Music Accessibility for Children with Hearing Loss in Music Education: Acoustic Features of Audible Timbres

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Background

Music class with children with hearing loss:
- Teachers do not necessarily know about hearing loss.
- Teaching tips are not shared.

Can children with hearing loss access music at classes?

What are instruments whose timbres are easy to listen to by children with hearing loss?

Timbre:
Two non-identical sounds, similarly presented and having the same loudness, pitch, spatial location, and duration, are dissimilar.

Discrimination of timbres by hearing people:
Attack time, spectral centroid

What are their acoustic features?

Method

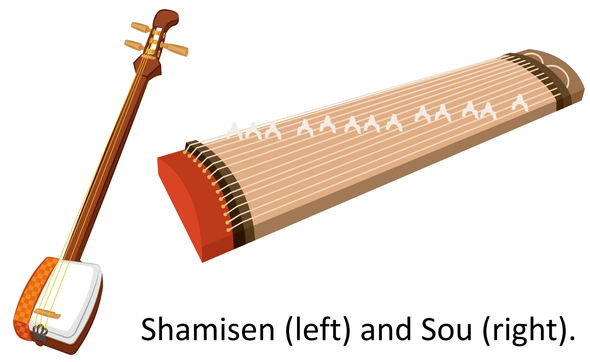
Online Experiment:
Participants subjectively evaluated the ease of listening and preference.
They listen to sounds with their devices at the time and place of their convenience.
Not in laboratory, but in their everyday listening condition.

Material: 19 instruments, 5 pitches
classical guitar, electric guitar, harp, cello, violin, piano, clavinet, horn, trombone, trumpet, tuba, bassoon, clarinet, flute, recorder, accordion, harmonica, shamisen, and sou in C3/G3/C4/G4/C5

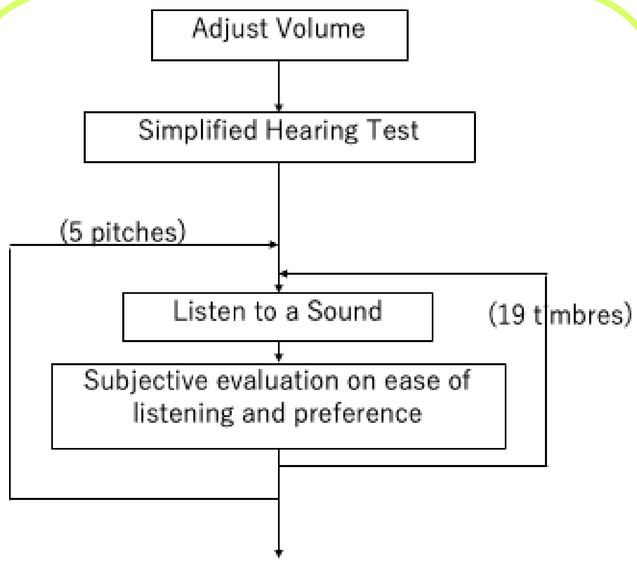
Participants: 11M/20F, age 18-22, snowball sampling
Hearing Aid Both Ear (HABE) 21, HA One Ear (HAOE) 4, Cochlear Implant BE 1, bimodal 3, CIOE 1, none 1

All students in our department are with hearing loss. The difference in audibility by prosthesis is different from our interest.

MIR Toolbox: calculate 12 audio features
attack time, attack slope, zero crossing, roll-off, brightness, centroid, spread, skewness, kurtosis, flatness, entropy, and irregularity



Shamisen (left) and Sou (right).



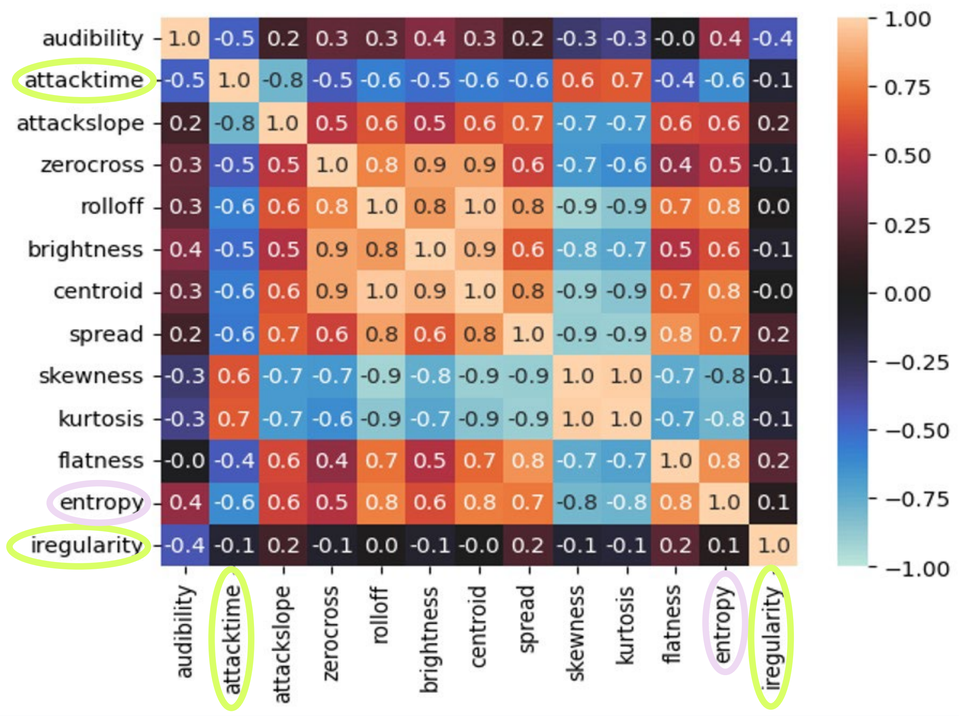
The flow of the experiment.

Results

Instruments easy to listen to by children with hearing loss

	Audio feature	min	max	easiness in listening to: min	easiness in listening to: max
C3	attack time	CVN	FLT	REC	BSN
	irregularity	FLT	VIN		
	entropy	REC	SHM		
G3	attack time	SHM	FLT	REC	TUB
	irregularity	FLT	CGT		
	entropy	REC	SHM		
C4	attack time	CVN	FLT	REC	TUB
	irregularity	FLT	APF		
	entropy	REC	SHM		
G4	attack time	SHM	FLT	REC	TRB
	irregularity	FLT	CLN		
	entropy	REC	EGT		
C5	attack time	SHM	FLT	REC	TRB
	irregularity	TRP	REC		
	entropy	REC	SHM		

Audio features: good audibility by
the shorter attack time,
the larger entropy,
the smaller irregularity



Discussion

Closer investigation:
in pitch differences

Evaluate the online hearing test:
its possibility and limitations

Clustering: to predict ease of listening
timbres by audio features
people with HL by audiogram

Analysis

Future application

At music classes:
share experiences, knowledge, findings

Music for all:
music recommendation system for people with hearing loss