appeared. A maximum of 7 s was allowed for the response. Guessing was encouraged. No feedback was given about the correctness of the judgment.

4.0 RESULTS

Figure 1 shows the mean percentage of correct responses, averaged across the six azimuths, for each of the twelve bandwidth/frequency (BF) by duration/RD (DRD) listening conditions. Standard deviations ranged widely from 2% to 37%, increasing with decreases in accuracy. Regardless of the DRD combination, accuracy was close to 100% for broadband noise. In comparison, subjects achieved 75% correct, on average, when localizing the one-third octave bands, presented using the three longer durations. The short stimulus resulted in a relative increase in accuracy at 500 Hz and a decrease at 4000 Hz.

A repeated measures analysis of variance (ANOVA) was applied to the raw scores (i.e., number of correct responses) obtained for combinations of BF, DRD and azimuth. The data obtained for corresponding right and left azimuths (e.g., 30 and -30 deg) were averaged, since there was no evidence of left/right bias in response for any subject. Standard deviations ranged from 0.4 to 7.3 for the twelve BF/DRD combinations. The one-third octave bands generated values between 5.0 and 7.3. The analysis yielded significant effects of BF, azimuth, BF by azimuth, BF by DRD, and BF by DRD by azimuth ($p<0.01$). By itself, DRD was not a significant factor. Post hoc pairwise comparisons using Fisher's LSD test (Daniel, 1983) to further assess the BF by azimuth effect showed that subjects made significantly more errors when attempting to localize 500 Hz coming from the rearward speaker. In contrast, for the 4000 Hz stimulus, they had greater difficulty localizing sounds emitted by the frontal speaker.

The interaction of BF and DRD was investigated by studying response bias. Figure 2 shows the mean number of trials (out of 120), in which subjects used each of the front (F), side (S) and back (B) response keys for each of the twelve listening conditions. For this analysis, the results for right and left sides were combined. If there were no perceptual bias, then the three keys would be used equally often, i.e., on 40 out of 120 trials. This outcome was observed for the broadband noise.

A repeated measures ANOVA applied to the number of times front, side and back keys were used by each subject for the twelve BF by DRD conditions yielded significant outcomes for response key ($p<0.05$), response key by BF ($p<0.01$), and response key by BF by DRD ($p<0.05$). Post hoc pairwise comparisons of the results for the short stimulus and the average results for the three longer stimuli (which were similar) indicated that for the longer stimulus, the one-third octave band noise centred at 500 Hz was significantly less likely to be perceived as coming from the back than the front and side. The one-third octave band centred at 4000 Hz was significantly less likely to be perceived as coming from the front than the side and back. When the stimulus duration was reduced, the front/side bias for the low frequency diminished by a small amount (4%). In contrast, for the 4000 Hz stimulus, the bias toward the side increased significantly by 9% ($p<0.05$). These changes in perceptual bias likely underlie the observed decrease in the accuracy of localizing 4000 Hz and the improvement for 500 Hz (see Fig. 1), when stimulus duration decreased.

5.0 DISCUSSION

Regardless of duration or RD, subjects had no difficulty in localizing broadband noise. There was no difference due to stimulus duration, RD or duration of peak amplitude. Further, no response bias was evident: front, side and rearward speakers were localized with equal accuracy, suggesting that subjects had the full advantage of binaural and spectral cues for determining location.

Performance was compromised when one-third octave bands were substituted for broadband noise. For the three longer stimuli, subjects achieved 75% correct, on average, regardless of the centre frequency of the stimulus, 500 Hz vs 4000 Hz. There was no effect of RD or duration of peak amplitude. The finding supports the earlier conclusion of Tobias and Schubert (1959) that, in the case of noise bursts, onset loses its effectiveness when the duration exceeds 150 ms. The lack of a frequency effect is in line with Rakerd and Hartmann's (1986) and Giguère and Abel's (1993) contention that subjects are able to use random interaural temporal fluctuations in the envelope to good advantage for sound localization.

Variation in the centre frequency of the one-third octave band did affect accuracy in localizing the short stimulus. An improvement was observed for the lower frequency and a decrement for the high frequency. These effects may be attributable to the short RD, which may have assumed a more dominant role, given the short duration. The frontwards bias observed for the longer 500 Hz stimulus diminished, posssibly because judgments were now determined to a greater degree by the precedence effect. For 4000 Hz, subjects were more likely to use the side key than they had for the longer stimulus, signifying that the ability to distinguish front from back had diminished. In a previous study, front/back discrimination of speakers in lateral arrays was shown to improve with an increase in the centre frequency of one-third octave noise bands, presumably because of the increasing effectiveness of spectral cues from the pinna (Giguère and Abel, 1993). However, front/back judgements are also affected by the precedence effect (Blauert, 1971; Zurek, 1987). Thus, the high-frequency decrement, given the short DRD, in the present study, may have resulted from a conflict between the now stronger onset cue and spectral cues from the filtering effect of the pinna.

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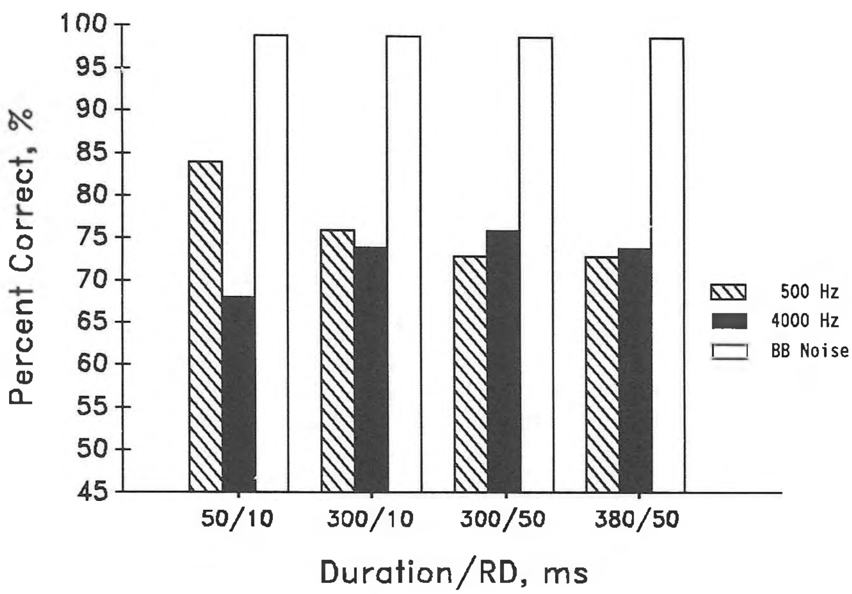

Figure 1. Overall percent correct in sound localization as a function of duration/RD. The parameter is bandwidth/centre frequency.

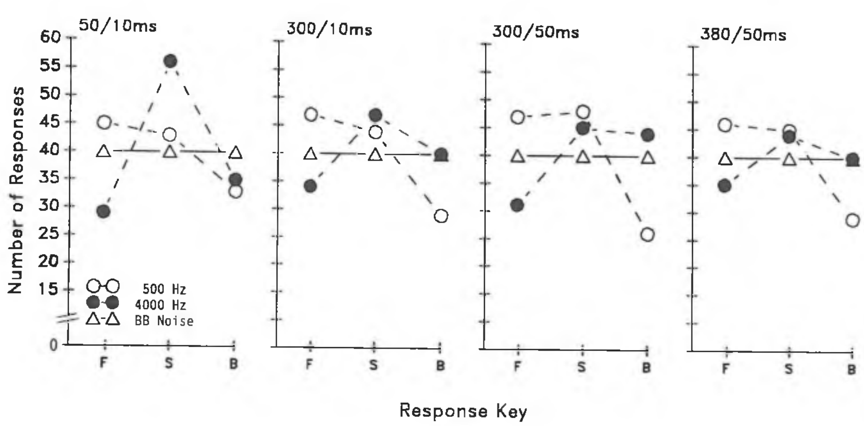

Figure 2. Response bias in sound localization as a function of response key for four duration/RD combinations. Within panel, the parameter is bandwidth/centre frequency.

Issues re: International INCE

David Quirt

The International Institute of Noise Control Engineering is a federation of national associations involved in acoustics and noise control, including the CAA. The organization is governed by a General Assembly which meets each year at the end of the InterNoise conference. The last meeting of International INCE at Liverpool (for which J. D. Quirt was the official delegate representing the CAA Board) raised some issues which should be considered by the members of the CAA.

International INCE is producing policy papers nominally representing the consensus of the international acoustical engineering community on specific noise issues. The intent of these is to influence development of better legislation dealing with noise control. Each paper is developed by a working group selected by the permanent executive of I-INCE. The process and intent are described in more detail in *Noise/News International* which is mailed to members of all Member Societies (which should include all those receiving Canadian Acoustics). Current working groups include:

Subject	Chair	Status
Noise in the Workplace	Embleton	Final draft ballot (18 for, 1 against)
Traffic Noise		Draft balloted in 1996
Community Noise	Ollerhead	In preparation
Noise Barriers	Daigle	In preparation

I-INCE expects that member bodies such as the CAA will vote to endorse these documents. This poses some procedural and policy problems:

1. Member bodies should have a process to establish their position, which may reasonably be interpreted as representing the consensus of society members. The CAA has no such process. Presumably, the CAA as a voting member should define and ratify a procedure for establishing national consensus positions, or decide to abstain in principle. This requires direction from our members.

Proposal: CAA positions should be developed by letter ballot of the Board (8 Directors plus executive officers) as elected representatives of the membership-at-large. In the absence of an established position, the CAA should abstain.

2. There is a potential conflict between international standards developed by consensus process through ISO and these more informal expert opinions developed by invited teams of experts. This was obviously a major concern of the German member body, and there was a rather heated discussion at the 1996 I-INCE meeting. Should CAA endorse positions which may potentially conflict with national and international standards? This requires direction from our members.

Proposal: CAA positions should be developed and expressed the procedure above. Input from Canadian standards committees should be obtained when possible, to provide the basis for an informed decision.

All members are invited to express their opinions on these suggestions in *Canadian Acoustics*, or directly to J. D. Quirt - FAX: 613-952-8102, Phone: 613-993-9746.

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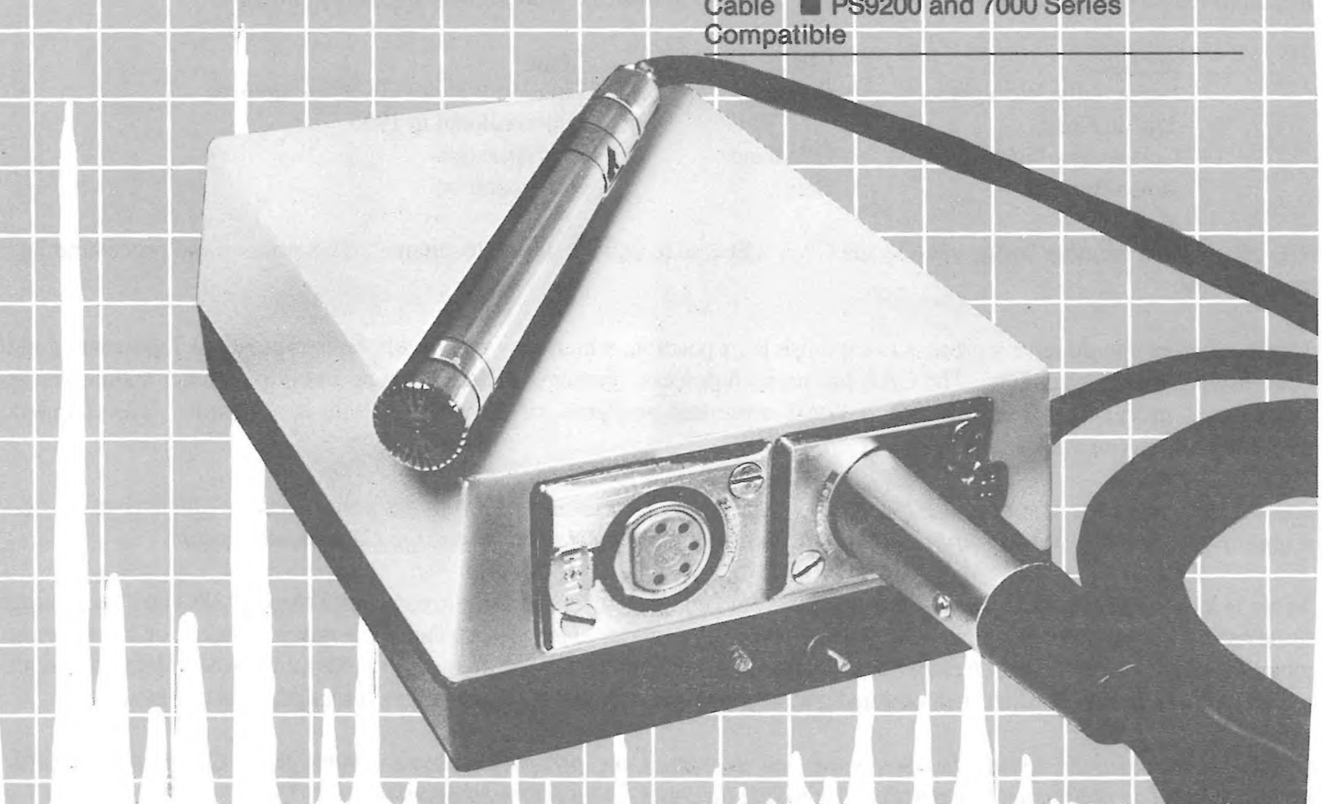

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DEUXIÈME APPEL DE COMMUNICATIONS
Semaine canadienne d'acoustique 1997
SYMPOSIUM, 8 - 10 octobre

Celui-ce la deuxième appel de communications parce que le délai de la dernier Acoustique canadienne. Cette année, la thème pour Semaine Canadienne d'Acoustique 1997 est Environnement, Société, et l'Industrie. Des présentations vent sollicitées sur tous les domaines de l'acoustique et des vibrations. Un nombre de session techniques portant sur la thème vent déjà planifiées. En voici la liste:

Le Qualité du Son
Physio-acoustique
Parole
Contrôle du Bruit en Milieu de Travail
Acoustique Musicale
Contrôle du Bruit de l'Aéroport et des Aéroplanes
Acoustique Sous-marine
Contrôle Actif du Bruit
Contrôle du Vibration
Psycho-acoustique
Audition
Audiologie
Acoustique Architecturale
HVAC
Règlements et Bruit Environmental
Contrôle du Bruit Industriel
Normalisation Canadienne

Envoyer un sommaire de une-page. Si le sommaire est accepter, les présentations soumises seront réparties dans les sessions précédentes ou dans d'autres sessions si besoin est.

Pour soumettre une présentation:

- Envoyer un sommaire de une-page au responsable technique **avant le 8 août 1997**. Cette échéance devra être scrupuleusement respectée. Les sommaires devront être préparés en suivant les instructions incluses dans ce numéro d'**Acoustique canadienne**. Une notification d'acceptation du sommaire sera envoyée aux auteurs avant le 15 août 1997 avec un formulaire d'inscription au Symposium. Les sommaires seront publiés dans les actes du Symposium.

Veuillez faire parvenir les résumés et les sommaires à:

Dr. Robert Gaspar
Dept. of Mechanical and Materials Engineering
University of Windsor
Windsor, ON N9B 3P4
Tel. (519) 253-4232 X 2619, Fax. (519) 973-7062
e-mail: gasparr@engn.uwindsor.ca

Dr. Ramani Ramakrishnan
Vibron Ltd.
1720 Meyerside Drive
Mississauga, ON L5T 1A3
Tel. (905) 670-4922, Fax. (905) 670-1698

Frais d'inscription: les frais d'inscription au Symposium et le formulaire d'inscription dûment complété devront être expédiés après l'acception du sommaire.

Résumé des dates importantes:

8 août 1997	Date limite de réception des résumés.
15 août 1997	Notification d'acceptation.
22 août 1997	Date limite de réception du sommaire, du formulaire d'inscription et des frais d' inscription.
8 - 10 octobre 1997	Symposium.

Concours étudiants: la participation des étudiants au Symposium est fortement encouragée. Des prix en argent seront décernés pour les trois meilleures communications. Les étudiants doivent indiquer leur intention de participer en complétant le formulaire ***"Prix annuels relatifs aux communications étudiantes"*** qui figure dans le présent numéro et en le joignant au résumé.

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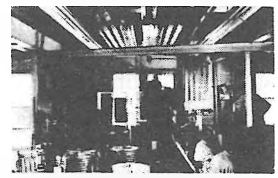

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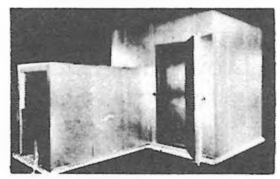

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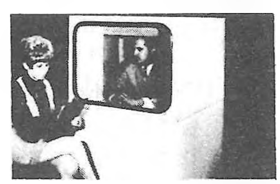

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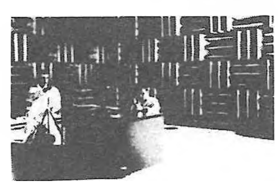

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SECOND CALL FOR PAPERS
Acoustics Week in Canada 1997
SYMPOSIUM, October 8 - 10

Due to the delay in delivery of the first call for papers, the submission time has been extended. This years CAA conference will deal with sound quality within the Environment, Society and Industry. Presentations covering acoustics within theses areas are solicited. A number of special technical sessions on particular themes have already been created. The list of the special sessions is as follows:

Sound quality
Psycho-acoustics
Automatic Speech Recognition
Speech Production
Architectural Acoustics
HVAC
Legislation/Environment Noise
Industrial Noise Control
Vibration Control
Physiological Acoustics
Speech Perception
Occupational Hearing Loss & Hearing Protection
Musical Acoustics
Airport (transportation) Noise
Underwater Acoustics & Sound Propagation
Active Noise Control
Canadian Standards

To speed the acceptance process, final versions of the proposed paper may be submitted. If accepted, papers will be incorporated into the program by assigning them to the existing sessions or creating new sessions when necessary.

To submit a paper:

- Send a **one-page** summary paper, prepared in accordance with the enclosed instructions to the technical program chair **before 8 August 1997**. This deadline will be strictly enforced. The summary paper should be prepared in accordance with the instructions enclosed in this issue of **Canadian Acoustics**. The summary papers will be published in the proceedings issue of Canadian Acoustics.

  A notification of acceptance will be sent to the authors by 15 August 1997 with a registration form.

Address the summary papers to:

Dr. Robert Gaspar
Dept. of Mechanical and Materials Engineering
University of Windsor
Windsor, ON N9B 3P4
Tel. (519) 253-4232 X 2619, Fax. (519) 973-7062
e-mail: gasparr@engn.uwindsor.ca

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Mississauga, ON L5T 1A3
Tel. (905) 670-4922, Fax. (905) 670-1698

Registration fee: the registration fee for the Symposium and the completed registration form must be sent upon acceptance of the summary paper.

Summary of dates:

8 August 1997	Deadline for receipt of summary paper
15 August 1997	Notification of acceptance.
22 August 1997	Deadline for registration form and registration fee.
8 - 10 October 1997	Symposium.

Student competition: student participation to the Symposium is strongly encouraged. Monetary awards will be given to the three best presented papers. Students must signify their intention to compete by submitting the ***"Annual Student Presentation Award"*** form in this issue, to be enclosed with the abstract.

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 d'une page 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 la date de tombée. Le format optimal peut être obtenu de deux façons:

Méthode directe - Imprimer directement sur une feuille 8.5" x 11" en respectant des marges 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 d'une page 8.5" x 11" avec des marges de 3/4" dans le haut et sur 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 one page 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 the deadline date. The optimum format can be obtained in two ways:

Indirect method - Type or print as follows, reduce to three-quarters size (please ensure good copies) and assemble article on a maximum of one 8.5" x 11" page 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.

Direct method - Print directly on one sheet 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.

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ANNUAL STUDENT PRESENTATION AWARDS

The Canadian Acoustical Association makes awards to students whose papers are presented at the CAA Annual Symposium. Students contemplating presenting papers at 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 décerne des prix aux étudiant(e)s qui présenteront une communication au congrès annuel de l'ACA. Les étudiant(e)s qui considèrent présenter un papier doivent s'inscrire à ce concours au moment où ils (elles) soummettent leur résumé.

REGLEMENTS

1. Ces prix sont décernés annuellement aux auteurs de communications exceptionelles presentées par des étudiants lors des sessions techniques de la Semaine Canadienne d'Acoustique.
2. Au total, trois prix de 500$ sont remis.
3. Les présentations sont jugées selon les critères suivants:
   - i) La façon dont le sujet est présenté;
   - ii) Les explications relatives à l'importance du sujet;
   - iii) L'explication de la méthodologie;
   - iv) La présentation et l'analyse des résultats;
   - v) La consistence des conclusions avec la théorie et les résultats.
4. Chaque présentation est evaluée séparément 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 membre de l'ACA;
   - iv) un participant 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 DECERNES AUX ETUDIANTS LORS DE LA SEMAINE CANADIENNE D'ACOUSTIQUE

NAME OF THE STUDENT:______________________________NOM DE L'ETUDIANT

SOCIAL INSURANCE NUMBER:______________________________NUMERO D'ASSURANCE SOCIALE

TITLE OF PAPER:______________________________TITRE DU PAPIER

UNIVERSITY/COLLEGE:______________________________UNIVERSITE/COLLEGE

NAME, TITLE OF SUPERVISOR:______________________________NOM ET TITRE DU SUPERVISEUR

STATEMENT BY THE SUPERVISOR: The undersigned affirms that the above-named student is a full-time student and the paper to be presented is the student's original work.

Signature:______________________________

DECLARATION DU SUPERVISEUR: Le sous-signé affirme que l'étudiant(e) mentionné(e) ci-haut est inscrit(e) à temps plein et que la communication qu'il (elle) présentera est le fruit de son propre travail.

Date:______________________________

APPLICATION FOR STUDENT TRAVEL SUBSIDY TO ACOUSTICS WEEK IN CANADA

Travel subsidies are available to students presenting papers at Acoustics Week in Canada if they live at least 150 km from the conference venue, if the subsidy is needed, if supporting receipts are submitted, and if they publish a summary of their paper in the proceedings issue of *Canadian Acoustics*.

I wish to apply for a CAA Travel Subsidy: _____yes _____no.

STATEMENT BY THE SUPERVISOR: The undersigned affirms that the CAA Travel Subsidy, combined with other travel funds that the above-named student may receive to attend the meeting will not exceed his/her travel costs.

Signature:______________________________

FORMULAIRE DE DEMANDE DE REMBOURSEMENT POUR FRAIS DE DEPLACEMENT A LA SEMAINE CANADIENNE D'ACOUSTIQUE

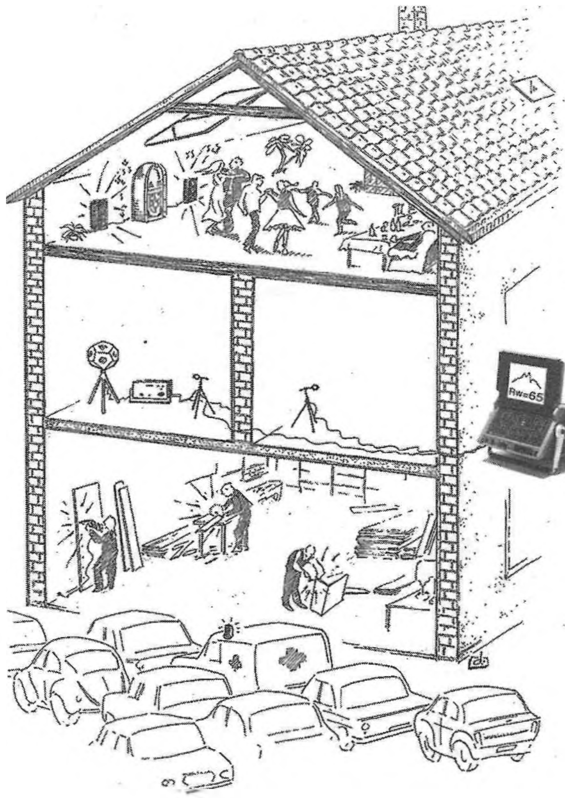
Un remboursement de frais de déplacement est offert aux étudiants qui présentent une communication lors de la Semaine Canadienne d'Acoustique, s'ils demeurent à plus de 150 km du site du congrès, si le remboursement est nécessaire, si les reçus à l'appui sont soumis et s'ils publient un résumé dans les Actes du Congrès.

Je désire demander un remboursement: _______oui _______non.

DECLARATION DU SUPERVISEUR: Le sous-signé affirme que le remboursement, jumelé à d'autres fonds que l'étudiant(e) ci-haut mentionné(e) peut recevoir ne dépasseront pas ses coûts réels de voyage.

Date:______________________________

More noise than signal?



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SOME OF THE FEATURES LISTED ARE OPTIONAL, CONTACT THE FACTORY FOR DETAILS

The Canadian Acoustical Association
l'Association Canadienne d'Acoustique

Minutes of the Board of Directors Meeting
Toronto, June 14, 1997

Present:	S. Abel	M. Hodgson	J.D. Quirt
	A. Cohen	J. Bradley	S. Dosso
	R. Gaspar	D. Jamieson (Chair)	
Regrets:	D.Chapman	C. Sherry	E. Slawinski
	J. Nicolas	D. Giusti	J. Hemingway

Meeting called to order at 11:00 PM.

President's Report

No new business other than agenda items.

Treasurer's Report

The treasurer reported that last years cost cutting measures and the increase in the annual membership fee to $50. had restored the Association's finances and a small surplus is expected. Funds have now been clearly separated into operating and capital accounts. (Capital funds are those invested to support the various prizes). Although current expected interest income is not sufficient to fund all prizes and awards, we do not usually award all of them each year. Operating funds are currently sufficient to make up any short fall in interest income. (Moved by S. Abel, seconded by S. Dosso, passed).

Secretary's Report

Membership is decreasing in all categories. Total membership in October 1995 was 408: in October 1996, was 376, and in June 1997 is 326. Extra measures were taken this year to encourage the renewal of memberships. A second 'reminder' letter was mailed and sustaining subscribers were telephoned to encourage them to renew for 1997.

A proposed new level of membership with a reduced fee for retired members was discussed. J. Bradley is to draw up a proposal for the October meeting.

The secretary reported a balance of $243.70 in the secretarial account after receiving $800. from the treasurer. The secretarial costs have been reduced this year. (Moved by J. Bradley, seconded by M. Hodgson, passed).

Editor's Report

M. Hodgson reported that Canadian Acoustics operations are once again quite stable after last year's problems with a bankrupt printer. Some changes are to be made to the new editorial board to improve its effectiveness. Printing charges may increase later this year but funding has improved because of better collection of advertising revenue. (Thanks to C. Hugh and S. Abel). The editor apologized for late issues but this is frequently due to the late arrival of key material such as announcements for our annual meeting. As agreed previously this years conference issue will contain one-page summary papers. (Moved by M. Hodgson, seconded by J.D. Quirt, passed).

Membership

Initiatives since the previous annual meeting have included a mailing to selected departments at all Canadian Universities, including copies of the awards brochure and the CAA brochure. There has been further development of the CAA Web page as well as responses to various requests for membership information.

The membership chair proposed that CAA consider a new category of membership to be referred to as a *Fellow*. This would be an honour that CAA would bestow on members who had made significant contributions to acoustics and to the Association. D. Jamieson is to bring a formal proposal to the October meeting for consideration by the Board of Directors and the members.

The possibility of seed money to help with the initial set up of local chapters was discussed. A. Cohen and D. Jamieson are to consider various possibilities and report back to the Board of Directors. There was concern expressed that this should not strain CAA finances.

Future Meetings

1997 Windsor

R. Gaspar reported that the Cleary International Centre has been booked and block bookings in adjacent hotels have been made. Current plans are to have the annual general meeting and banquet on the Thursday. A number of special sessions are being organised.

Discussion resulted in recommendations that the deadline for submissions be extended to clearly encourage more participants. As previously agreed by the Board of Directors, the conference fee for non-members is to be $50. greater than for members and will include a one year membership to CAA.

1998 Sherbrooke, Victoria?

Earlier suggestions for a meeting in Sherbrooke have not been confirmed. S. Dosso and M. Hodgson are to explore the possibility of a Victoria or Vancouver meeting.

1999 Toronto?

Awards Coordinator's Report

The Shaw Prize and the Fessenden Prize will not be awarded this year. The Youth Science Fair funds have been awarded. Winners of the Bell and Eckel Prizes have been selected subject to verification of their membership status.

Raymond Hétu Prize

M. Hodgson reported that the fund now had over $2,000. and that the committee had considered various options but had not come to a consensus. Various options were discussed and it was suggested that the committee develop a proposal for an annual book prize to be awarded to an undergraduate student. It is intended that this prize would encourage students to become more involved in acoustics.

New Business

J.D. Quirt made a presentation pointing out the need for CAA to develop a policy concerning how it will respond to International INCE requests for societies to approve various policy papers that it is producing. One of these concerning noise in the workplace was published in Canadian Acoustics. I-INCE is asking member societies (including CAA) to vote on approval of these documents. We currently have no mechanism to do this.

Discussion questioned whether we should support an effort that seems to parallel the activities of various existing standards groups and if we do how this will be performed. J.D. Quirt is to prepare a statement explaining the issues to be published in Canadian Acoustics so that all members can vote by mail on how we should respond to I-INCE.

A. Cohen questioned whether directors should write to the press as Directors of CAA. There was a consensus that a letter from the CAA president might be more effective.

Meeting adjourned at 15:11.

VIBRATION / ACOUSTICS ENGINEER

Rowan Williams Davies & Irwin Inc. (RWDI) is a consulting engineering firm specializing in environmental engineering, wind engineering, the microclimate, industrial process flows, noise, vibration and acoustics analysis. We are a firm of 120+ professional and support staff, located in Guelph, Ontario, CANADA servicing an international clientele. We are currently seeking a Vibration / Acoustics Engineer able to work on a wide array of building design issues. Candidates should possess the following qualifications:

*post-graduate degree in Mechanical/Structural Vibration complemented by one to two years of practical experience in building vibration and acoustics consultation

*experienced with:
* vibration isolation and measurement techniques
* determination of mode shapes and damping in structures
* flow-induced noise/vibrations and control
* advanced finite elements analysis
* sound structure interactions and propagation
* random vibrations in structural mechanics (linear and nonlinear systems, excitation by ground motion, turbulence)
* multi-channel FFT analysers and data collectors
* advanced vibration signalling
* machine vibrations and control
* stress waves in solids

*preference will be given to candidates with additional experience in building and architectural acoustics, specializing in HVAC noise control and auditorium acoustics.

*excellent communication skills, with a desire, an ability to work in a fast-paced consulting environment and a willingness to relocate to Guelph, Ontario, Canada are essential.

For confidential consideration please respond to: Anne Jenner, Recruiting Coordinator
Rowan Williams Davies & Irwin Inc.
650 Woodlawn Road West
Guelph, Ontario, CANADA N1K 1B8
Fax (519) 823-1316 Telephone: (519) 823-1316
Email: aj@rwdi.com Website:http://www.rwdi.com

NEWS / INFORMATIONS

CONFERENCES

The following list of conferences was mainly provided by the Acoustical Society of America. If you have any news to share with us, send them by mail or fax to the News Editor (see address on the inside cover), or via electronic mail to desharnais@drea.dnd.ca

1997

3-5 June: 8th International Meeting on Low Frequency Noise & Vibration, Gothenburg, Sweden. Contact: W. Tempest, Multi-Science Publishing Co. Ltd., 107 High St., Brentwood, Essex CM14 4RX, UK, Fax: +44 1277 223453.

5-7 June: Conference on ICP and Inner Ear Pressure, Bath, UK. Contact: British Society of Audiology, 80 Brighton Rd., Reading RG6 1PS, UK; Fax: +44 1734 351915.

15-17 June: NOISE-CON 97, State College, PA. Contact: Institute of Noise Control Engineering, P.O. Box 320, Arlington Branch, Poughkeepsie, NY 12603, Tel.: 914-891-1407; FAX: 914-463-0201.

15-20 June: Eighth International Symposium on Nondestructive Characterization of Materials, Boulder, CO. Contact: Debbie Harris, The Johns Hopkins University, Ctr. for Nondestructive Evaluation, 102 Maryland Hall, 3400 N. Charles St., Baltimore, MD 21218, Tel.: 410-516-5397; FAX: 410-516-7249, E-mail: cnde@jhuvms.hcf.jhu.edu

16-20 June: 133rd Meeting of the Acoustical Society of America, State College, PA. Contact: Acoustical Society of America, 500 Sunnyside Blvd., Woodbury, NY 11797, Tel.: 516-576-2360; Fax: 516-576-2377; E-mail: asa@aip.org; WWW: http//asa.aip.org

18-21 June: 3rd European Conference on Audiology, Prague, Czech Republic. Contact: Paediatric Otolaryngologic Clinic, Faculty Hospital Motol, V Uvalu 84, 15018 Prague 5, Czech Republic; FAX: +42 2 2443 2620.

23-25 June: 1st International Conference on Marine Electromagnetics, London, UK. Contact: Marelec97, Electronic and Electrical Engineering, Imperial College, Exhibition Rd., London SW7 2BT, UK, Fax: +44 171 823 8125; Email: marelec@ic.ac.uk.

24-27 June: 1st European Conference on Signal Analysis and Prediction, Prague, Czech Republic. Contact: ESCAP Secretariat, Institute of Chemical Technology, Technicka 5, 166 28 Praha 6, Czech Republic; Fax: +42 2 243 11082; E-mail: escap@vscht.cz; WW: http://www.vscht.cz/escap97/

25-27 June: 5th International Congress of the International Society of Applied Psycholinguistics, Porto, Portugal. Contact: Maria da Graça Pinto, Universidade do Porto, Faculdad de Letras, Via Panorâmica, s/n, PT-4150 Porto, Portugal; FAX: +351 2 610 1990.

25-27 June: 12th Echocardiology Symposium and 9th Meeting of the International Cardiac Doppler Society, Rotterdam, The Netherlands. Contact: LMC Congress Service, P.O. Box 593, 3700 AN Zeist, The Netherlands, FAX: +31 343 533 357.

2-4 July: Ultrasonics International '97, Delft, The Netherlands. Contact: W. Sachse, Dept. of Theoretical and Applied Mechanics, Cornell Univ., Ithaca, NY 14853; Fax: 607 255 9179; E-mail: sachs@msc.cornell.edu

CONFÉRENCES

La liste de conférences ci-jointe a été offerte en majeure partie par l'Acoustical Society of America. Si vous avez des nouvelles à nous communiquer, envoyez-les par courrier ou fax (coordonnées incluses à l'envers de la page couverture), ou par courrier électronique à desharnais@drea.dnd.ca

1997

3-5 juin: 8e rencontre internationale sur les bruits et vibrations à basse fréquence, Gothenburg, Suède. Info: W. Tempest, Multi-Science Publishing Co. Ltd., 107 High St., Brentwood, Essex CM14 4RX, UK, Fax: +44 1277 223453.

5-7 juin: Conférence sur l'ICP et pression de l'oreille interne, Bath, Royaume Uni. Info: British Society of Audiology, 80 Brighton Rd., Reading RG6 1PS, UK; Fax: +44 1734 351915.

15-17 juin: NOISE-CON 97, State College, PA. Info: Institute of Noise Control Engineering, P.O. Box 320, Arlington Branch, Poughkeepsie, NY 12603, Tel.: 914-891-1407; FAX: 914-463-0201.

15-20 juin: Huitième symposium international sur la caractérisation non-destructive des matériaux, Boulder, CO. Info: Debbie Harris, The Johns Hopkins University, Ctr. for Nondestructive Evaluation, 102 Maryland Hall, 3400 N. Charles St., Baltimore, MD 21218, Tel.: 410-516-5397; FAX: 410-516-7249, E-mail: cnde@jhuvms.hcf .jhu.edu

16-20 juin: 133e rencontre de l'Acoustical Society of America, State College, Pennsylvanie. Info: Acoustical Society of America, 500 Sunnyside Blvd., Woodbury, NY 11797, Tel.: 516-576-2360; Fax: 516-576-2377; E-mail: asa@aip.org; WWW: http//asa.aip.org

18-21 juin: 3e conférence européenne en audiologie, Prague, Czech Republic. Info: Paediatric Otolaryngologic Clinic, Faculty Hospital Motol, V Uvalu 84, 15018 Prague 5, Czech Republic; FAX: +42 2 2443 2620.

23-25 juin: 1ère conférence internationale sur l'électromagnétisme marin, Londres, Royaume-Uni. Info: Marelec97, Electronic and Electrical Engineering, Imperial College, Exhibition Rd., London SW7 2BT, UK, Fax: +44 171 823 8125; Email: marelec@ic.ac.uk

24-27 juin: 1e conférence européenne sur l'analyse et la prédiction de signaux, Prague, République Tchèque. Info: ESCAP Secretariat, Inst of Chemical Technology, Technicka 5, 166 28 Praha 6, Czech Republic; Fax: +42 2 243 11082; E-mail: escap@vscht.cz; http://www.vscht.cz/escap97/

25-27 juin: 5e congrès international de la Société internationale de psycho-linguistique appliquée, Porto, Portugal. Info: Maria da Graça Pinto, Universidade do Porto, Faculdad de Letras, Via Panorâmica, s/n, PT-4150 Porto, Portugal; FAX: +351 2 610 1990.

25-27 juin: 12e symposium d'échocardiologie et 9e rencontre de la Société internationale du doppler cardiaque, Rotterdam, Pays Bas. Info: LMC Congress Service, P.O. Box 593, 3700 AN Zeist, The Netherlands, FAX: +31 343 533 357.

2-4 juillet: Ultrasonics International '97, Delft, Pays-Bas. Info: W. Sachse, Dept. of Theoretical and Applied Mechanics, Cornell Univ., Ithaca, NY 14853; Fax: 607 255 9179; E-mail: sachs@msc.cornell.edu

9-13 July: International Clarinet Association, Texas Tech Univ., Lubbock, TX. Contact: Keith Koons, Music Department, Univ. of Central Florida, P.O. Box 161354, Orlando, FL 23816-1354, Tel; 407-823-5116; E-mail: kkoons@pegasus.cc.ucf.edu

14-17 July: 6th International Conference on Recent Advances in Structural Dynamics, Southampton, UK. Contact: N. Ferguson, ISVR, University of Southampton, Southampton SO17 IBJ, UK; FAX: +44 1703 593033; E-mail: mzs@isvr.soton.ac.uk

18-22 August: 3rd EUROMECH Solid Mechanics Conference, Stockholm. Contact: B. B. Storakers, Department of Solid Mechanics, Royal Institute of Technology, 100 44 Stockholm, Sweden; E-mail: 3esmc@hallf.kth.se

19-22 August: International Symposium on Musical Acoustics, Edinburgh. Contact: D.M. Campbell, Department of Physics and Astronomy, University of Edinburgh, James Clerk Maxwell Building, Mayfield Road, Edinburgh EH9 3JZ, Scotland; Fax: +44 650 5902; E-mail: Isma.97@ed.ac.uk; http://www.music.ed.ac.uk/research/conferences/isma/

21-23 August: ACTIVE 97 Inter-Noise Satellite Symposium, Budapest, Hungary. Contact: ACTIVE 97 Secretariat, POAKFI, Fou 68, 1028 Budapest, Hungary; Fax: +36 1 202 0452.

24-27 August: 1997 World Congress on Ultrasonics, Yokohama, Japan. Contact: S. Ueha, Precision and Intelligence Lab., Tokyo Inst. of Technology 4259 Nagatsuta, Midori-ku, Yokohama 226, Japan; Fax: +81 45 921 0898; E-mail: wcu97@pi.titech.ac.jp

25-27 August: Internoise 97, Budapest, Hungary. Contact: OPAKFI, Fo. u. 68, 1027 Budapest, Hungary; Fax: +36 1 202 0452.

1-4 September: Modal Analysis Conference - IMAC-XV Japan, Tokyo, Japan. Contact: N. Okubo, Chuo University, 1-13-27 Kasuga, Bunkyo-ku, Yokyo 112, Japan; FAX: +81 3 3817-1820; E-mail: jmac@okubo.mech.chuo-u.ac.jp

7-11 September: American Academy of Otolaryngology--Head and Neck Surgery, San Francisco, CA. Contact: American Academy of Otolaryngology--Head and Neck Surgery, One Prince St., Alexandria, VA 22314. Tel.: 703-836-4444; FAX: 703-683-5100.

9-12 September: 31st International Acoustical Conference "Acoustics - High Tatra 97", High Tetra, Slovakia. Contact: E. Rajcan, Technical University Zvolen, 96053 Zvolen, Slovakia; FAX: +42 855 321 811; E-mail: 31iac@tuzvo.sk

10-12 September: New Zealand Acoustical Society Biennial Conference, Christchurch, New Zealand. Contact: NZ Acoustical Society, P.O. Box 1181, Auckland, New Zealand.

15-18 September: 3rd EUROMECH Fluid Mechanics Conference, Gottingen. Contact: G.E.A. Meier, DRL-Institut fur Stromungsmechanik, Bundestrasse 10, 37073, Gottingen, Germany; E-mail: efmc972msfdl.gwdg.de

18-20 September: Intonation: Theory, Models and Applications, Athens, Greece. Contact: ESCA Workshop Dept. of Informatics, Univ. of Athens, Panepistimioupolis, Ilisia, 15784 Athens, Greece, Fax: +30 1 722 8981; Email: tonesca@di.uoa.gr

9-13 juillet: Association internationale de la clarinette, Texas Tech Univ., Lubbock, TX. Info: Keith Koons, Music Department, Univ. of Central Florida, P.O. Box 161354, Orlando, FL 23816-1354, Tel: 407-823-5116; E-mail: kkoons@pegasus.cc.ucf.edu

14-17 juillet: 6e conférence internationale sur les progrès récents en dynamique structurale, Southampton, Royaume-Uni. Info: N. Ferguson, ISVR, University of Southampton, Southampton SO17 IBJ, UK; FAX: +44 1703 593033; E-mail: mzs@isvr.soton.ac.uk

18-22 août: 3e conférence EUROMECH sur la mécanique des solides, Stockholm. Information: B. B. Storakers, Department of Solid Mechanics, Royal Institute of Technology, 100 44 Stockholm, Sweden; E-mail: 3esmc@hallf.kth.se

19-22 août: Symposium international sur l'acoustique musicale, Edinbourg. Info: D.M. Campbell, Department of Physics and Astronomy, University of Edinburgh, James Clerk Maxwell Building, Mayfield Road, Edinburgh EH9 3JZ, Scotland; Fax: +44 650 5902; E-mail: isma.97@ed.ac.uk; http://www.music.ed.ac.uk/research/conferences/isma/

21-23 août: ACTIVE 97 Symposium satellite d'Inter-Noise, Budapest, Hongrie. Information: ACTIVE 97 Secretariat, POAKFI, Fou 68, 1028 Budapest, Hungary; FAX: +36 1 202 0452.

24-27 août: Congrès mondial de 1997 sur les ultrasons, Yokohama, Japon. Info: S. Ueha, Precision and Intelligence Lab., Tokyo Inst. of Technology 4259 Nagatsuta, Midori-ku, Yokohama 226, Japan; Fax: +81 45 921 0898; E-mail: wcu97@pi.titech.ac.jp

25-27 août: Internoise 97, Budapest, Hongrie. Info: OPAKFI, Fo. u. 68, 1027 Budapest, Hungary; Fax: +36 1 202 0452.

1-4 septembre: Conférence sur l'analyse par modes - IMAC-XV Japon, Tokyo, Japon. Info: N. Okubo, Chuo University, 1-13-27 Kasuga, Bunkyo-ku, Yokyo 112, Japan; FAX: +81 3 3817-1820; E-mail: jmac@okubo.mech.chuo-u.ac.jp

7-11 septembre: Académie américaine d'otolaryngologie - Chirurgie de la tête et du cou, San Francisco, CA. Info: American Academy of Otolaryngology--Head and Neck Surgery, One Prince St., Alexandria, VA 22314; Tel.: 703-836-4444; FAX: 703-683-5100.

9-12 septembre: 31e conférence internationale d'acoustique "Acoustics - High Tatra 97", High Tetra, Slovakia. Info: E. Rajcan, Technical University Zvolen, 96053 Zvolen, Slovakia; FAX: +42 855 321 811; E-mail: 31iac@tuzvo.sk

10-12 septembre: Conférence biennale de la Société d'acoustique de la Nouvelle-Zélande, Christchurch, Nouvelle-Zélande. Info: NZ Acoustical Society, P.O. Box 1181, Auckland, New Zealand.

15-18 septembre: 3e conférence EUROMECH sur la mécanique des fluides, Gottingen. Info: G.E.A. Meier, DRL-Institut fur Stromungsmechanik, Bundestrasse 10, 37073, Gottingen, Germany; E-mail: efmc972msfdl.gwdg.de

18-20 septembre: Intonation: théorie, modèles et applications, Athènes, Grèce. Info: ESCA Workshop Dept. of Informatics, Univ. of Athens, Panepistimioupolis, Ilisia, 15784 Athens, Greece, Fax: +30 1 722 8981; Email: tonesca@di.uoa.gr

22-24 September: Second Biennial Hearing Aid Research and Development Conference, Bethesda, MD. Contact: National Institute of Deafness and Other Communication Disorders, 301-970-3844; FAX: 301-907-9666; E-mail: hearingaid@tascon.com

22-25 September: 5th European Conference on Speech Communication and Technology, Patras, Greece. Contact: G. Kokkinakis, Department of Electrical and Computer Engineering, University of Patras, 26110 Rion-Patras, Greece; Fax: +30 61 991 855, E-mail: gkokkin @wcl.ee.upatras.gr

6-9 October: Oceans '97 MTS/IEEE, Halifax, Canada. Contact: IEEE Travel and Conference Management Services, 445 Hoes Lane, Piscataway, NJ, 08855-1331, USA. Tel: (908) 562-5598; Fax: (908) 981-1203.

7-10 October: 1997 IEEE Ultrasonics Symposium, Toronto, Canada. Contact: S. Foster, Department of Medical Biophysics, Sunnybrook Health Science Ctr., 2075 Bayview Avenue, Toronto, Ontario M4N 3M5, Canada; E-mail: stuart@owl.sunnybrook.utoronto.ca

8-10 October: 1997 Acoustics Week in Canada, Windsor, Canada. Contact: Dr. R. Ramakrishnan, Vibron Ltd, 1720 Meyerside Drive, Mississauga, Ontario, L5T 1A3. Tel.: (905) 670-4922; FAX: (905) 670-1698.

23-26 October: Reproduced Sound 13, Windermere, UK. Contact: Inst. of Acoustics, Agriculture House, 5 Holywell Hill, St. Albans, Herts AL1 1EU, UK, Fax: +44 1727 850 533; Email: acoustics@clus1.ulcc.ac.uk.

19-21 November: WESTPRAC VI 97, Hong Kong. Contact: S.K. Tang, WESTPRAC Secretary, Department of Building Services Engineering, The Hong Kong Polytechnic University, Hung Hum, Hong Kong; FAX: +852 27746146; E-mail: besktang@polyu.edu.hk

20-23 November: IOA Autumn Conference: Environmental Noise, Windermere, UK. Contact: Institute of Acoustics, Agriculture House, 5 Holywell Hill, St. Albans, Herts AL1 1EU, UK, Fax: +44 1727 850 533; Email: acoustics@clus1.ulcc.ac.uk

1-5 December: 134th Meeting of the Acoustical Society of America, San Diego, CA. Contact: Acoustical Society of America, 500 Sunnyside Blvd., Woodbury, NY 11797, Tel.: 516-576-2360; Fax: 516-576-2377; E-mail: asa@aip.org; WWW: http//asa.aip.org

15-18 December: 5th International Congress on Sound and Vibration, Adelaide, Australia. Contact: ICSV5 Secretariat, Department of Mechanical Engineering, University of Adelaide, South Australia 5005, Australia; FAX: +61 8 8303 4367; E-mail: icsv5@mecheng.adelaide.edu.au

1998

23-27 March: DAGA 98 - German Acoustical Society Meeting, Zürich, Switzerland. Contact: DEGA, Physics/ Acoustics Department, Universität Oldenburg, 26111 Oldenburg, Germany; FAX: +49 441 798 3698; E-mail: dega@aku.physik.uni-oldenburg.de

25-27 May: Noise and Planning 98, Naples, Italy. Contact: Noise and Planning, Via Bragadino 2, 20144 Milano, Italy, Fax: +39 248018839; Email: md1467@cmlink.it

22-24 septembre: 2e conférence biennale sur la recherche et le développement des prothèses auditives, Bethesda, MD. Info: National Institute of Deafness and Other Communication Disorders, 301-970-3844; FAX: 301-907-9666; E-mail: hearingaid@tascon.com

22-25 septembre: 5e conférence européenne sur la communication et la technologie de la parole, Patras, Grèce. Info: G. Kokkinakis, Dept of Electrical and Computer Engineering, University of Patras, 26110 Rion-Patras, Greece; Fax: +3061 991855, E-mail: gkokkin@wcl.ee. upatras.gr

6-9 octobre: Oceans '97 MTS/IEEE, Halifax, Canada. Info: IEEE Travel and Conference Management Services, 445 Hoes Lane, Piscataway, NJ, 08855-1331, USA. Tel: (908) 562-5598; Fax: (908) 981-1203.

7-10 octobre: Symposium de 1997 de l'IEEE sur les ultrasons, Toronto, Canada Info: S. Foster, Department of Medical Biophysics, Sunnybrook Health Science Ctr., 2075 Bayview Avenue, Toronto, Ontario M4N 3M5, Canada; E-mail: stuart@owl.sunnybrook.utoronto.ca

8-10 octobre: Semaine canadienne d'acoustique 1997, Windsor, Canada. Info: Dr. R. Ramakrishnan, Vibron Ltd, 1720 Meyerside Drive, Mississauga, Ontario, L5T 1A3. Tel.: (905) 670-4922; Fax: (905) 670-1698.

23-26 octobre: Sons reproduits 13, Windermere, Royaume-Uni. Info: Inst. of Acoustics, Agriculture House, 5 Holywell Hill, St. Albans, Herts AL1 1EU, UK, Fax: +44 1727 850 533; Email: acoustics@clus1.ulcc.ac.uk

19-21 novembre: WESTPRAC VI 97, Hong Kong. Info: S.K. Tang, WESTPRAC Secretary, Department of Building Services Engineering, The Hong Kong Polytechnic University, Hung Hum, Hong Kong; FAX: +852 27746146; E-mail: besktang@polyu.edu.hk

20-23 novembre: Conférence d'automne de l'IOA: Bruit environmental, Windermere, Royaume-Uni. Renseignements: Inst. of Acoustics, Agriculture House, 5 Holywell Hill, St. Albans, Herts AL1 1EU, UK, Fax: +44 1727 850 533; Email: acoustics@clus1.ulcc.ac.uk

1-5 décembre: 134e rencontre de l'Acoustical Society of America, San Diego, Californie. Info: Acoust Soc. of Am, 500 Sunnyside Blvd., Woodbury, NY 11797, Tel.: 516-576-2360; Fax: 516-576-2377; E-mail: asa@aip.org; http//asa.aip.org

15-18 décembre: 5e congrès international sur les sons et vibrations, Adelaïde, Australie. Info: ICSV5 Secretariat, Department of Mechanical Engineering, University of Adelaide, South Australia 5005, Australia; FAX: +61 8 8303 4367; E-mail: icsv5@mecheng.adelaide.edu.au
1998

1998

23-27 mars: DAGA 98 - Rencontre de la Société allemande d'acoustique, Zürich, Suisse. Info: DEGA, Physics/ Acoustics Department, Universität Oldenburg, 26111 Oldenburg, Germany; FAX: +49 441 798 3698; E-mail: dega@aku.physik.uni-oldenburg.de

25-27 mai: Bruit et planification 98, Naples, Italie. Info: Noise and Planning, Via Bragadino 2, 20144 Milano, Italy, Fax: +39 248018839; Email: md1467@cmlink.it

8-10 June: EAA/EEAA Symposium "Transport Noise and Vibrations", Tallinn, Estonia. Contact: East-European Acoustical Association, Moskovskoe Shosse 44, 196158 St.-Petersburg, Russia; FAX: +7 812 127 9323; E-mail: krylspb@sovam.com

22-26 June: 135th meeting of the Acoustical Society of America/16th International Congress on Acoustics, Seattle, WA. Contact: ASA, 500 Sunnyside Blvd., Woodbury, NY 11797, Tel.: 516-576-2360; FAX: 516-576-2377; E-mail: asa@aip.org, WWW: http://asa.aip.org

13-17 September: American Academy of Otolaryngology--Head and Neck Surgery, San Francisco, CA. Contact: American Academy of Otolaryngology--Head and Neck Surgery, One Prince St., Alexandria, VA 22314. Tel.: 703-836-4444; FAX: 703-683-5100.

12-16 October: 136th meeting of the Acoustical Society of America, Norfolk, VA. Contact: ASA, 500 Sunnyside Blvd., Woodbury, NY 11797, Tel.: 516-576-2360; FAX: 516-576-2377; E-mail: asa@aip.org; WWW: http://asa.aip.org

16-18 November: Inter-Noise 98, Christchurch, New Zealand. Contact: New Zealand Acoustical Society, P.O. Box 1181, Auckland, New Zealand.

23-27 November: ICBEN 98: Biological Effects of Noise, Sydney, Australia. Contact: N. Carter, NAL, 126 Greville St., Chatswood 2067, Australia, Fax: +61 2 411 8273.

8-10 juin: Symposium EAA/EEAA "Bruit et vibrations des transports", Tallinn, Estonia. Info: East-European Acoustical Association, Moskovskoe Shosse 44, 196158 St.-Petersburg, Russia; FAX: +7 812 127 9323; E-mail: krylspb@sovam.com

22-26 juin: 135e rencontre de l'Acoustical Society of America/16e congrès international d'acoustique, Seattle, WA. Info: ASA, 500 Sunnyside Blvd., Woodbury, NY 11797, Tel.: 516-576-2360; FAX: 516-576-2377; E-mail: asa@aip.org; WWW: http://asa.aip.org

13-17 septembre: Académie américaine d'otolaryngologie - Chirurgie de la tête et du cou, San Francisco, CA. Info: American Academy of Otolaryngology--Head and Neck Surgery, One Prince St., Alexandria, VA 22314. Tel.: 703-836-4444; FAX: 703-683-5100.

12-16 octobre: 136e rencontre de l'Acoustical Society of America, Norfolk, VA. Info: ASA, 500 Sunnyside Blvd., Woodbury, NY 11797, Tel.: 516-576-2360; FAX: 516-576-2377; E-mail: asa@aip.org; WWW: http:// asa.aip.org

16-18 novembre: Inter-Noise 98, Christchurch, Nouvelle-Zélande. Info: New Zealand Acoustical Society, P.O. Box 1181, Auckland, New Zealand.

23-27 novembre: ICBEN 98: Effets biologiques du bruit, Sydney, Australie. Info: N. Carter, NAL, 126 Greville St., Chatswood 2067, Australia, Fax: +61 2 411 8273.

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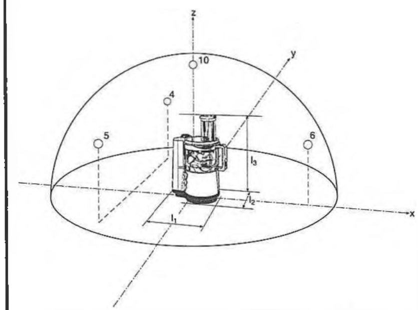

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The Canadian Acoustical Association
l'Association Canadienne d'Acoustique

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*	*1995*	*Jing-Fang Li*	*University of British Columbia*
1993	*Roland Woodcock*	*University of British Columbia*	*1996*	*Vijay Parsa*	*University of Western Ontario*
1994	*John Osler*	*Defense Research Estab. Atlantic*			

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*	*1993*	*Aloknath De*	*McGill University*
1991	*Steven D. Turnbull*	*University of New Brunswick*	*1994*	*Michael Lantz*	*Queen's University*
	Fangxin Chen	*University of Alberta*	*1995*	*Kristina Greenwood*	*University of Western Ontario*
	Leonard E. Cornelisse	*University of Western Ontario*	*1996*	*Mark Pell*	*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*	*1994*	*Craig L. McNeil*	*University of Victoria*
1993	*Douglas J. Wilson*	*Memorial University*	*1996*	*Dean Addison*	*University of Victoria*

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.

1994	*Todd Busch*	*University of British Columbia*	*1996*	*Nelson Heerema*	*University of British Columbia*
1995	*Raymond Panneton*	*Université de Sherbrooke*			

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: David Quirt, Acoustics Section, Institute for Research in Construction, NRCC, Ottawa, ON K1A 0R6.

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.

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. Pour les quatre premiers prix, les candidats doivent soumettre un formulaire de demande ainsi que la documentation associée au coordonnateur 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 coordonnateur 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*	*1995*	*Jing-Fang Li*	*University of British Columbia*
1993	*Roland Woodcock*	*University of British Columbia*	*1996*	*Vijay Parsa*	*University of Western Ontario*
1994	*John Osler*	*Defense Research Estab. Atlantic*			

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*	*1993*	*Aloknath De*	*McGill University*
1991	*Steven D. Turnbull*	*University of New Brunswick*	*1994*	*Michael Lantz*	*Queen's University*
	Fangxin Chen	*University of Alberta*	*1995*	*Kristina Greenwood*	*University of Western Ontario*
	Leonard E. Cornelisse	*University of Western Ontario*	*1996*	*Mark Pell*	*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*	*1994*	*Craig L. McNeil*	*University of Victoria*
1993	*Douglas J. Wilson*	*Memorial University*	*1996*	*Dean Addison*	*University of Victoria*

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.

1994	*Todd Busch*	*University of British Columbia*	*1996*	*Nelson Heerema*	*University of British Columbia*
1995	*Raymond Panneton*	*Université de Sherbrooke*			

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: David Quirt, Section d'acoustique, Institut de Recherche en Construction, NRCC, Ottawa, ON K1A 0R6.

PRIX DE PRESENTATION ÉTUDIANT

Trois prix, de $500 chacun, 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.

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

Title: Bold, 14 pt with 14 pt spacing, upper case, centered.

Authors/addresses: Names and full mailing addresses, 10 pt with single (12 pt) spacing, upper and lower case, centered. Names in bold text.

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

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Photographs: Submit original glossy, black and white photograph.

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Reprints: Can be ordered at time of acceptance of paper.

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

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