

BIOFEEDBACK GAMES

PSYCHOLOGICAL MECHANISMS OF CHANGE

Joanneke Weerdmeester, PhD

Donders Session - Nov 16th 2023

NICE TO MEET YOU

Joanneke Weerdmeester

- Behavioural scientist
- Post-doc (HKU)
- Consultant
- Part of GEMH lab

Expertise and interests

- Games
- Biofeedback
- Emotion regulation
- Virtual Reality
- Playful interventions

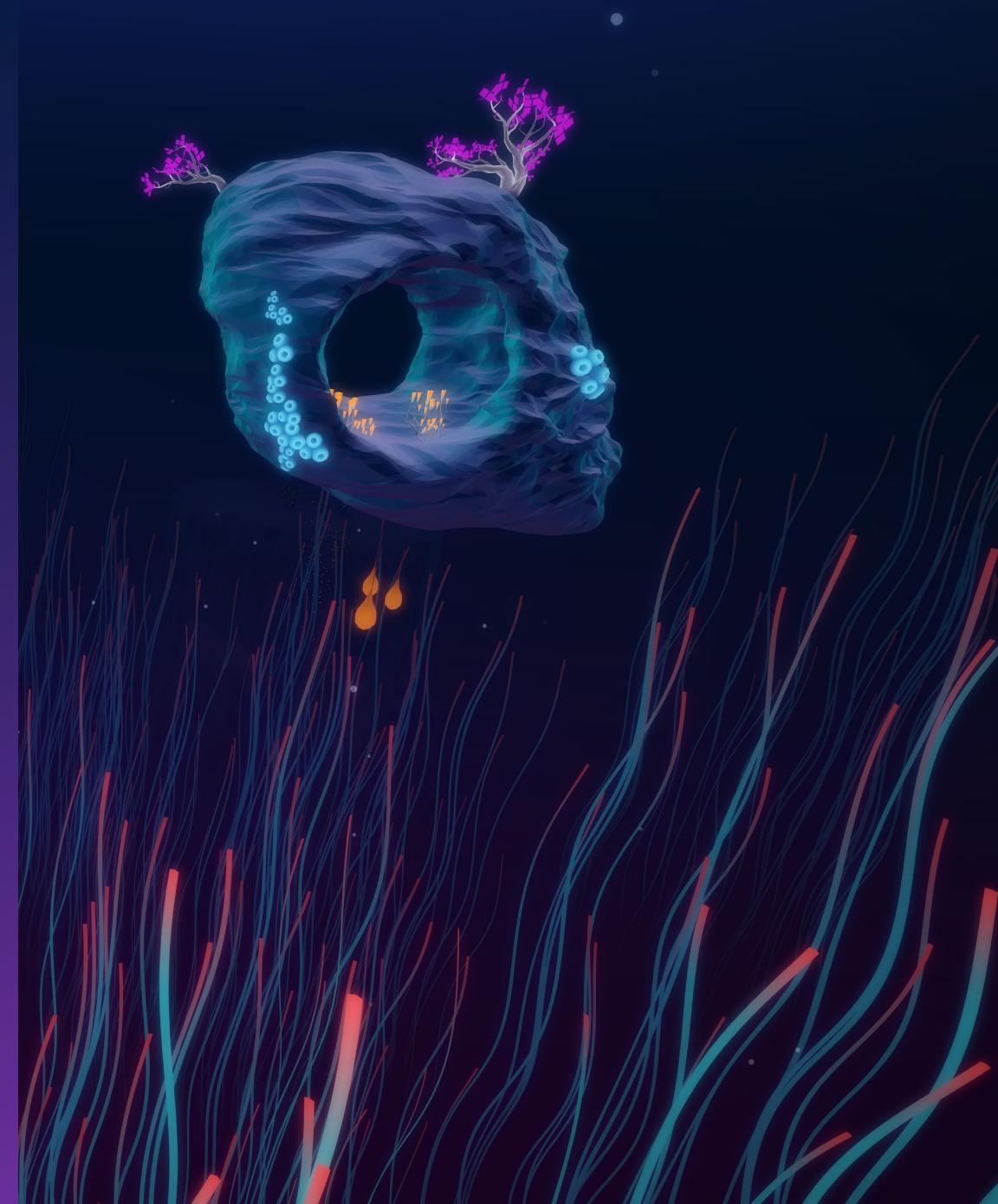


A VIRTUAL REALITY GAME CONTROLLED BY BREATHING



AREAS OF RESEARCH

- **Anxiety regulation**
- Anger and disruptive behaviour
- Functional (Neurological) Disorders
- Emotional resilience (in PTSD/Trauma)
- Long-covid and lung rehabilitation



Current Research Partners



Radboudumc



UNIVERSITY OF TWENTE.



Pilot Partners + Customers

Radboud University



Behavioural
Science
Institute



NHS

Central and
North West London
NHS Foundation Trust

NHS

Torbay and South Devon
NHS Foundation Trust





ANXIETY RESEARCH

Behavioural
Science
Institute



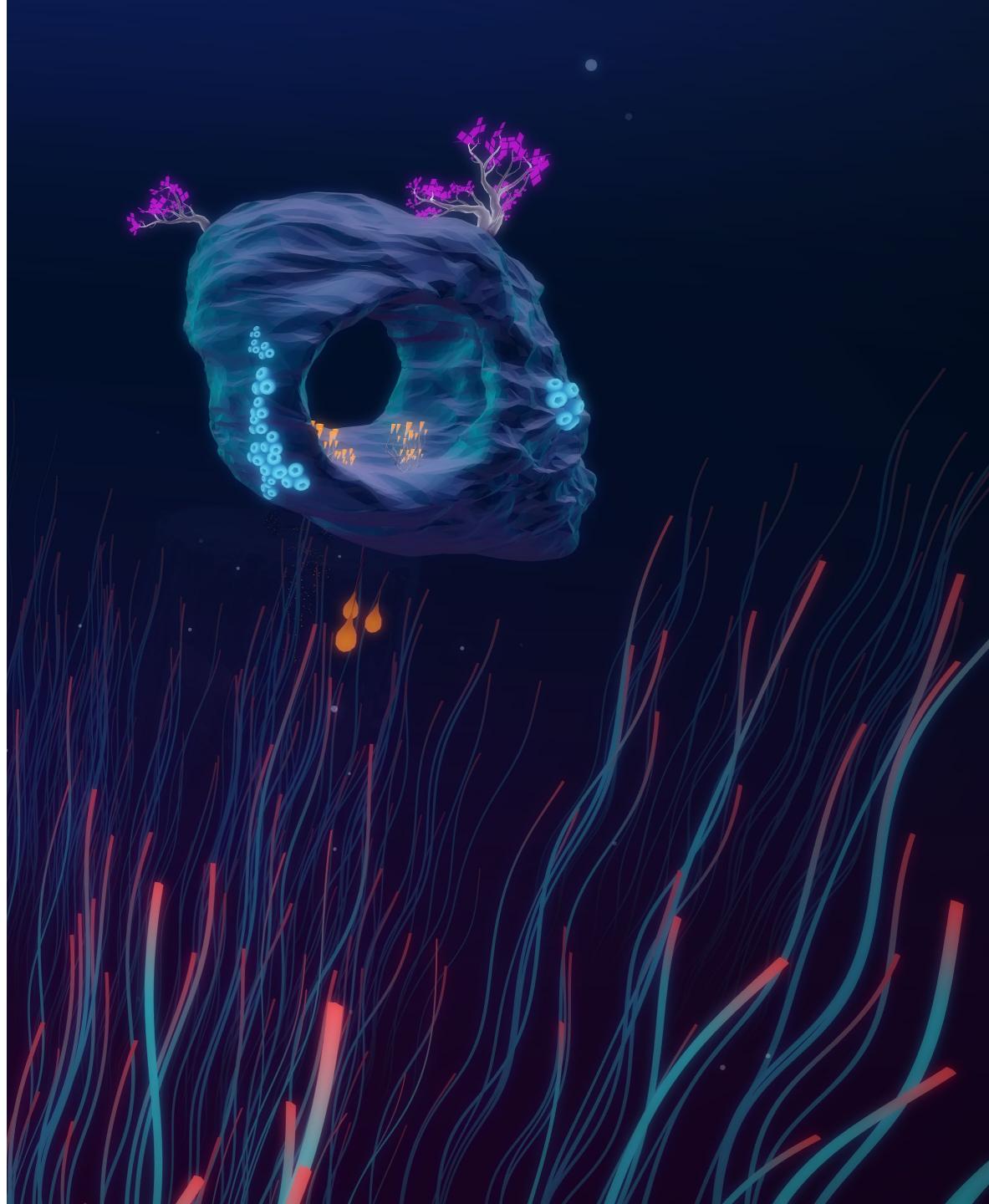
Radboud University



creative
industries
fund NL

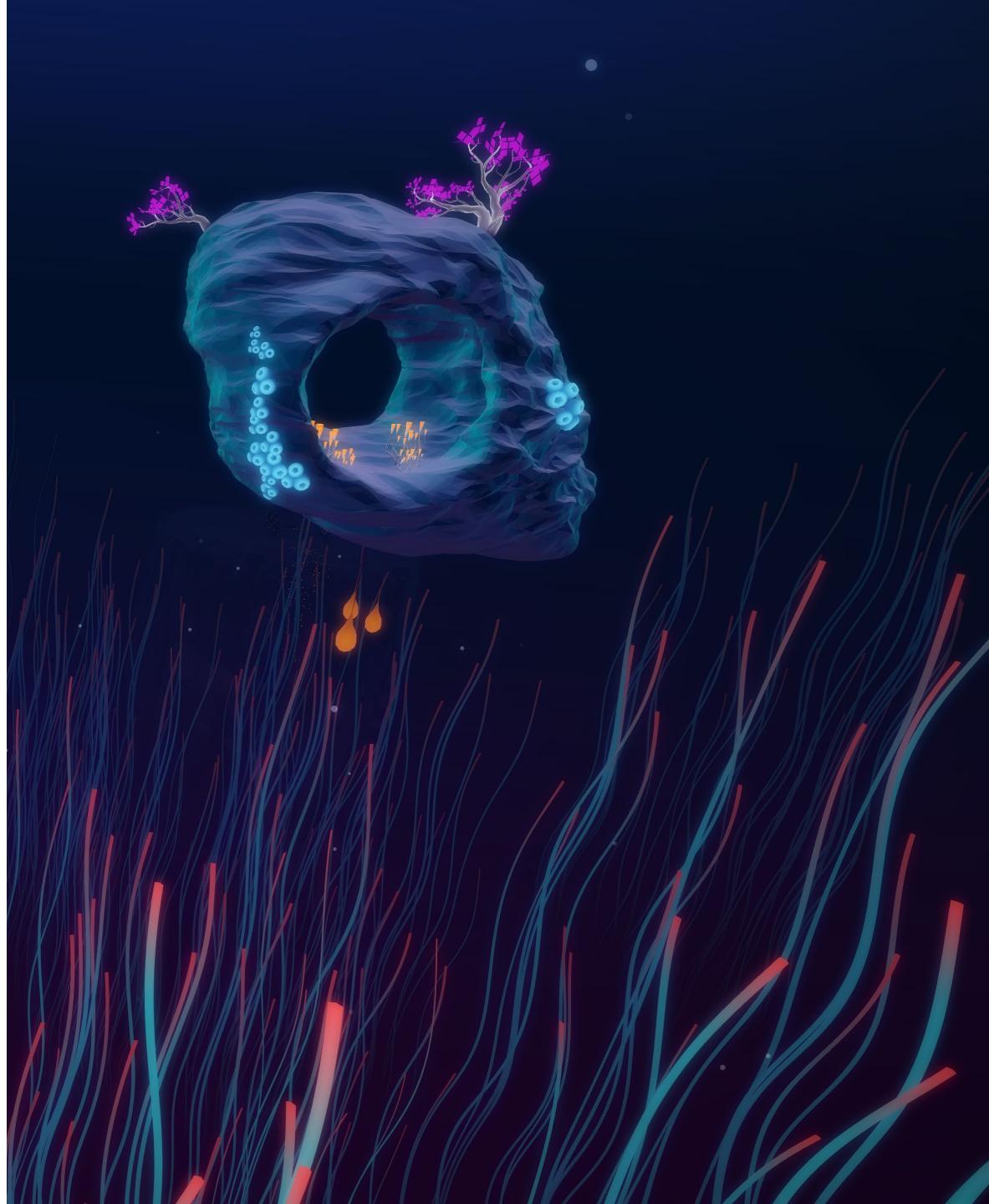


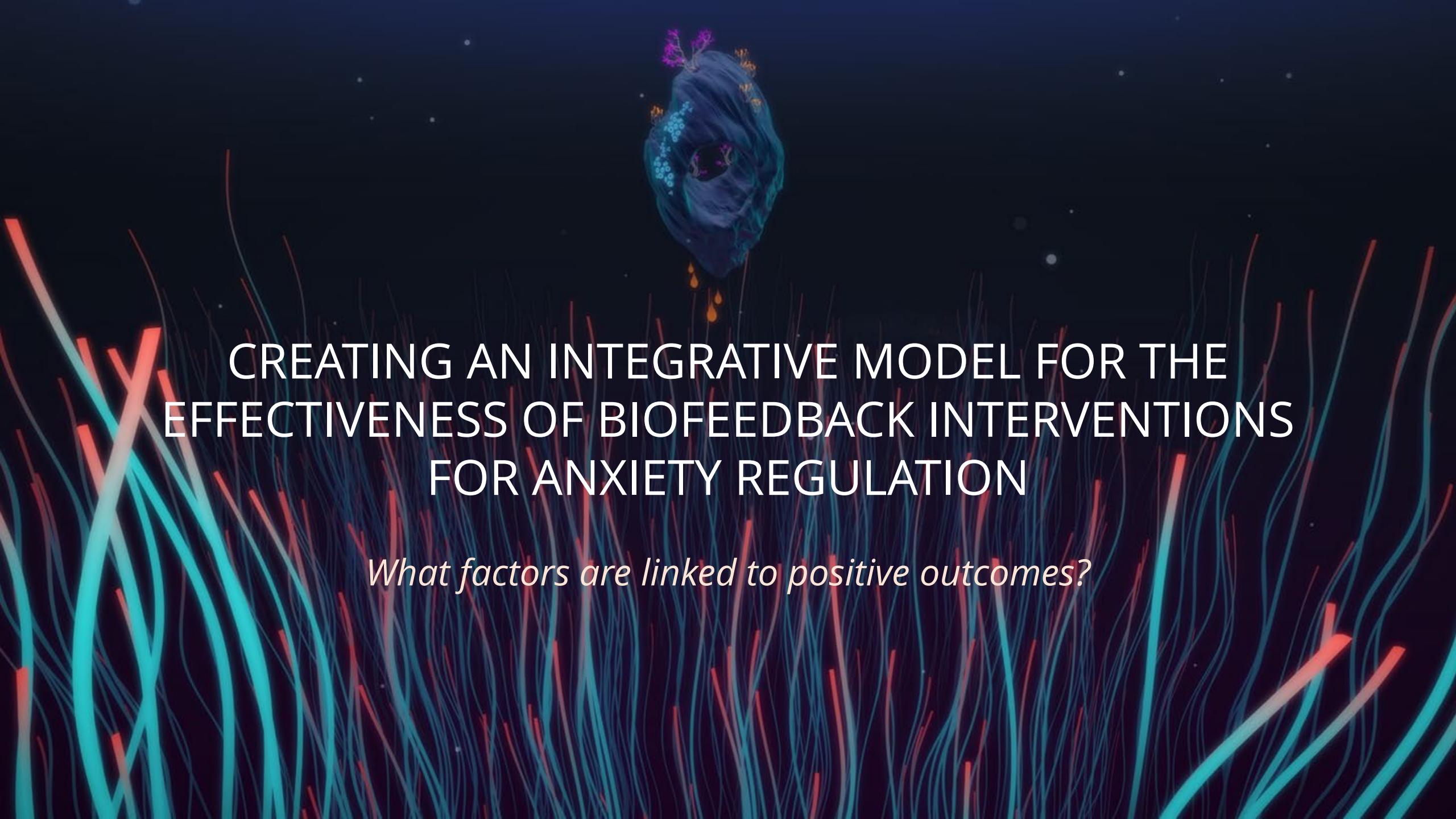
- Anxiety is the most common form of psychopathology among youth
 - Current treatments focus less on physical aspects of anxiety
 - Biofeedback has shown to be effective but it is not widely adopted
- Game-based biofeedback seems particularly promising



PHD AIMS

1. Create an integrative theoretical model for the effectiveness of biofeedback interventions for anxiety regulation
2. Develop and assess the efficacy of DEEP as an anxiety regulation tool
3. Formulate guidelines for future research and design of game-based biofeedback interventions

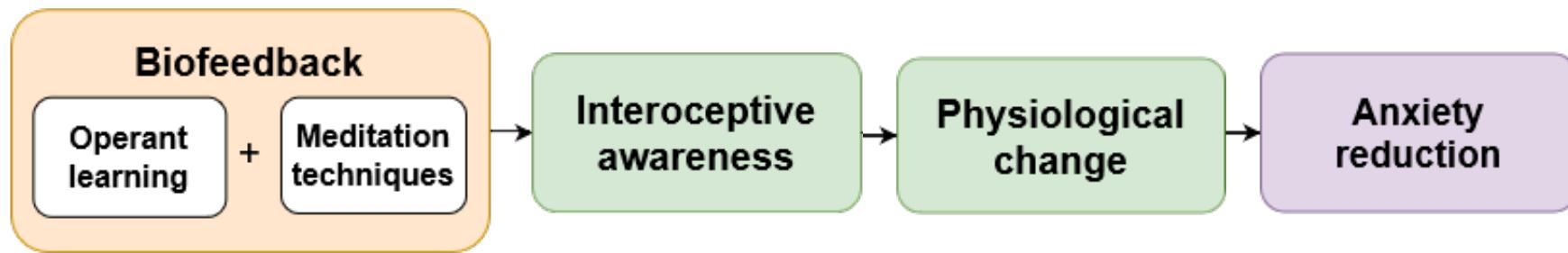




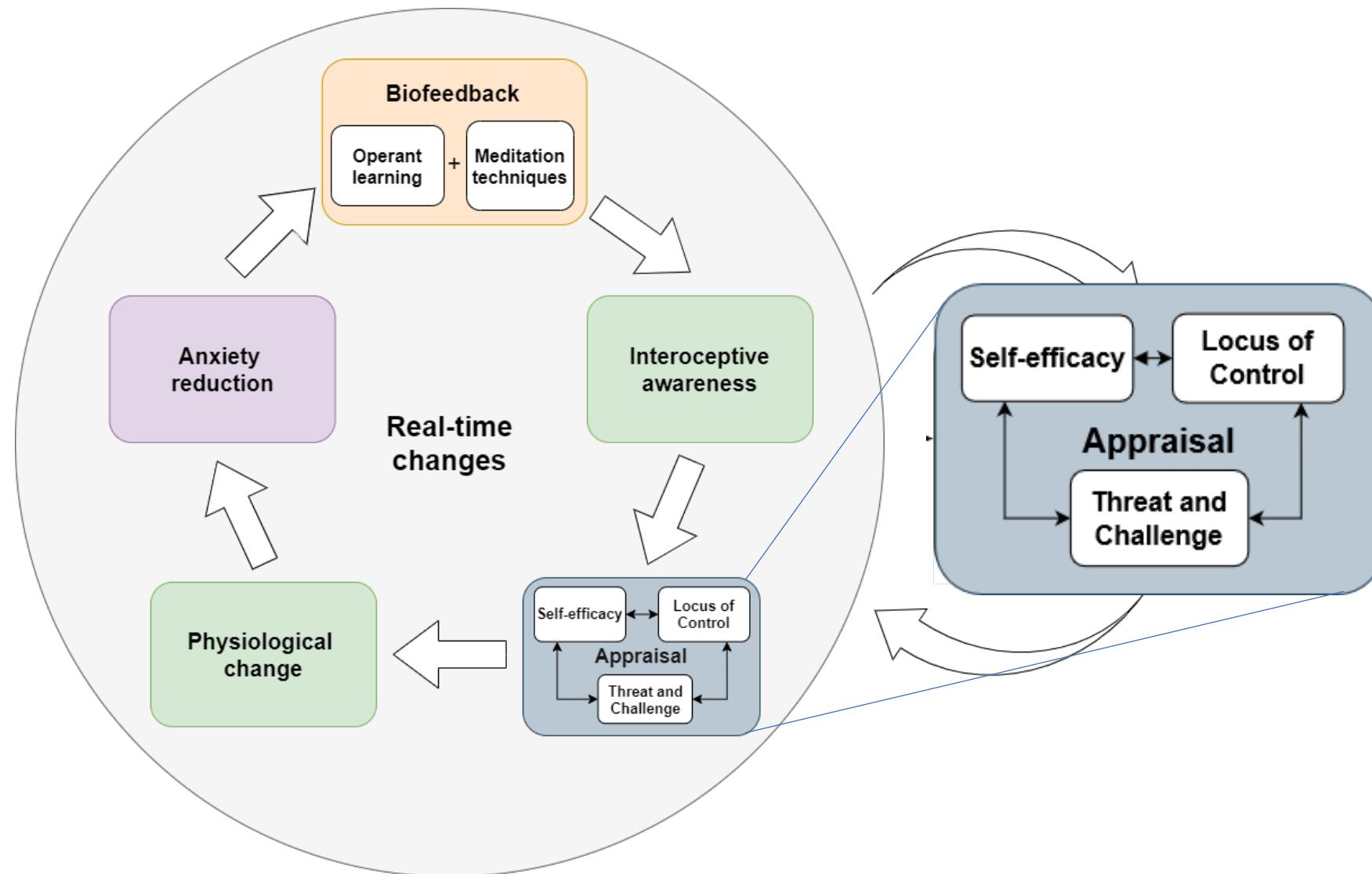
CREATING AN INTEGRATIVE MODEL FOR THE EFFECTIVENESS OF BIOFEEDBACK INTERVENTIONS FOR ANXIETY REGULATION

What factors are linked to positive outcomes?

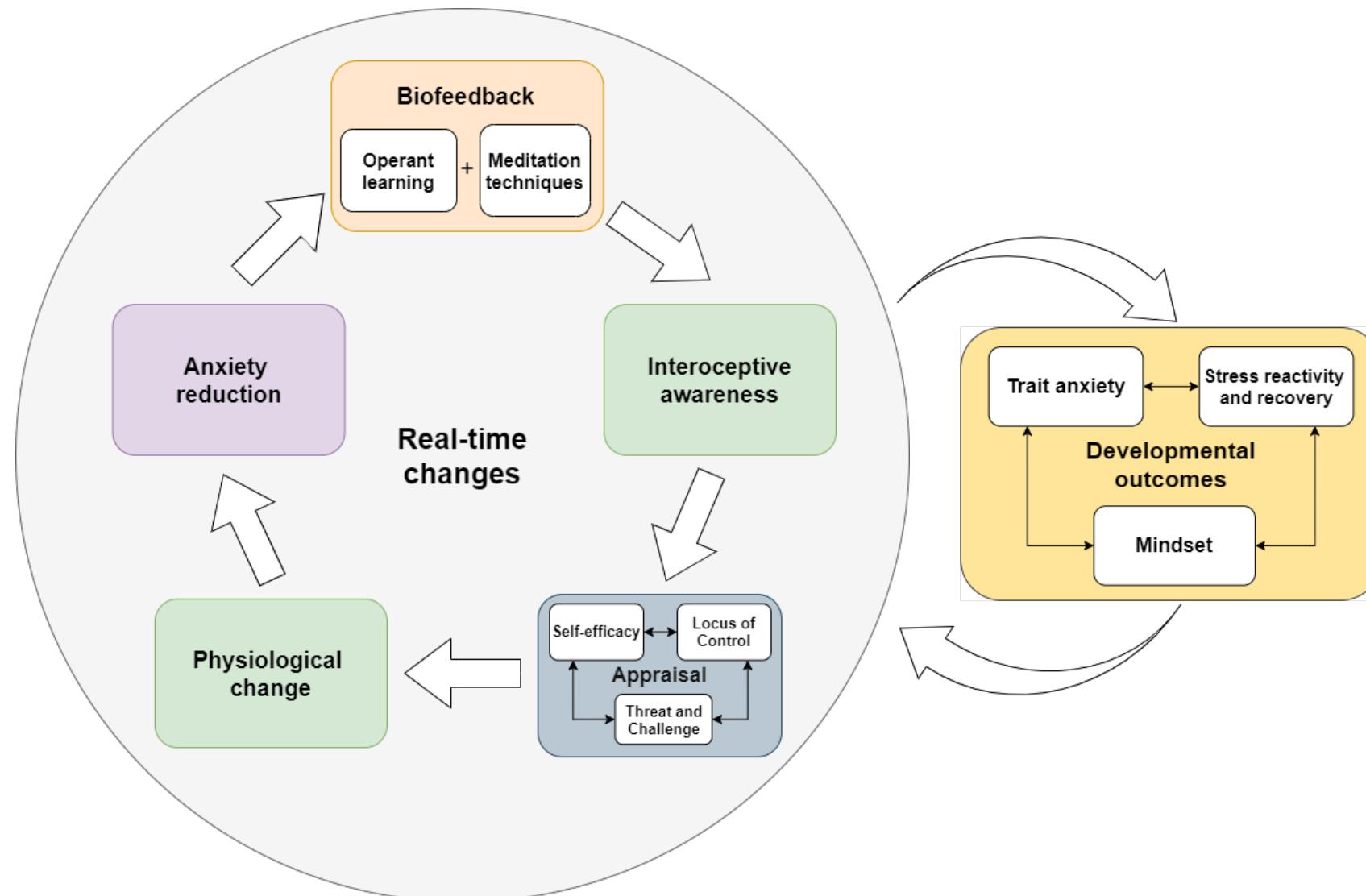
TRADITIONAL MODEL



INTEGRATIVE MODEL



INTEGRATIVE MODEL



Mechanisms of change

↑ Self-efficacy

↑ Internal Locus of Control

Threat → Challenge

Evidence-based techniques

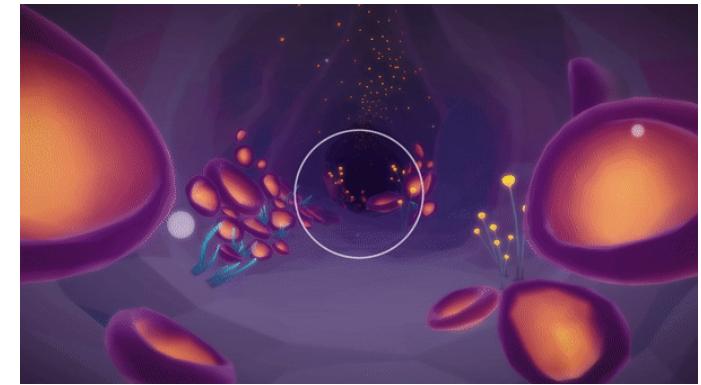
Feedback on mastery

Reinforcement

Visualisation

Exposure

DEEP mechanics





DEVELOPING AND TESTING DEEP

Can DEEP help youth regulate their anxiety?

What is the role of cognitive appraisals?

What is the role of specific techniques and mechanics?

RESEARCH OVERVIEW

Participants

- Children (8-12)
- Adolescents from special education (12-17)
- Emerging adults (17-25)
 - In RCT pre-selected on anxiety symptoms

Measures

- Changes in anxiety (state/trait)
- Psychological mechanisms
- App evaluation (e.g. engagement)
- Influence of specific techniques/mechanics

Study designs

- Pilot studies
- Dismantling study
- Randomized controlled trial
- Implementation in special education

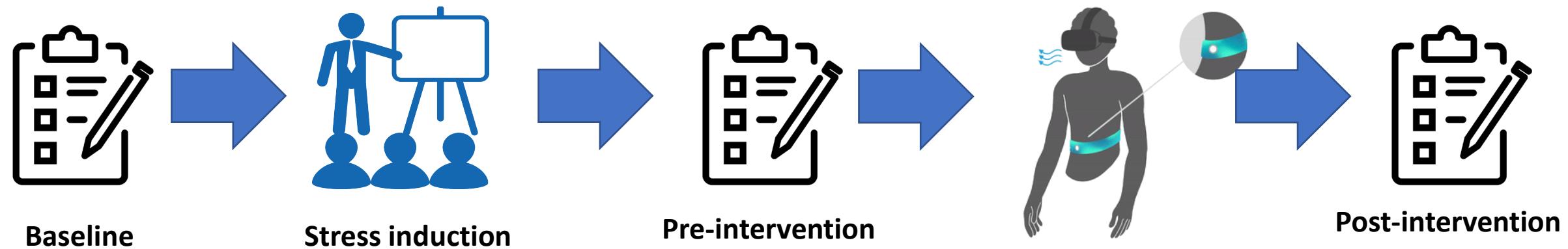
TAKE A DEEP BREATH

Exploring the Potential of Game-based
Biofeedback Interventions for Anxiety Regulation



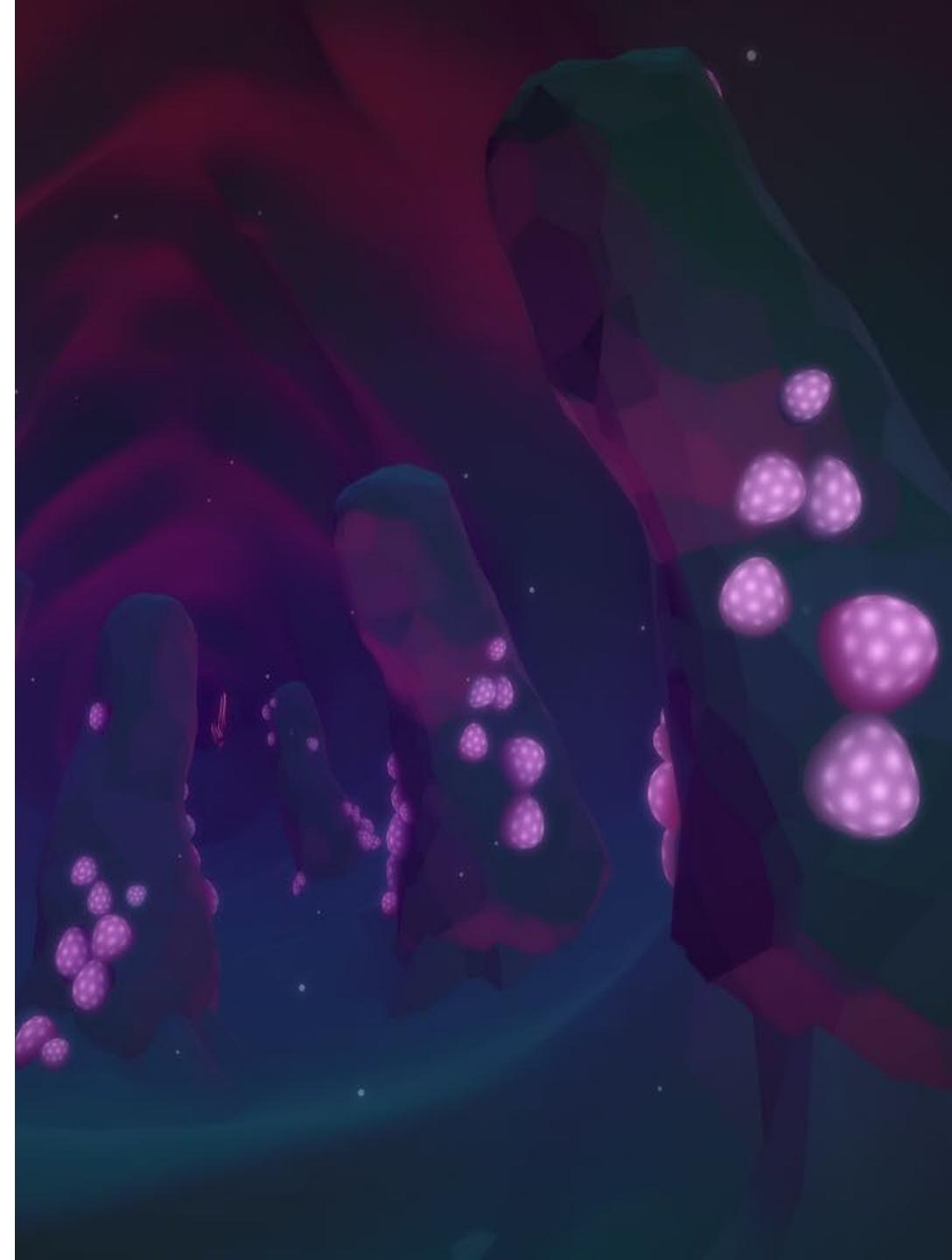
Joanneke Weerdmeester

Study 1: Pilot

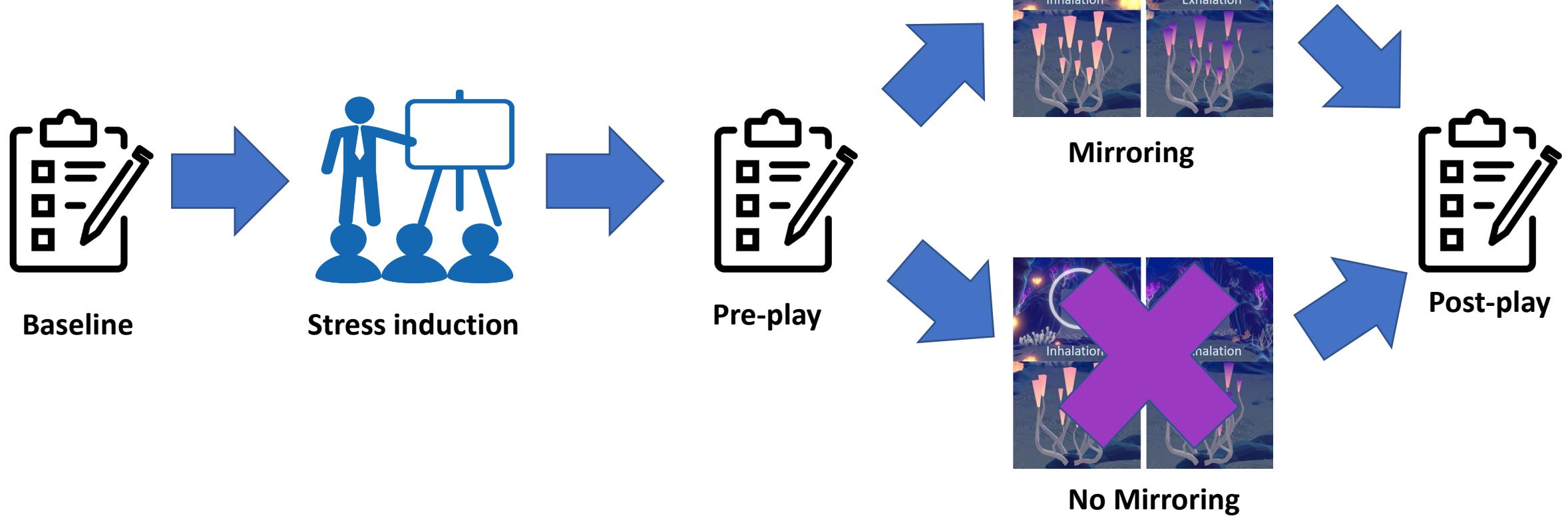


Study 1: Pilot results

- Increase in self-reported arousal in response to the stress induction
- Decrease in self-reported arousal from before to after playing DEEP
- Players who reported higher self-efficacy experienced less arousal

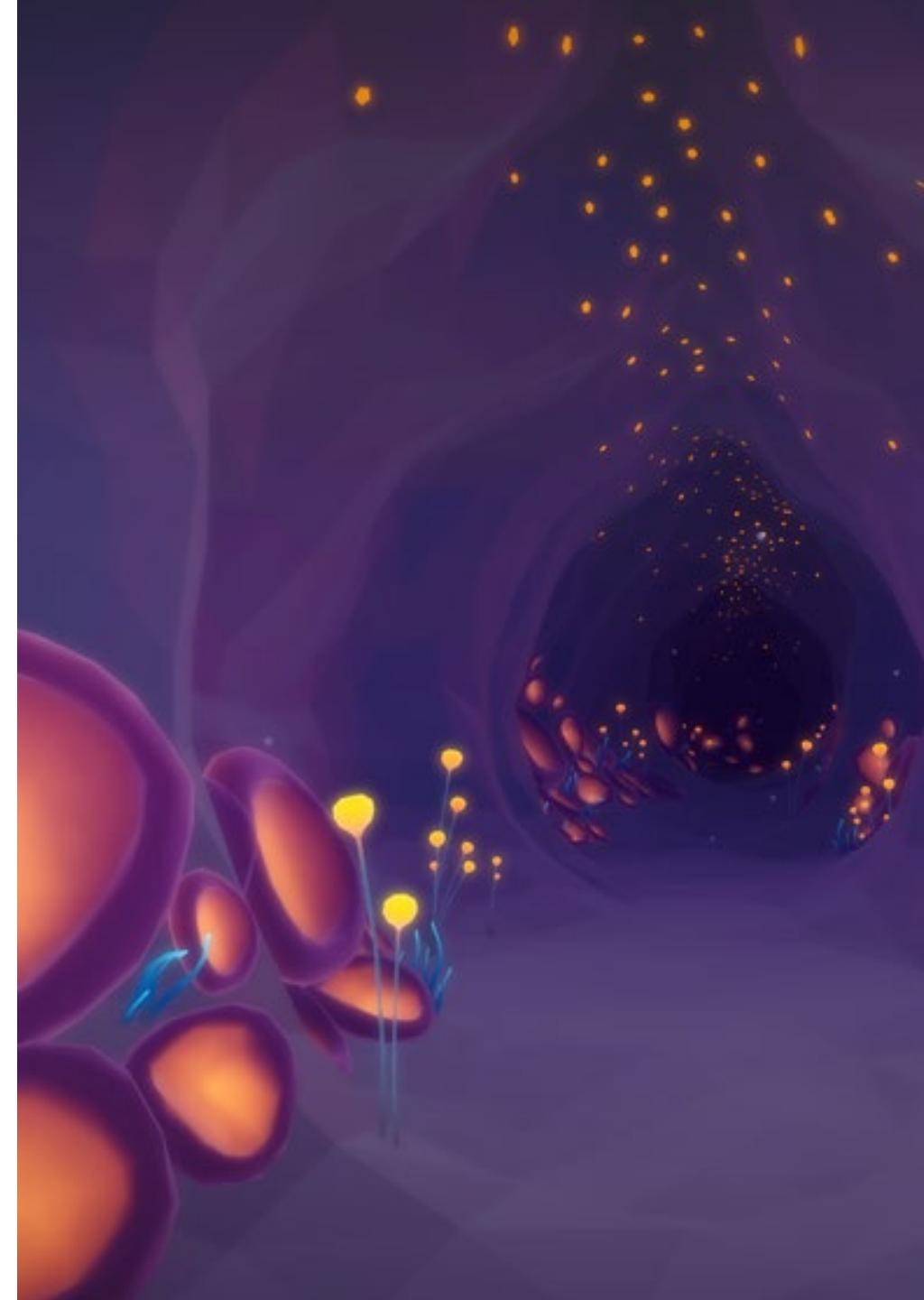


Study 2: Dismanteling

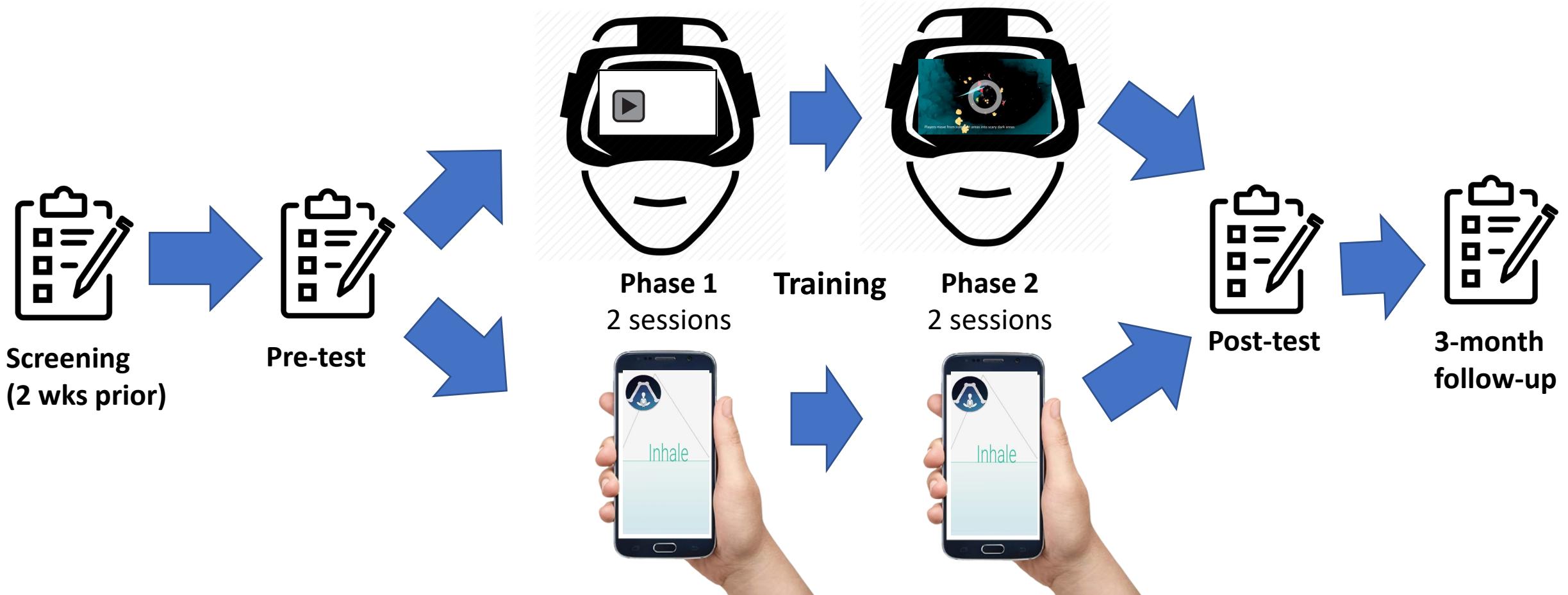


Study 2: Results

- Decrease in arousal and anxiety from before to after playing DEEP
- Participants with higher self-efficacy and a stronger internal locus of control felt less anxious
- No clear benefit of mirroring visualisations above and beyond the reinforcement linked to in-game movement



Study 3: RCT



Weerdmeester et al., 2021. TMB. doi: 10.1037/tmb0000028

Study 3: RCT Results

- Significant decrease in trait anxiety symptoms from before to after the training
- Symptoms remained stable until the 3 month FU
- Similar change in anxiety in the control condition
- However, only DEEP players increased in self-efficacy and coping resources
- Challenge appraisals and higher self-efficacy = stronger anxiety decreases



Study 4: SCED STUDY

Week 1: Baseline Phase

No intervention

3 x a day



Anxiety and Disruptive Classroom Behaviour



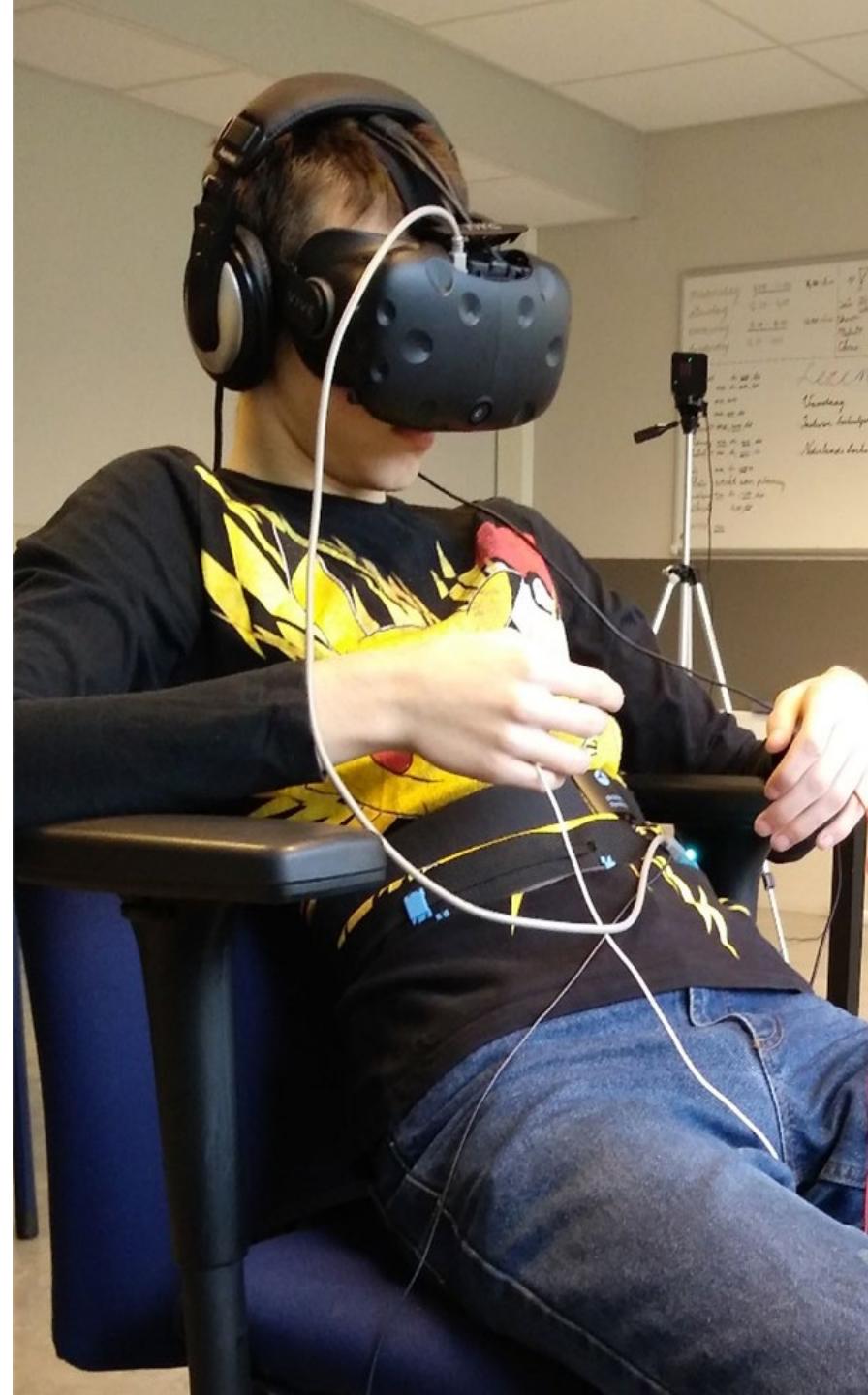
**Week 2-4:
ABAB Phase**

Withdrawal (A) / DEEP (B)

3 x a day



Anxiety and Disruptive Classroom Behaviour



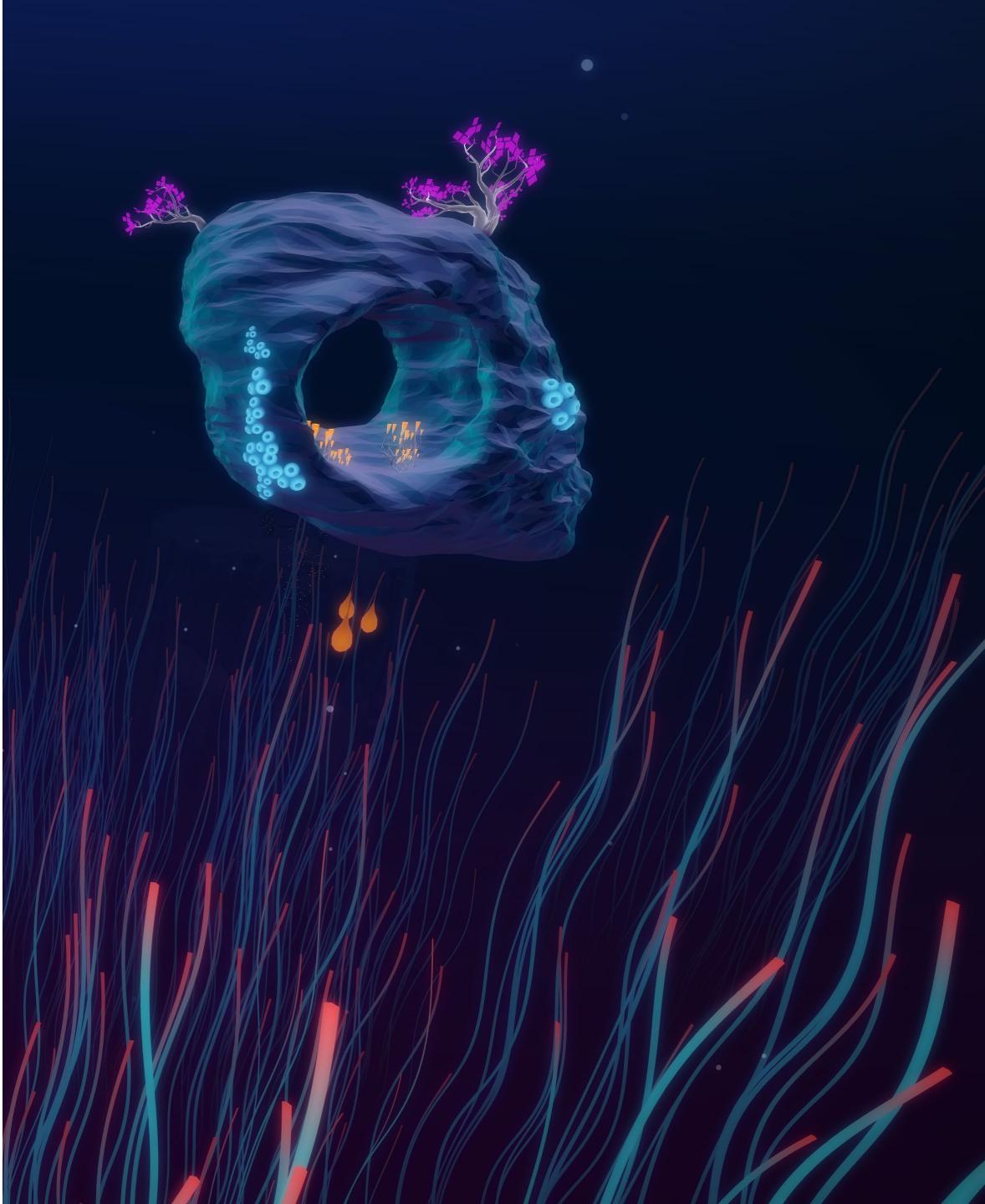
Study 4: SCED Results

- Adolescents experienced less anxiety on days when DEEP was played
- Anxiety-relieving effect of DEEP sessions lasted 2 hrs after playing
- Some youth also showed less disruptive classroom behaviour



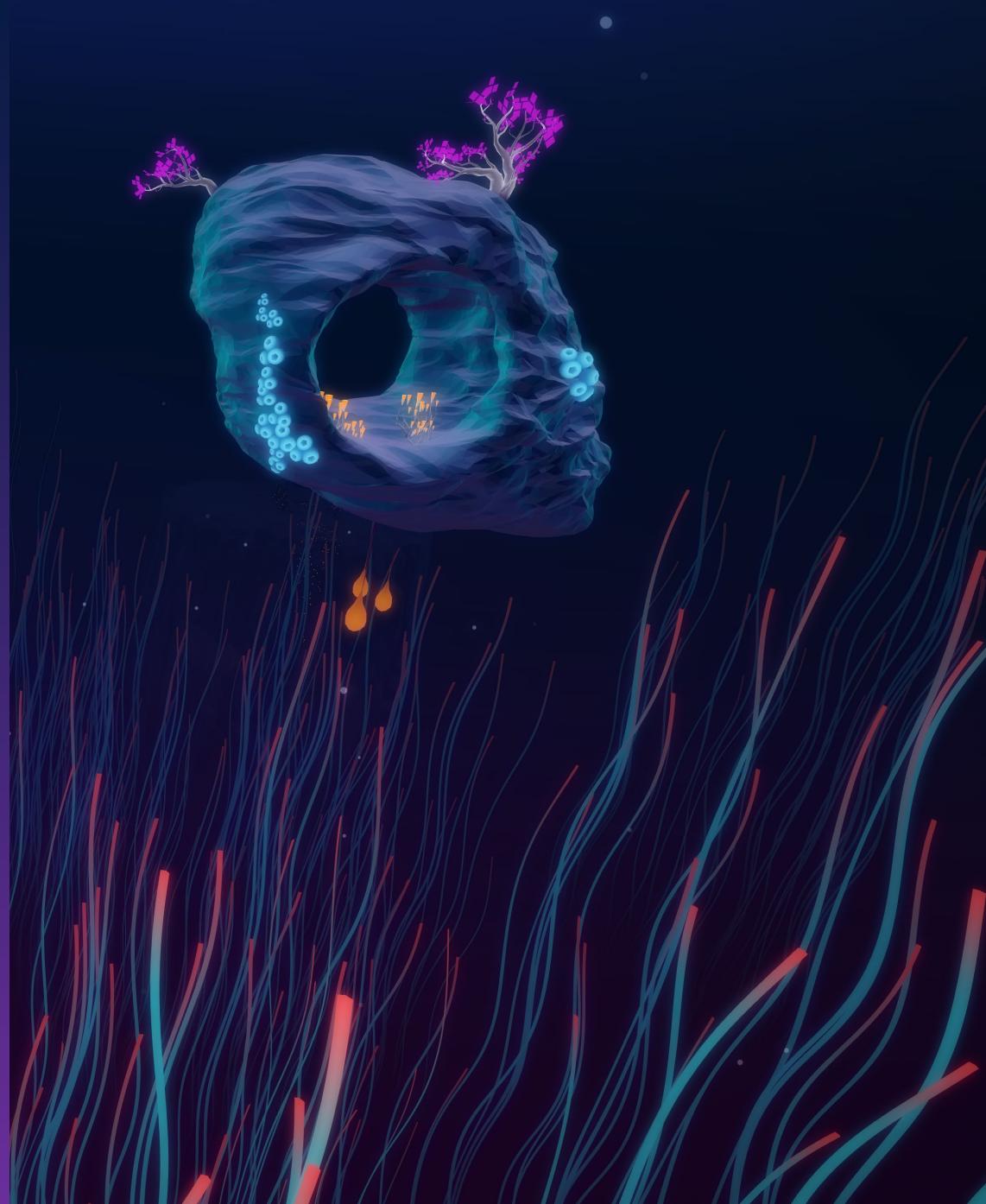
CONCLUSIONS

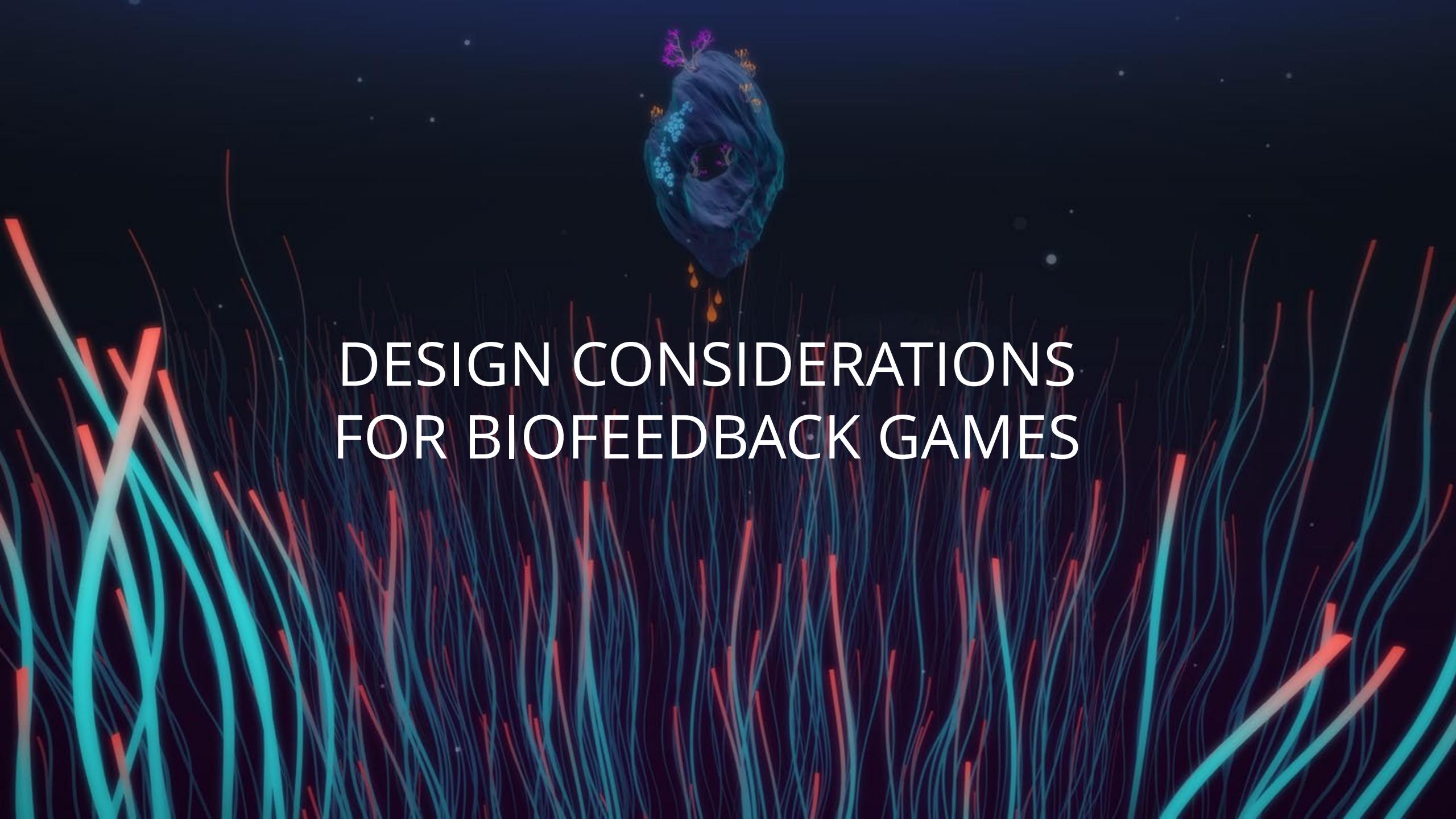
- Game-based biofeedback interventions like DEEP can help youth regulate momentary bouts of anxiety and diminish anxiety symptoms with extended practice
- Cognitive appraisals may serve as vital mechanisms of change in biofeedback interventions
- Important to examine which specific design choices lead to better outcomes



NEXT STEPS

- Continue research
 - Dutch Youth Forensic Care with UT and Transfore
 - Long-covid ex-patient pilot with Radboud UMC
 - Feasibility trial FD patients in Wroclaw
 - FND patient pilot with St. Mauritius
 - Youth detention centers Brave Research Center USA
- Explore CE and MDR regulation
- Incorporate clinical feedback and implementation needs into last development goals





DESIGN CONSIDERATIONS FOR BIOFEEDBACK GAMES

DESIGN CONSIDERATIONS

Input modalities

- Brain activity (EEG), Heart Rate (Variability), Breathing, Muscle tension, etc.

Input considerations

- Accuracy
- Controllability
- Practicality

Feedback

- Visual/auditory/haptic/multisensory
- Explicit vs Implicit
- Intensity and frequency

Reinforcement

- Types of reinforcement (e.g. negative vs positive)
- Which game parameters linked to input and performance

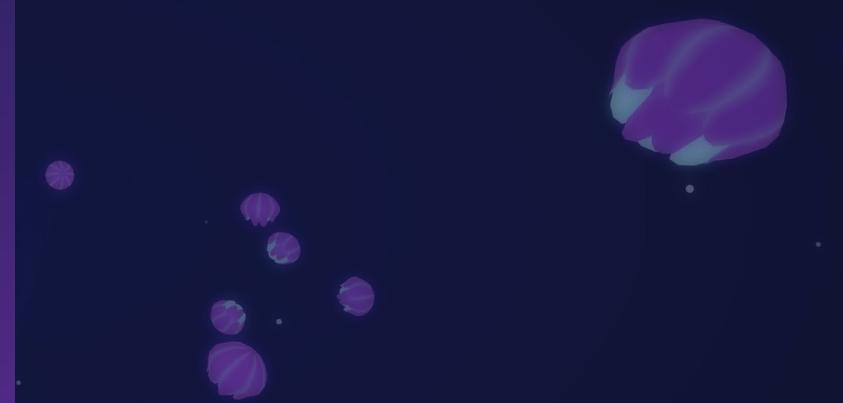


FURTHER DESIGN CONSIDERATIONS

Psychological Mechanisms	Design Mechanic
Interoceptive awareness Balanced not hyperfocus	(intermittent) visualization of changes in physiology, embedded in an engaging environment
Self-efficacy and locus of control	Emphasize player influence Show progress Dynamic difficulty
Threat-challenge Threat -> Challenge	Practice under duress Frame arousal as adaptive (e.g. in feedback, messaging, story)
Mindset Fixed -> Growth	Emphasize ability to change Show journey of progress

TAKE HOME MESSAGES

- Game-based biofeedback is a promising method to facilitate emotion regulation
- Input modalities, accuracy, practicality, controllability, and choices in types of feedback and reinforcement are important design challenges
- Cognitive appraisals like self-efficacy can be considered as potential change mechanisms to target
- Collaborations between scientists, health care experts, and game designers can lead to innovative, playful, and meaningful interventions that can empower people to improve their wellbeing!



CONTACT INFO

Find DEEP on:

-  Exploreddeep.com
-  @ExploreDeep
-  @ExploreDeepVR
-  @exploreddeep_VR



Find GEMH-lab on:
www.gemhlab.com



Find me on:
www.joannekeweerdmeester.com