

# AR cognitive training cube game

**Design Document**  
(kind of...)

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## **Overview**

Working title: cleverQb (pronunciation: cleverbue)

Working logo: <http://goo.gl/3jgQH2>

Genre: Collection of puzzle games for cognitive training

Platform: Android application for tablets

Target audience: Healthy people, people at high risk of cognitive decline (Mild Cognitive Impairment)

Technology utilized: Augmented Reality

## **Game description**

CleverQb is a collection of 7 puzzle games for cognitive training. The concept of the mini-games concerns “classic” patterns of cognitive games like: shape-matching, word-colour matching, arithmetic calculation, reminiscence, figure-matching and logical path games (e.g. [www.lumosity.com](http://www.lumosity.com)). However the games are ported into the real space, utilizing the manipulation of physical objects (cubes) as the dominant interaction technique. The game addresses the following cognitive functions of the player: response inhibition, spatial memory recall, problem solving, and visuospatial/executive functions.

## **Goal**

To develop a cognitive game, utilising Augmented Reality, in order to:

- Keep the players cognitively active and/or slow down their cognitive decline.
- Keep track of the player’s cognitive performance and document the cognitive changes (if any) that take place over time.
- Use AR to provide a new experience about cognitive training, utilising the “wow effect” and developing a more enjoyable and engaging experience.

## **Branding**

The game is branded, firstly as a collection of puzzle games, and secondly as a cognitive training, thus investing, firstly on the fun and enjoyment, and then on the cognitive and physical function of the player, even though the latter is the essence of the game. Therefore, the notion is that the players will not do cognitive training by solving puzzles, but they will play games that also train them cognitively. Consequently phrases/words like “mental workout”, “cognitive score”, “health” et al. are excluded from the content of the game. However, terms like “cognitive training” or “mental exercise” can be used to describe the game. To summarise, cleverQb **is** a game for health but its cause remains hidden to the player, while playing, mostly in order to test engagement and cognitive effects, in the most objective way possible.

## Game elements

### Interaction

The game takes place in natural space (e.g. a table, an office et al.). The player places the tablet on a stand holder (Fig. 1) in front of him and he is looking the real world around him, through the screen and the tablet camera. He places the cubes in front of the tablet camera and, through the tablet screen he can see the cubes getting augmented with digital content. The cubes (with stickers of 5x5 cm framemarkers on each side, e.g. Fig. 2) act as Augmented Reality markers, on top of which the digital content is added through camera view (e.g. Fig. 3). The player manipulates the cubes to perform in-game actions (cubes as input devices), using both hands (since he does not have to hold the tablet), again, in front of the tablet camera. Therefore, the hands of the player stay in front of the tablet camera, whereas he is looking at the tablet screen to experience the augmented world (Fig. 4).



Figure 1: The tablet's stand holder, allowing the player to interact with the cubes using two hands.



Figure 2: An example of cubes with AR markers on their sides.

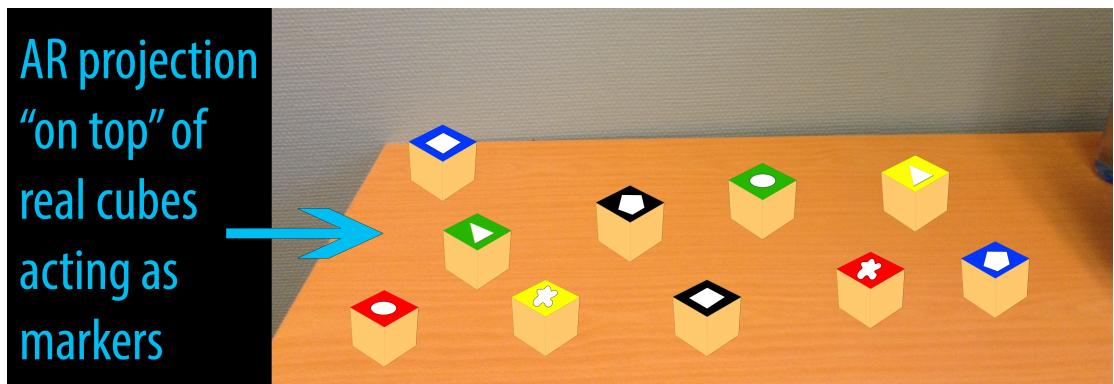


Figure 3: A concept of the player's camera view.



Figure 4: The setting of the game.

### Visual style

The graphics of the game are cartoonish with live colours (light orange, light green, light blue, purple etc.). The 3D models projected on cubes are pretty plain without any shading effects. Suggested fonts: Wendy One (for logo), Lato or Gudea (for text), source: Google fonts. Landscape orientation of the screen.

### Game structure

The game can support opportunistic use, i.e. the player can choose one of the 7 mini-games, trying to set a high-score, as well as for regular use, i.e. the player can follow a linear gaming structure, thus playing all of the seven mini-games, trying to improve his total score. For that reason, the game menu comes in two flavours: it displays the 7 buttons/icons of the 7 mini-games, as well as a button ("START FULL GAME") that leads to a linear gaming structure, opening all of the 7 mini-games, back-to-back.

## **Registration**

The registration of the player when loading the application is necessary in order for us to be able to provide him with personal content and create the notion of a "private space", while playing the game. Therefore, email and username will be necessary, as well as he will be able to set up a date (day and time) on which we will send him a reminder for loading the app and playing the game.

## **Points system**

The points system depends on the time that the player needs in order to complete the task of the mini-game. It also depends on the false responses of the player, which carry a penalty. The total sum of each mini-game's score creates the total score of the player and is visible at the main menu.

## Starting the game

- Logo/loading screen appears.
- Going to main menu.
- The main menu consists of 7 icons each opening one mini-game
- The player chooses the game from the main menu.
- When loading an intro page appears with instructions on how to play the game, the leaderboard and a START button.
- By pressing START the game begins.

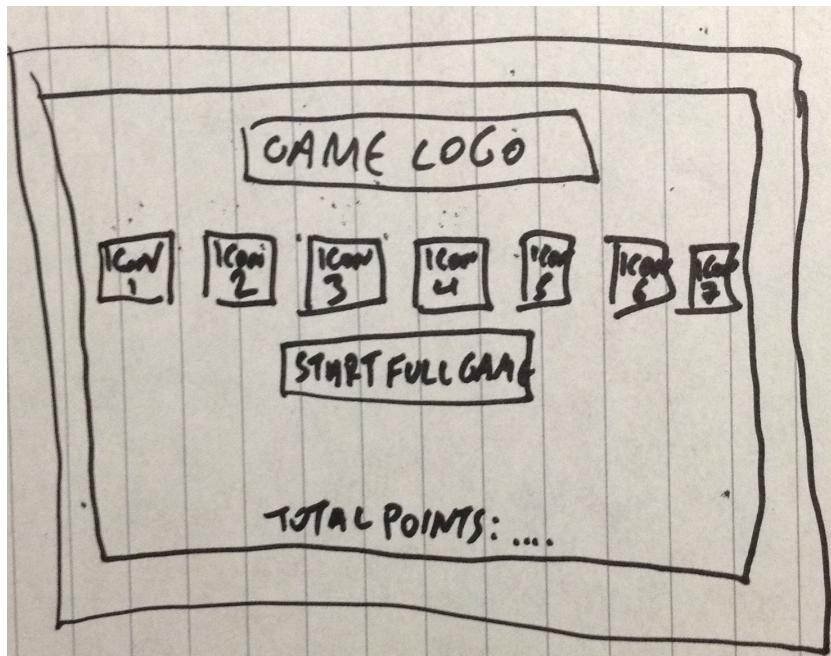


Figure 5: The main menu screen.



Figure 6: The loading screen of the mini-games.

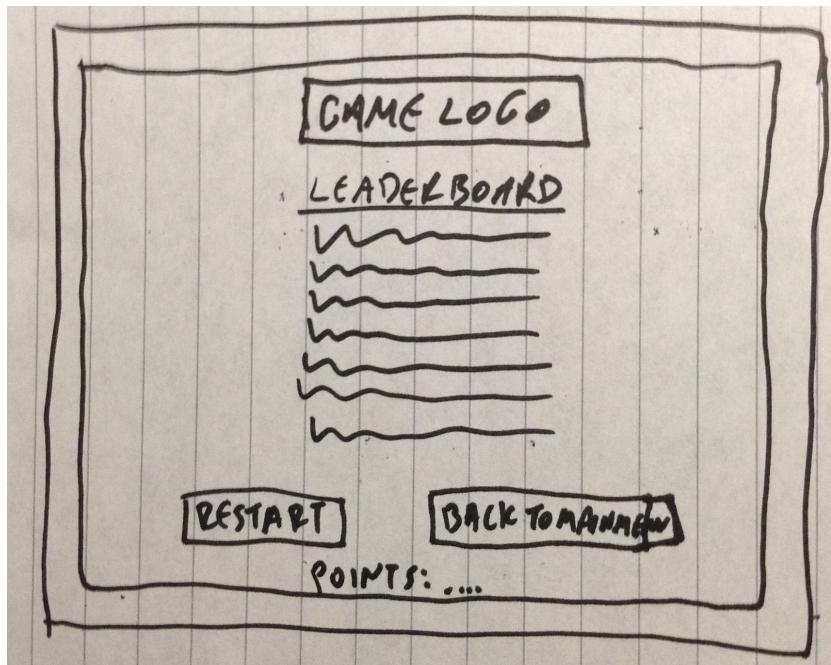


Figure 7: The screen at the end of each mini-game.

## Pausing the game

When the player presses the PAUSE button a pause screen appears with three options: RESUME, RESTART GAME, BACK TO MAIN MENU.

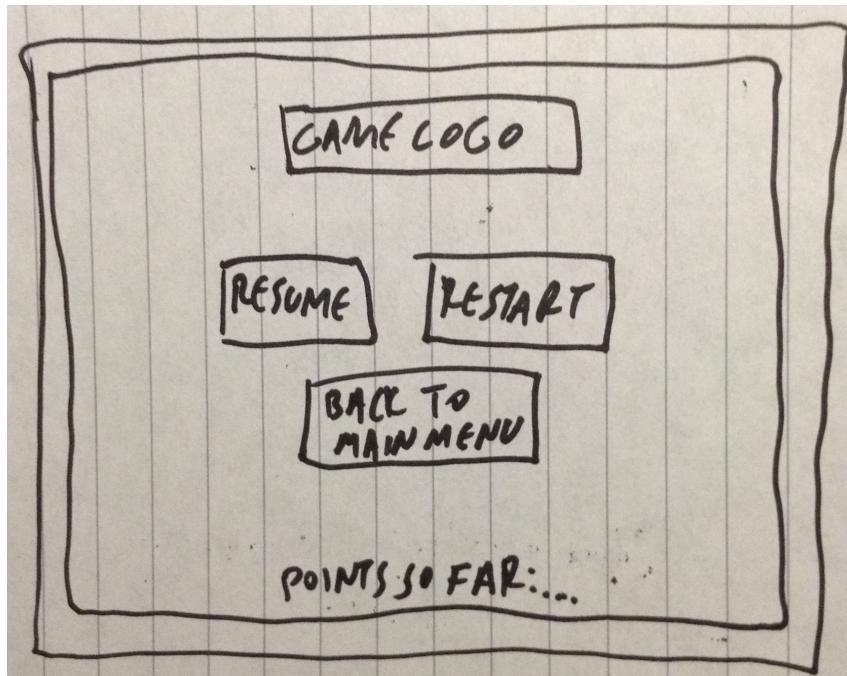


Figure 8: The pause screen.

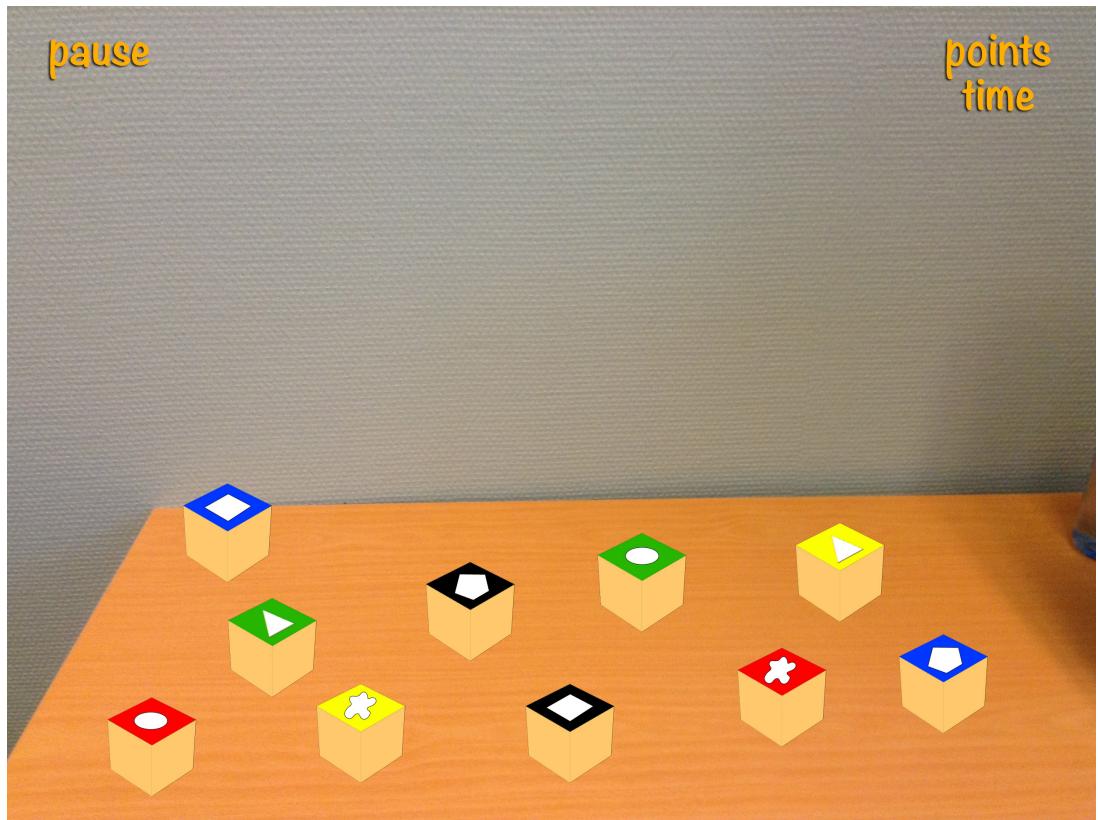
## **Mini-game #1: Shape match (working title)**

Goal: The player has to match the cubes according to the shape displayed on the surface of each cube.

Cognitive function addressed: flexibility - response inhibition (impulse control)

Interaction: The player matches the cubes in pairs (nr. of cubes: 10). The cubes have to touch one another to be considered as matched.

- The cubes display coloured shapes on top of them and the player has to match them according to the shape and not the colour.
- Time and points are displayed at the upper right side of the camera view. The points depend on the time needed to complete the game and there is a point penalty for wrong matches.
- If the matching is correct, a “correct”-sign 3D object appears on top of those two cubes and stays there. If the match is wrong, a “wrong”-sign 3D object appears.
- The game finishes when all shapes are matched correctly. There are no extra levels in this mini-game. The game is only time-dependent.
- When the game finishes an end screen appears with the leaderboard (top 10 point scores). The points, the time taken to complete the task and the accuracy (number of correct/total number x %) are given. If the player’s performance should be registered in the leaderboard his username is displayed highlighted in the leaderboard. Below there are three buttons: RESTART, BACK TO MENU and NEXT GAME.
- One flawless mini-game session is calculated to last about 15 seconds, providing feedback (points) for enabling the player to do better and play again.
- Movements of the markers/cubes are documented in a log file; the wrong matches (error rate) are documented as well.



**Figure 9: Mini-game #1**

## **Mini-game #2: Colour match (working title)**

Comment: The philosophy behind this mini-game is almost identical to that of mini-game #1.

Goal: The player has to match the comparing one word's meaning to another word's colour.

Cognitive function addressed: flexibility - response inhibition (impulse control)

Interaction: The player matches the cubes in pairs (nr. of cubes: 10). The cubes have to touch one another to be considered as matched.

- The cubes display coloured shapes on top of them and the player has to match them according to the shape and not the colour.
- Time and points are displayed at the upper right side of the camera view. The points depend on the time needed to complete the game and there is a point penalty for wrong matches.
- If the matching is correct, a "correct"-sign 3D object appears on top of those two cubes and stays there. If the match is wrong, a "wrong"-sign 3D object appears.
- The game finishes when all shapes are matched correctly. There are no extra levels in this mini-game. The game is only time-dependent.
- When the game finishes an end screen appears with the leaderboard (top 10 point scores). The points, the time taken to complete the task and the accuracy (number of correct/total number x %) are given. If the player's performance should be registered in the leaderboard his username is displayed highlighted in the leaderboard. Below there are three buttons: RESTART, BACK TO MENU and NEXT GAME.
- One flawless mini-game session is calculated to last about 15 seconds, providing feedback (points) for enabling the player to do better and play again.
- Movements of the markers/cubes are documented in a log file; the wrong matches (error rate) are documented as well.

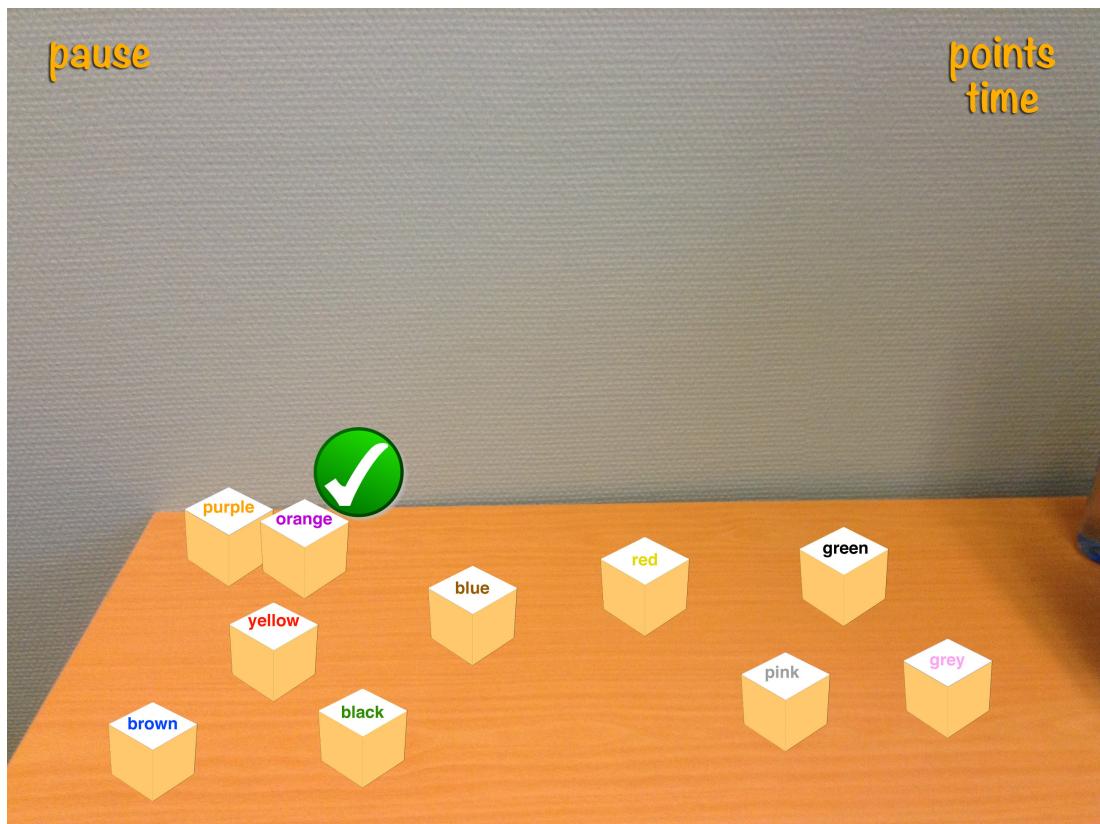


Figure 10: Mini-game #2

## Mini-game #3: Total sum (working title)

### (Save it for last)

Goal: The player has to place a specific number of cubes on top of each to create a certain total sum.

Cognitive function addressed: problem solving – arithmetic calculation

Interaction: The player creates a certain total sum by placing **three** cubes on top of each other...Jenga style (nr. of cubes: 10).

- The cubes display numbers and the player has to match them in order to create the required total sum.
- Time and points are displayed at the upper right side of the camera view. The points depend on the time needed to complete the task and there is a point penalty for wrong sums.
- At the upper left side of the camera view, the arithmetic calculation appears.
- If the sum is correct, the sum number will appear on top of the cubes and it goes on with the next level, thus there is a new arithmetic calculation at the upper left side.
- The game has 8 levels, thus 8 arithmetic calculations, with various levels of difficulty (level 1: 0, level 2: +1, level 3: +4, level 4: +8, level 5: -9, level 6: -11, level 7: +22, level 8: +13). The cubes always display the same numbers on top of them (numbers as in screenshot).
- The mini-game follows linear structure, therefore the player has to finish all 8 levels to move on to another game or restart the same mini-game.
- The game finishes after the 8<sup>th</sup> level.
- When the game finishes an end screen appears with the leaderboard (top 10 point scores). The points, the time taken to complete the task and the accuracy (number of correct/total number x %) are given. If the player's performance should be registered in the leaderboard his username is displayed highlighted in the leaderboard. Below there are three buttons: RESTART, BACK TO MENU and NEXT GAME.
- One flawless mini-game session is calculated to last about 10 minutes, providing feedback (points) for enabling the player to do better and play again.
- Time to complete a task (i.e. finding the right answer) and movements of the markers/cubes are documented in a log file. The wrong matches are documented as well.

pause

## CALCULATION

points  
time

+4

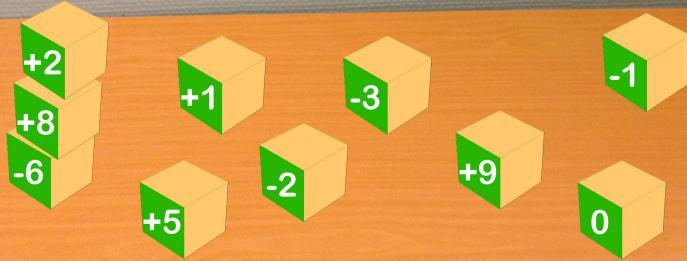


Figure 11: Mini-game #3

## **Mini-game #4: Find the answer (working title)**

Comment: The philosophy behind this mini-game is almost identical to that of mini-game #3.

Goal: The player has to find the correct answer to simple arithmetic calculations.

Cognitive function addressed: problem solving – arithmetic calculation

Interaction: The player creates he number which is the answer to the displayed arithmetic calculation (nr. of cubes: 10).

- The cubes display numbers and the player has to match them in order to create the required right answer.
- The cubes display all the numbers from 0-9, therefore answers with double same digits like 11, 22, etc. are off the table.
- Time and points are displayed at the upper right side of the camera view. The points depend on the time needed to complete the task and there is a point penalty for wrong answers.
- At the upper left side of the camera view, the arithmetic calculation appears.
- If the answer is correct, a “correct”-sign 3D object appears on top of the cubes and the game goes on with the next level, thus there is a new arithmetic calculation at the upper left side.
- The game has 8 levels, thus 8 arithmetic calculations, with various levels of difficulty. The cubes always display the same numbers on top of them.
- The mini-game follows linear structure, therefore the player has to finish all 8 levels to move on to another game or restart the same mini-game.
- The game finishes after the 8<sup>th</sup> level.
- When the game finishes an end screen appears with the leaderboard (top 10 point scores). The points, the time taken to complete the task and the accuracy (number of correct/total number x %) are given. If the player's performance should be registered in the leaderboard his username is displayed highlighted in the leaderboard, ...coin-up style. Below there are three buttons: RESTART, BACK TO MENU and NEXT GAME.
- One flawless mini-game session is calculated to last about 8-10 minutes, providing feedback (points) for enabling the player to do better and play again.
- Movements of the markers/cubes are documented in a log file; the wrong matches (error rate) are documented as well.

pause

## CALCULATION

points  
time

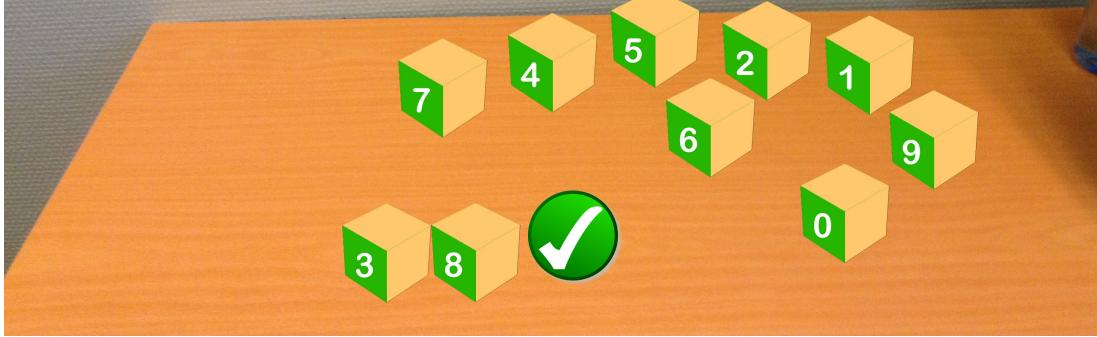


Figure 12: Mini-game #4

## **Mini-game #5: Memory cubes (working title)**

Goal: The player has to memorize the image with the highlighted tiles and after it disappears, he has to reminiscent the tiles' formation and display it using the cubes.

Cognitive function addressed: spatial memory recall

Interaction: The player recreates the formation that is given to him by creating a 3x3 square using the augmented cubes (nr. of cubes: 9).

- The cubes display two kinds of colour: white and light green. The player has to memorize the initial formation and represent it using the cubes and forming a 3x3 square.match them in order to create the required right answer.
- Time and points are displayed at the upper right side of the camera view. The points depend on the time needed to complete the task and there is a point penalty for wrong patterns.
- The game consists of 5 levels. Level 1: 2 highlighted tiles, Level 2: 3, Level 3: 4, Level 4: 5, and Level 5: 6.
- At the upper left side of the camera view, the targeted tiles' pattern is presented for 2 seconds at the first 3 levels and 1 second at the next 2 levels.
- If the right pattern is formed, a "correct"-sign 3D object appears on top of the cubes and the game goes on with the next level, thus there is a new tiles pattern at the upper left side. If the pattern is wrong, a "wrong"-sign 3D object appears on top of the cubes and the player has to try until it gets it right or he can pause the game and restart it.
- The mini-game follows linear structure, therefore the player has to finish all 5 levels to move on to another game or restart the same mini-game.
- The game finishes after the 5<sup>th</sup> level.
- When the game finishes an end screen appears with the leaderboard (top 10 point scores). The points, the time taken to complete the task and the accuracy (number of correct/total number x %) are given. If the player's performance should be registered in the leaderboard his username is displayed highlighted in the leaderboard. Below there are three buttons: RESTART, BACK TO MENU and NEXT GAME.
- One flawless mini-game session is calculated to last about 8-10 minutes, providing feedback (points) for enabling the player to do better and play again.
- Movements of the markers/cubes are documented in a log file; the wrong matches (error rate) are documented as well.

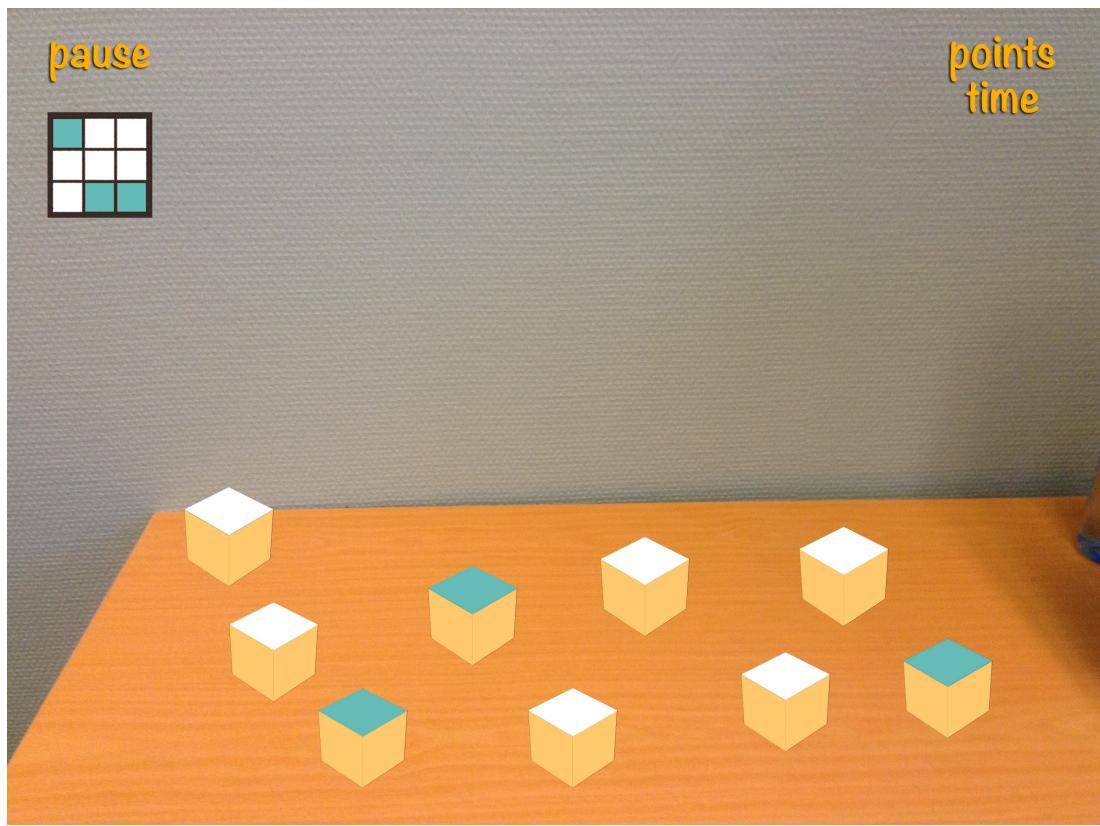


Figure 13: Mini-game #5

## **Mini-game #6: The path (working title)**

Goal: The player has to create a path, using the cubes, following the logical order of number-letter.

Cognitive function addressed: visuospatial/executive functions

Interaction: The player moves the cubes and matches them in a straight line/path (nr. of cubes: 10).

- The cubes display numbers (1-5) and letters (A-E).
- Time is displayed at the upper right side of the camera view. The points depend just on the time needed to complete the task.
- The game does not have levels.
- The player places the 10 cubes next to each other. If the logical path is wrong then a “wrong”-sign 3D object appears on top of the cubes. If it is correct, the game finishes.
- When the game finishes an end screen appears with the leaderboard (top 10 point scores). The points, the time taken to complete the task and the accuracy (number of correct/total number x %) are given. If the player's performance should be registered in the leaderboard his username is displayed highlighted in the leaderboard. Below there are three buttons: RESTART, BACK TO MENU and NEXT GAME.
- One flawless mini-game session is calculated to last about 15 seconds, providing feedback (points) for enabling the player to do better and play again.
- Movements of the markers/cubes are documented in a log file; the wrong matches (error rate) are documented as well.

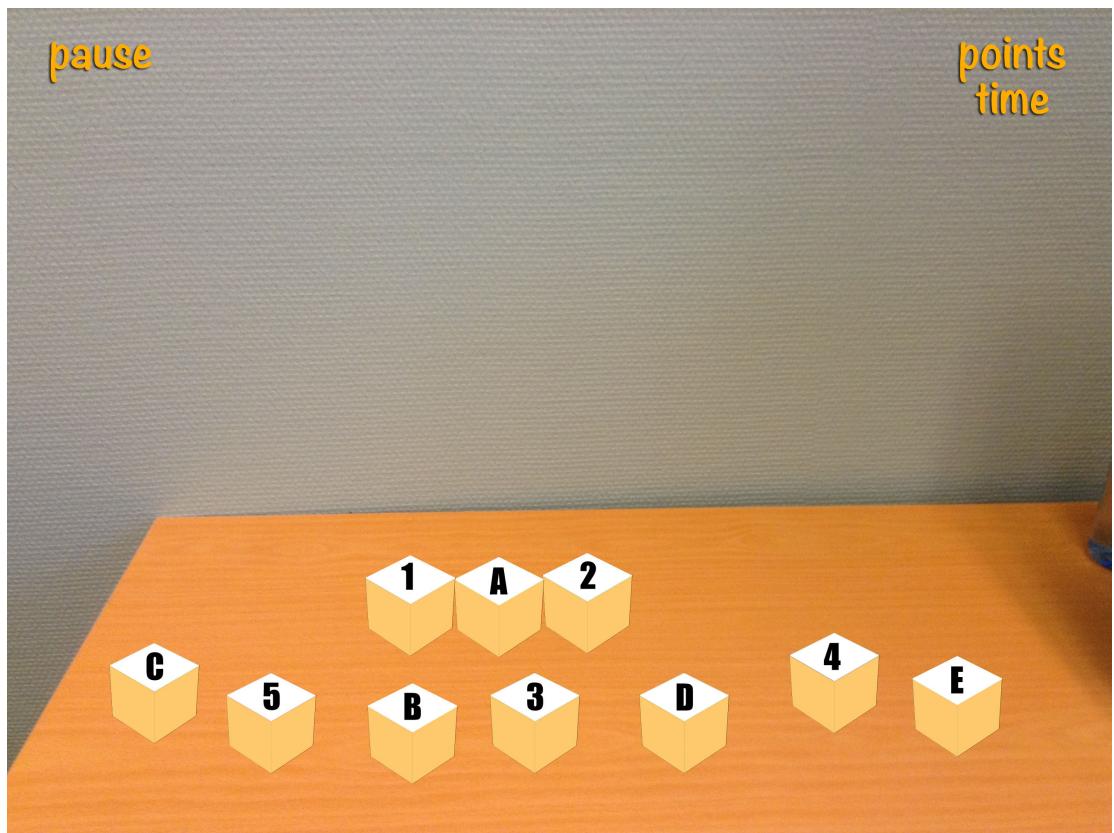


Figure 14: Mini-game #7

## **Mini-game #7: Woord game (working title)**

Goal: The player has to form words out of letters. The words will be related with a specific subject. The game is influenced by the Android game Woords.

Cognitive function addressed: logical reasoning

Interaction: The player moves the cubes and matches them in order to form a word (nr. of cubes: 9).

- The cubes display various letters with different colours.
- Time (10 minutes) is displayed at the upper right side of the camera view. The points depend on the words formed and if all words found a bonus is given. Also time plays a part in case there is a tie in players' scores.
- The game has levels of the same difficulty, which are randomly given to the player.
- When the game finishes an end screen appears with the leaderboard (top 10 point scores). The points and the time taken to complete the task are given. If the player's performance should be registered in the leaderboard his username is displayed highlighted in the leaderboard. Below there are three buttons: RESTART (another level), BACK TO MENU and NEXT GAME.
- Movements of the markers/cubes are documented in a log file; the wrong matches (error rate) are documented as well.

### **4 levels and their solutions:**

[https://dl.dropboxusercontent.com/u/17733678/PhD\\_thesis/gamedesign/cubes/woords.txt](https://dl.dropboxusercontent.com/u/17733678/PhD_thesis/gamedesign/cubes/woords.txt)

## **Extra suggestions/thoughts**

- Audio: the games can contain simple audio elements (e.g. the “correct” sign can be accompanied by a “success” sound etc.)
- The mini-games that contain similar elements can be combined into one levelled mini-game, with the old entities acting as levels (e.g. mini-game #1 and #2).