CHILDREN'S AND TEACHERS' PERCEPTIONS OF ENVIRONMENTAL NOISE IN CLASSROOMS

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1. INTRODUCTION

A study has recently been carried out in which the effects of environmental and classroom noise on the attainments and cognitive development of children in London primary schools have been examined. The study included noise surveys in and around primary schools in three London Boroughs. In addition a questionnaire survey of primary school children and teachers in one borough was undertaken in order to ascertain their awareness of environmental noise and annoyance caused by different noise sources. Children were also asked to rate the ease with which they were able to hear their teacher in various situations.

This paper reports and compares the results of the pupil and teacher questionnaire surveys and relates responses to the recorded incidence of environmental noise sources and noise levels outside schools.

2. BACKGROUND TO THE RESEARCH

There have been many studies of the effects of environmental noise on children at school, many of which have focused on the effects of aircraft noise on children's learning [1-8]. Fewer studies have examined the noise environment and acoustic conditions in classrooms, their effects upon children at school or the annoyance experienced by children as a result of noise [8-14].

While much is known about adult annoyance from noise there has been little work with children, and there is a danger that work on the effects of noise on children will be coloured by adult perceptions of noise. Research with children has often been compromised by a failure to consider the child's perspective of the variable under consideration, which has led to underestimation of children's abilities and a failure to identify the range of factors that may impact on successful performance [15].

Work with adults has shown that capturing an accurate reflection of annoyance and levels of annoyance is complex [16]. The noise environment generally comprises more than one source of noise so research needs to identify the noises that are typical for children. Not all sources of noise will be equally annoying and it may not be the level of the noise that is the key feature, as work from adults has demonstrated [17]. Children will be exposed to a range of sounds and these different sources need to be considered individually and in combination.

Therefore aims of the questionnaire surveys described here included

- Assessing children's awareness of environmental noise sources at home and at school and the extent to which children are annoyed by these sources
- Assessing teachers' awareness of environmental noise sources at school and the extent to which they consider children are affected by these sources
- Documenting children's ability to differentiate good and poor listening situations in classrooms

3. QUESTIONNAIRE DESIGN

3.1 Pilot work

The questionnaires for children and teachers were based upon the results of semi-structured interviews carried out with Year 2 and Year 6 children and their teachers in a primary school in Hertfordshire. The objectives were to establish different noise sources that children were aware of and to determine types of noise they might be exposed to and annoyed by both at school and at home. Interviews with teachers explored their attitudes towards noise in the school environment and

its effect upon children's performance. In order not to bias the children's responses the interviewers used the term 'sound' throughout the interviews; the children used the terms 'noise' and 'sound' interchangeably.

The significant noise sources that emerged from the children's interviews were categorised as follows:

i) Noise made by people
ii) Transportation noise (e.g. cars, buses, aeroplanes etc)
iii) Entertainment noise (e.g. stereo, musical instruments, TV etc)
iv) Noise from nature (e.g. trees, birds, dogs, cats etc)
v) Noise from machines (e.g. telephone etc)

This information served as the basis for developing both a child questionnaire and a teacher questionnaire. Two pilot stages were undertaken to validate the questionnaires. Initially they were administered to two Year 2 (39 pupils), two Year 6 (45 pupils) classes and their teachers. As a result of feedback and ambiguity minor changes were made to the pupil questionnaire, and decisions made as to the method of administration. The revised questionnaire was then piloted in 6 schools, with a sample of 343 pupils from six Year 2 classes and eight Year 6 classes. No problems or areas of concern were found in administration or results during the pilot survey.

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3.2 The children's questionnaire

The ten-page children's questionnaire was divided into three sections. Section A examined the sound sources children were exposed to in their environment both at home and at school. Fourteen sources were listed and for each the child was asked a) whether they ever heard the noise while at school and b) if they heard it, whether they were annoyed by it. Questions were accompanied by a graphic representation of the noise source followed by 'yes' and 'no' tick boxes. The same questions were repeated for 'hear' and 'annoy' at home. The 14 sources included were the following: cars, musical instruments, planes, trains, telephones, motorbikes, buses, television, animals (including birds), helicopters, lorries, stereos, trees, and emergency sirens.

Section B of the questionnaire examined listening situations across nine classroom activities and contexts. These situations were chosen from the interviews with children from the relevant age groups or previous work [18]. Children were asked how easily they could hear the teacher in each of the following situations:

- when they cannot see the teacher's face
- when the teacher is moving around the classroom
- when they are working in groups
- when there is no noise outside the classroom
- when other children are making noise outside the classroom
- when they are doing a test
- when they are doing PE in the playground
- when there is no noise at all.

Children were also asked if they could hear a classmate answering a teacher's question.
The children responded to each of these questions using a 5 point 'smiley faces' scale which ranged from 'very well to 'not at all', and was based upon the work of Arnold and Canning [18].

Section C addressed demographic information. Both Section A and section B were preceded by a series of trial items to familiarise the children with the demands of the questionnaire and to allow for any problems or questions to be addressed.

3.3 Teacher Questionnaire

A five page questionnaire with open-ended and closed questions was developed to determine the environmental noise(s) which teachers hear in the classroom, the impact that they consider noise has on children's performance, and their perceptions of noise as related to classroom and school activities. The questionnaire asked about the sound sources heard in the classroom (the same sources as in the children's questionnaire), and whether particular sounds affected the pupils' concentration.

4. ADMINISTRATION OF QUESTIONNAIRES

The questionnaire was administered to all Year 2 and Year 6 pupils in 43 schools in the chosen borough. The total number of children participating in the study was 2036. Of these, 885 (43.5%) were Year 2 pupils and 1151 (56.5%) were from Year 6. The sample consisted of 1041 (51.1%) boys and 995 (48.9%) girls. The age distribution of the children was as follows: 6 year olds 8.1%, 7 year olds 35.9%, 10 year olds 14.2%, 11 year olds 41.8%.

The children's questionnaires were completed during morning or afternoon school hours. At the beginning of each session, there was a brief introduction to the project followed by a thorough description of the questionnaire and an explanation of the way children should record their answers. Children were told that they could work at their own pace, as the questionnaire was not time-limited. In addition, the administrators assured participants that the data would be treated confidentially. Children were allowed and encouraged to ask questions at any time during the presentation.

An important difference between the Year 2 and Year 6 administration procedure was that the Year 6 children completed the questionnaires as a whole class in the classroom, whereas, to ensure accurate understanding, the Year 2 pupils were guided through the questionnaire in groups of up to 10 children. The questionnaire completion time was approximately 20 minutes for the Year 6 children and 35 minutes for the Year 2 pupils.

The teacher questionnaire was given to the teachers of all the classes used in the pupil survey. The Year 6 teachers completed the questionnaire at the same time as their pupils. However, the Year 2 teachers tried to complete the questionnaire during break-time. They were given the option of completing the questionnaire at a convenient time and returning it by post. It took approximately 20 minutes to fully answer all the questions. Fifty-one teachers completed the questionnaires (12 in Year 2 and 39 in Year 6). Eleven were male and 40 female. Over half the sample (59%) had more than five years experience, with 20 per cent having more than 20 years experience. For those who reported their age (39) there was a mean of 37 years (range 26-55).

5. NOISE SURVEY

Noise levels were measured outside 53 primary schools in the borough. At each school five minute samples of noise were measured using a Bruel and Kjaer hand held sound level meter, Type 2236. The environmental noise parameters $L_{Aeq,5min}$, $L_{A10,5min}$, $L_{A90,5min}$, $L_{A99,5min}$, $L_{Amax,5min}$ and $L_{Amin,5min}$ were recorded at each site. For security reasons measurements were made off the school premises, where possible outside the noisiest façade, at the kerbside of the nearest road. In many cases the measurement position was at approximately 4 metres from the school façade. For consistency measurements at other positions were corrected to give the corresponding level 4 metres from the façade.

The 5 minute measurement period was chosen to be typical of the school day. For this reason rush hours, times when children were arriving at or being collected from school, and times when children were outside in the school playground were avoided

In addition to noise levels, during the 5 minute measurement period the noise sources heard were noted.

5.1 Noise levels

The means and standard deviations of the levels measured outside primary schools in the borough are shown in Table 1.

Table 1. *Means and standard deviations of external levels in Haringey*

$L_{Aeq,5min}$		$L_{A10,5min}$		$L_{A90,5min}$		$L_{A99,5min}$		$L_{Amax,5min}$		$L_{Amin,5min}$	
Mean	*sd*	*Mean*	*sd*	*Mean*	*sd*	*Mean*	*sd*	*Mean*	*sd*	*Mean*	*sd*
57.4	8.8	59.4	9.0	49.2	7.7	47.0	7.4	70.5	10.5	46.0	7.5

5.2 Noise sources

Noise sources heard outside each school during the 5 minute sampling period were noted. The percentages of schools outside which each of the most common sources was heard are shown in

Figure 1. It can be seen that the most commonly occurring source of noise was road traffic, principally cars. Sirens were heard at surprisingly few schools, although they are commonly regarded as a regular feature of the London noise environment.

6. RESULTS OF QUESTIONNAIRE SURVEY

6.1 Children's attitudes to environmental noise at home and at school

Children reported hearing a wide range of environmental sound sources both at home and school. The percentages of children reporting hearing the different sources in the two situations are shown in Figure 2. As the figure shows different patterns emerge for reported hearing in class and at home. A mean score for hearing each sound source was computed for each class and this was compared with their mean hearing score for home. Statistically significant differences emerged for all home-school pairs apart from hearing musical instruments with children significantly more likely to report hearing all the other sounds at home. To some extent these results reflect the typical sound sources that occur in homes such as stereos and televisions; however in addition it is likely that they reflect a lack of precision in the questionnaire. At home could be the living room, kitchen, bedroom or garden thus allowing much more variation in the child's interpretation of the questions, whereas the school question referred to classrooms only.

Once the children report hearing a sound source annoyance levels were found to be similar between home and school for the following items: phone ($r=.331$, $p.<.05$); bus ($r=.409$, $p.<.01$); TV ($r=.445$, $p.<.001$); motorbike ($r=.566$ $p.<.001$); car ($r=.566$, $p.<.001$); train ($r=524$, $p.<.001$); trees ($r=.676$, $p.<.001$); helicopters ($r=.344$, $p.<.05$); sirens ($r=.534$, $p.<.001$); stereos ($r=.499$, $p.<.001$); planes ($r=.646$, $p.<.001$); lorries ($r=.421$, $p.<.001$); but not for animals ($r=.23$, ns) and music ($r=.008$, ns). Thus, it would appear that for the children the majority of sound sources assessed in this questionnaire are annoying independent of the context in which they are heard.

The percentages of children in each year group reporting hearing a particular sound source in the classroom, and having heard it being annoyed by it are shown in Table 2. It can be seen that, in general, older children were more likely to report hearing a sound source, whereas younger children reported greater annoyance.

Table 2. *Percentages of children hearing and being annoyed by sounds in the classroom*

Noise source	***Heard***		***Annoyed***	
	Year 2	***Year 6***	***Year 2***	***Year 6***
Animal	32.4	25.1	44.9	38.4
Phone	36.4	40.9	41.0	41.4
Musical inst	57.0	53.0	40.4	34.8
Bus	35.1	37.9	55.9	47.5
TV	32.3	22.2	30.1	20.0
Motorbike	52.1	58.8	58.8	61.1
Car	67.6	73.9	53.3	45.0
Train	19.1	24.5	58.2	66.1
Trees	42.4	44.9	22.9	19.7
Helicopter	43.0	53.7	56.9	46.4
Sirens	49.8	69.0	67.6	52.0
Stereo	27.9	34.2	47.0	24.7
Planes	55.5	53.5	47.3	34.6
Lorries	53.4	61.9	58.2	59.1

There were significant differences across schools in the sound sources reported. In all cases greater than 4% of variance was accounted for by school location and for train and phone noise school location accounted for 26% of the variance in the children's responses. Thus there was a clear indication that school factors played a significant part in whether children were reporting the occurrence of particular forms of environmental noise.

6.2 Ease of listening

The means and standard deviations of children's listening scores in the different contexts are shown in Table 3, where 1 corresponds to 'very well' and 5 to 'not at all' and the mean scores for the two age groups are shown in Figure 3.

Table 3.*Reported hearing acuity by Year 2 and Year 6 children in different school contexts*

	Year 2		*Year 6*	
	Mean	***sd***	***Mean***	***sd***
Cannot see teacher's face	1.93	0.84	2.34	1.02
Teacher talking & moving	2.29	0.83	1.96	0.95
Working in groups	2.44	0.93	2.39	1.11
No noise outside classroom	1.90	0.93	1.68	1.10
Children making noise outside classroom	2.70	1.08	3.01	1.06
Doing a test	1.87	0.89	1.53	1.04
PE in playground	2.79	1.05	2.62	1.09
No noise at all	1.46	0.83	1.24	0.79
Speaking classmate	2.47	1.00	2.15	1.00

These data are not normally distributed so non-parametric statistical analysis was carried out. This showed that over all age groups the children's reported ability to hear the teacher varied significantly across situations (X^2 =4426, p<.001) with 'no noise at all' and 'doing a test' reported as the best listening conditions and 'children making noise outside the classroom' the worst. There were significant differences between the responses of the two age groups. Younger children reported that hearing the teacher was significantly more difficult in 6 of the 8 situations assessed: 'teacher talking and moving', 'no noise outside the classroom', 'doing a test'; 'PE in the playground'; 'no noise at all'; they also reported greater difficulty in hearing a classmate. The older children reported significantly greater difficulty when they could not see the teacher's face and when children are making noise outside the classroom. There were no significant differences between the older and younger children in reported hearing acuity when children were working in groups. These results indicate that primary school children are able to judge situations where they have difficulty hearing the teacher, and that younger children report relatively greater difficulty than older children.

6.3 Teachers' questionnaire responses

Teachers reported occurrences of environmental noise sources were similar to those of the pupils, the only significant difference being that teachers reported sirens more often than the children. Figure 4 compares the teachers' and pupils' reports of noise sources, and their respective rankings of the sources are shown in Table 4. It can be seen that the rankings by teachers and pupils are very similar (r=.918, p<.001). Trains were the least reported source by both children and teachers.

Certain sounds were regarded by the teachers as being more likely than others to affect the children's concentration. The percentages of teachers reporting the various noises to be distracting are shown in Figure 5. Overall 90.2% of the teacher respondents reported that outside noise affected the children's concentration. Many teachers believed that children with special educational needs were more affected than their mainstream peers (68.6%).

7 COMPARISON OF QUESTIONNAIRE AND NOISE SURVEYS

7.1 Classroom listening conditions

The relationships between external noise levels and children's hearing across classroom situations were assessed by a series of correlations. There were no significant relationships between the measured external noise levels and ability to hear in 8 of the 9 conditions assessed. However, children's ratings of ability to hear the teacher when there is no noise outside the classroom were significantly related to external noise level parameters. The higher the objective noise levels the more difficult the children found it to hear the teacher (L_{Aeq} r=.365, p<.05, L_{Amax} r=.338, p<.05, L_{A99} r=.330, p<.05, L_{A90} r=.376, p<.05, L_{A10}=.345, p<.05). Thus all aspects of the sound, the ambient, background, underlying and maximum noise levels were related to the children's ability to hear the teacher. However, these variables only account for approximately 11% of the variance in the

children's responses, with L_{A90} accounting for the highest proportion of variance (14%). Thus, external school noise levels did affect the children's reported relative ease of hearing their teacher when other confounding noise sources such as other children were not present.

7.2 Environmental noise sources

The noise sources that were noted during the external noise survey of schools have been ranked in order of occurrence. The children's and teachers' reported hearing of these sources has also been ranked, as shown in Table 5. It can be seen that, apart from cars which were the most commonly occurring source during the noise survey and the source most commonly reported by the children, there is little agreement. Of particular significance is the high ranking of sirens by children and teachers but the low ranking in the sound observations.

Table 4. *Children's, teachers' and survey rankings of occurrences of sound sources*

Sound source	Children's ranking	Teachersranking	Survey ranking
Aircraft	5	7	2
Helicopter	7	6	10
Bus	9	9	3
Cars	1	2	1
Lorry	3	4	3
Motorbike	4	5	9
Train	11	11	7
Sirens	2	1	11
Music	6	3	8
Trees	8	8	6
Birds/animals	10	10	5

8. CONCLUSIONS

A questionnaire survey of over 2000 children and over 50 teachers in 43 London primary schools has shown the following. Children are aware of and annoyed by certain noise sources when at home and at school. Children as young as seven are able to discriminate classroom situations in which they have difficulty hearing the teacher or fellow classmates; however this difficulty is only related to external noise levels when there is no noise outside the classroom. In general younger children report greater difficulty than older children. Similarly younger children reported more annoyance than older children when hearing external sounds in the classroom. Teachers show similar awareness of external noise to that of children in the classroom and consider that certain external noise sources affect children's concentration, children with special educational needs being more affected than other children.

9. REFERENCES

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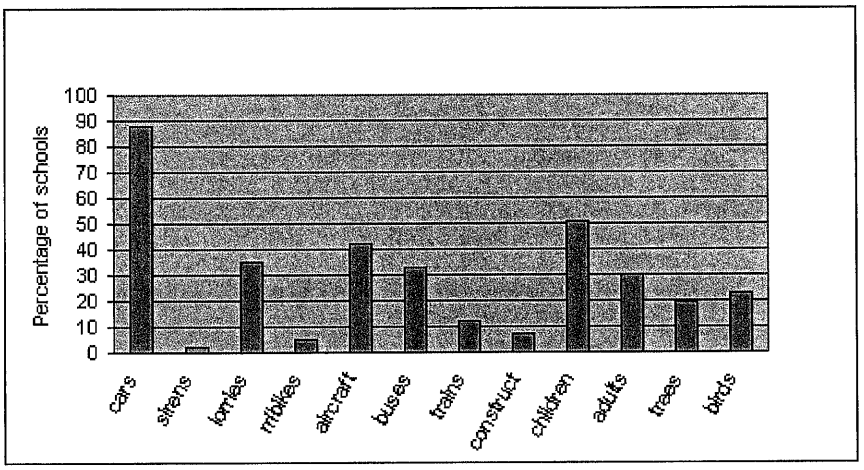
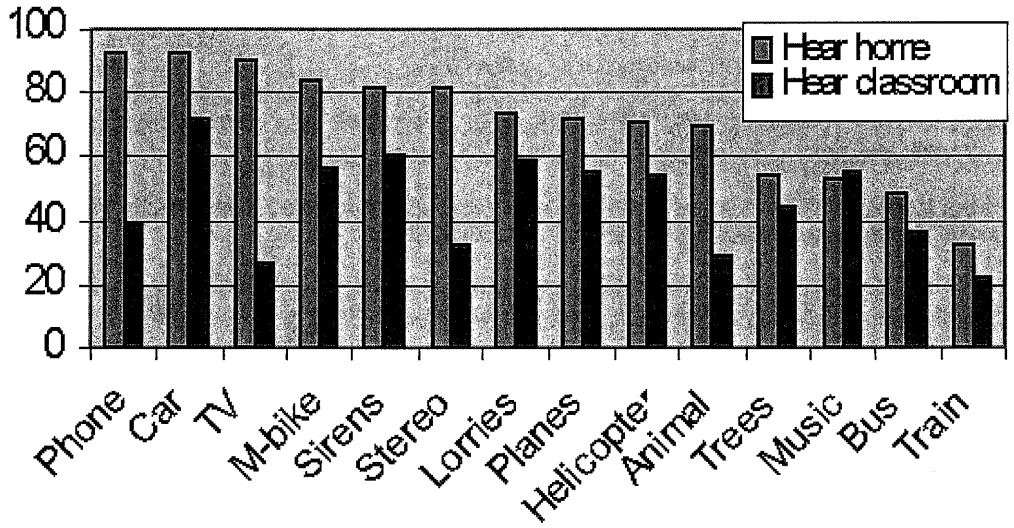


Figure 1. *Percentages of schools where noise sources heard*

Figure 2. *Percentages of children hearing noise sources at home and in the classroom*



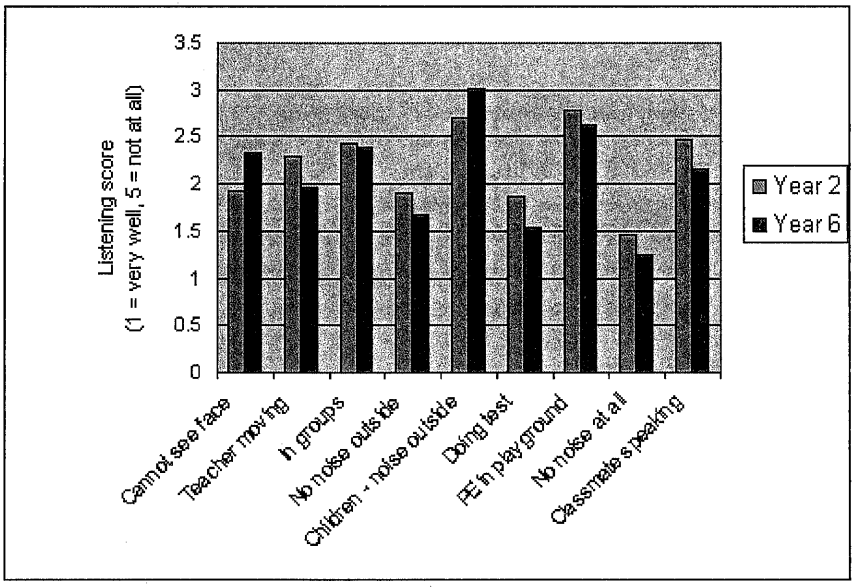


Figure 3. *Mean listening scores for two age groups*

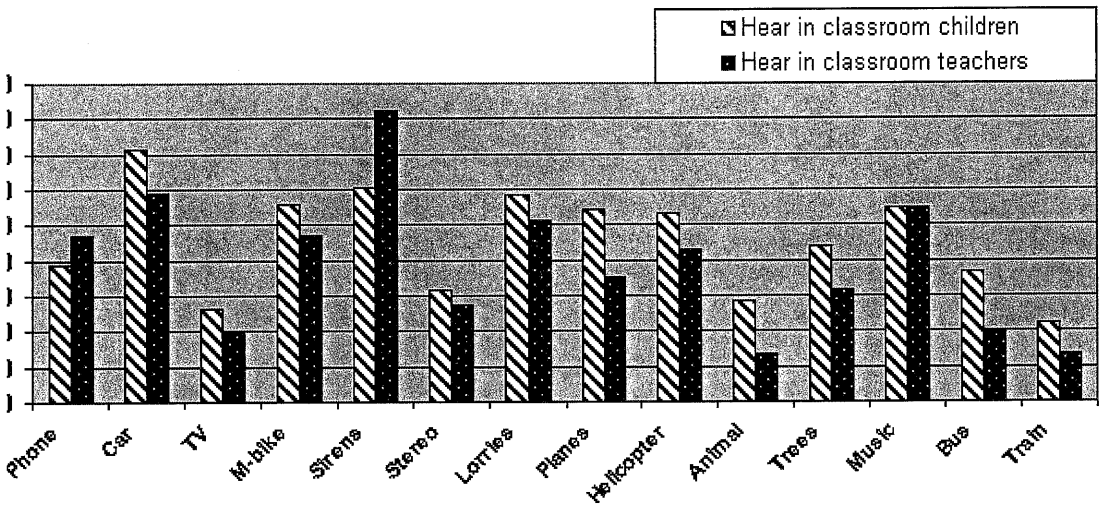


Figure 4. *Teachers' and children's reported hearing of noise sources*

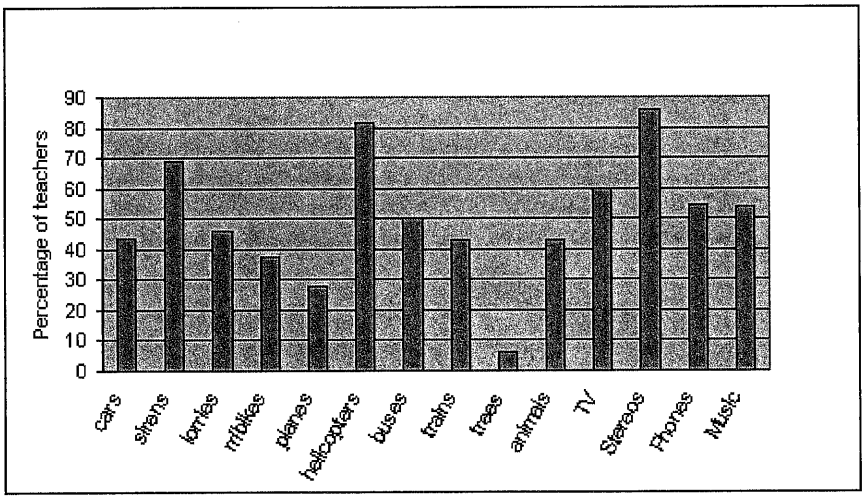


Figure 5. *Percentages of teachers reporting various noises to be distracting*