Music for Deaf and Hard of Hearing Persons: on Beat

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Deaf and Hard of Hearing Students
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• hearing acuity over 60dBs
• hearing aids / cochlear implants / none
• speech-centered listening training
• varieties of hearing ability
MIBURI play by a student
MIBURI play by a student
Tsukuba University of Technology
Research Themes by Students

- Music visualization
- Practice system for rhythm — to enjoy Karaoke
- Music game for hearing-impaired persons
- ...
- Practice system for speech
- Speech visualization
- Alarm detection system
- ...
- Practice system of Environmental Sound with sound visualization
- Effect of timber on Rhythm Perception
- Vibration system to detect beat
Deaf and Hard of Hearing Persons (DHH)

Love Music!

Listen to, Karaoke, Dance, Taiko, Game, …

Difficulties in Music

Pitch discrimination, Detect timing, …

Music … is not … by hearing acuity

appreciation limited
perception restricted
enjoyment impeded
Research Questions

• How do DHH enjoy music?

• What are the defects of music assessments for hearing people when we use them to DHH?

• How could we increase their hearing ability with IT?
Past Research

Ise

perception of emotion in music performance improvisation by a professional percussion player
• timbre
• harmony
• Tapping Game
• Music Puzzle
Beat

• Rhythm: critical element of music perception for DHH students

• Beat: basic pattern of rhythm

• Beat tapping game
  for improving hearing ability
  play with music only / music and visual information
  visual information improves the tapping accuracy

• Beat recognition with different timbres

• Beat alignment tests (BAT)

Research proposed by a deaf student
DHH enjoy music more

- with *audible* timbre

>> music classes for DHH children
   Is a piano good?
   Is a recorder good?

- The student: profoundly deaf, plays Music Puzzle like experienced hearing persons.
Beat Tapping Experiment with Different Timbres by DHH

• tap a display along with the beat sound while listening (BAT)

• Sound data

   C4, quarter notes, 16 beats, 90BPM, 20 instrumental sounds

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## Instruments

<table>
<thead>
<tr>
<th>Family</th>
<th>Instruments</th>
</tr>
</thead>
<tbody>
<tr>
<td>String Plucking</td>
<td>Mandolin (MDN), Class. Guitar (CGT), Elec. Guitar (EGT), Harp (HRP)</td>
</tr>
<tr>
<td>String Rubbed</td>
<td>Violin (VLN), Cello (VCL)</td>
</tr>
<tr>
<td>Hammer</td>
<td>Piano (APF), Clavinet (CVN)</td>
</tr>
<tr>
<td>Brass</td>
<td>Trumpet (TRP), Trombone (TRB), Tuba (TUB), Horn (HRN)</td>
</tr>
<tr>
<td>Woodwind</td>
<td>Bassoon (BSN), Clarinet (CLN), Flute (FLT), Recorder (REC)</td>
</tr>
<tr>
<td>Others</td>
<td>Accordion (ACC), Harmonica (HMC), Shamisen (SHM), Sou (SOU)</td>
</tr>
</tbody>
</table>
Beat Tapping Experiment

- Participants: nineteen DHH
  - with Hearing Aids (HA): eleven (M:3)
  - Cochlear Implanter (CI): eight (M:4)
- Procedure
  - Practice
    - Tap with beats, twice for each instrumental sound
  - Subjective evaluation
  - Interval
    - repeat for 20 instrumental sounds
Subjective Evaluation

marked from 1 (Strong No) to 5 (Strong Yes)

1. Was the sound easy to hear? (EASY)
2. Did you hear sounds at higher pitches? (HIGH)
3. Was it easy to tap with the beats? (BEAT)
4. Did you like the instrumental sound? (LIKE)
# Results

## Differences between Instrumental Sounds

<table>
<thead>
<tr>
<th></th>
<th>HA</th>
<th>CI</th>
<th>Differences</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EASY</strong></td>
<td><strong>REC</strong> (2.36) and <strong>SHM</strong> (4.18)</td>
<td>-</td>
<td>Recorder sounds higher than other instruments and not easy to listen to.</td>
</tr>
<tr>
<td><strong>HIGH</strong></td>
<td><strong>CGT</strong> (2.27) and <strong>REC</strong> (4.45)</td>
<td><strong>CGT</strong> (2.13) and TRP/TUB/SOU (4.25)</td>
<td>The subjective evaluations are different between DHH with HA and CI</td>
</tr>
<tr>
<td><strong>BEAT</strong></td>
<td><strong>CVN</strong> (2.8), <strong>SHM</strong> (2.45) and <strong>REC</strong> (4.45)</td>
<td>-</td>
<td>Shamisen does not sound high and easy to listen to.</td>
</tr>
<tr>
<td><strong>LIKE</strong></td>
<td>-</td>
<td><strong>REC</strong> (2.38) and <strong>HRP</strong> (4.59)/<strong>EGT</strong> (4.63)/<strong>SHM</strong></td>
<td></td>
</tr>
</tbody>
</table>

*: p<.05, **: p<.01
What are pitches?

• Calculate pitch with MIRToolbox (Matlab)/iOS app1/iOS app2
  • REC: 131/C5/104(G)
  • SHM: 261/C3/130

Subjective evaluation of “HIGH” by Hearing People (four participants, average)
  • REC: 4.0
  • SHM: 2.5

- Recorder sounds higher
- Shamisen does not sound high
- DHH with HA and Hearing People feel similar to pitch of REC and SHM
Results

Differences between Participant Groups

• EASY
  ** VCL: HA(2.9) CI (4.6)
  * EGT: HA(3.6) CI(4.8)

• LIKE
  ** VCL: HA (2.6) CI (4.0)

*: p<.05, **: p<.01
Discussion

• Differences in subjective evaluation between two DHH groups

• Which instruments are good to understand?

HI children can enjoy music classes at elementary school?

• No instrument was found commonly good for HI

• How about the combination of several instruments?
Discussion

Future Work

• The effect of sound features
• The relationship between the subjective evaluation and an objective evaluation (tapping accuracy)
• Future music assistive technology for DHHs … personalized music recommendation system
Fine