Digiatal therapeutics for Children with ADHD

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Background

Gender medical personnel

with 'activity and attention disorder (ADHD)' from 2017 to 2021

Unit: People , %

Sort	In 2017	In 2018	In 2019	In 2020	In 2021	Rate1	Rate2
Sum	**53,056**	**59,602**	**72,452**	**79,238**	**102,322**	**92.9**	**17.8**
Male	42,453	46,996	55,637	58,394	72,332	70.4	14.2
Female	10,603	12,606	16,815	20,844	29,990	182.8	29.7

Source: Health Insurance Agency

Rate1: Year-on-year growth rate ('compared to 2017)

Rate2: Annual average growth rate

There is a significant upward trend in the number of individuals diagnosed with ADHD. These statistics underscore the growing need for effective treatment and support for individuals with ADHD.

The target: Elementary School Students

1. The first aspect is that the experiments referenced during game development targeted elementary school students.
2. The second aspect is that elementary school students have the highest incidence rate among ADHD patients.
3. The third aspect is that the early grades of elementary school are considered the appropriate period for ADHD treatment.

Overview

ADHD is a Neurodevelopmental disorder, characterized by persistent patterns of inattention, impulsivity, and hyperactivity. Have a persistent patterns of inattention, impulsivity, and hyperactivity that interfere with daily functioning and development

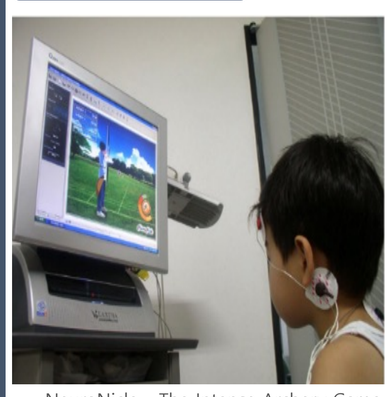
1. Difficulty with attention and sustaining focus.
2. Challenges in emotional regulation.
3. Disorganization and forgetfulness.

Source: Seoul Asan Hospital

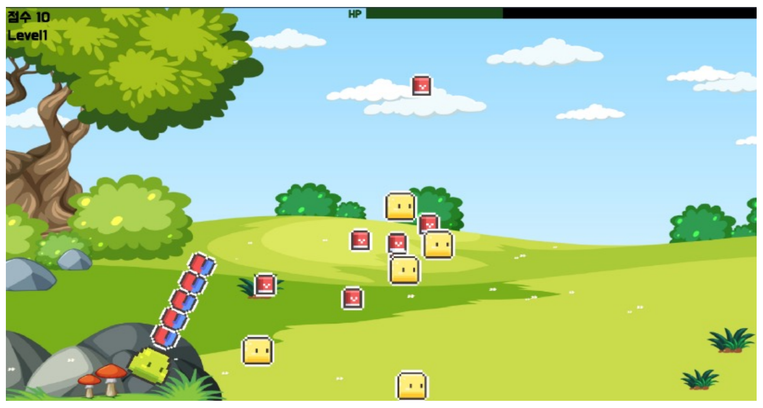
System Architecture

Implementation

Shooting Game

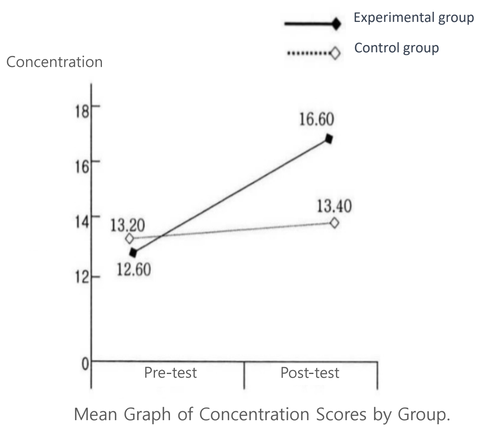


NeuroNicle - The Intense Archery Game



The Shooting game was developed based on a study referencing the improvement of concentration through the “NeuroNickle Shooting Game.”[1] Therefore we have decided to make a slight modification of this game, and decided to make a game by shooting a moving object with a weapon that the main character has. Shooting game‘s main character is the green jelly. This main character uses a magnet to shoot the enemy's yellow jelly or it’s can. The score goes up by 2 or 5 points. Multiplying each difficulty level by 10 points allows progression to the next level.

Maze Game



Mean Graph of Concentration Scores by Group.

The study we referenced concluded that maze games improve the concentration of children with attention deficit.[2] We have decided to make a maze game in our digital therapeutics game.

To move on to the next stage the user has to succeed the current stage. The difficulty level of the maze increases indefinitely, and the more difficult it becomes, the more complicated it becomes to solve the maze.

Maze Game - Hardware

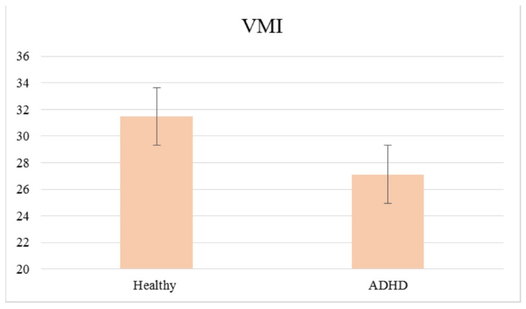
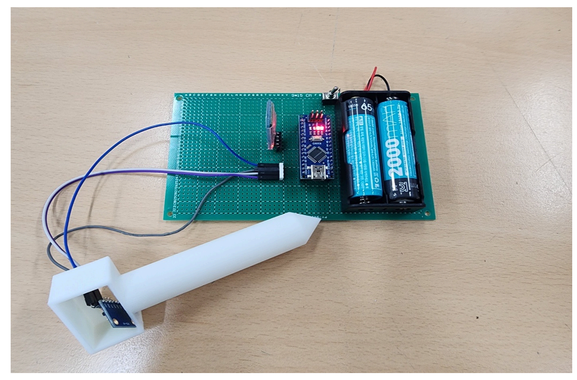


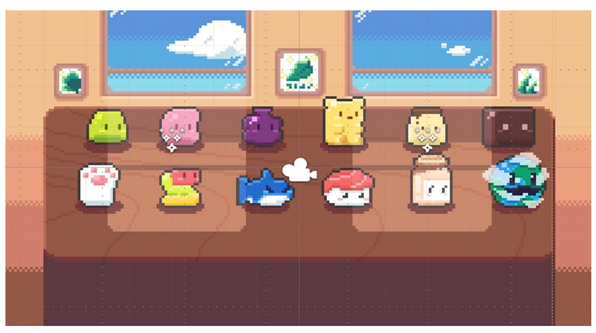
Fig.1: VMI scores of healthy and ADHD children, n=48.
ADHD: Attention deficit hyperactivity disorder, VMI: Visual-Motor Integration.



The paper states that one of the characteristics of ADHD patients is lower writing ability compared to the general public, and activities involving hand manipulation can help improve their writing ability and condition.[3] Based on this, it was determined that hardware pencils could be beneficial, so they were produced.

The hardware pencil is applied to the maze game, and when the user draws a line in the right direction according to the angle of the gyro sensor inside the pencil, the character moves to the right. Similarly, when the line is drawn in the upward direction, the character moves upward.

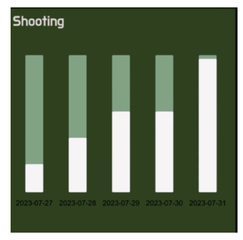
Compensation



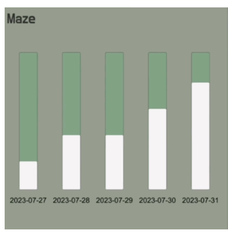
A total of two rewards are offered in this game. Firstly, the user can unlock multiple jelly characters through coins in the game world and this coin can be obtained by clicking on the jelly you have bought like in the picture on the right. Second, the user can collect jelly characters with the coin the user have owned. These coin is paid 100 cash every time the user successes on a game stage.

Data Visualization

The plot visualizes the data that be collected using the stage number, every time the user clears the stage. By visualizing the increasing difficulty level of the games performed, we can intuitively observe the improvement in concentration as reflected in the data. Furthermore, this data can provide visibility into the treatment effectiveness for both patients and caregivers and assist healthcare professionals in their diagnosis.



[Shooting]



[Maze]

Conclusion

We have developed functional games for elementary school students among patients with ADHD and to prevent addiction, we have limited the count to 10 games per day. We’ve made this game for therapeutic purposes to assist the main treatment, not to cure the disease completely. We hope that our functional games will reduce the resistance to treatment of ADHD patients and will be more active in responding to treatment.

Future Study

In the maze game, The automatic maze generation can be implemented with algorithms such as binary tree, side winder, and recursive backtracking. And It is to give the user some hints on going on the right path by applying the Dykstra algorithm.

In the shooting game, we think it would be good to apply reinforcement learning of machine learning in the shooting game. From the enemy's point of view, reinforcement learning is conducted while analyzing the patterns of ADHD patients. This will set the level of difficulty for each ADHD patient, and it is expected that the level of difficulty will automatically increase gradually.

In the data visualization section, we aim to capture and display the characteristics of ADHD patients during the game. We collect specific behaviors as data to observe if they gradually decrease through our game. For instance, this involves counting the number of attacks in a shooting game or measuring the maze traversal in a maze game.

[1] Jo Seungju & Yoon Hyungsop. (2011). A Study on the Improvement of Concentration through Serious Games. Journal of Korea Game Society, 11(4), 27-35.
[2] Kim Sunja. (2007). The Effects of Maze Learning Program on Children's Concentration. Master's thesis, Dong-A University, Korea.
[3] Farhangnia, S., Hassanzadeh, R., & Ghorbani, S. (2020). Handwriting Performance of Children with Attention Deficit Hyperactivity Disorder: The Role of Visual-Motor Integration. International Journal of Pediatrics, 8(11), 12317-12326.