Quantifying Preschool Classroom Acoustics: A Preliminary Report

Tina M. Grieco-Calub¹, Danielle Henry²

¹Northwestern University, The Roxelyn & Richard Pepper Department of Communication Sciences and Disorders
²Professional Hearing Center, Kansas City, MO

Introduction
Poor classroom acoustics, including background noise and reverberation, interfere with children’s speech perception, serial recall, literacy, and cognitive skills (e.g., Crandall & Smaldino, 2000; Maxwell & Evans, 2000; Shield & Dockrell, 2003; Klatte, Hellbr"uck, Seidel & Leismer, 2010). Younger children in particular are at greater risk for impaired performance in these critically complex environments (e.g., Wightman & Kistler, 2005; Leibold, Bonino, & Buss, 2016). National standards exist for K-12 classrooms to minimize the negative effects of classroom acoustics on children’s outcomes (ANSI, 2010).

Purpose of the study
Currently, no set of comparable standards exist for preschool classrooms. Additionally, current public policy on preschool education does not include classroom acoustics as a factor when determining preschool quality (Dept. of Children and Family Services rules, Part 407). Preschool classrooms are often located in residential or commercial buildings that were not initially constructed to be a learning space. Thus, quantifying preschool classroom acoustics may be necessary to ensure optimal learning environments for preschool children.

Methods
Participants: Ten classrooms across five preschools in the northern region of a large metropolitan area participated in the pilot study. Table 1 describes the location of each school.

Procedure: The ANSI S12.60-2010 national standard was used to quantify the acoustics of the preschool classrooms. Prior to acoustical measurement, microphone placement was determined based on the daily routine of the classroom and in accordance with the ANSI standard. Figure 1 illustrates the experimental setup for the following measurements:

Reverberation
EASERA, a software program for acoustic measurements running on the PC, was used to stimulate the room with a sine sweep and record the impulse response at each microphone location. The RT-60, or the time it takes for the stimulus to decay by 60 dB, was quantified from the recording by the software program. We extrapolated the RT-60 value from the RT-30 measurement.

Unoccupied background noise
A Tascam digital recorder was connected to each microphone to capture 10 minutes of the acoustical environment. Recordings from each microphone were analyzed off-line to determine the average intensity level. Three 1-minute samples were extracted from the 10-minute sample for each microphone. Customized software (SysRes, 2002) was used to generate a spectral average of each sample. Customized software (OctoCalc) was subsequently used to quantify the intensity level of each spectrum in 1/3 octave bands. Results are reported in intensity level (dB[A]) for each sample, averaged across microphones. A-weighted measurements reflect the average filtering of the human ear.

Occupied classroom noise intensity
The set-up and post-hoc analyses for unoccupied classroom measurements were used to quantify intensity levels in occupied classrooms.

Table 1. List of preschools.

<table>
<thead>
<tr>
<th>School</th>
<th>Classroom</th>
<th>Microphone</th>
<th>RT-60 (ev)</th>
<th>RT-30 (ev)</th>
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</thead>
<tbody>
<tr>
<td>1</td>
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Reverberation

Results

Unoccupied background noise

A Tascam digital recorder was connected to each microphone to capture 10 minutes of the acoustical environment. Recordings from each microphone were analyzed off-line to determine the average intensity level. Three 1-minute samples were extracted from the 10-minute sample for each microphone. Customized software (SysRes, 2002) was used to generate a spectral average of each sample. Customized software (OctoCalc) was subsequently used to quantify the intensity level of each spectrum in 1/3 octave bands. Results are reported in intensity level (dB[A]) for each sample, averaged across microphones. A-weighted measurements reflect the average filtering of the human ear.

Occupied classroom noise intensity

The set-up and post-hoc analyses for unoccupied classroom measurements were used to quantify intensity levels in occupied classrooms.

Table 2. The ANSI S12.60-2010 standard recommends RT-60 values of less than 0.6 ms. Eight of the ten classrooms were within this range.

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</table>

Reverberation

Occupied background noise

Children chose their own work in the classroom.

Children were engaged in a teacher-led activity while sitting in a circle.

Summary

1. Preschool classrooms have equivalent, or possibly poorer, acoustics than classrooms in elementary school (Crandall & Smaldino, 2000).

2. Reverberation was within the normal range for most of the classrooms. All of the preschool classrooms contained unoccupied noise at intensity levels exceeding the ANSI S12.60-2010 standard of 35 dB(A).

3. The intensity levels of occupied noise in three of the classrooms were either the same or higher than the intensity level of conversational speech of 60 dB.

   i. Classroom 10, the room with the poorest unoccupied acoustics did not have the poorest occupied acoustics. This may have been the result of the class size.

   ii. Class size, however, is likely not the only factor relating to occupied intensity levels. Classroom 5 is a Montessori school, which traditionally promotes self-directed learning. Thus, the “independent play” in Classroom 5 may have been qualitatively different than that in Classroom 2, which had higher intensity levels of occupied noise with an equivalent number of students.

   iii. The intensity levels measured during Rug Time were largely dominated by the teacher’s voice, which in some classrooms exceeded the typical intensity level of conversational speech.

Implications of the preliminary findings

1. Preschool classrooms have equivalent, or possibly poorer, acoustics than classrooms in elementary school (Crandall & Smaldino, 2000).

2. Efforts to improve early childhood education may be stunted by poor preschool acoustics, which can limit children’s learning opportunities by interfering with the development and maintenance of positive caregiver-child interactions (Evans & Wacha, 2010).

3. Teachers who need to overcome high intensity levels of occupied classrooms may experience voice disorders.

References


Acknowledgments

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