The COSMO@Home Application – Iterative Development and Implementation of the Learning Goals

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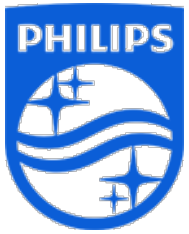
Partners



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The MRI scanning procedure

Undergoing an MRI-scan could be a challenge – especially for young children:

- They have to enter a small tunnel in a large unfamiliar machine
- The machine makes loud, jarring noises (up to 118 dB)
- They have to lay perfectly still for 10-40 minutes

Aim with the project

- COSMO@Home aims to prepare children for their MRI-scan
- So that parents know what to expect
- To empower the children
- Provide the doctors with the high-quality images they need to make correct diagnosis without unnecessary costs

Most important learning goals

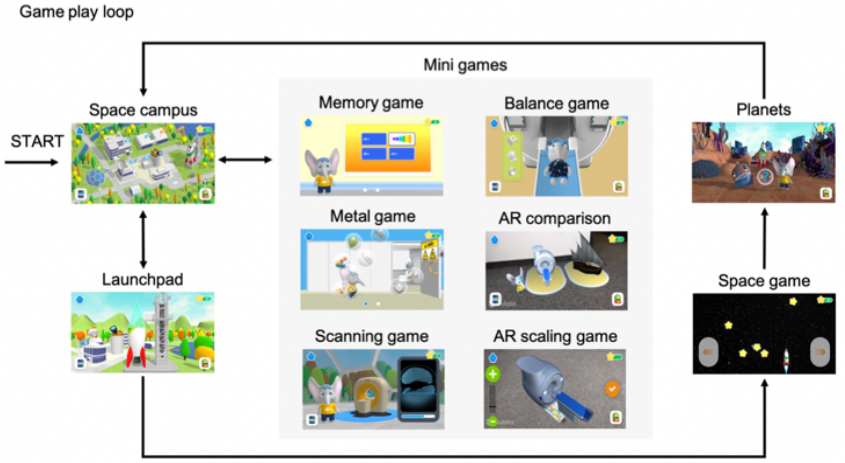
1. Explain the procedure
2. Familiarization with MRI sounds
3. Familiarization with size of the MRI machine (it is big)
4. Practice the timings (it takes very long)
5. Practice lying still
6. Learn about accessories (earplugs, head coil etc)
7. Understand metals

COSMO@Home app – Space campus

- The starting page or the “home page” of the application is the space campus from which six mini-games can be reached
- Each mini-game is designed to teach the player something about the MRI procedure
- The app is built around a space theme, and the players are told they need to train to become an astronaut that can fly to space in a rocket
- As part of their training they will need to complete space missions - they need to build a rocket and fly it to a distant planet

COSMO@Home app – Game play loop

- The user can collect rocket parts in each game, when all mini-games have been completed one time the player has gathered all the rocket parts
- In the launchpad the user can put together a rocket and set off for space
- During the space journey there is a space game in which the player can collect stars
- After the space journey the player reaches a planet, meets an alien and hand over a gift to the alien - in return the user gets a mystery item that can be scanned once back at the space campus
- Five space missions that the player needs to complete in order to become a full-fledged astronaut



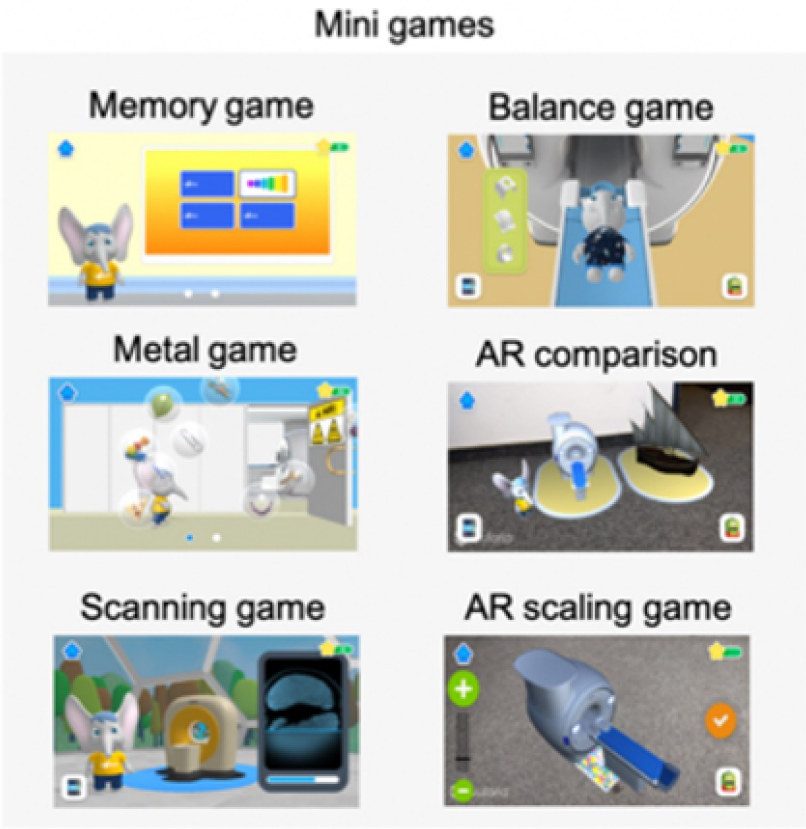
COSMO@Home app – The mini-games

Four 3D games:

- The Memory game – pair MRI sounds
- The Metal game – select objects not allowed in the MRI-scanner
- The Scanning game – scan a fruit, understand the procedure and the time it takes
- The Balance game - select accessories and conduct a scan – hold the phone still during the scanning

Two augmented reality AR-games:

- The AR Comparison game - compare objects with an MRI scanner – which one is the largest one
- The AR Scaling game – "walking around" the scanner



Aim of this work

Describe the design journey of developing a set of mini-games that successfully contribute to achieving the learning goals

Iterative user testing

- Phase 1: Initial tests – concept and functionalities (15 children)
- Phase 2: Tests with children at the hospital (17 children)
- Phase 3: User tests in the home environment (13 children)

Location	Date	Aim	Participants
Initial tests – concept and functionalities			
RISE Sweden	August - September 2019	Get a first impression of how the app was perceived by children of different ages.	6 children, 3-15 years old
RWTH, Germany	October 2019	Feedback on first mini-games and on the use of AR.	9 children, 6-9 years old
Tests at the hospital			
KU Leuven, Belgium	November 2019	Feedback on improved version of the prototype with further features. How the learning goals were conveyed.	9 children, 4-10 years old
KU Leuven, Belgium	April/May 2020	Feedback on improved version of the prototype, entire app with all the mini-games and the reward system. How the learning goals were conveyed.	8 children, 4-9 years old
Tests in the home environment			
KU Leuven, Belgium	October - November 2020	Practical aspects related to home usage, feasibility, and inclusion in hospital workflow.	13 children, 5-11 years old

Initial tests – concept and functionalities

- Tests were conducted in Sweden and Germany with children that were not associated with a hospital
- Concept and a first version of a few games included in this version
- To get a first impression of how the app was perceived by children of different ages, and to get feedback on the mini-games and the concept
- The participants tried the app and played the games
- Questions were asked about what they liked about the app and about what they did not liked about the app
- Observations of usage were made by the test leader - engagement, understanding of the concept, navigation, understanding of the learning goals

Initial tests - insights

- The children liked the concept and the games
- Not obvious that it was possible to click on the buildings
- Memory game and metal game worked well – difficult for young children to know what objects that were made out of metal
- Not clear that it was absolute forbidden with metal objects
- The AR games added value but were difficult to interact with
- Challenge to establish a clear connection between the games and the learning goals

Tests with children at the hospital

- Tests were conducted with children at the University Hospitals in Leuven
- To get feedback on improved versions and new features of the prototype
- Extended version with more games, narrative and reward system
- First tests about to which extent the learning goals were conveyed
- More detailed questionnaire about what they thought of the games and if they had understood the learning goals
- Development of questionnaires for forthcoming tests

Tests with children at the hospital - insights

- Improved understanding of the learning goals, but much of the knowledge seemed to come from the intro movie
- Not clear to which extent the youngest children understood the learning goals - they still needed much supervision from their parents
- The memory game was liked, but they used the images rather than the sounds to pair objects
- AR game (scaling game) needed a large physical space to be able to “walk around” the MRI scanner

User tests in the home environment

- Managed by University Hospitals Leuven in Belgium - the usage of the app took place in the children's homes
- A pilot study for a forthcoming clinical trial
- To test the complete application with home usage and workflow around the usage
- A start package was sent to their homes at least four days before the scan - the package contained an introduction folder, a smartphone with installed app, a marker for the AR games and an informed consent form
- At the time of the scan, the children answered a questionnaire about which game they liked/disliked the most and which game they thought was the easiest/most difficult
- Questions about general likeability of the app and about desire to play the app again
- Both children and parents also answered questions about anxiety related to the scanning procedure

User tests in the home environment - insights

- Likeability of the app: m=7.69 (scale ranging from 0-10)
- Desire to play the app again: m=6.77 (scale ranging from 0-10)
- Anxiety related to the scanning procedure - before usage of the app and at the day of the scan (scale ranging from 0-10) :
  - The reported anxiety for children dropped from 2 to 1
  - The reported anxiety for parents dropped from 5 to 3
- The observations made on the scanning day also showed that the children had fewer questions and that they were much better prepared
- The most important learning goal to address further was the lying still goal
- All other aspects seemed to be sufficiently addressed at home and needed no additional training in the hospital
- Home usage and workflow - the app could be used at home without the supervision of a researcher and it worked well within the clinical workflow

	Most liked	Most boring	Easiest game	Hardest game
Memory	3	2	3	2
Metal	1	1	2	4
Scanning	1	2	3	1
Balance	2	2	2	1
Comparison	2	2	1	2
Scaling	0	2	0	2

Conclusions - interaction

- Looked nicer on a tablet but difficult for younger children - heavy to hold and limitations due to motor skills
- Even though spoken messages were held short, they needed to be shorten further to get the messages through to the youngest children
- In-app tutorial avoided in line with guide lines, however the complex narrative around the space journey demanded a tutorial that explained the path through the app

Conclusions – learning goals

- Much knowledge of the procedure and the accessories were gained through the introduction movie
- Not bring metal objects in the MRI-scanner was addressed by the metal game – a bit difficult for young children to understand which objects that were made out of metal
- Understanding the time that it takes – need for games that include waiting time but at the same time does not become boring
- Getting familiar with the sound worked well (the memory game), but they mainly did the pairing based on the images (not the sounds)
- AR-games for understanding the size of the MRI scanner – some challenges to use the markers and need for physical space to be able to "walk around" the MRI scanner
- The most important learning goal (laying still) was the most challenging one to address in terms of a mini-game.
- A new AR-game was added where the child actually had to lay still (not just get the information or play a game where he/she had to hold the phone still)

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