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Project-Report

"Designing Virtual reality- based experiments to understand human behaviour on decision paradigms."

Submitted by

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CERTIFICATE

This is to certify that the project entitled **"Designing Virtual reality- based experiments to understand human behaviour on decision paradigms"** submitted by **Anmol Gupta** (S2230752) as a part of Summer Undergraduate Research and Graduate Excellence 2022 offered by the Indian Institute of Technology, Kanpur, is a bonafide record of the work done by him under my guidance and supervision at the Indian Institute of Technology, Kanpur from 14th June, 2021 to 31st July, 2021.

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I am extremely grateful to sir for encouraging me at every moment. He also motivated me to work on Unity and LSL, which is unexplored horizon. I am thankful to him for guiding and mentoring my project. His motivation gave me a chance to explore my caliber.

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ANMOL GUPTA

Abstract:

One of the fundamental behaviours that entails any action is decision-making. Decisions can vary from simplistic choice between two options or as complex as planning a move on chessboard. There are multitudes of paradigms in use to study how humans make decisions and how brain devices an optimal strategy to make these decisions. There's a lot of emphasis on making decision task to be ethological or as naturalistic as possible. However, it becomes difficult to control the variables in a natural setting. Therefore, computer-based virtual reality paradigms have proven to be a handy tool to design immersive naturalistic task in a controlled environment.

In the current study, I am designing a virtual-reality based foraging game, which is based on approach-avoidance conflict, a task that can be implemented across species. Approach-avoidance conflict is generated when one option has both reward and punishment associated with it, thus putting participants in a dilemma to approach or avoid that option. It has been noted that humans can optimally decide when to approach or avoid an option but in case of mental health conditions like anxiety, depression, etc. these decisions can become suboptimal. Therefore, the goal is to get a behavioural marker to identify individuals with high trait anxiety.

The game is being developed in Unity3D which has a naturalistic environment, the player can explore the environment and collect rewards while moving on fixed path. The probability of reward decreases in different settings and there's probabilistic punishment associated. The decision to explore or avoid will prove to be useful in understanding behavioural aspect of decision-making process.

Keywords: Virtual reality, Decision Paradigm, Anxiety, Natural setting

Contents

1.Introdunction

Recent technological advancements have taken behavioural neuroscience to a higher level by introduction of applications like Psychopy which enables experimenters to develop paradigms with whole range of interactive stimuli in the form of a game. Several studies in humans employ these tasks to understand various cognitive processes in the brain. With the evolvement of virtual- reality based paradigms which provides users a complete immersive experience on one hand and providing necessary control to the experimenters on the other has removed biases from the study thus enabling better understanding of brain processes.

Unity 3D software has proved a milestone in developing these 3D virtual environment paradigms. The best thing about working with unity is one can easily implement things like player animation, movement, sound effects as it corresponds to different part of the game, establishing the natural environment, designing interesting UI, building various texture among other things.

In the current game deign, the basic environment is of 30*30 grid of trees to give it a naturalistic and real environment appearance to the user as they play the game. User starts with a menu page followed by Instructions page in which all the necessary instruction are written and a play button. After clicking on the play button game starts with the trial level, the main motive to build a trial level is that the user become environment friendly and can play upcoming level easily. Further user will play the upcoming four different level with different natural settings like morning view, evening view with light rain, night view with foggy environment, also at the end of each level total number of rewards collected will be shown and then next level will automatically start.

The game also contains natural sound effect for each, and all details like for reward collection coins sound effect is used, for punishment lighting sound effect is used, for morning view camp sound effect if used, for evening view rainy sound effect is used, and for night view horror sound effect is used etc.

The game data is collected by integrating LSL with Unity that runs in the background while the user plays the game. Behavioural data like transformation, position, time taken etc. by the player are recorded in a single XDF file. This data will be further analyzed for various decision variables to understand their approach- avoidance behaviour[1][2]

2.Background and literature review

Avoidance of potential dangers at the cost of approach opportunities is a hallmark of anxious behaviors across all mammalian species. Excessive and maladaptive avoidance contributes to the development and maintenance of anxiety disorders and prevents the extinction of fearful responding in humans. We are going to use Unity to develop the game. Finding the time to human to explore the open world in jungle. And the anxiety he feels during the time of exploration the jungle.

Approach–avoidance conflicts occur when there is a single target or event that has both positive and negative effects or characteristics that make the target both attractive and unattractive. For example, in this game user must make the decision for punishment. The influence of negative and positive aspects creates a conflict because the decision maker must either move towards the goal or avoid it altogether.

Approach-avoidance conflict is a basic psychological concept and is used to characterize anxiety-like behavior and pessimistic decision-making. An optimistic view leads to more approach decisions; a pessimistic view leads to greater avoidance of decisions. Decisions in the approach-avoidance conflict have primarily contributed to characterizing the effect of different types of antianxiety drugs.

Existing approach-avoidance studies in:

a. Rodents (Mouse/Rats): Classical models of anxiety-like behavior in rodents focus on morally relevant assays to assess approach versus avoidance, early warning, or defensive behavior. The approach-avoidance paradigm uses scenarios in which environmental stimuli can be considered a threat. Waiting time to approach or time spent on novel objects (potential threats) is measured and used as an estimate of anxiety. Rodents usually prefer dark and closed spaces, which reduces the risk of predation [5]

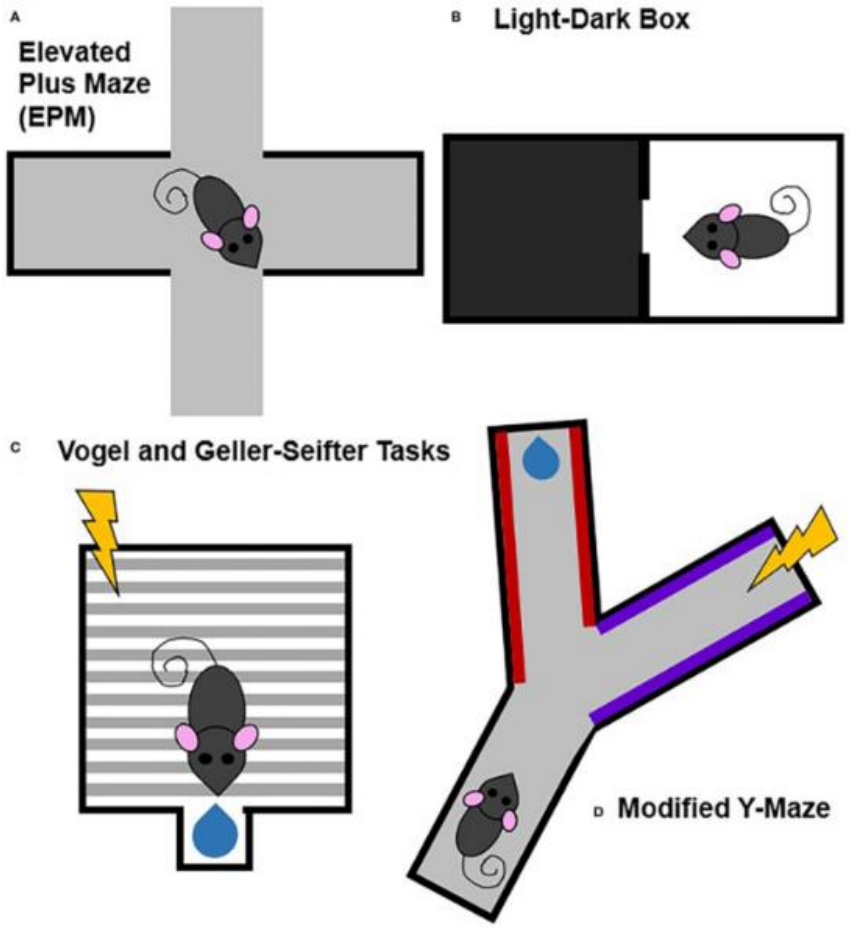


Figure1: Depicting approach-avoidance conflict in rodent studies

b. Other animals: The evidence that behavioral stress in animals can cause a persistent increase in blood pressure is controversial. While episodes of acute hypertension can be initiated, the development of more persistent hypertension

is elusive. Aversive conditions such as restraint stress, unpredictable shock, and conflict between approach and avoidance cause chronic hypertension in some studies but not in others. These effects vary from species to species and are

more pronounced in the presence of risk factors such as genetic predisposition and increased salt sensitivity.

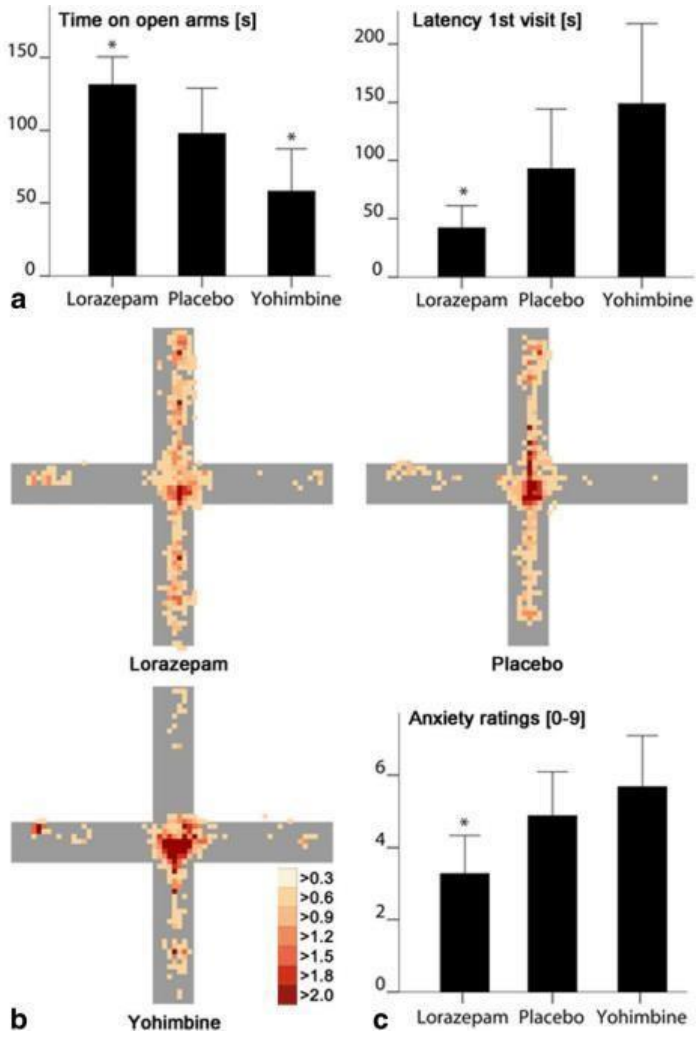


Figure2: Depicting aproch-avoidance conflict using mixed reality paradigm in human [2]

c. Humans: Approach and avoidance tendencies have been investigated in various basic and applied areas of psychology, including emotional research, attitude research, neuropsychology and behavioral therapy. A large number of studies have shown that people automatically evaluate the salience of environmental stimuli and that they are voluntary. Appraisal is associated with facilitation or suppression of approach and avoidance behavior.

The use of virtual reality (VR) promises great potential for studying human behavior. Approach and avoidance tendencies have been studied in various areas of basic and applied psychology, such as attitude and affective research, basic learning psychology, and behavioral therapy, but what is studied in VR is rare. One of the main focuses of this study is to understand the psychological mechanisms underlying automatic behavioral tendencies towards or away from positively or negatively evaluated stimuli. We have implemented a whole-body motor stimulus response adaptation task to investigate

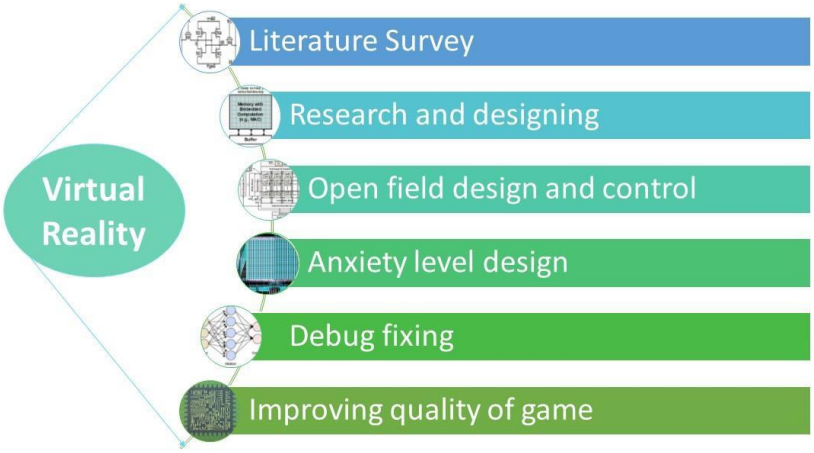
approach-avoidance behavior in an immersive virtual environment.

3.Research problem and methodology

3.1 Research problem

The main research problem that will be explored is:" Designing Virtual reality- based experiments to understand human behavior on decision paradigms." Our main aim will be to perfectly apply the thing that our project wants and virtual human works smoothly and effectively.

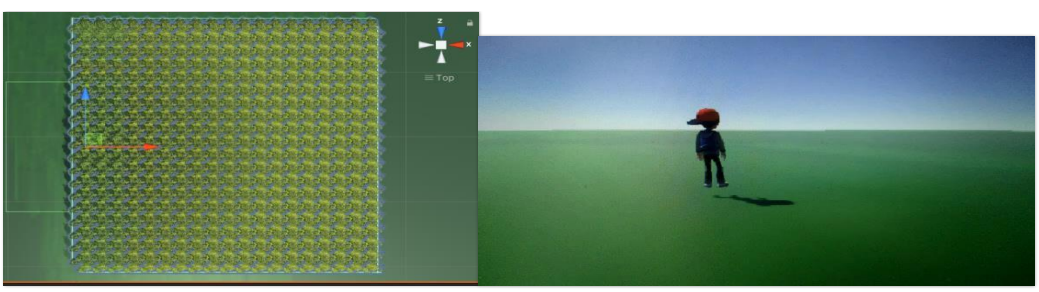
3.2 Methodology



3.2.1 WORK DONE IN UNITY

Game is basically a virtual 3D grid game, which is based on approach avoidance conflict where user had to take the decision for his/her path so that they can maximize the rewards within the stipulated time.

Step 1: Made the Player control using keyboard keys and build the 30*30 grid using trees to have the feel of naturalistic environment. In each level time bar was displayed at the left top corner and total coins at the center top of the screen.



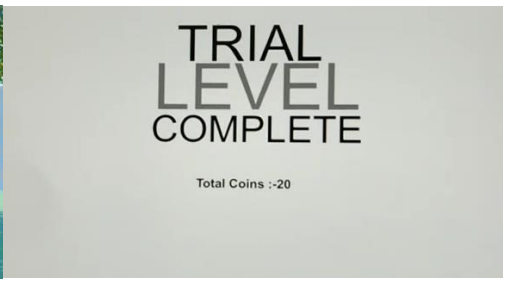
Step 2: Now the rewards and punishments were placed in pre-decided manner as there would be fixed percentage of the rewards as well as punishment on the path. Neutral bushes were placed with zero reward.

Note: Reward, punishment and neutral bushes look like the figure in the left.

Step3: There are total of 4 levels in the game

-**LEVEL 0:** This is the trial level so that the user can become familiar with the environment.

Design**:** Level 0 will be morning view as same as level 1. Time for trial will be of 1 minute and rewards and punishments (which looks as same as rewards) are placed in decided manner as there will be 66.67% of the total rewards will be in the horizontal direction with 30% rewards of punishment and 20%rewards of normal bushes will be distributed in random way and rest of 33.34% of the total rewards will be in vertical direction with 0 punishment and normal bushes will be double the normal bushes in horizontal. Reward as well as punishment will also be shown on individual bushes for 1second.



-**LEVEL 1**: This will be the morning view

Design: Level 1 will be same as level 0 the only difference will be if time i.e., of 3 minutes.

-**LEVEL 2**: This will be the cloudy evening view contains rain

Design: Level 2 will have different distribution and different value of rewards, punishments, and neutral bushes as comparison with level 1.

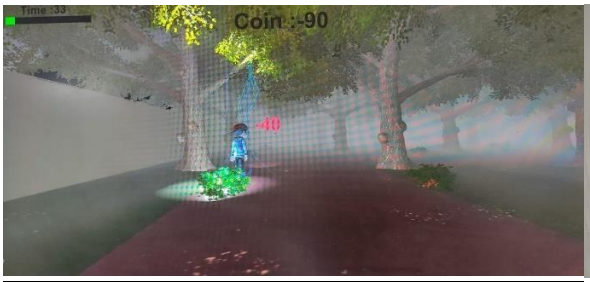
¼ rewards is increase in vertical direction

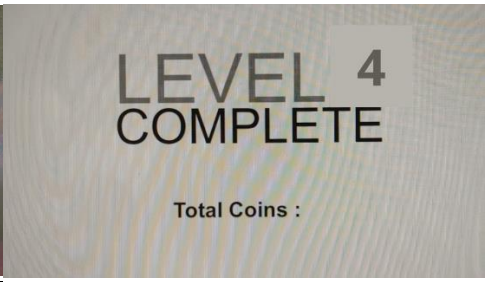
-**LEVEL 3**: This will be the fogy night view

Design: Level 3 will also have different distribution of rewards, punishment and normal bushes. We exchange ¼ rewards from horizontal direction to punishments.

-LEVEL 4: This will be same as level 3

Design: Level 4 will same as level 3 but there will be difference in reward and punishment value.





Step 4: Set the player in the environment with the display of the coin in the top center of the screen and as the player collect the rewards and punishment the coin will automatically updated in the screen. Time will continuously be shown on top left corner in form of time bar.

-As the rewards is collected

- Trial Level/Level 1 -> Total reward will increase by 10

- Level 2 -> Total reward will increase by 20

-Level 3 -> Total reward will increase by 20 in vertical direction and increase by 30 in horizontal direction

-Level 4 ->Reward in vertical direction is increase in multiplication of 2 and similarly by 5 in horizontal direction. Also, Punishment is present only in horizontal direction that starts with -10 however progresses with subsequent -5 increase

- sound of coin is played for 1 second with a colored ball animation.

-As the punishment is collected

- Level 0 /Level 1 -> Total reward will decrease by 20 and player will feel a small shock in reality

- Level 2 /Level 3 -> Total reward will decrease by 40

- a thunder sound with lighting effect for 1 second is played

Step 5: Key Points:

- Player can move only on the roads and unable to move on the greenery part of the jungle.
- Player must make his/her decision to move and accordingly the path, anxiety level, transformation (include position, scale, rotation), time etc. be store from the unity via LSL.

Step 6: Aim for the game

-maximize the coins
-explore the game

Step 7: Game also contains the menu page

Menu page welcomes you to the game with set of instructions for the game and

Contains plays button which will directly redirect you to the Trial level that is level 0.

Step 8: Quit page

Quit page Will thank you for playing the game and contain the menu button and quit button.

Step 9: Integration Unity with LSL

So, first we should know about LSL: LSL stands for Listening and Oral Language. Provides a set of strategies and principles for teaching deaf infants and toddlers spoken language through listening.

Unity Machine Learning Agents (ML-Agents) allow developers to create more engaging gameplay and more advanced gaming experiences. Using this platform, developers can teach intelligent agents through a combination of deep reinforcement learning and imitation learning.

The Unity environment also provides implementations of advanced TensorFlow-based algorithms that make it easy for game developers to train intelligent agents for 2D, 3D, and VR/AR games.

LSL easily collect data from Unity through Visual Studio for training, import some LSL files into Unity and link to various objects in Unity to collect everything that needs to be collected. he does. Used to integrate with Unity for easy information display.

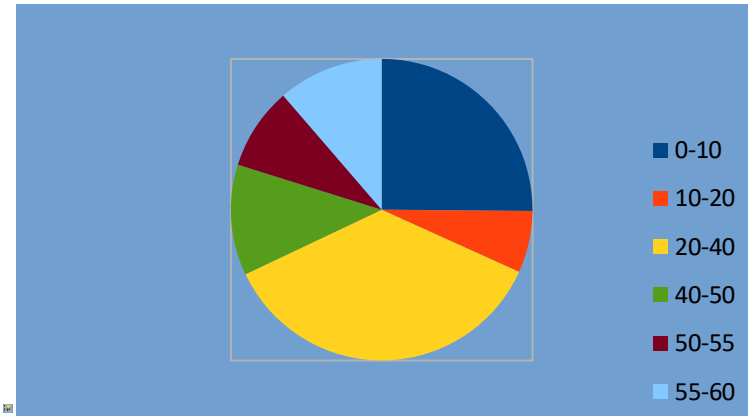
Step 10: Integration Unity with VR: HTC vive pro eye

Step 11: Future development:

11.1 Replacing punishment with shocks by using bipolar constant current stimulator

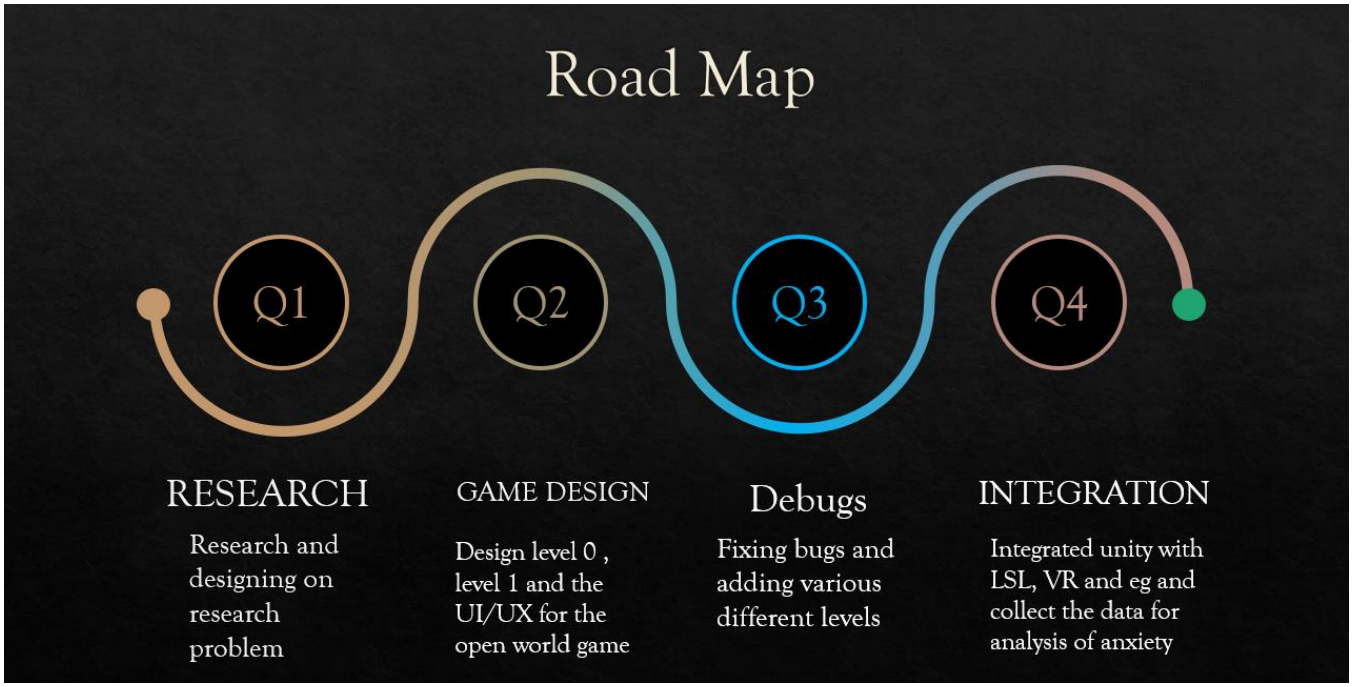
12.2 Using in conjunction with EEG device to monitor brain activity during task.

4. Time Chart



Duration (in days)	Objectives
0-10	Literature review
10-20	Research and designing
20-40	Open field design and control UI/UX,
40-50	Anxiety level design and implementation
50-55	Debug fixing and adding the different levels
55-60	Improving quality and finishing the report and video

5. Road Map



6. Conclusion

Increasing the precision and accuracy for virtual human is necessary for successful mission. However, evidence for correlations between open field behavior and anxious traits was rather weak and not unequivocal. Thus, the re-translation of the animal OFT to a human virtual OFT was successful by revealing thigmotaxis in human.

We conclude that VR has the potential to transform the assessment, understanding and treatment of mental health problems. The treatment possibilities will only be realized if - with the user experience at the heart of design - the best immersive VR technology is combined with targeted translational interventions.

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