SOUND LISTENING AFFECTS:

THE IMPACT OF ACOUSTICS ON STUDENT LEARNING

SARAH BURNS, M.S., R. AUD.
EDUCATIONAL AUDIOLOGIST

ELLEN BUCHAN, P.ENG.
SENIOR ACOUSTICAL ENGINEER
TECHNICAL SERVICES & PROCUREMENT BRANCH
ALBERTA INFRASTRUCTURE

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AGENDA

INTRODUCTION

GOALS

ACCESSIBILITY:

Accessibility needs to be a fore-thought not an afterthought. We want people to feel welcomed, not tolerated.

Paraphrased from “Misa on Wheels”

Acoustical accessibility is achieved when what is spoken is received by the listener at a volume that allows the words to be clearly heard and potentially understood.

WHY IS ACOUSTICS IMPORTANT?

1. The most common complaint
2. Improve the listening environment equals improved learning
3. **Developmentally important**

AUDITORY DEVELOPMENT

Pre-birth to 6 months	6 months-5 years	5 years~13 years

WHO HAS DIFFICULTY LISTENING IN NOISE?

No one is immune to the impact of distance, reverberation or noise.

Some adults do better than others.

REACTIONS TO AN UNFAVORABLE LISTENING ENVIRONMENT

Adults

- Repairing message
- Errors, and laugh
- Ask for clarification
- Move to different location
- Read
- Take out
- Don't go

REACTIONS TO AN UNFAVORABLE LISTENING ENVIRONMENT

Children and students

- Errors in work
- Continue
- Gaps in learning
- Negative responses
  - Speak louder, yell
  - If sensory issues they may be removed
  - Increased support for students

Hearing	Listening	Comprehending
Ear level	Brain L…	…meaning and • Intent
…detect sound	Demands mental effort	

56%

*Require cognitive and *auditory comprehension.*

Classification: Protected A

CLASSROOM RECORDING: BEGINNING OF GROUP WORK

Classification: Protected A

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WHAT DOES THE RESEARCH SAY?

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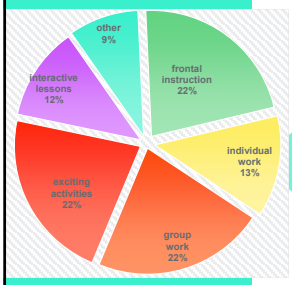
Listening activities:



Frontal instruction 22% of the day

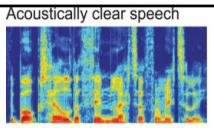
Groups or interacting:34% of the day.

Listening activities = 56% of classroom time.

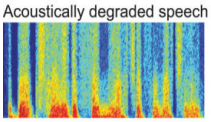
All require the ability to hear, listen and process

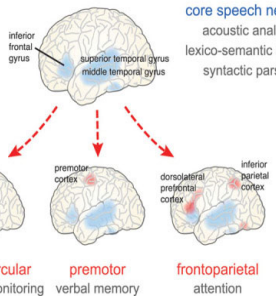
SOUND LISTENING AFFECTS

Acoustically clear speech



Acoustically degraded speech





core speech network
acoustic analysis
lexico-semantic access
syntactic parsing

cingulo-opercular
performance monitoring

premotor
verbal memory

frontoparietal
attention

Peelle JE. Listening Effort: How the Cognitive Consequences of Acoustic Challenge Are Reflected in Brain and Behavior. Ear Hear. 2018

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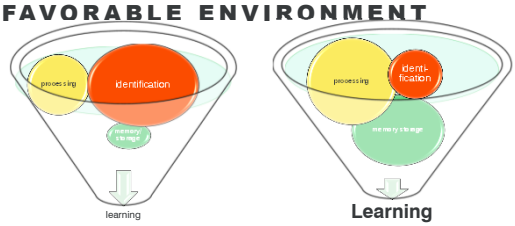
SOUND LISTENING AFFECTS

LEARNING IN AN UNFAVORABLE LISTENING ENVIRONMENT VS. A FAVORABLE ENVIRONMENT



IDENTIFICATION → PROCESSING → MEMORY AND STORAGE

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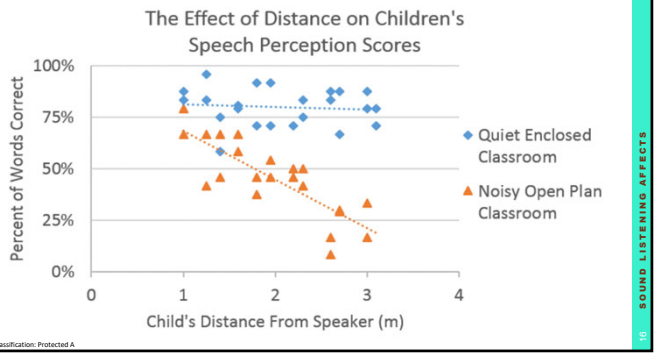

PEELE SUMMARY

"Acoustic challenge is thus not merely an auditory problem but significantly affects a variety of cognitive operations required for both linguistic and nonlinguistic tasks. The cognitive processes engaged when listening to acoustically degraded speech likely include verbal working memory and attention-based performance monitoring. "

Inclusion of all students means complex learning groupings. *The physical environment needs to be inclusive as well.*

Students with diverse needs are in all classrooms :

- Neuro-developmental needs such as Autism spectrum Disorder, or sensory processing
- Cognitive Late effects of cancer treatment: slower processing
- Mental health and behavioural needs
- Sensory Needs including vision and hearing
- Other: short/long term medical, cognitive, English language learners
- *Young learners developing skills

3 ELEMENTS OF ACOUSTICS

1. **NOISE** (chair, HVAC, hallway, hand dryers, electronics)
2. **DISTANCE**, the further from the source of the speech the less likely speech will be clearly heard
3. **REVERBERATION**…which take the noise and changes its characteristics.

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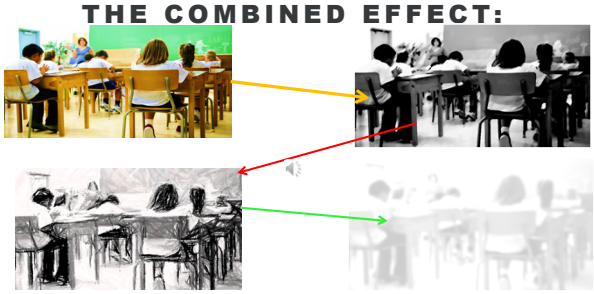
THE COMBINED EFFECT:



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NON-STUDENT IMPACT

- Heart rate increase
- Blood pressure increase
- Vocal fatigue need for vocal rest
- Increase in classroom management vs instruction

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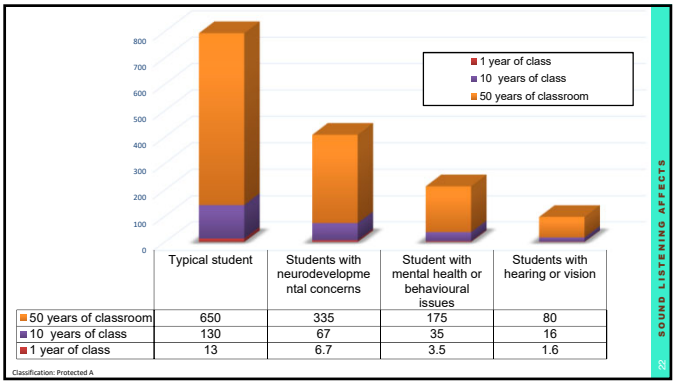

	Typical student	Students with neurodevelopmental concerns	Student with mental health or behavioural issues	Students with hearing or vision
50 years of classroom	650	335	175	80
10 years of class	130	67	35	16
1 year of class	13	6.7	3.5	1.6

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OFFICE OF THE ADVOCATE FOR PERSONS WITH DISABILITIES

Have undertaken the work to:

- Define accessibility;
- Understand the current state of accessibility in Alberta;
- Understand the barriers and opportunities connected with accessibility; and,
- Understand what Government of Canada and other provinces and territories are doing legislatively to ensure inclusion through accessibility legislation.

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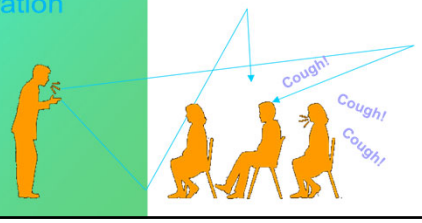
CLASSROOM ACOUSTICS

- noise
- reverberation



SOUND LISTENING AFFECTS

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ACOUSTICAL STANDARDS FOR SCHOOLS

United States

ANSI/ASA S12.60-2010/Part 1 American National Standard Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools, Part 1: Permanent Schools

Britain

Department for Education Acoustic design of schools: performance standards - Building bulletin 93 - February 2015

Australia

AS/NZS 2107:2016 Acoustics — Recommended design sound levels and reverberation times for building interiors

Association of Australasian Acoustical Consultants Guideline for Educational Facilities

Alberta

Alberta standards for schools: Technical Design Requirements for Alberta Infrastructure Facilities 2022/ 7.0 Acoustics

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BUILDING CERTIFICATIONS

- LEED v4.1

BUILDING DESIGN AND CONSTRUCTION

- WELL

Advancing health and well-being in buildings

- BREEAM

value in higher performing assets across the built environment lifecycle, from new construction to in-use and refurbishment

Classification: Protected A

LEED V4.1

BUILDING DESIGN AND CONSTRUCTION

INDOOR ENVIRONMENTAL QUALITY (EQ)

- **Prerequisite: Minimum Acoustic Performance --- Required**
- **EQ Credit: Acoustic Performance: 1 point**

Classification: Protected A

Technical Design Requirements

for Alberta Infrastructure Facilities

March 2019

Classification: Protected A

ACOUSTICAL DESIGN GOALS

Sound Isolation from the Construction Assembly = **ASTC**

Background Noise due to HVAC = **RC**

Foot Fall Noise - **IIC** *(only relevant for multiple story buildings)*

Speech Intelligibility = **RT60**

Classification: Protected A

ALBERTA INFRASTRUCTURE – REQUIREMENTS

Spaces that have special requirements:

- Classroom
- Gymnasia
- Music room
- Music practice rooms
- Student gathering areas, flex spaces & computer labs Drama theater
- CTS shops

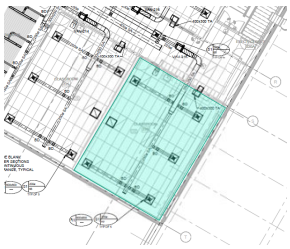
Classification: Protected A

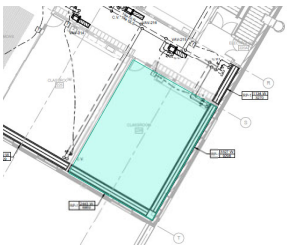
POSITIVE DESIGN TRENDS FOR ACOUSTICS

- Gymnasium and Classrooms Finishes- Reverberation Control
- Standard Classroom HVAC System Design – Mechanical Noise Control

GYMNASIUM AND CLASSROOMS FINISHES- REVERBERATION CONTROL

STANDARD CLASSROOM HVAC SYSTEM DESIGN – MECHANICAL NOISE CONTROL

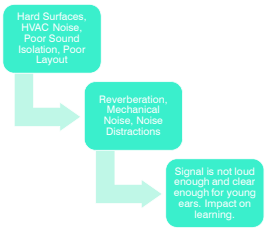




CHALLENGES IN DESIGN TRENDS

- Excessive use of operable partitions
- School Layout: Music Room
- Excessive Mechanical (HVAC) Noise Non-Standard Spaces
- Furniture Movement Noise

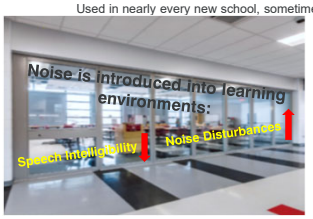
CHALLENGES



OPERABLE PARTITIONS POSE ACOUSTICAL CHALLENGES

"operable walls to allow classes to blend together"

Used in nearly every new school, sometimes rather often



Strategies

- Minimize
- Provide Buffer Zones
- Select High Quality Products
- Use Excellent Construction Details
- Understand Misleading Performance Data

http://www.infrastructure.alberta.ca/Content/docType486/Production/DTSeries08OpPart2017.pdf

COMMISSIONING- ACOUSTICAL TESTING

Target – ASTC 45

Test Results – ASTC 22 – 34 (typical 26)

Classification: Protected A

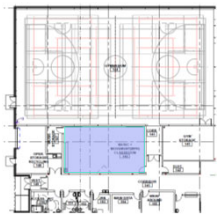
SCHOOL LAYOUT: MUSIC ROOM

Music Room – Loud Noise Generated & Low Background Noise Requirement (Critical Listening Space)

- ASTC 55 to 60
- RC 30
- Isolate
- Sound Doors

Classification: Protected A

SCHOOL LAYOUT: MUSIC ROOM

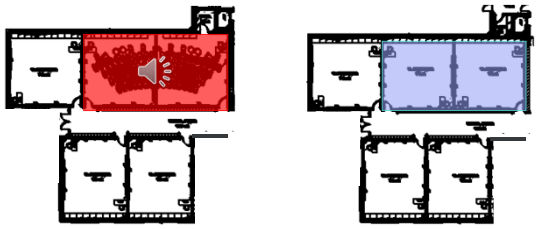


Main Floor

2nd Floor

Classification: Protected A

SCHOOL LAYOUT: MUSIC ROOM



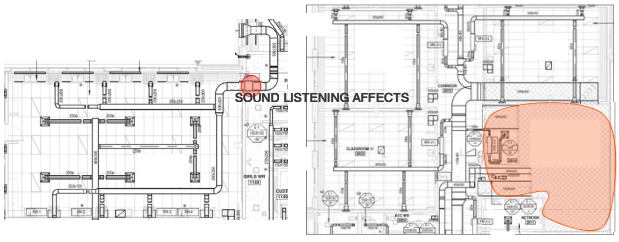
Main Floor

2nd Floor

EXCESSIVE MECHANICAL (HVAC) NOISE

RC RC RC RC RC

EXCESSIVE MECHANICAL (HVAC) NOISE



FURNITURE MOVEMENT NOISE

EFFECTS OF MEASURED ACOUSTIC AND OTHER INDOOR ENVIRONMENT FACTORS

ACOUSTIC QUALITY

- 220 CLASSROOMS ACROSS FIVE K-12 SCHOOL DISTRICTS
- MEASURED:
  - Sound Pressure levels: Source: Teacher, Students, Interaction, Speech/Noise from outside the classroom
  - Reverberation Time
- SIGNIFICANT EFFECT OF SPEECH LEVELS ON MATH ACHIEVEMENT

QUESTIONS?

CONTACT INFORMATION

Sarah Burns
Low-Incidence Team
Alberta Ed
Sarah.burns@gov.ab.ca
780-293-4161

Ellen Buchan, P.Eng.
Senior Acoustical Engineer
Alberta Infrastructure
ellen.buchan@gov.ab.ca
TEL/Cell 780-288-3809

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