**University of Denver**

Electrical and Computer Science Department

Music Autism Project

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# Overview

NAO, a small humanoid robot, will be used as a social agent where kids will listen to music and interact by playing a small toy-sized xylophone during each experiment session. Each session will consist of the robot playing some pre-recorded music meant to elicit varying t emotions for the first part of the session. The second portion of each session will consist of the robot having thee kid play the xylophone with him in a similar fashion to a musical instrument lesson. Both Autism Spectrum Disorder (ASD) and Typically Developing (TD) kids will be recruited to take part in the experiment.

# Goals

1. **Do I hear what you hear? Do I feel what you feel?:** Is emotion in music recognizable in children with autism? Do they feel the same as what they understand from the music? Is there a difference in the way ASD kids and TD kids perceive the emotions of the musical pieces?
2. **You teach, I listen and learn:** Can playing music help ASD kids better communicate (i.e. turn taking during social activities) with their peers? Do they feel stressful or uncomfortable during social activities? Will they calm down when they listen to the music they like the most?

# Experiment Pre-setup

Before we start the experiment, several things need to be done:

1. Music pieces with easily identifiable emotions should be composed by a professional music player or composer.
2. Music pieces should be annotated by multiple people to ensure accuracy in the emotion represented by the piece, and will be labeled under these different emotions. (at least 50 non-music major students will listen to each piece and label them)
3. Music pieces which will be played by NAO should also be composed and programmed on NAO. Implement emotions in this part if at all possible.

# Experiment Setup

The whole experiment contains two parts. NAO will provide all instructions during the session and the researcher will only provide help or interrupt sessions if necessary. In total, there will be 5 sessions for this experiment: the first will include a human therapist, three will have only NAO, and the final session will also involve a human therapist.

1. Part One, Music listening, Do I hear what you hear, do I feel what you feel:
   1. At the beginning of the session, each kid will be asked to wear a Q-sensor for EDA signal collection;
   2. The kids will then be asked to listen to 6 pieces of music for the first part of the session. Musical selections will be made via a simple user interface shown on a computer with 6 numbered buttons to click.After a kid clicks 1 of the 6 buttons, a short piece of music will be played via NAO’s speaker.
   3. At the conclusion of each piece of music, the kids will be asked to make a emotion selection based on how they experienced the music.
   4. After all music have played once, the kids can have a few minutes of free play, where they can play whichever piece they want again Results will be recorded as well.
2. Part Two, Music playing, You teach I listen and learn:
   1. NAO will use verbal instruction to ask the kids to select which piece (at least one piece should be practiced) to be played and practiced. NAO will wait for response and start to play.
   2. NAO plays the piece at original speed, and then asks what the kid thought about it. If the response was positive go to part c., if negative go to part d.
   3. At this point, the teaching process will begin. NAO will play the piece slowly and ask the kids to imitate it. After imitating it, the robot will provide feedback regarding how the kid played (correct notes and notes sequence). Also, due to the uncertainty during music play, all play activities will be recorded the whole time for post-process.
   4. Ask the kid to select again and repeat part b.
   5. After some practice, the kid will have few a minutes of free play. All activities will also be recorded for post-process.

# Measurements

## Emotion selection result between ASD and TD

Based on the selection kids have from both groups, we should be able to answer “do I hear what we hear?” No matter what the results show, it can be a very interesting topic for future studies.

## EDA data from Part One

Based on the method from the paper, we should be able to analyze different emotions from both groups, and answer “do I feel what you feel?” No matter what the results show, it can be a very interesting topic for future studies.

## Turning taking

In part two, video and audio will be recorded, and we will be able to find out whether NAO was interrupted during teaching or playing the xylophone. We will also be able to see how well the kid engaged during the music play process (a decision making algorithm implemented in NAO where real time feedback during sessions can be provided would be ideal).

1. EDA data from Part Two

Learning can be stressful, so the hypothesis is during part two, a signal change might reflect stress in the kids when repeating what the robot just played. To combat the stress, they can quit anytime they want, or they can request the robot to play anything again and again, or play something they like, if that can help them calm down. This might prove that music could be a good media for ASD kids to better communicate and deal with stressful situations. Also from free play, we may see some interesting signal changes which may represent happiness.

# Experiment setup

Brief explanation for the experiment :

1. Pre-session part: in this part, human baseline assessment will be applied, researcher/therapist will conduct this session, and NAO will also be exposed to kid for music play demonstration. Activities includes: music listening, emotion recognition, music teaching (color matching, rhythm matching, single/multiple notes play). Both TD and ASD group will asked to complete this session. Social skills will be evaluated during music teaching activity such as: turn taking, joint attention, basic communication skills. TD group will only have this assessment and will not allow to continue the rest of the experiment. A baseline report will be generated after this part.
2. Intervention-sessions part: in this part, music teaching are splitted into small simple tasks in first few sessions, and a complete music play task will be assigned to last intervention sessions. Only ASD group will attend this part.
3. Post-session part: same as pre-session, a researcher/therapist will repeat what have been done in the pre-session and provide an assessment report afterwards.

Detailed steps in each session see table as follows:

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| --- | --- | --- | --- | --- |
| Session # | Session  Type | Outline | Session Details | Session Purpose |
| 1 | Pre-Session  Part I | * Emotional Music Enjoy. | 1. Computer music listing, participant will be asked to listen few music pieces composed by professional; 2. Participant should describe the feeling based on what they just listened, make selection on computer or tell researcher/therapist; 3. Participant free play the music pieces (2 mins), computer/researcher record to see which music which played /liked the most from Step 1. | * Have better understanding of how ASD group perceive emotions from music. * Compare EDA signals between ASD and TD groups, find out similarity. |
| 1 | Pre-Session  Part II | * Social baseline collection. * Human assessment. | 1. NAO plays the the music piece select by participant; 2. Teach music piece from Step 1 gradually, form single strike, color strike, rhythm strike, multiple strike the entire music piece. 3. Participant free play xylophone (2 mins), NAO record how kids played for post process. | * Getting social baseline from both groups in different tasks for future usage; * Compare difference between both groups. |
| 2 | Intervention  Sessions  Intervention  Sessions | * Signal note teaching. * Color based signal note teaching. | 1. Participant should hit an arbitrary bar after each robot’s struck; 2. Repeat Step 1, while the participant should use both hands in order; 3. NAO strikes single bar associate with a random color, and participant should select the proper color on a computer screen; 4. NAO show Red, Green, Blue, Pink on its eyes, participant strike the matching color on xylophone. | * Improve in Joint Attention skills; * Colors Recognition. |
| 3 | * Hitting bars while counting numbers/color names. | 1. Review Step 4 from Session 2; 2. NAO demonstrates hitting one or two bars in order and verbally repeats “one-two” with the movement; 3. Participant verbally says “one-two” along with robot hitting movement; 4. Repeat Step 2, use “color names” instead of “one-two”, kid should imitate the strikes along with oral response. | * Improve Verbal short-term Memory; * Improve the perception of numbers and counting. |
| 4 | * Rhythm Perception; * Playing a virtual xylophone on the screen and move to turn-taking games. | 1. Review Step 4 from Session 3; 2. Imitation from the robot while striking 3 or 4 notes in order considering the time interval between each notes with saying “colors”; 3. Repeat Step 2 without oral response. 4. Participant play 3 or 4 notes on a virtual xylophone on tablet/computer, NAO imitate what has been played on real xylophone. | * Improve auditory imitation skill; * Good cooperation between eye and hands movements; * Improve the Visual pursuit; * Sharing attention between different tasks; * Improve in playing turn-taking and group games in robot-child interactions. |
| 5 | * Notes teaching. | 1. Review Step 3 from Session 4; 2. NAO demonstrates striking 2 or 3 notes with saying “note names from A to G”, participant verbally repeats the notes name while robot hitting the bars; 3. Imitation from the robot while striking 3 or 4 notes in order considering the time interval between each notes with saying “note names/colors”; | * Working memory of children with autism, Dual task performance; * Improve in joint attention skill; * Improve in shifting attention skill; * Improve in auditory memory of children. |
| 6 | * Ultimate challenge for participant, get data from Session 6 and 7 for post process. | 1. Review Step 3 from Session 5; 2. NAO plays the music selected from Step 3 in Pre-Session; 3. NAO plays the simple version of that piece on xylophone with saying “note names/colors”; 4. Participant will expected to repeat this after NAO played, notes sequence will be shown on screen after first trial. | * Improve the cooperation between behavior and motor skills of child. |
| (7) | * Finish up music play and get final data for post process. | 1. Repeat Session 6. | * Same as Session 6. |
| 8 | Post-Session | * Human assessment. | 1. Repeat Pre-Session | * Compare results between ASD vs TD, Pre-Session vs Post-Session. |