

# CHARACTERISTICS OF THE NOISE, REVERBERATION TIME AND SPEECH-TO-NOISE RATIO FOUND IN DAY-CARE CENTERS

Michel Picard

Ecole d'orthophonie et d'audiologie, Université de Montréal, Qc, Can., H3C 3J7. michel.picard@umontreal.ca

## 1. INTRODUCTION

Today's day-care centers are apparently extremely noisy environments. Several authors have been reporting high-level of exposure of children to noise with representative values ranging from about 65 to 92 dBA in groups of children aged between 18 and 60 months (Truchon-Gagnon & Héту, 1988; Picard & Boudreau, 1999, McLaren & Dickinson, 2002). Given the paucity of data on this particular issue and causes of the problem (Golden, 2001), characteristics of the noise (exposure levels and spectrum), reverberation time and speech-to-noise ratios were studied in active day-care centers.

## 2. METHOD

Noise measurements were collected for 24 sites accommodating groups of 1.5 to 5 years-old children (N = 4-16 children per group). Ten minutes exposures to three types of children's activity noise were recorded on a minidisc recorder for further analysis in laboratory, namely: 1- unstructured activities of the children; 2- structured ones (e.g. story telling); and 3- lunch time. Noise levels were also collected for the unoccupied case before the children's arrival. Reverberation time (RT) at 1000 Hz in the unoccupied condition was also studied as a covariate and similarly for signal-to-noise ratio (SNR) when personnel is addressing children in the conduct of regular activities. RT was measured in accordance with ISO 3382 (1997) interrupted noise method. SNR was derived from samples of discourse when personnel is instructing children or conducting verbal activities with them in a manner to isolate meaningful discourse or instructions from the din. The principles behind this approach was to fit two normal distributions to statistical distributions of measured sound levels consisting of combination of sound sources. This method was proposed by Hodgson, Rempel & Kennedy (1999) and is currently being used by Sato & Bradley (2004) in the NRC classroom acoustics research program. All measurements were collected in the center of the room usually occupied by children with the microphone of a precision sound level meter (class 1) located 95 cm above the floor.

## 3. CHARACTERISTICS OF THE NOISE FOUND IN DAY-CARE CENTERS: EXPOSURE LEVELS AND SPECTRUM

Statistical distributions of A-weighted levels of

exposure for the various sites and measurement conditions (in 10 min. integration interval) ranged from 66 to 94 dBA with representative values of 79.4 dBA for unstructured activities, 75.3 dBA for structured ones and 75.9 dBA for lunch time. By comparison, values in the unoccupied condition varied from 29 to 62 dBA for the various sites with an average integrated level of 45.3 dBA. Third-octave band analysis of the noise found in day-care centers while activities are in progress revealed a long-term spectrum corresponding to Pearsons 'loud' (and possibly 'shout') speech uttered by children and females (Pearsons, Bennett & Fidell, 1977). The observed low frequency boost by 8 dB between 200 and 400 Hz may be the result of interacting room reverberation.

## 4. REVERBERATION TIME

Reverberation time at 1000 Hz obtained in ten of the 24 rooms taken as representative showed no correlation with noise exposure levels nor room volume (actually ranging from 99 to 319 cubic meters). More specifically,  $RT_{1\text{kHz}}$  ranged from 0.3 to 0.56 s. in facilities with a suspended ceiling of sound-absorbing tile (n = 5), not so different from the five rooms without this feature ( $RT_{1\text{kHz}}$  from 0.55 to 0.85). In both cases,  $RT_{1\text{kHz}}$  was not far from values in the range of 0.4-0.6 s. recommended for classrooms and rooms used for speech communication (Bradley, 1986; ANSI, 2002).

## 5. SIGNAL-TO-NOISE RATIO

Derivation of SNR when personnel is interacting with children or giving instructions is currently indicating a wide range in values. Of the five sites analyzed to date, SNRs can be close to 0 dB as a result of some intrusive speech of children not participating in the on-going activity or not paying attention to it (or speech of nearby personnel). Conversely, SNRs in excess of 10 dB are not uncommon. On average, SNR of 6 dB was identified. This is far from recommended value of +15 dB for classrooms (Bradley, 1986). However, SNRs in excess of 10 dB indicate that unobstructed verbal communication is not beyond reach with appropriate controls of the communication situation in day-care centers. This is suggesting pedagogical style as an important ingredient of successful verbal communication beyond acoustical solutions.

## 6. CONCLUSION

Overall, current findings suggest that speech from

conversations in parallel is the principal component of the so-called 'noise' problem in day-care centers. Excessive reverberation does not seem to be a major contribution to speech interference. Given the high levels of sound signals in day-care centers, it is not clear that children could initiate or sustain any meaningful verbal communication activity of their own unless they use extreme vocal effort to speak loud enough to raise their voice above the din. This is far from an ideal listening situation - and generally speaking, communication environment, at a time when children are developing their language competence.

## REFERENCES

- ANSI (2002). Acoustical performance criteria. design requirements and guidelines for schools. ANSI 12.60. American National Standards Institute, Melville.
- Bradley JS (1986). Speech intelligibility studies in classrooms. Journal of the Acoustical Society of America, 80, 846-854.
- Golden MV (2001). An acoustical analysis of infant/toddler classrooms in child care centers. Unpublished Master thesis. Penn.State Univ., State College.
- Hodgson MR, Rempel R & Kennedy S (1999). Measurement and prediction of typical speech and background-noise levels in university classrooms during lectures. Journal of the Acoustical Society of America, 105, 226-233 .
- ISO (1997). Acoustics - Measurement of the reverberation time of rooms with reference to other acoustical parameters. 2nd Ed. ISO\_3382. International Standards Organization, Geneva.
- McLaren SJ & Dickinson PJ (2002). Noise in early childhood centres and its effects on staff and children. Paper 811. Internoise 2002.
- Pearsons KS, Bennett RL & Fidell S (1977). Speech levels in various noise environments. EPA-600/1-77-025. Washington: Environmental Protection Agency.
- Picard M & Boudreau C. (1999). Characteristics of the noise found in day-care centres. Paper presented at the 137th meeting of the Acoustical Society of America, Berlin.
- Picard M, Bradley JS (2001). Revisiting speech interference in classrooms. Audiology, 40, 221-244.
- Sato H & Bradley JS (2004). Evaluation of acoustical conditions for speech communication in active elementary school classrooms. XVIIIe International Congress of Acoustics, ICA-2004. Kyoto, Japan
- Truchon-Gagnon C, Héту R (1988). Noise in day-care centres for children. Noise Control Engineering Journal, 30, 57-64.