



A therapeutic Virtual Reality
musical game for children with
Autism Spectrum Disorder.

Solo Project
Timeline: 5 months (2022)

'Hypothetical' Studio
Exhibited in RMIT University (2022)

RESEARCH: Inspiration & About ASD

Amazing Hallelujah

This 'Hallelujah' is performed by a choir from a special school of Autism children.

I was in tears watching those angels singing out their efforts, gifts & strengths.

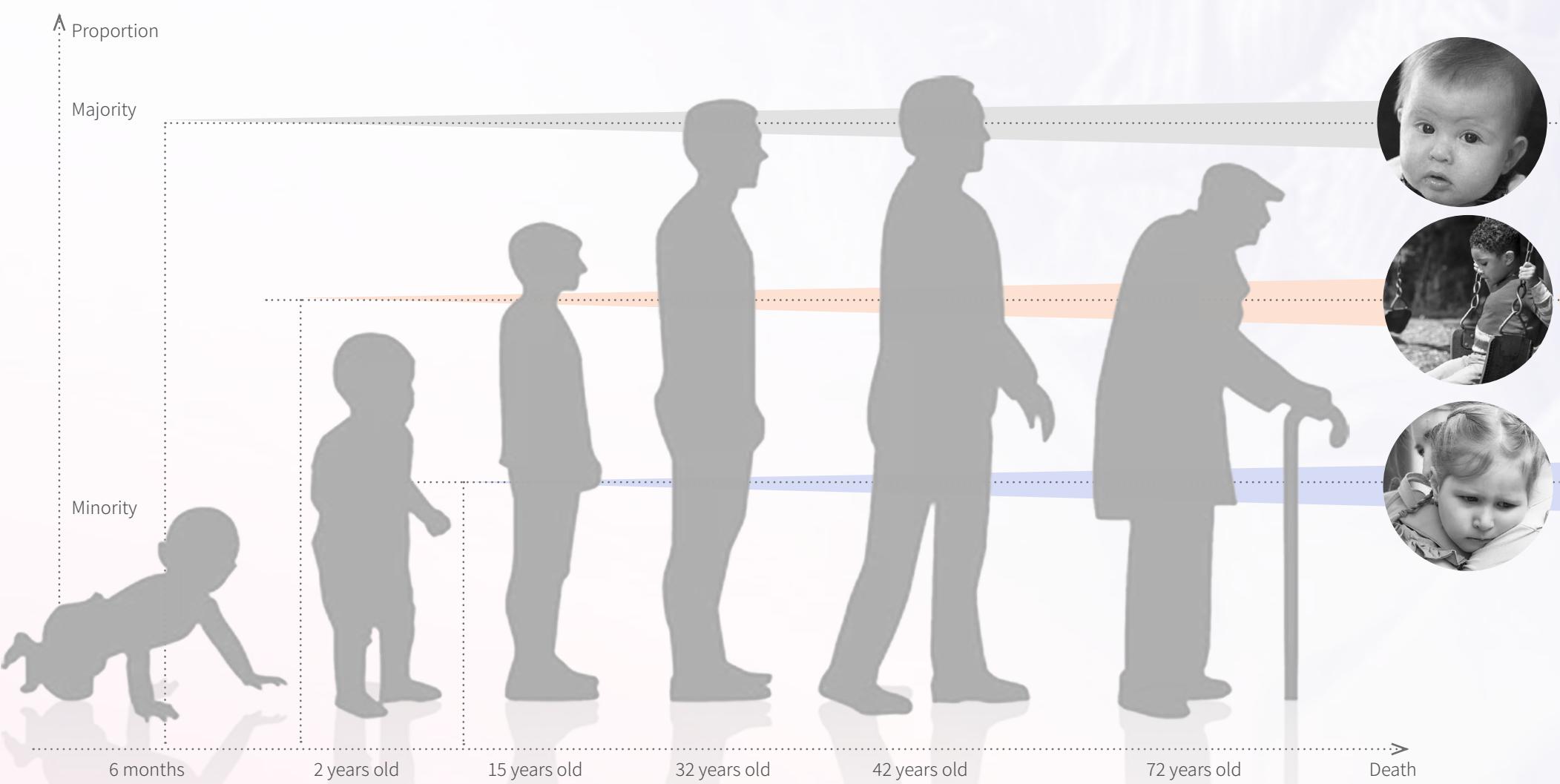
Music speaks to all when words fail.

Inspired by this performance and my passion for music, I start my research on Music Therapy and Autism.



<https://www.youtube.com/watch?v=BmxBjeN7o>

Symptoms Revelation Timeline



PAGE 2

What is ASD?

Autism Spectrum Disorder(ASD) is a neurological and developmental disorder that **begins early in childhood** and **lasts lifelong**.

By far, it is not curable. Early intervention is important for children.

(Autism spectrum disorder - Symptoms and causes, n.d.)

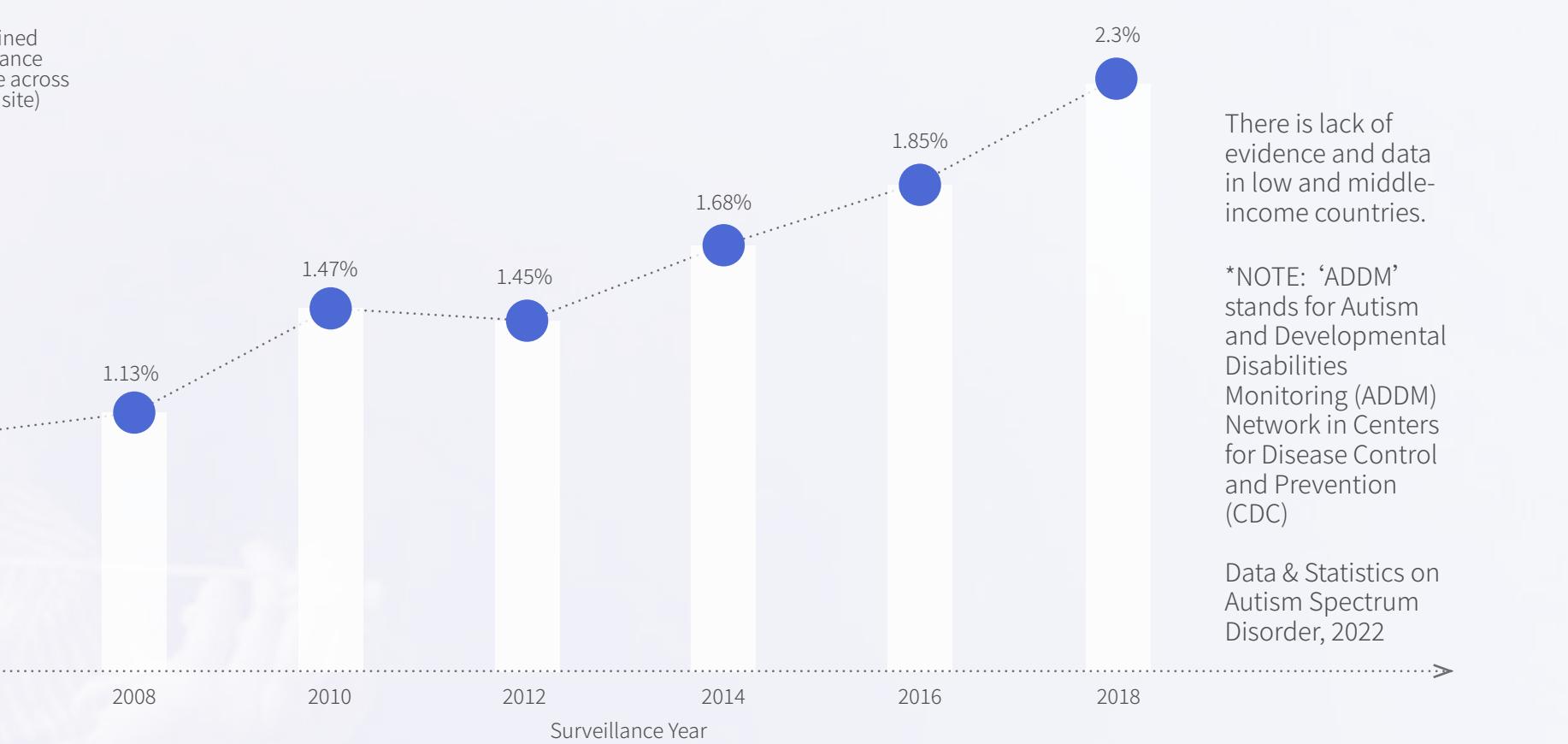
Diagnosis

- **No definite medical test due to its complicated causes**
- **More relevant data-collection is required**

(Begum and Mamin, 2019)

Chart: Identified Prevalence of Autism Spectrum Disorder

1 in 44 children has ASD. The number is still increasing.



Main symptoms of ASD

Spotting the signs of Autism in early childhood can be complicated due to unstable symptoms.



RESEARCH: About Music Therapy & Gamification

What is Music Therapy?

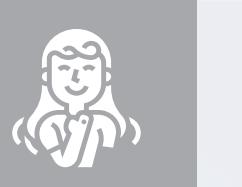
Music Therapy is the **clinical & evidence-based** use of musical engaging interventions within a **therapeutic** relationship.

It has been effectively used in ASD intervention by many.

(Wigram, 2000)

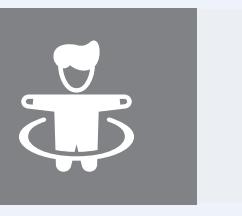
Gamifications

Video games have been studied in psychological and cognitive research.



ENGAGING PLATFORM

A solution for intermittent participation of ASD prevalence.



Construct Target Data

Quantitative relevant data for research which is urgently required

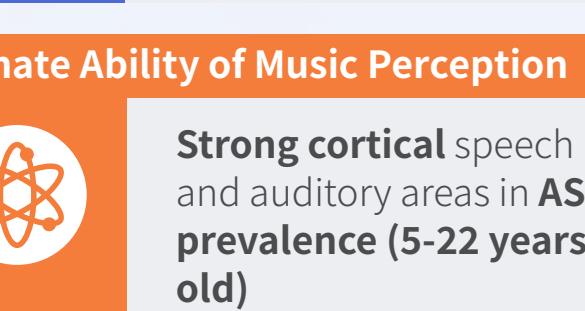
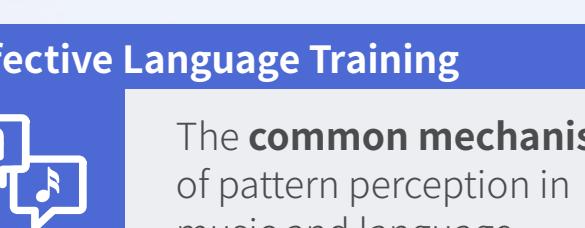
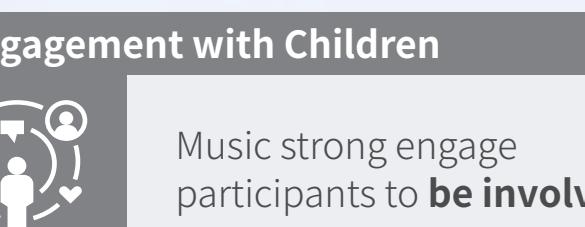


Prevent Aging Effect

Assess aging effect on cognitive function in senior people

Orange & Green: (Li et al., 2018) Blue: (Anguera et al., 2013)

Underscore of Music



Orange: (Lai, Pantazatos, Schneider & Hirsch, 2012) (Wigram, 2000) | Blue: (Thaut, 1999) | Green: (LaGasse, 2014) | Grey: (Kaplan & Steele, 2005; Whipple, 2004)



"My experience as a mom is vastly different."

Open discussion upon occurred difficulties, conflicts, and facts after her child being diagnosed with ASD.

Insights: Music Therapy for Autism



High rate of Music Therapy class far exceeds a median hourly earnings worker in US.



Unavoidable extra cost upon economy, time for parents who have already been impacted by ASD prevalence.



Trained music therapist for ASD children are in short worldwide.

Cuckoo: Next Paradigm of Music Therapy for Autism Kids

RESEARCH: Market Research & Analysis

Current solution & shortages

 Government subsidy
✓ Economical support
✗ Undeveloped system in many developing countries: limits on audience demography

 Educational Institution
✓ Professional clinicians support
✗ The training time for therapists is too long to cope with the increasing need of ASD patients

 Volunteers
✓ YouTube streaming well-approach some
✗ Relatively small group Missing social context approach

 Robotic platform <small>(Feng, Mahoor & Dino, 2022)</small>
✓ Pilot study has potential for further approach
✗ Less engaging than human characters • Missing social context approach

Pinpoints of improvement

Economical & more trained therapists : accessibility

Maintain the high engagement of musical games

Support ASD research by providing more related data

Case Study: Therapeutic gamification on Executive Functioning

Source:
Li, B., Atyabi, A., Kim, M., Barney, E., Ahn, A., & Luo, Y. et al. (2018) Social Influences on Executive Functioning in Autism.

Abstract:
A mobile game that uses **social and nonsocial stimuli** to assess children's **Executive Function (EF) skills**. The game comprised three components involving different EF skills: **cognitive flexibility (shifting/inference), inhibitory control, short-term memory**.

Set-shifting game

Theory: **Wisconsin Card Sorting Test**

Set-shifting thinking may be a general deficit in ASD, spanning across both **social and non-social domains**.

Aim: Set-shifting skills practice

Go/Non-go task

Presence of an angry face as "stop touching screen" sign.

Salient emotional expressions that may yet **provide an effective method** for the **external regulation** of behavior in children with ASD.

Aim: Inhibitory Control practice (social factor)

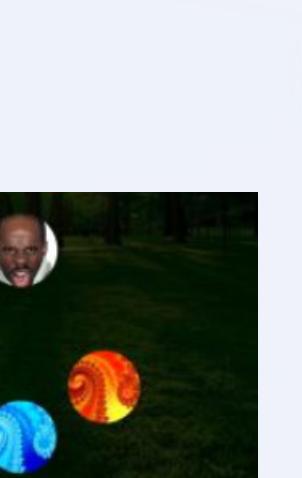
High-stimuli of interaction & support social circumstance

Data of habitual movement by hand controllers / headset

Impaired motor skills are practiced largely when gaming

(Lima and Castro, 2012)

(Lima and Castro, 2012)

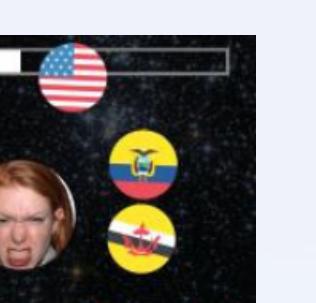


Set 1: face

Set 2: color



Shifting Game: player has to guess the rule associated with the correct answer. Rule changes within few seconds.



Stop sign: angry face

Inhibitory Control: when angry face appears, player is required to stop touching screen when face gone.

EARLY GENERATIVE: Diagram Synthesis

With the advantages of high-stimuli interactive environment, embedded Executive Function intervention in gaming mechanics in musical ambience



Virtual Reality Stimuli

Disadvantages

Severe motion sickness

Might gaming too much

Real-life alike stimuli

Body Exercises

Data traced from user habitual movement

Advantages

Extra stress for carers

Inadequate music therapist

Less constraint on audience demography

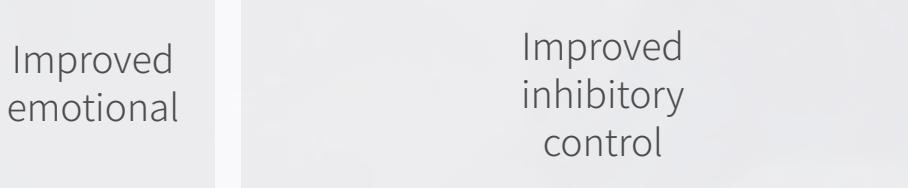
High engaging participation

Effective vocal training via music

Gaming Mechanics & Theory Support

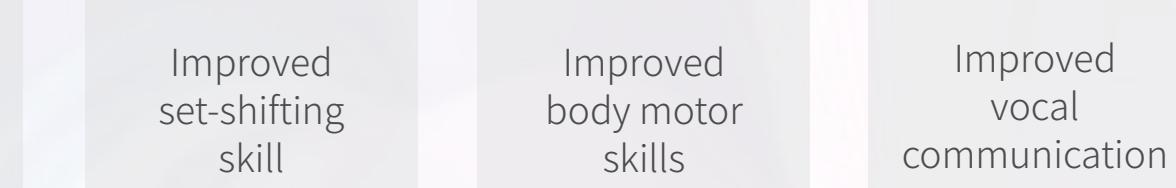
Emotional Regulation

Improved emotional

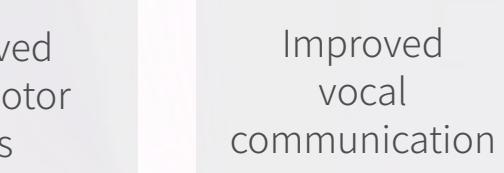


Executive Function

Improved inhibitory control



Data for ASD research



Theories support

Inter-subjective area / affect attunements

Rhythmic auditory stimuli facilitate

Perceptual motor

Base for all application: Innate ability of music perception in ASD

IDEATION: Conceptualization

CUCKOO

To promote the accessibility of Music Therapy for more ASD children, 'CUCKOO' is practical, clinically-relevant, interactive musical Virtual Reality game to develop Autism children in impaired Emotional Regulations and Executive Functions.

Keywords

Autism Spectrum Disorder
Executive Functioning
Emotional Regulations
Human Computer Interaction

CUCKOO

'CUCKOO' is a dynamic, onomatopoeic name with good wishes inspired by cuckoo birds.



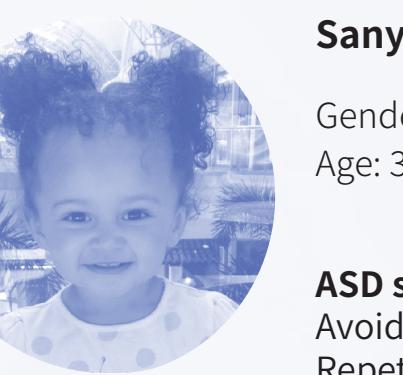
*Note: Low-functioning autism are not recommended. If seeking for music therapy, real life lesson fits better with more agile trained human therapists.

IDEATION: Persona & User Flow



Sarah (Sanya's caregiver)

Female, 35 years old
Marriage Status: Divorced
Employment: Full-time employed
Wage: 3000 USD monthly



Sanya (child with ASD)

Gender: Female
Age: 3 years old

ASD symptoms
Avoiding eye contact
Repetitive behavior
Impaired inhibitory control



PROTOTYPE: Visual Identity & User Interface

Visual Identity

Typeface

Lapsus Pro

Title Body
CUCKOO

Logo



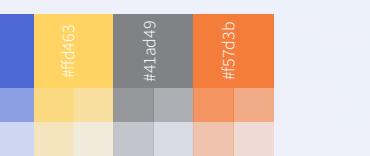
NPC



Final Logo

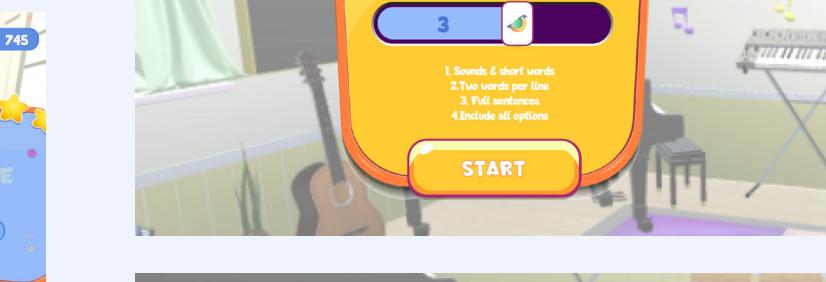
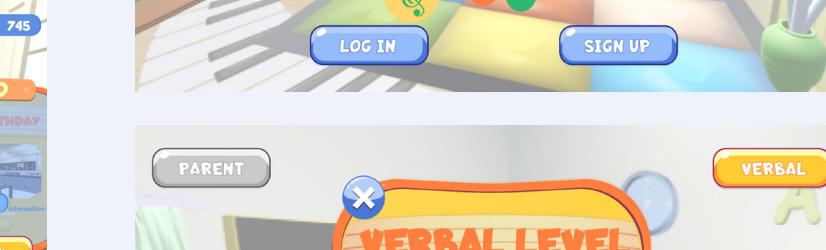
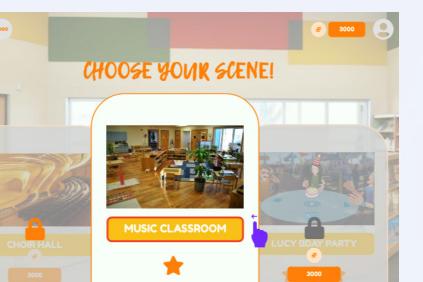
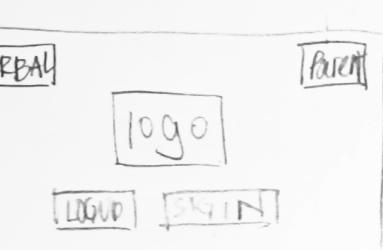
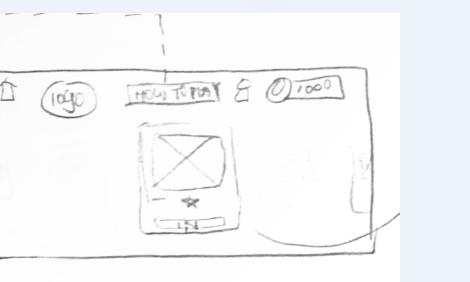
CUCKOO

Colour Palette



Teacher will play the piano and conduct user. Others will role-play with user together.

UI in VR (Lofi)



PROTOTYPE: Games Mechanic Design

Therapeutic Intervention Element: Drum (Example)

Changing Indicators Categories

Aim: Executive Function: Set-shifting skills

Without being told the rules, user must hit the indicated drums (success). Types of indicators randomly change to practice user's set-shifting skills.



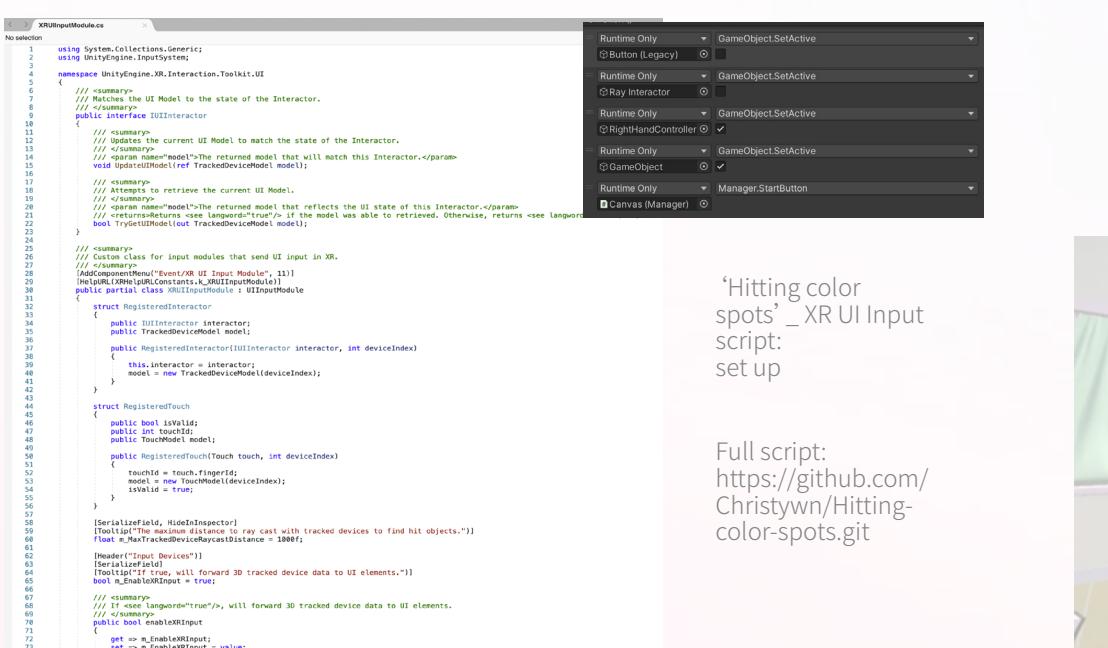
Targets to hit



Indicator type01: Color



Indicator type02: Shape + Color



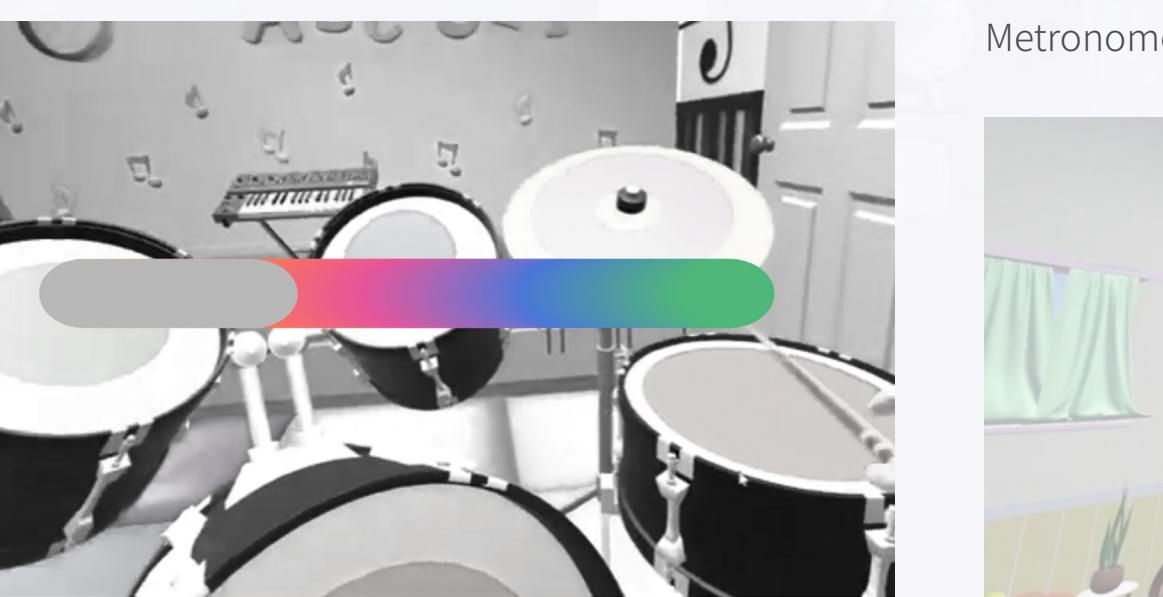
'Hitting color spots' _X UI Input script: set up

Full script:
<https://github.com/Christywn/Hitting-color-spots.git>

Freeze: Go/Non-go task

Aim: Inhibitory Control practice

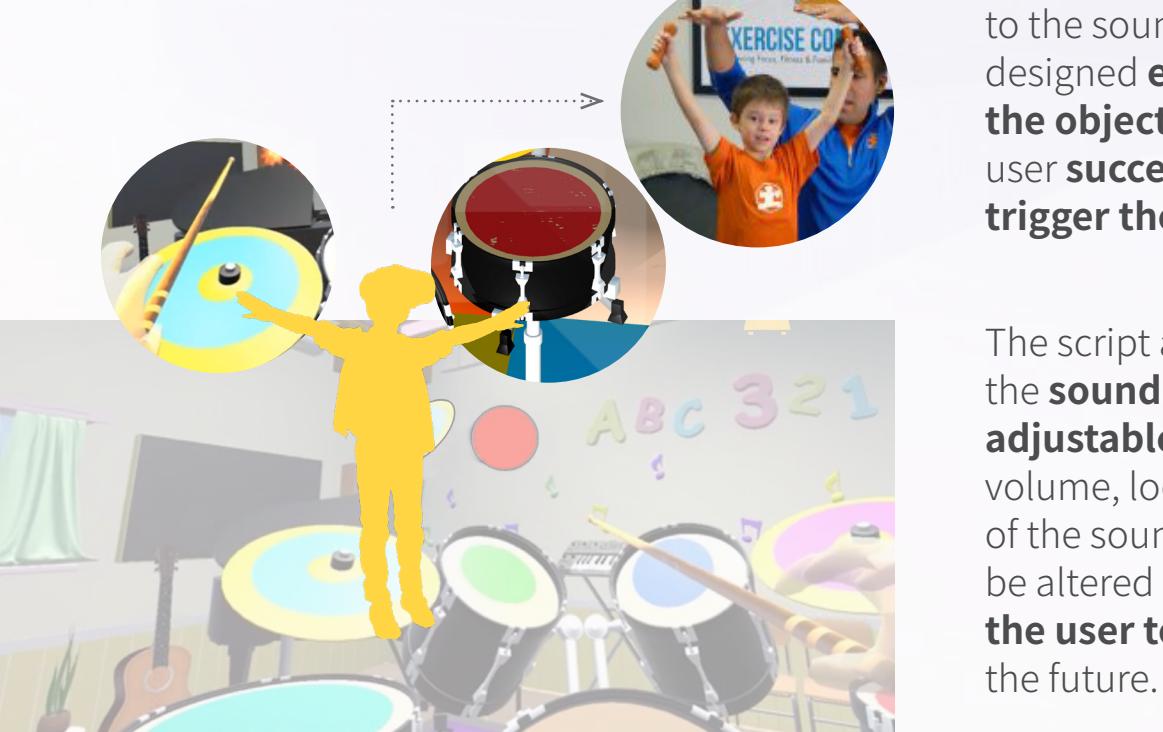
This is added in every scenes and roles (drummer, singer,etc.). When teacher indicates 'Stop', the interaction between the user and the drum will be inactivated. "Freeze" is allocated randomly.



Indicator Location Design

Aim: Maximize body motor skills practice

Indicators trigger body function training. Structured as prescriptive music scores to guide user to complete movements designed from certain physical rehabilitation training, user with mentor skill deficit can practice functional motor skills.



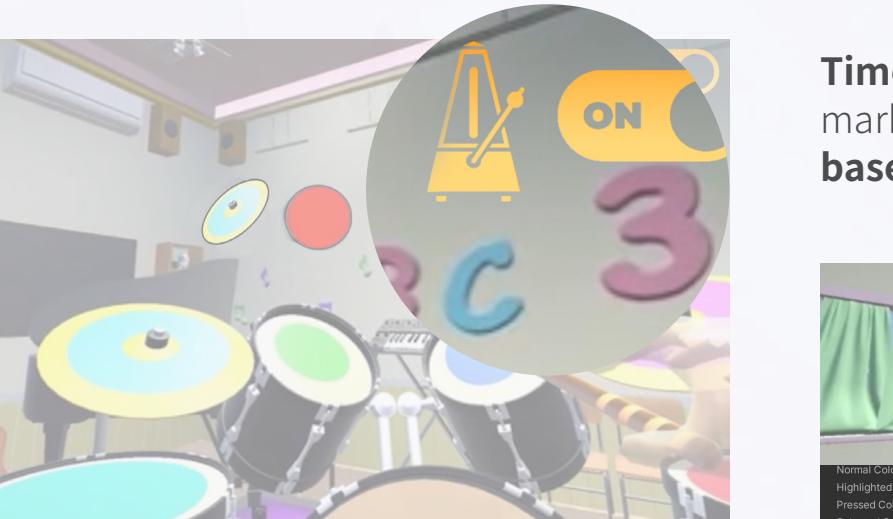
The script allows the sound be adjustable. The volume, loop, pitch of the sound could be altered based on the user testing in the future.

Metronome: rhythmic input enhancer

Aim: Inhibitory Control through rhythm auditory input

Rhythm is a stimuli in inhibitory control and impaired motor skill. A metronome (ref to Fig.13) strengthens the rhythm input.

Metronome can be on/off to suit the needs.

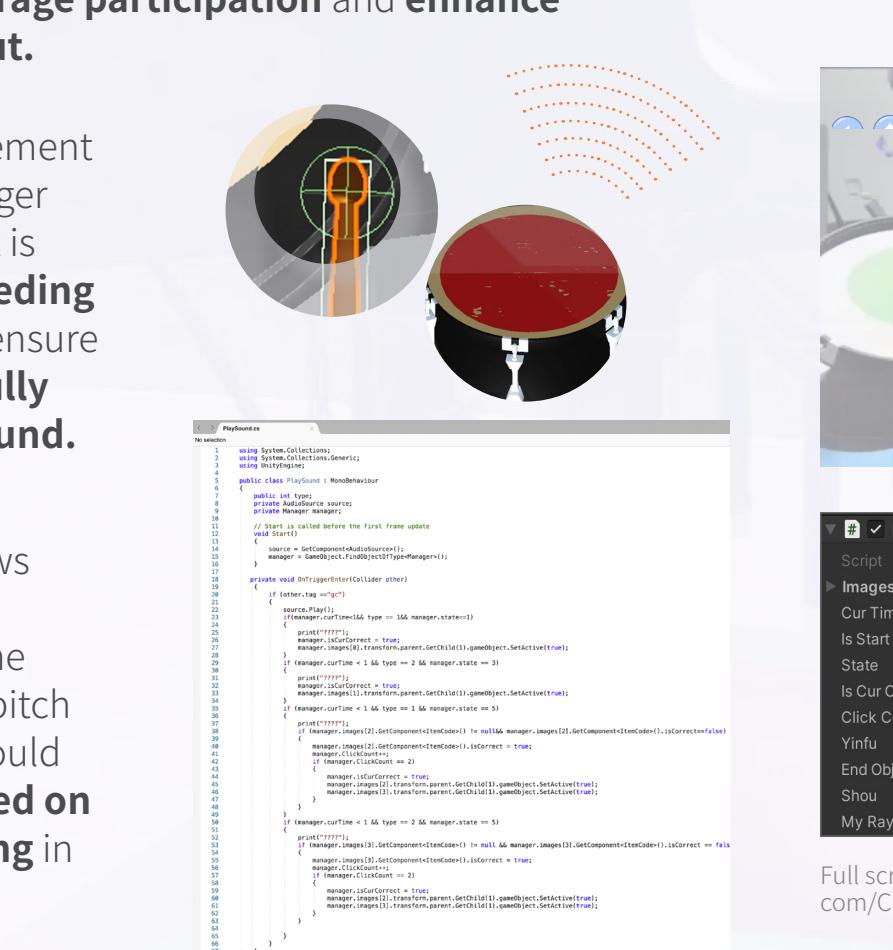


Real sounds of drums

Aim: Engaging stimuli for user

Sounds encourage participation and enhance rhythmic input.

The collider element of stick is a trigger to the sound. It is designed exceeding the object to ensure user successfully trigger the sound.



Full script of 'Canvas Manager': <https://github.com/Christywn/Cuckoo-Drummer.git>

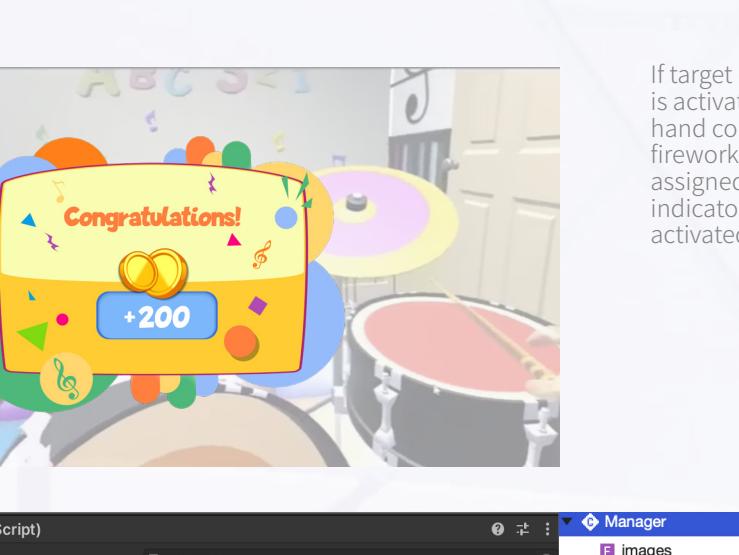
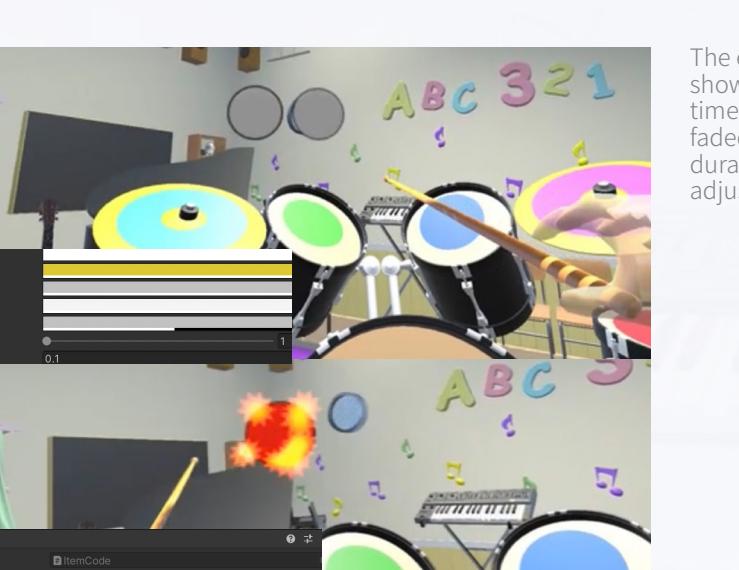
User Experience Improvement

Reward mechanism for user input

This system is the basic structure of events from specific user inputs (ref to Fig.20).

'Firework' is triggered with successful hits from user to improve sense of competence. 'Turning into grey' is resulted from users' wrong/missed hits to minimize the lost of competence. The rewarding coins are shown in the interface when finish.

Time duration length for user response before system marking user input as 'wrong or miss' is adjustable based on further testing.



Full script of 'Character Movement Helper': <https://github.com/Christywn/Cuckoo-Drummer.git>

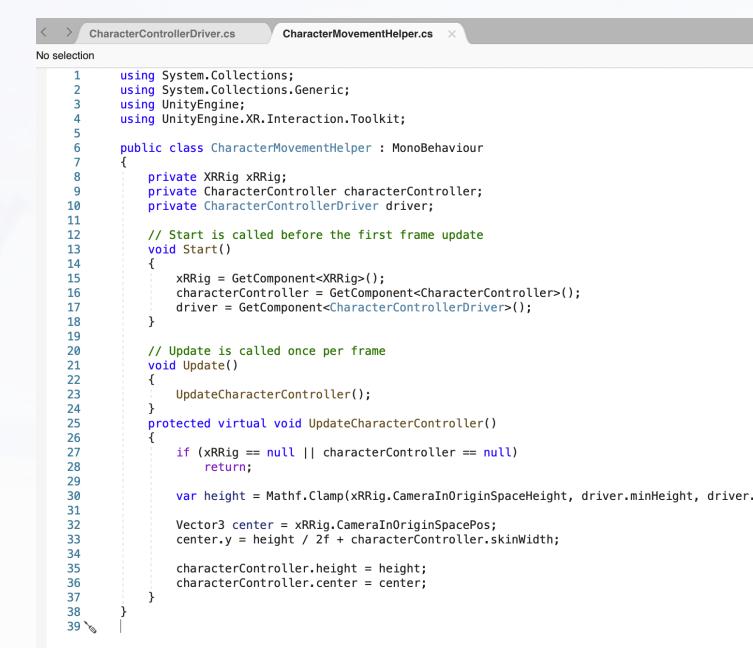
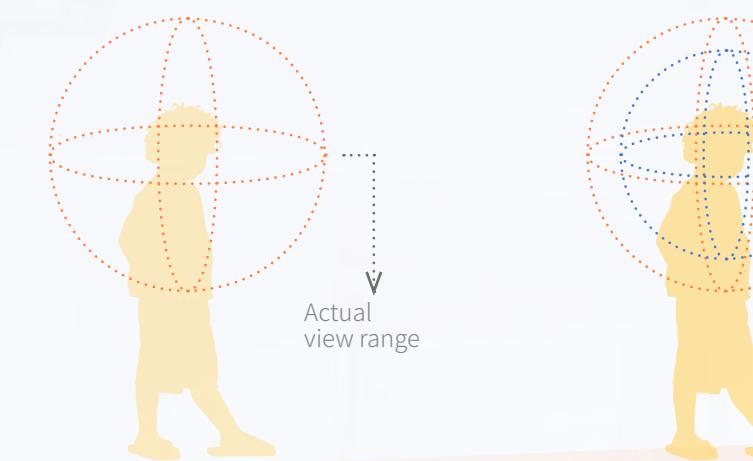
Motion Sickness Control System

Motion sickness is a concern for VR user. The symptoms may include fatigue, uneasiness, dizziness, vomiting, etc.

Motion sickness might be more severe for ASD with deficit in inhibitory control & motor skills. Unstable movements might result in wagging view in VR sight, which result in motion sickness.

Character Movement Helper (CMH)

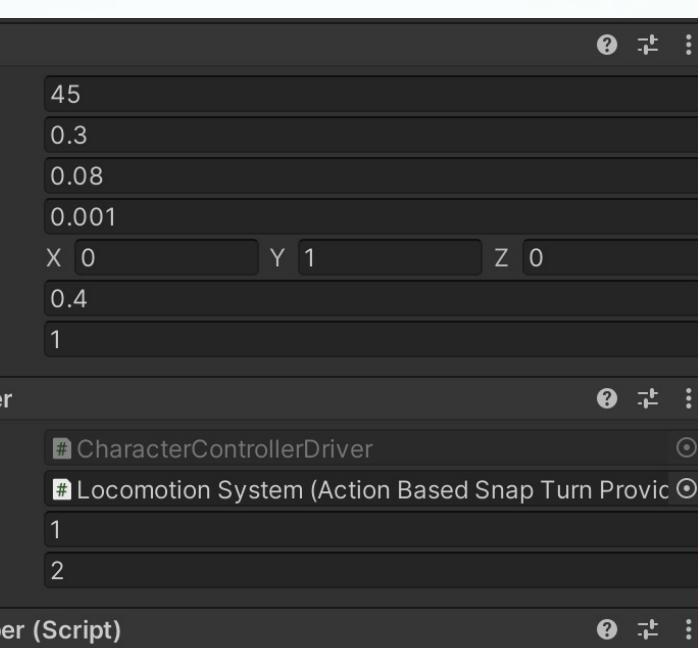
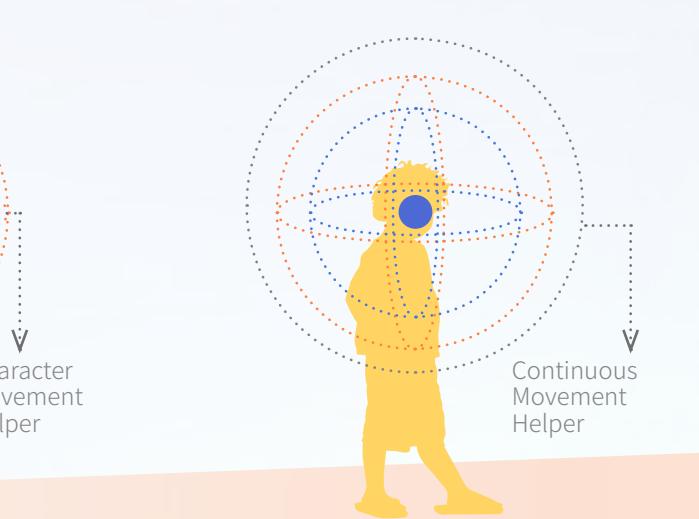
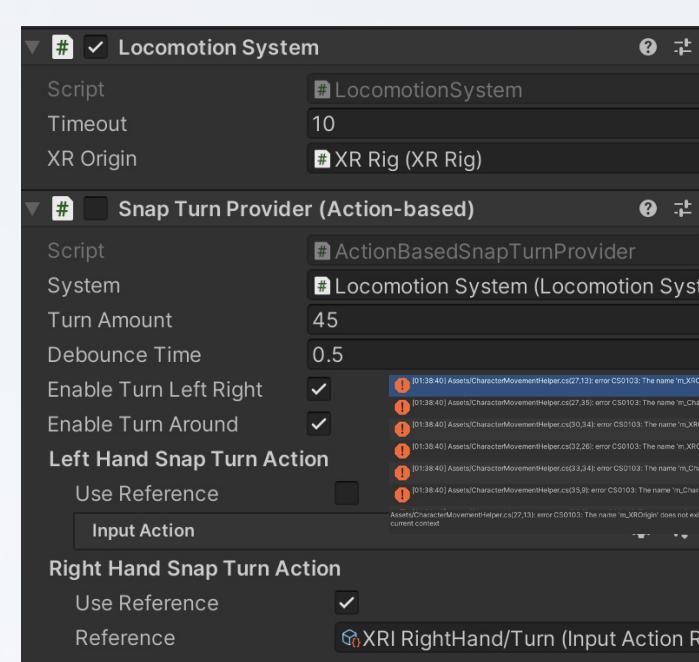
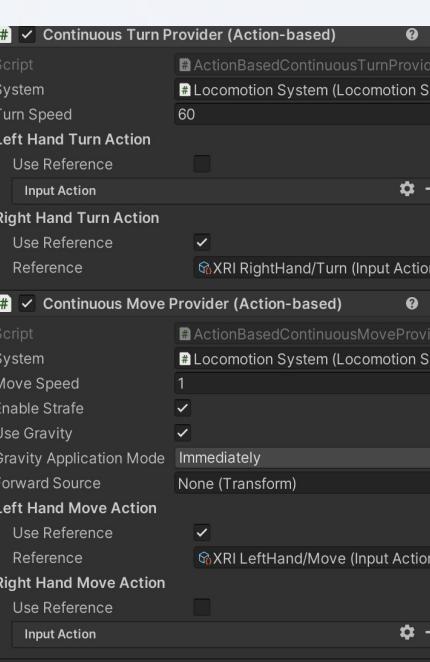
CCD is a Unity system to stabilize user's view in VR glasses to minimize motion sickness. To ensure the center of CCD is re-updated with every update from user movements, I added CMH to ensure every updates from the user is updated in CCD.



Motion Sickness Control System

Locomotion System: Continuous Movement Provider

This is a stabilizer to smooth the visuals in VR when user turning around to minimize the resulted motion sickness. It is used to settle down 'turn' 'snap turn' of the virtual view.



PROTOTYPE: VR Scenario Models

Beginner (Music Classroom)

Design principles for space (Autism)

- **Acoustics.** Autistic people are painfully sensitive to sounds.
- **Lighting.** Light, color affect mood, and cognitive behavior
- **Spatial configuration.** Ordered space is easier for the autistic.
- **Materials.** Modular furniture are preferable. (Thuong, 2018)



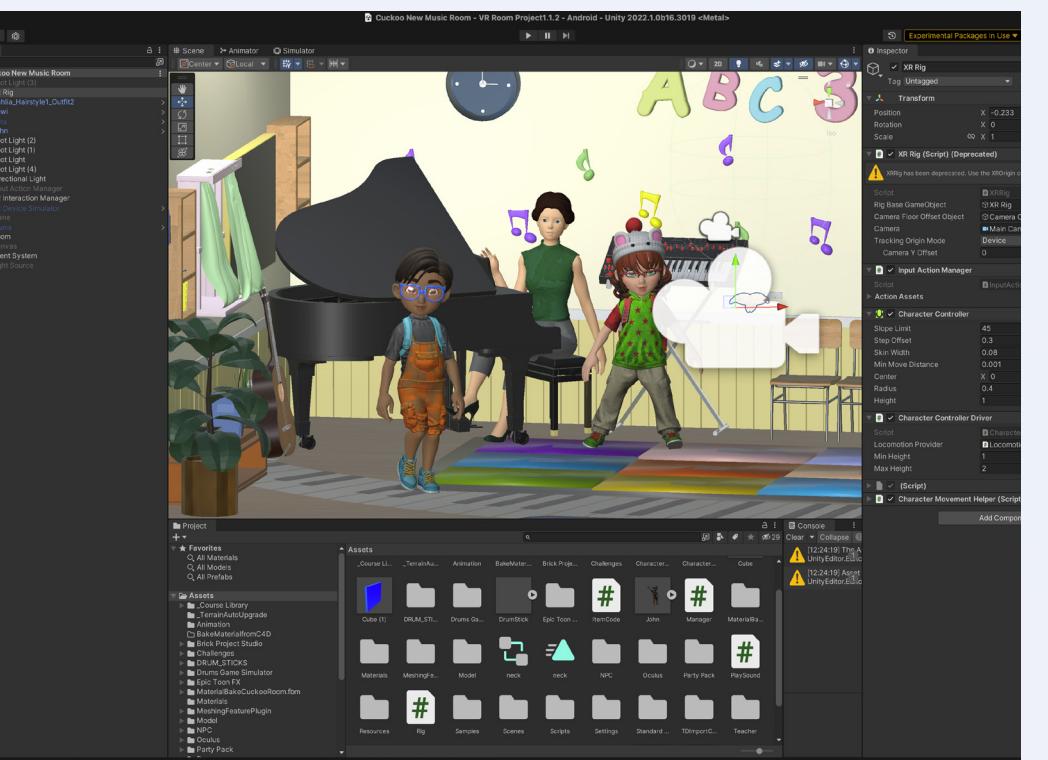
Familiar scenario as a start is sanguine for adaption.

Advanced (Lucy's Birthday Party)

There are other guests, shop workers in the pizza shop! We are going to perform on the stage to celebrate her! **The purpose of putting audience: improve social skills & impaired emotional regulation**



USER TESTING: Early Testing & Feedbacks



Selected student project in 'Hypothetical' Studio, RMIT University, 2022
Exhibited in RMIT University



User Testing 01:

Robert

Gender: Male
Age: 15 years old
Health: Healthy
Occupation: Student



This game provides an immersive and realistic experience. Reaction time of each movement can be improved since the interval between the signal is too short, and user is difficult to adjust it.



Using Testing 02

Han

Gender: Female
Age: 18 years old
Health: Healthy
Occupation: Student



The characters and scenarios are engaging. The 'Drummer' role-play is interesting with real-sounds. User Interface is effective design and straightforward-guiding.



Video Trial

