

COGNICITY

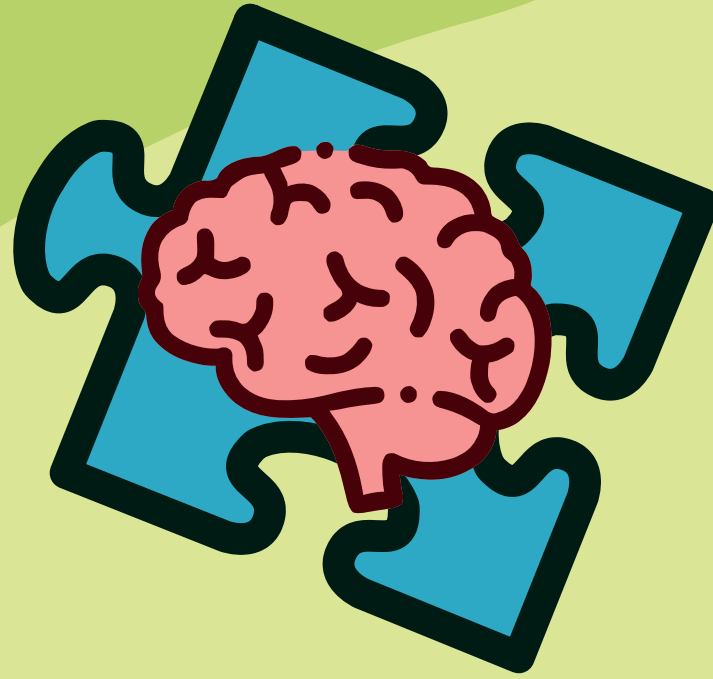
A Serious Game Suite to help enhance cognitive abilities

IMI SHOWTIME



Alexander Schimanko, Anton Schöps, Eve Schütze, Justin Pallas, Pauline Röhr

COGNICITY



A Serious Game Suite to help enhance cognitive abilities



Games suite with different games that each focus on training a certain cognitive ability.



Dynamic difficulty of the games depending on previous performance to suit the individual user.



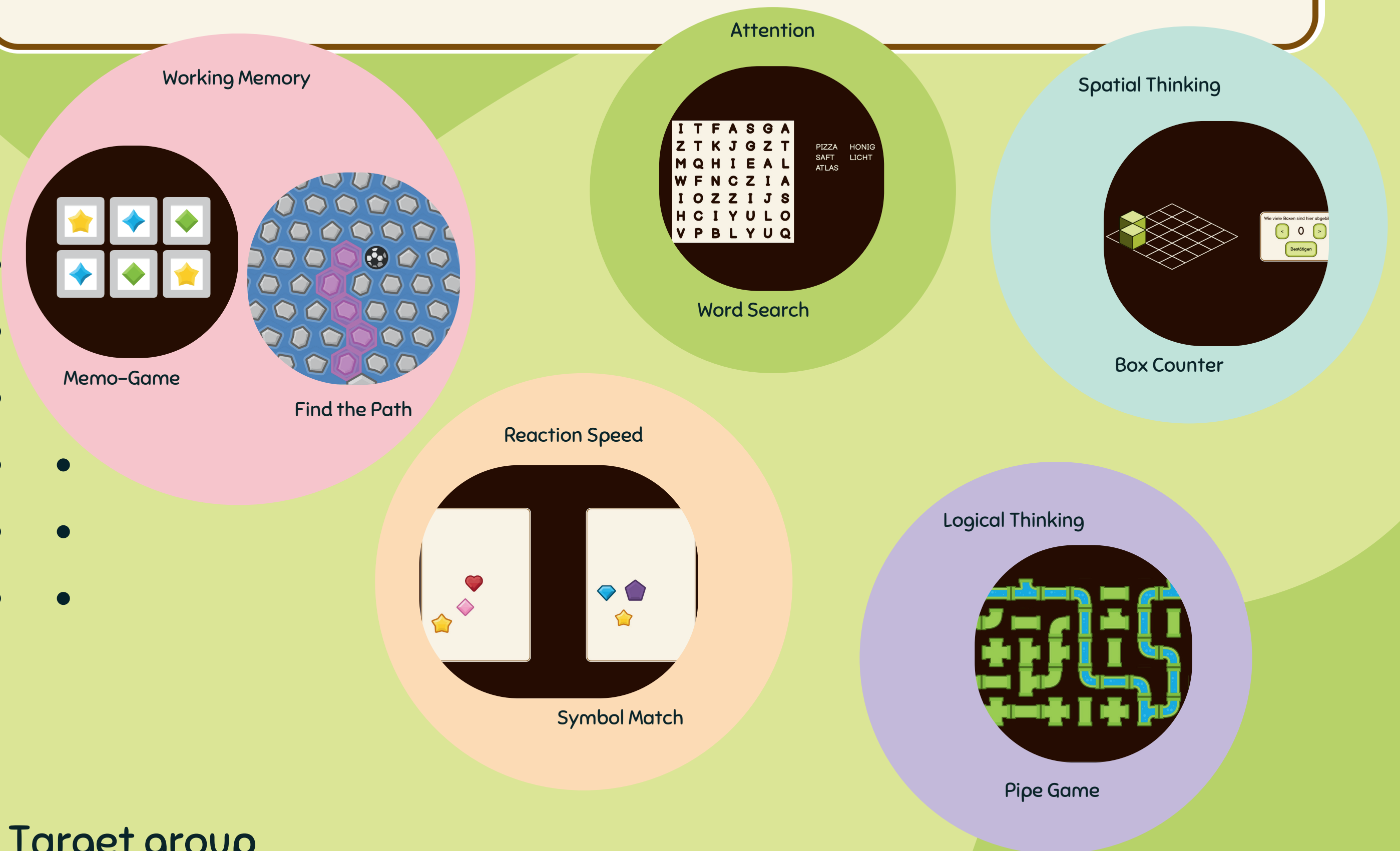
Created for mobile to ensure flexibility and accessibility for patients



Embedded in a research project of the Freie Universität Berlin, we aim to develop a game suite that is specifically designed to support individuals who are in danger of cognitive decline due to health conditions or their treatments. Our goal is to provide a fun and engaging way to train cognitive abilities, while also keeping track of the progress made. CogniCity provides a variety of minigames that can be used to train different cognitive abilities, such as logical thinking, working memory or spatial thinking.




Concept

CogniCity is a mobile game suite that offers people fun way to train their cognitive abilities. Built in the open-source game engine Godot players can find currently six minigames divided into five categories of cognitive skills (Logical Thinking, Working Memory, Spatial Thinking, Attention and Reaction Speed), a small but colourful town to explore and characters to meet. CogniCity is not a game to play for long hours at a time, instead it is supposed to be played for a short time each day to slowly but steadily improve. The scoring system let's you see your current standing and automatically adjusts the difficulty of the respective game.



Target group

Adolescents and young adults between the ages of 13 and 30 who either suffer from chronic physical illnesses and spend a lot of time in hospital, or who are at risk of suffering cognitive impairment.

 <p>Name: Lisa</p> <p>Background: A 27-year-old young adult who has to take regular medication for a heart disease, which can potentially affect her cognitive abilities.</p>	 <p>Name: Tim</p> <p>Background: A 16-year-old teenager suffering from a chronic illness, spends a lot of time in the hospital and often feels bored. His doctor recommended for him to find a way to stimulate his brain during hospital stays to prevent decay of his cognitive abilities</p>	 <p>Name: Max</p> <p>Background: A 22-year-old who does not have any specific health issues but loves to train his brain and face mental challenges.</p>
<p>Goals: To preserve her mental abilities and find an entertaining way to do so.</p> <p>Fears: That her medication might affect her cognitive abilities.</p> <p>Challenges: Managing her heart disease, the potential cognitive impact of her medication, and finding an engaging way to keep her mind active.</p>	<p>Goals: To keep his brain active during his hospital stays and to find an engaging way to feel mentally stimulated.</p> <p>Fears: Getting bored and not being mentally challenged during his hospital stays.</p> <p>Challenges: Dealing with a serious illness and the resulting hospital stays, along with boredom and a lack of mental stimulation.</p>	<p>Goals: To find new ways to improve his cognitive abilities while having fun.</p> <p>Fears: Stagnation or not progressing in his cognitive abilities</p> <p>Challenges: Constantly seeking new ways to improve his cognitive abilities while keeping it enjoyable</p>
<p>Hobbies & interests: Lisa is also an avid reader, enjoys solving puzzles, and has a passion for nature walks. She likes painting in her spare time and is a fan of yoga for physical well-being.</p>	<p>Hobbies & interests: Tabletop Gaming and Video Games, Cozy Games in particular, reads Comics</p>	<p>Hobbies & interests: All types of puzzles and mental challenges, Outdoor activities like hiking and biking, cooking</p>

Cognitive Abilities & how to assess them

Good cognitive abilities are an important part of our life and have an impact on its quality. [1] Recognising, Remembering, Realising. Without them it would be hard to live and yet some people have to face issues regarding their cognitive abilities. Be it because of age, illness or medication. However, efforts can be made to improve ones own abilities, especially through training, sometimes during psychological therapy. This project focuses on improving cognitive abilities through playing a game, which is not unprecedented. Games can give a fun and engaging way to train, and has been used for example with children. [2] But what defines cognitive abilities for this project? To start, it had to be clear what different cognitive abilities exist and what they mean. Different listings of cognitive abilities as seen below in Fig. 1 [3] have been created as well as how to evaluate acquiring skills [4]–[5]. These created an overview from which further decisions were based on. Certain categories don't lend themselves well to a game format that can be translated to many different people. Creativity for example is a very subjective part and language processing now much depends on the fact that the person is able to understand the language. So these categories were broken down and games that could train these aspects were chosen.

Interview

An expert interview was conducted with a psychologist from Freie Universität Berlin to confirm previous research and give further insights. The main points of the interview were: the quality of the chosen categories of cognitive abilities and how to possibly improve them, if perceived pressure through a timelimit or a leaderboard is beneficial, what feedback from the game might be beneficial to the user and their improvements through the games. The answers showed that the categories were too broad and needed to be concentrated on a few, distinguishable ones. The HAWIK test, an intelligence test based on the WAIS-IV test [6] by David Wechsler and other IQ tests were mentioned as good guidelines. With this taken into consideration, 5 categories were chosen to train in this game suite. Both the leaderboard and the time limit were deemed as useful information and tools to help the player. A leaderboard gives opportunity to compare oneself to others or ones previous achievements which motivates further improvement. Time limits are good when speed is needed to finish a task. For example how fast one can be if they are presented with finding a pair of the same in a group of many different objects. However it was noted that this doesn't work for every game concept and should be evaluated if it is needed on a case by case basis. Furthermore they were presented the standings of our target group, that covered a larger unspecified group with a mild mental illness profile. This was criticised to be too broad and changed to the current form.

Cognitive Ability	Description
Attention	The ability to concentrate on certain signals or information
Memory	The ability to save, retain and recall learned information.
Problem Solving	The ability to analyse challenges and create effective solutions.
Creativity	The ability to create a regional an innovative ideas
Language Processing	The ability to understand and use written or spoken language.
Spatial Thinking	The ability to understand and manipulate the spatial relationship between objects.
Logical Thinking	The ability to draw a logical conclusion and make rational decisions.
Perception	The ability to recognise signal from the surrounding and interpret them.
Process Information	The ability to process information efficiently and extract the relevant details.
Problem Recognition	The ability to identify potential problems or challenges.
Concentration	The ability to stay focused over a long period.
Learning Aptitude	The ability to learn from experience and assimilate new information.

Scoring

The score represents the current level that a player is at, split up into the different categories. To improve in one category means performing well in the respective games. Should a player need more time to improve they are kept at the same level through the system. The score can be viewed as an overview of all categories in a radar chart or for each game individually with a timeline of the players improvement.

Since each game is unique in its composition the exact way of scoring them differs. To explain the concept here's how to score it is calculated on the example of Memory and Find The Path: The end score is always calculated by dividing the reached points by the maximal possible points of the level and multiplying that by 100. This maps the score to scale from 0 – 100, thus making 100 and maximum reachable score of one category.

$$\text{Score for the Round} = (\text{Reached Points} / \text{Maximal Points for the Round}) * 100$$

Memo-Game

$$\text{Reached Points} = \text{Base Points} * \text{Time Bonus} * \text{Correction Rate}$$

$$\text{Base Points} = 10 * \text{Amount of Pairs}$$

$$\text{Time Bonus} = \frac{10 + 2 * \text{Amount of Pairs}}{\text{Time}}$$

Time Bonus is capped at either 1,5 or 1

$$\text{Correction Rate} = \text{Amount of Pairs} / \text{Attempts}$$

Correction Rate is maximal 1

Attempt: Reveal 2 Cards

$$\text{Amount of Pairs} = 3 \quad \text{Time Bonus} = 1,5 \quad \text{Correction Rate} = 1$$

$$\text{Maximal Points for the Round} = 30 * 1,5 * 1 = 45$$

$$\text{Attempts} = 5 \quad \text{Time} = 0:16 \rightarrow \text{float (Time)} = 16$$

$$\text{Reached Points} = 30 * 1 * 0,6 = 18$$

$$\text{Score for the Round} = (18/45) * 100 = 40$$

Wordsearch

$$\text{Reached Points} = \text{Base Points} * \text{Time Bonus} - \text{Mistake Rate}$$

$$\text{Path Length} = \text{Level number} + 2$$

$$\text{Base Points} = 15 * \text{Path Length}$$

$$\text{Time Bonus} = \frac{(10 + 3 * \text{Path Length}) * 100}{\text{Time}}$$

Time Bonus is capped at either 1,2 or 1

$$\text{Mistake Rate} = \text{Mistakes} * 10$$

$$\text{Path Length} = 3 \quad \text{Time Bonus} = 1,2 \quad \text{Mistake Rate} = 2$$

$$\text{Maximal Points for the Round} = 45 * 1,2 * 1 = 54$$

$$\text{Mistakes} = 2 \quad \text{Time (in ms)} = 5542 \rightarrow 5,542$$

$$\text{Reached Points} = 45 * 1 - 20 = 18$$

$$\text{Score for the Round} = (18/54) * 100 = 46$$

[1] A. Behr, R. Meyer, M. Holzhausen, A. Kuhlmeier, and L. Schenk, "Lebensqualität und Gesundheit – Subjektive Perspektiven von selbstauskunftsfähigen Pflegeheimbewohnern – eine qualitative Studie," *Pfleger*, vol. 27, no. 6, pp. 369–380, Dec. 2014, doi: <https://doi.org/10.1024/1012-5302/a000390>.

[2] A. Szczesna, J. Grudzinski, T. Grudzinski, R. Mikuszewski, and A. Debowski, "The psychology serious game prototype for preschool children," 2011, pp. 1–4. doi: <https://doi.org/10.1109/SeGAH.2011.6165435>.

[3] NeuroNation, "Kognitive Fähigkeiten – Welche gibt es und was machen sie?," www.neuronation.com, Apr. 30, 2016. <https://www.neuronation.com/science/de/kognitive-faehigkeiten/> (accessed Jun. 28, 2024). Translated from German

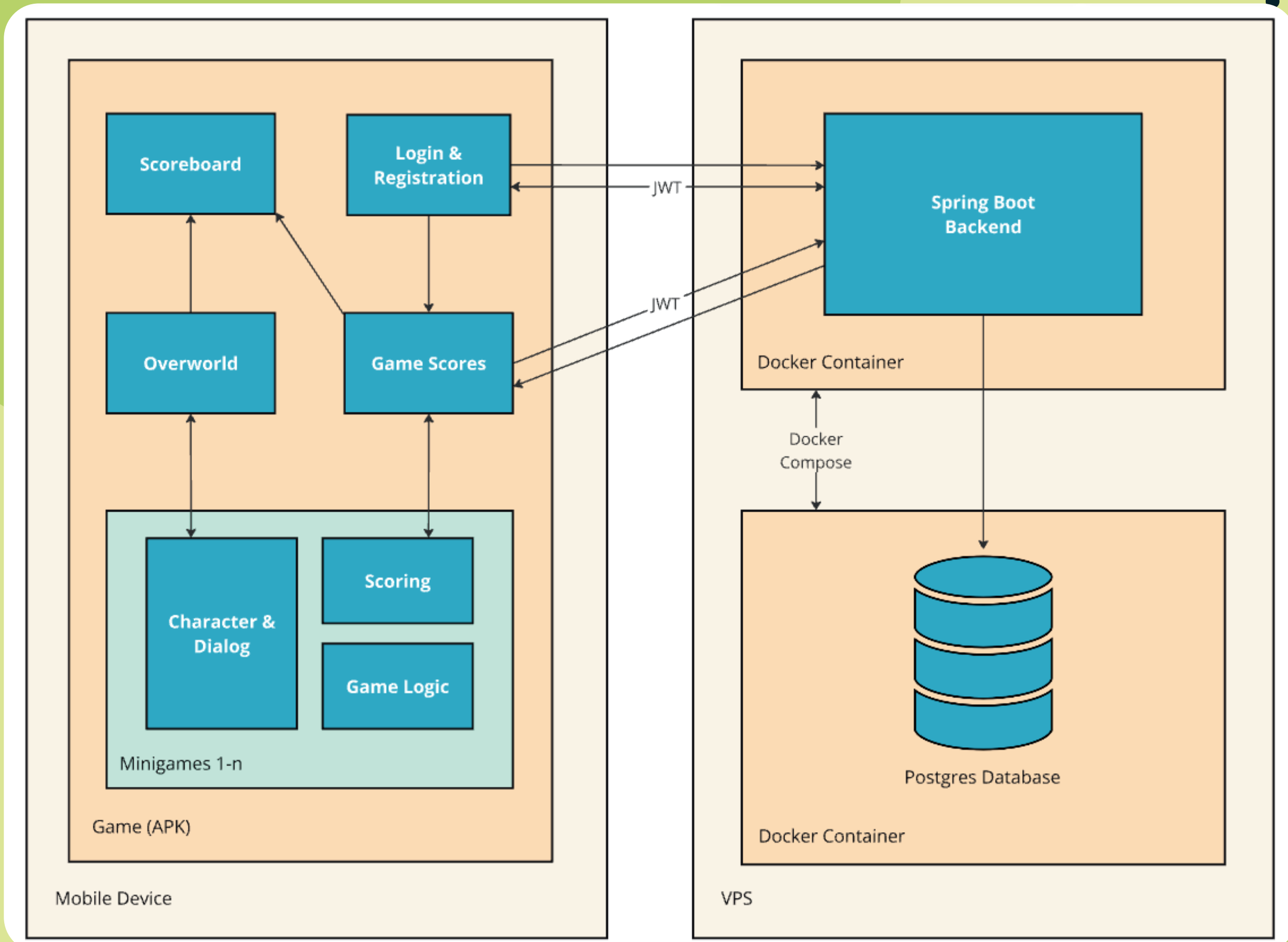
[4] J. M. Royer, C. A. Cisero, and M. S. Carlo, "Techniques and Procedures for Assessing Cognitive Skills," *Review of Educational Research*, vol. 63, no. 2, pp. 201–243, Jun. 1993, doi: <https://doi.org/10.3102/00346543063002201>.

[5] R. Glaser, A. Lesgold, and S. Lajoie, "3. Toward a Cognitive Theory for the Measurement of Achievement," *The Influence of Cognitive Psychology on Testing*, vol. 3, Jan. 1987, Accessed: Jun. 28, 2024. [Online]. Available: <https://digitalcommons.unl.edu/burosocogpsych/6/>

[6] T. R. Valentine, C. K. Block, K. Eversole, L. Boxley, and E. Dawson, "Wechsler Adult Intelligence Scale-IV (WAIS-IV)," *ResearchGate*, Sep. 2020. https://www.researchgate.net/publication/320735194_Wechsler_Adult_Intelligence_Scale-IV_WAIS-IV

Designing the World

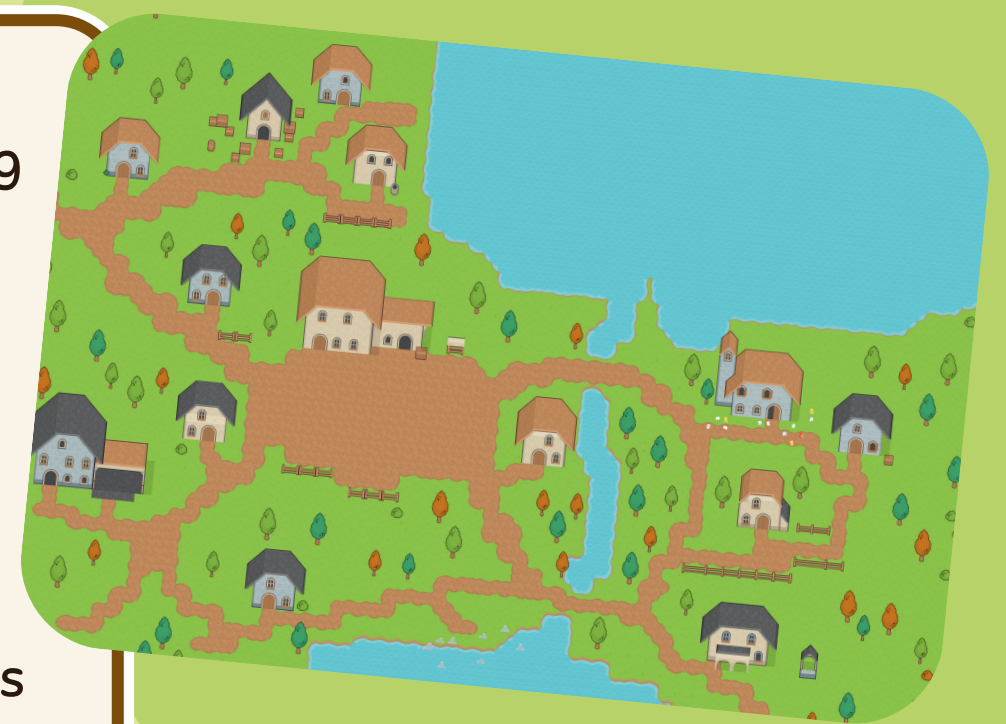
Architecture



Overworld & Characters

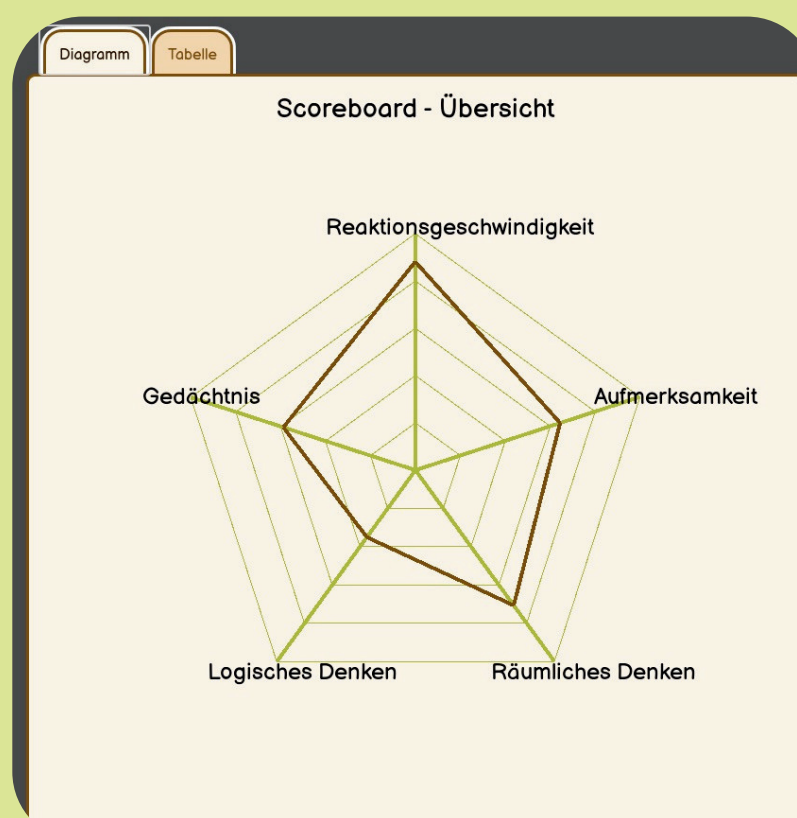
A quaint town by two lakes where things seem to regularly go wrong, invites the player to spend a little bit of time there. Other game suites with the focus on training the mind like “Big Brain Academy™” and “Dr. Kawashima's Brain Training™” usually only offer of a menu selection. So, inspired by open world games such as “Cuphead” and “Pokémon™” CogniCity gives room to explore and relax.

The people around town, like the jewellery smith Clara will enjoy help from the new person in their endeavors. They are the gate to the different games and make for good conversation too. The notice board can be used to see recommended activities of the day and is the place to find newly added games from third parties.



Scoring in concept

To track a player's ability and let them slowly and carefully improve a scoring system is implemented that sees how the player is performing during a game and gives them the appropriate difficulty next time depending on their scores. This ensures that the player is able to play on an appropriate level, doesn't have to attempt too easy or too hard levels and that games scale with the players ability improvements.



Design

CogniCity presents a clean and simple design that feels welcoming, colorful and engaging to keep the users motivated to continue training. This is supported by a warm and friendly color palette inspired by summerly fields and towns.