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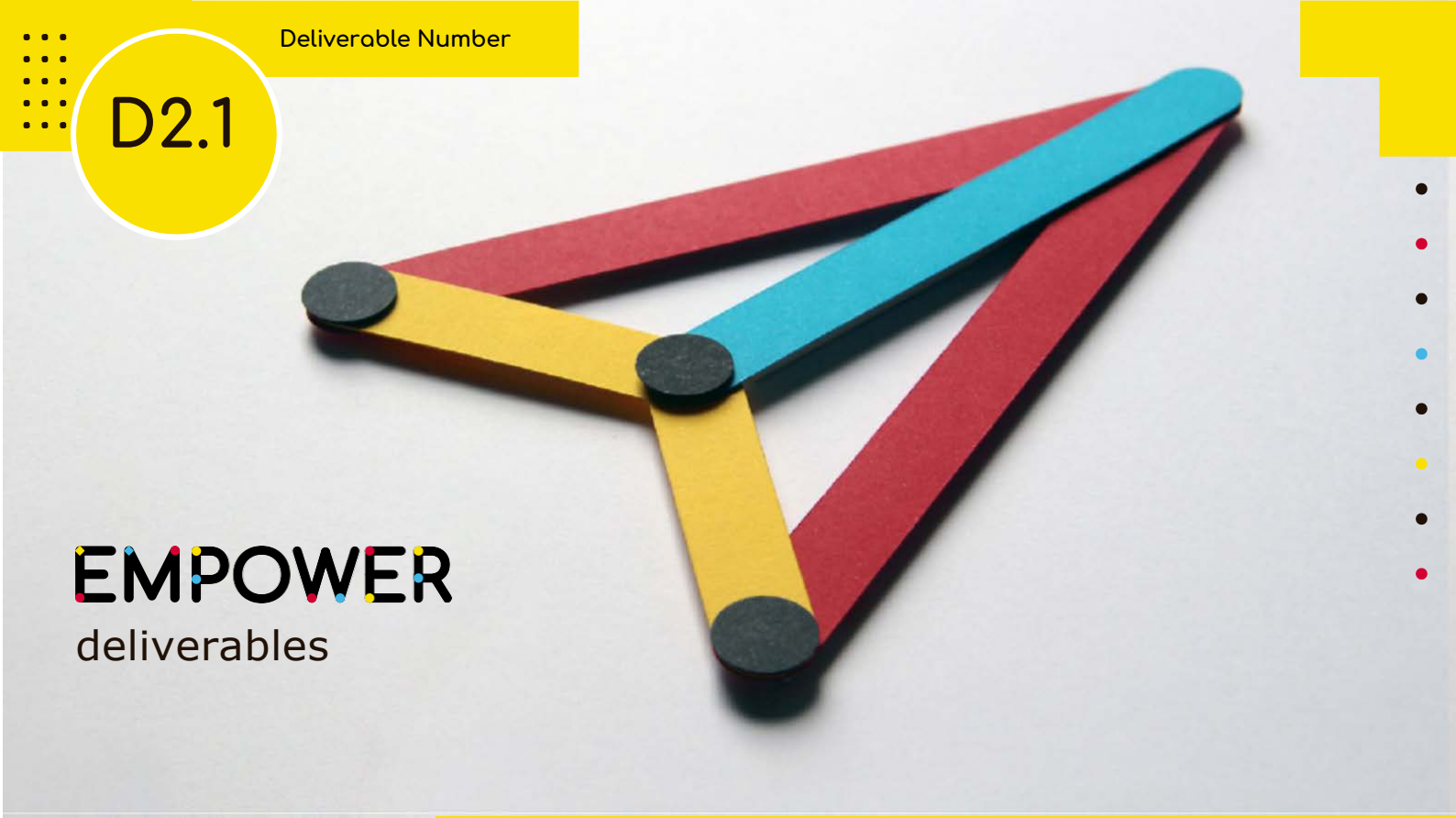

EMPOWER

deliverables

Deliverable name	COMMON FRAMEWORK FOR GAME DEVELOPMENT
Type	R - Document Report
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This deliverable describes the game development process, including the theoretical background, the description of standardized tasks which led to game development, the common framework used and the process which it guided, illustrations used for game development, content adaptation and appendix. It is part of WP2)

Description

WP.2

Work Package. 2

Lead Beneficiary – RU

Common Framework for Game Development

Executive Summary

This deliverable describes the game development process, including the theoretical background, the description of standardized tasks which led to game development, the common framework used and the process which it guided, illustrations used for game development, content adaptation and appendix. It is part of WP2)

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21.09.2023	1.0	First Draft: inclusion of required content, such as theoretical background, description of standardized tasks, common framework and process, illustrations and appendix.	Aristides Ferreira, Sara Lopes, Cristina Cotescu, Carmen David, Diana Stillwell, Diogo Domingues, Paula Ferreira, Lucia Vera, Ana Margarida Veiga Simão
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Table of Content

#1. Introduction

Children with neurodevelopmental disorders may have several challenges during the learning process. They may experience difficulties with processing spoken and written language, sensory challenges that can make sounds or kinds of lighting unpleasant and may make sitting still particularly difficult, executive functioning difficulties that make it hard to manage schedules, stay on task, and plan projects. Executive functioning refers to cognitive processes that enable goal-directed activity. According to Diamond (2013; 2020) the basic executive functions are inhibition, working memory and cognitive flexibility. Similarly, automatic response inhibition is defined as the ability to think before acting and to delay automatic responses/behaviours. Inhibition has as a subcomponent self-control, which refers to the resistance to acting impulsively and the control of interference, inhibition at the level of sustained attention. Working memory is defined as the ability to keep information in mind when students solve complex tasks, such as math problems, even if some distractors appear and mentally operate on that information. Cognitive flexibility is defined as the ability to consider a situation from different perspectives and to adapt quickly and flexibly to changed circumstances (Hoskyn, Iarocci, & Young, 2017). Deficits in executive functioning can make everyday tasks, such as organising homework or schoolwork, difficult and can also make it difficult to manage emotions and behaviours in stressful situations. Children with NDD have executive functioning deficits, which can make it difficult to adapt to the everyday activities and to independent learning necessary for success in school (Lee et al., 2011; Blasco, Saxton, & Gerrie, 2014). However, it is important to mention that there are also higher-order executive functions: planning, reasoning and problem solving. Planning is considered to be a high-level cognitive function encompassing processes such as formulating, evaluating, and selecting actions that are necessary to accomplish a desired goal; reasoning serves as the foundation for the processes of generalisation and abstraction, which are essential for forming concepts and fostering creativity; and problem solving refers to the act of analysing and resolving a problem by considering various aspects and employing mathematical or systematic approaches. It is considered to be a measure of an individual's ability to think critically (Diamond, 2013; Cristofori et al., 2019). According to Diamond (2013) these higher order executive functions are built from the three basic executive functions, therefore we will focus only on the basic executive functions.

Previous studies revealed that there is a link between executive functions and the use of emotion regulation strategies (Lantrip et al., 2016). There are some studies showing that working memory is linked with emotion regulation (Schweizer et al., 2013), others that revealed that inhibition and set shifting can predict emotional and behavioural regulation (Hendricks & Buchanan, 2016). Cognitive flexibility was also highly associated with emotional regulation (Guassi Moreira et al., 2022; Martins et al., 2016). The Emotional Dysregulation Model proposed by Mazefsky et al. (2013) suggests that the characteristics of children with ASD in combination with their emotional dysregulation deficits interact in a specific way and produce a heterogeneous presentation of the way children use their emotion regulation strategies (Mills et al., 2022). Their studies also assume that there is a link between EFs and emotion regulation and they consider that if a child has difficulties in inhibiting their automatic, rigid responses to an emotional event, they may also have difficulties to shift from one emotional regulation strategy to another and implement adaptive emotion regulation responses (Mazefsky et al., 2013). Therefore, within our work we considered basic EFs and we took into consideration some emotional competences that could be trained by using a digital platform. This deliverable defines the cognitive constructs and describes the process

that was implemented in order to develop the psychological contents of the games.

DOCUMENT OUTLINE

In the following sections we describe the theory behind the nine key developmental and educational areas of intervention of EMPOWER, as well as provide a description of the standardized task which led to game development, the common framework and process of game development from the constructs, the illustrations used as visual aids, and an appendix section.

#2. Theoretical background behind the EMPOWER games

This section provides an overview of the nine EMPOWER key developmental and educational areas of intervention. In this section, we define each of the constructs and present the standardized task used to measure/train the skill. These tasks are the scaffold for the games and how children perform in these tasks is the information necessary for the algorithms. The algorithms should be able to deliver information to the games allowing them to adapt to student performance in real time. The algorithms should also deliver feedback in an adequate form to all relevant stakeholders of EMPOWER, such as teachers, students, and parents.

UNDERLYING PSYCHOLOGICAL CONSTRUCTS

Executive functioning is an umbrella term that illustrates a group of high-order cognitive processes that facilitate goal-directed behaviours and an individual's approach in novel situations (Diamond, 2020; Wiebe & Karbach, 2017). Assessment of the cognitive and emotional factors plays an important role in the teaching-learning process, and it is a powerful tool for enhancing children's achievement and facilitating their access to personalised interventions (Neumann et al., 2018). In this project, we are interested in the following nine key developmental and educational areas of intervention (further elaborated below), which encompass components of EF:

1. Sustained Attention

Posner and Petersen (1990) proposed that the attentional system can be broken into three networks represented in distinct anatomical areas: (a) The vigilance network, responsible for maintaining a state of alertness; (b) the visual orienting network, which controls the selection of information from sensory input; and (c) the executive attention network, responsible for resolving conflicts among responses. The task developed is based on *Computerized Continuous Performance Task (CCPT; based on Rosvold, Mirsky, Sarason, Bransome, & Beck, 1956),* which was designed to improve the function of Sustained Attention, the second aspect from Posner Theory. The Comprehensive Continuous Task is designed to improve the function of Sustained Attention by training the cognitive system to activate and maintain attention at an optimal level for prolonged periods of time while simultaneously inhibiting the response system. The task is based on a continuous performance test (CPT) and was developed to improve the function of sustained attention, that is, to be able to maintain the focus of attention on a given task especially during monotonous activities. The task involves a long series of stimuli presented (mostly) sequentially with the participant instructed to respond as fast as possible only when a pre-specified target (e.g.,

brown mushroom) is presented, while withholding responses to other stimuli (e.g., flowers, small branches, butterflies (targets) appearing on the screen).

2. Working Memory

Refers to updating -the ability to dynamically modify the content of memory according to task requests (Morris & Jones, 1990). It is also defined as the system or mechanism underlying the maintenance of task-relevant information during the performance of a cognitive task (Baddeley & Hitch, 1974; Daneman & Carpenter, 1980; Miyake & Shah, 1999). Based on Miyake and colleagues' (2000) executive functions model, working memory/ updating is one of the core components, along with shifting and inhibition. Originally, the classical task was developed by Milner (1971). We modified a version of a Corsi block computerized task, as described in Macizo, Soriano and Paredes (2016). We added a concurrent task to the spatial- visual task. While processing the spatial location and updating, the children have to sort the peppers on a criterion. This addition we predict that it increases the demands of the task, while not allowing for visual rehearsal strategies or visual fixations. The computerized task from Macizo and colleagues (2016) was conducted with ASD children, ages 5-13 years old, with a mean age of 8.55 years old.

3. Cognitive Flexibility

Cognitive flexibility refers to the ability to adaptively switch between different cognitive tasks or mental sets, modifying thoughts and behavior according to changing task demands (FitzGibbon et al., 2014). According to Miyake and colleagues (2000), cognitive flexibility is one of the three core components of executive functioning, alongside working memory and inhibition. Research has demonstrated that cognitive flexibility is essential for several cognitive tasks, including problem-solving, reasoning, and decision-making. In addition, researchers have suggested that cognitive flexibility is associated with better academic performance and social functioning (Diamond, 2013). Importantly, this EF component is conceptualized as a later developing skill resulting from improvements in working memory and inhibition (Blackwell et al., 2014). This game is based on the WCST (Heaton et al., 1993), which is an instrument commonly regarded as ‘‘the gold standard executive function task’’ (Ozonoff et al., 2005, p. 532). It is a highly sensitive indicator of executive functions, especially such as mental flexibility, planning, and set maintenance.

4. Inhibition

Behavioral inhibition may be defined as the ability to stop mid-task to regulate behavior or complete a non-dominant response is supported by independent processes that are both reactive and proactive (Van Hulst et al., 2018; Verbruggen & Logan, 2008, 2009). Reactive inhibition measures the speed of the stopping process whereas proactive inhibition, or proactive slowing, involves strategic response slowing in order to complete more challenging tasks while maintaining accuracy (Van Hulst et al., 2018; Verbruggen & Logan, 2008, 2009). Finally, motivational inhibition gauges avoidance of losses in activities that include feedback or reward contingencies (Cassotti et al., 2014). Interference control is operationalized as the ability to suppress stimuli that may interfere with a response (Cragg, 2016). The fundamental idea is creating agreement (via congruent stimuli [C]) or conflict (via incongruent stimuli [IC]) between values of the target feature (recycle bin color) and the distractor feature (recycle bin color/types of trash) when responding to the target feature (Algom et al., 2022). Hence, a Stroop Effect = MRT (IC) − MRT (C).In a typical Stroop task set-up, the numbers of congruent and incongruent trials are matched (e.g., congruent/ incongruent) (Parris et al., 2022). A typical Stroop task takes between 20 and 40 min to complete

and includes 4 conditions, each of which contains 36 stimuli (Adams & Jarrold, 2009).

4. Delayed Gratification;

Delayed Gratification is the extent to which one can resist the temptation of an immediate reward and wait for a larger reward later. It is a self-regulatory skill (Duckworth et al., 2013) that predicts positive outcomes. The ability to delay gratification is one of the skills that may support individuals' self-regulation, affecting how they adapt across many different contexts. Delayed gratification and inhibition are two cognitive processes that are closely related (Rothbart et al., 2004). Studies have shown that individuals with better inhibition skills are more likely to be able to delay gratification (Mischel et al., 1989). Additionally, interventions targeting inhibition have been found to enhance delayed gratification abilities in both children and adults (Diamond & Lee, 2011; Duckworth et al., 2018).

5. Emotion naming

Emotion Naming / Recognition is defined as the ability to identify emotions in oneself and others (Baron-Cohen et al., 1985, 1986). Emotion Recognition is an essential part of social development and is considered to be a basic ability that underlies more complex emotional understanding and social skills (Jones et al., 2011). This game is based on the Test of Emotion Comprehension (TEC) (Harris & Pons, 2003; Pons & Harris, 2000; Pons, Harris, & de Rosnay, 2004). The TEC is based on an extensive review of the experimental literature on the development of emotion understanding (for reviews, see Harris, 1989; Lewis, Haviland-Jones,& Barrett, 2000; Pons, Harris, & de Rosnay, 2000; Saarni & Harris, 1989; Saarni, Mumme, & Campos, 1998).)

6. Emotion Intensity level rating

Emotion Intensity - The intensity of an emotion is the magnitude or strength of the experienced or expressed emotion (Frijda et al., 1992, Sonnemans & Frijda, 1994). This game is based on The Emotions Thermometer, which is comprised of a graphic of a traditional analog thermometer with a scale of emotion intensity. The scaling of emotional intensity was added to a graphic of a thermometer to make it intuitive (Burg, 2005).

7. Emotion Understanding

Emotion understanding is more than a marker of general intellectual functioning. It is an valuable aspect of cognitive development that has been related to various outcomes (Sprung et al., 2015). Some of the literature has shown that children's understanding of mental states, such as emotion, is associated with their opportunities to engage in interactive patterns of communication, considering their level of intellectual functioning (e.g., verbal ability) (Harris et al., 2005). In fact, emotion understanding has been related to greater competence in emotion recognition, control and regulation (Harris, 2008). Furthermore, emotion understanding is associated with the broader construct of Theory-of-Mind (i.e., awareness and knowledge of mental states, involving desires, beliefs and emotions). Also, emotion understanding has been associated with improved academic performance (Jones et al., 2011). The literature has indicated that there are individual differences with regards to emotion understanding, as well as developmental differences (Pons, de Rosnay, Andersen, & Cuisinier, 2010).

8. Emotion Regulation Strategies

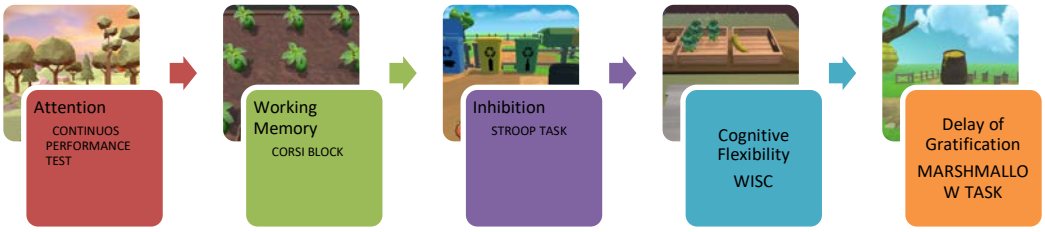
For developing the emotion regulation game we considered the definition proposed by Gross

(1998) 'the processes by which individuals influence which emotion they have, when they have them and how they experience and express these emotions" (p. 275). Even thought we categorize emotional strategies as adaptative or maladaptive, these strategies are not generally good or bad, as their adaptativity can vary across different context (Gross, 1998). The emotion regulation task is build based on tower construction task (Anger-eliciting task) developed and validated by Rohlf and Krahne (2015). The children's task is to build a wooden 10-block tower. A picture of a tower is first presented, then the children are instructed to build a tower exactly like the one in the picture within 2 min and 40 s in order to receive a reward (a candy in our study). The task is impossible to solve because two blocks are slightly rounded on one side. We will use the following adaptive emotional regulation strategies: emotional non-awareness, emotional acceptance, social support seeking, cognitive reappraisal, relaxation, and problem-solving.

#3. The standardized tasks behind the EMPOWER games

In order to have some reliable measurements in the EMPOWER platform we used some standardized tasks (see Figure 1 below) such as attention (continuous performance task), working memory (Corsi block), inhibition (Stroop task), cognitive flexibility (WISC), and delay of gratification (marshmallow task).

Fig. 1
Sequence of standardized tasks adopted in the EMPOWER project.



#4. Common Framework and Game Development Process

The EMPOWER team used a common framework (see Appendix 2) to develop the games. The objectives of using a common framework were essentially to coordinate a multidisciplinary team through a shared regulation of task execution. Specifically, a common framework enabled the team to engage in a forethought process which led to effective strategic planning to develop the games and anticipate obstacles, ways of overcoming these obstacles and outcomes. The common framework also allowed the team to create each game and monitor its development by re-evaluating ongoing development issues encompassed in the common framework as a team. This common framework also permitted a final self-reflection of each member and a group reflection concerning the process of the game development to evaluate the first prototypes to be implemented in pilot studies. We followed a strict social cognitive perspective (Bandura, 2006; Zimmerman, 2013) on the process of game development to be able to articulate the assets of the team in a structured manner in terms of varying competencies and to overcome possible scientific language barriers from the different areas (e.g., psychology, engineers, researchers, teachers…).
With a common framework, the EMPOWER team has been committed to establishing effective communication regarding game specificities. The common framework has been used as a guide in all the meetings about game development to share the regulation of task execution among team members from diverse areas (Järvelä & Hadwin, 2013). It was important to clarify a set of elements, to give the software developers as much clear information as possible by providing a description of each game in the Empower project. This information included a set of different elements to be considered, such as:

1. The game's name.
2. The objectives of each game.
3. The area/s of intervention covered in each game (working memory, inhibitory control, attention shifting, cognitive flexibility, delay of gratification, emotion naming, emotion intensity level rating, emotion understanding or emotion regulation strategies).
4. A complete description of the functionality of each game, including any interval, time or random element description that would be necessary.
5. The type of stimuli to be included in each game, namely, a description of what should contain each of the stimuli used in the game.
6. A description of modes of playing.
7. A detailed list of levels of difficulty and what should change in each one.
8. Custom options, such as changes to consider to adapt the game to the user.
9. A list of variables to be measured during the game.
10. A complete description of conditions to increase the level of difficulty.
11. The feedback used in the game and given to the player (e.g., immediate feedback during the game or final feedback at the end of the game).
12. The data to be recorded about the game and the user's performance.

#5. Illustrations which guided the EMPOWER game graphics.

To provide a visual basis for game development, the EMPOWER team used various illustrations to facilitate how the assessment and training of the various psychological constructs would be implemented by the game developers in each game. However, these initial illustrations were used only as a visual mechanism and did not remain in the actual games. They served as visual examples. Some of these illustrations can be seen in Figures 2 and 3.

Fig. 2

Initial illustrations which served as visual examples to assess and train the cognitive psychological constructs through gameplay.

Fig. 3
Initial illustrations which served as visual examples to assess and train the emotional psychological constructs through gameplay.

By providing the visual aid as a guide for better implementation of assessing and training the psychological constructs through gameplay, the EMPOWER team was able to develop the game graphics. Below (Figure 4) are just a few examples of what the EMPOWER items and figures look like in the first prototype of some of the games (see Appendix 1 for further images). Figure 4 shows the main console at the top left, followed by the BEeHOLD delay of gratification game in the top middle, along with the inhibitory control game at the top right. At the bottom left of Figure 4, there are example items of the sustained attention game, at the bottom middle is an example of the cognitive flexibility items, and lastly, at the bottom right, are example items of the WorM working memory game.

Fig. 4
A compilation of images from the EMPOWER games.

#6. Adapting the content with pilot study data

In the initial stages of this project, we met with expert teachers and independent experts via focus group interviews, to explore and gain deeper insights into their perspectives concerning the utility and need of resources to help children with neurodevelopmental disorders develop their executive functions and emotional skills. The data from these focus groups helped us to identify the main game features recommended for incorporation, which we took into consideration during the construction phase of the games.

After the games were completed, and before our pilot study, we presented them to the same sample of specialists to revise the items and the game's contents, enabling us to extract possible improvements. In this intensive review of each game, we considered the suggestions made by the teachers and changed the games accordingly. In this case, some of the changes that we made were:

· Sustained Attention game
  - Increased the size of the mushrooms and reviewed the size of the other elements integrated in the game.
  - Changed the color and shadows of the background to make it easier to see the mushrooms and other stimuli.
  - Changed the color of the target mushroom to make it more recognizable.

· Working Memory game
  - Included visual feedback for when the child does the sorting task, to help her understand if the selected basket was the correct or incorrect one.
  - Added an illustration in each type of basket. This was done by adding an image of a good pepper for one basket and an image of a pepper with a bug in the other basket.
  - At the end of the game, we added a scene with the number of peppers correctly and incorrectly classified.
  - Changed the size of the worm in the peppers to make it more visible.

· Inhibition game
  - Added different sounds for each type of trash for when the trash comes out of the black bin.

After this phase, the games were tested with children in the pilot studies. The pilot study was anonymized: no personal identifiers (such as the name of the children) were collected. For instance, each child had an associated code, that was used for the teachers' to create the child's profile in the game.
After playing and interacting with the platform and the games, the children and teachers provided us with their feedback. Considering their recommendations and taking into account how the games, database and wearables behaved during these trials, we have decided to implement the following changes for the next pilot studies:

- Record more data in the database on what is happening inside the game (the response time for each trial, the correct/incorrect answer for each trial, etc.) to make it possible the correlate this information with the eye tracker data and the watch.
- Reduce the number of levels in the attention game, because we had 9 levels and all the other games have 3, keeping the same number of levels for all the games.
- Control the access to games for the eye tracker, only calibrating once, because it is a long and tedious process for the children.
- Change the calibration scene for the eye tracker, making it more appealing for children. We noticed they might not be paying attention to the screen because it was not interesting enough, making the calibration take longer.
- Improvements are needed to acquire better data from the wearables and the eye tracker. Our IT team is focusing on finding solutions.
- Control the wearable device's local times to enable correlating data in the database using timestamps.

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Appendix 1

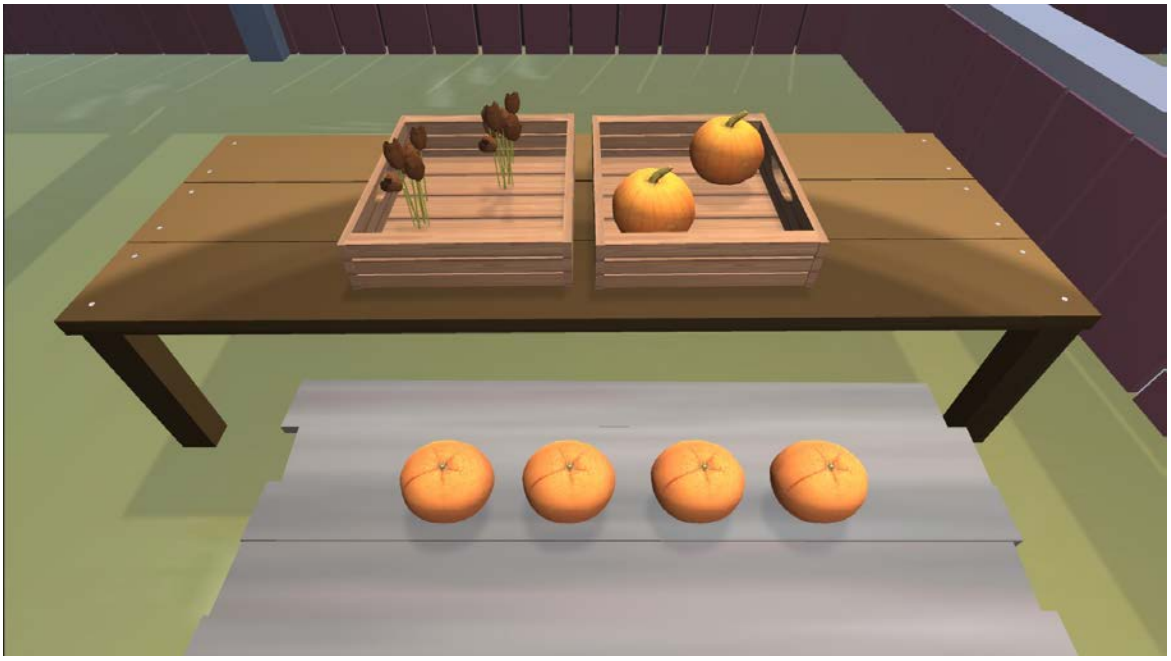
Screenshots from the EMPOWER games.

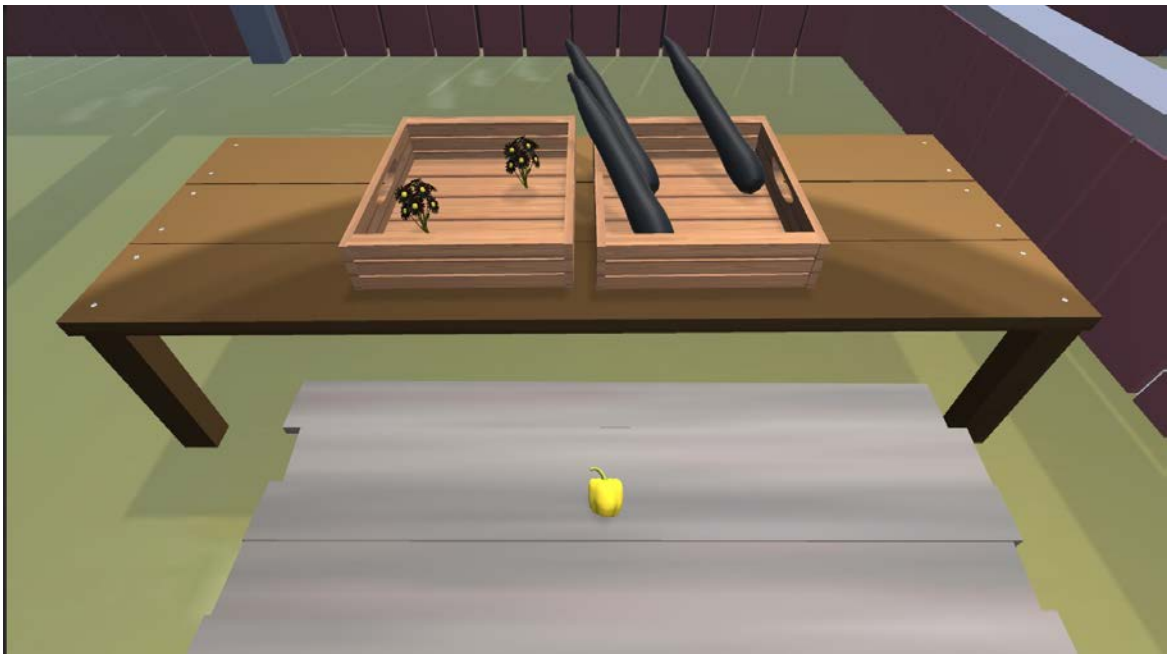
Main Screen of the EMPOWER games

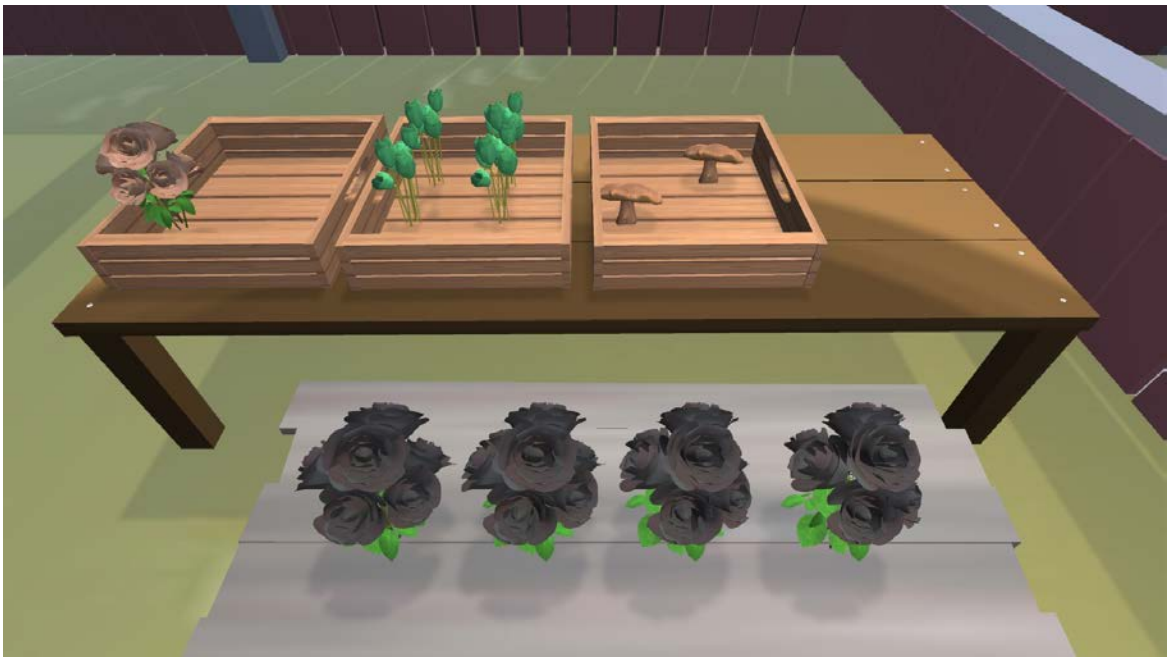
Sustained Attention Game - *Mushroom Hunters*

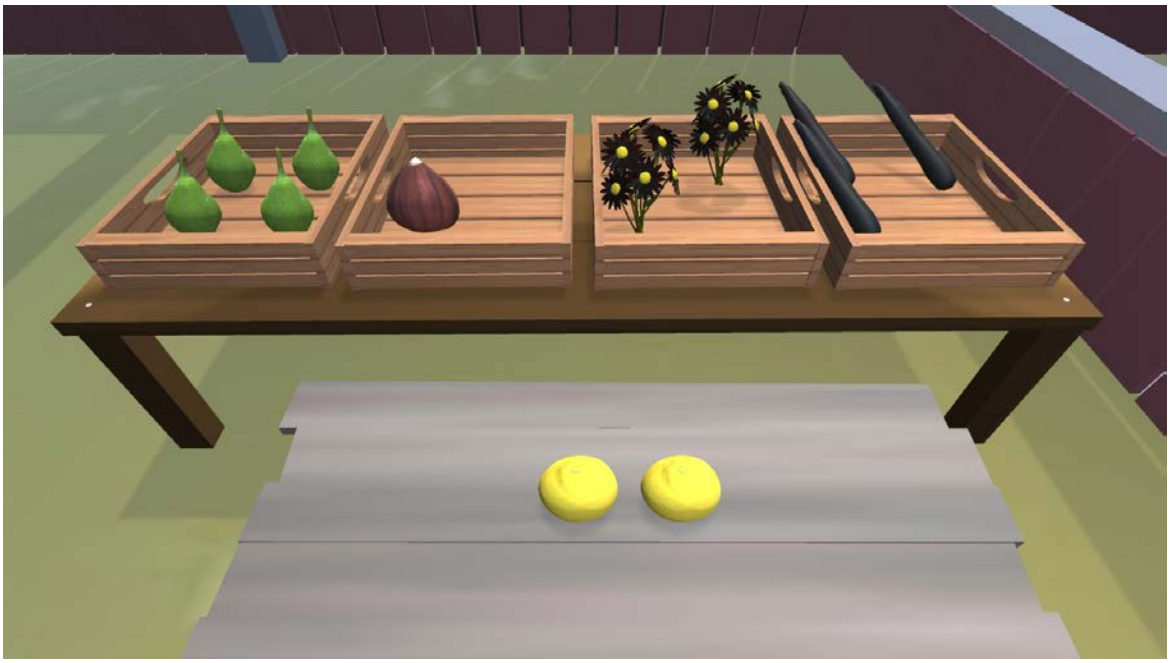

Instructions
Levels
1
1
2
2
3
3
Touch the correct mushroom on the screen.
DEMO

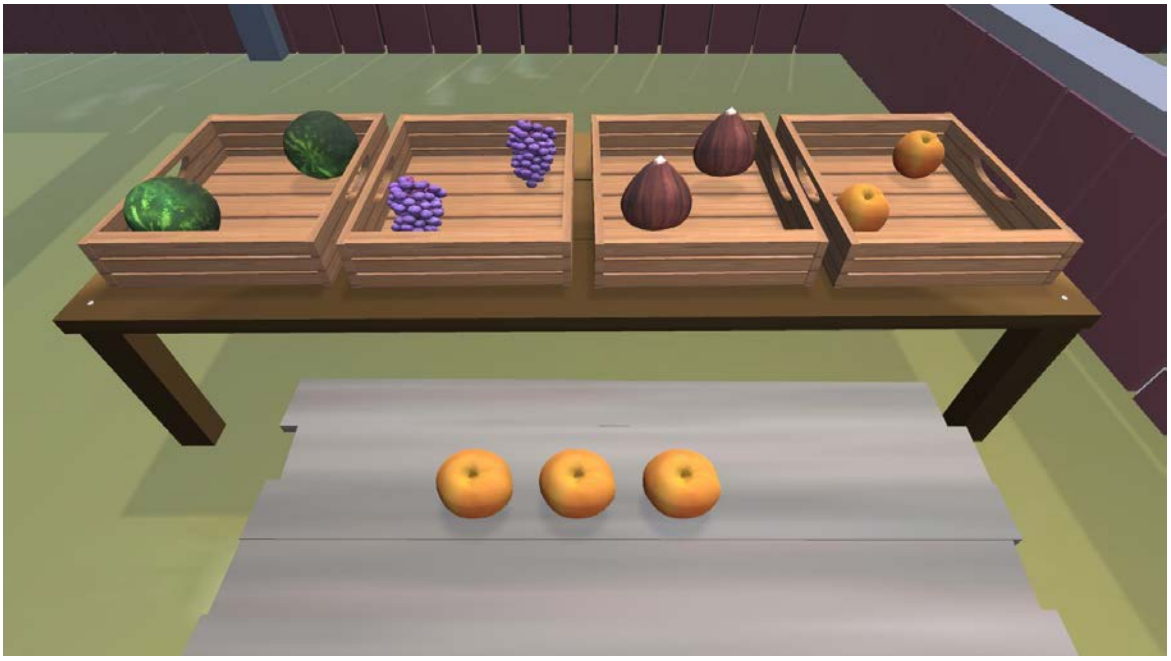
Cognitive Flexibility - ***ReFlex***









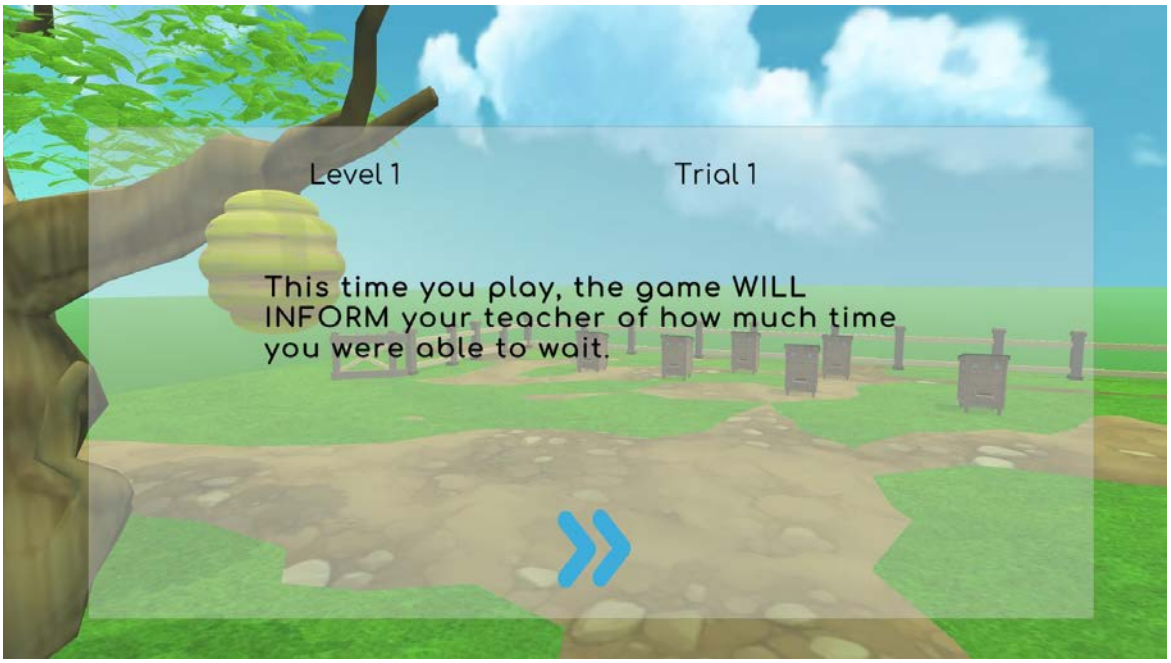


Delay of Gratification Game - ***BEeHOLD***


Magic Golden Honey can make your EcoFarm healthy because it is a Super Food! It has important nutrients that will make your Farm shine like gold!If it shines like gold, it will attract more honeybees that make more honey for your farm to be shinier and healthier!


Level 1
Trial 1
If you click on the golden button now, you get 1 pot! 1 pot attracts 5 more honeybees to produce more honey today!

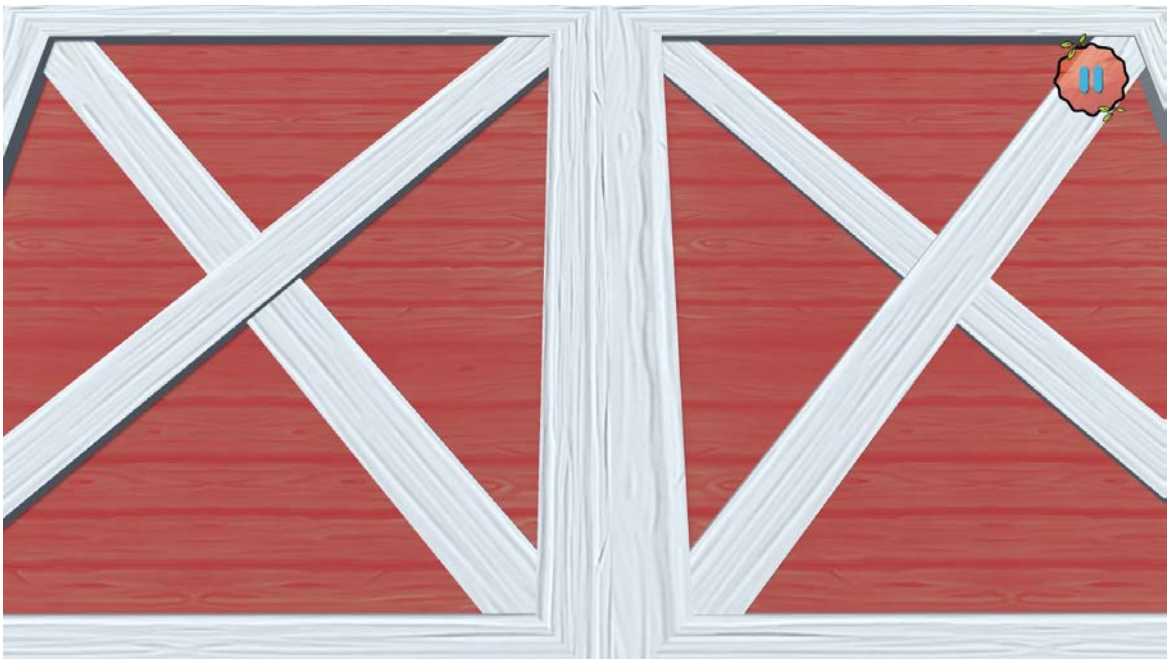

Level 1
Trial 1
If you wait for the beekeeper in order to click on the golden button, you get 2 pots! 2 pots make 1 area of the farm shine like gold and you attract 10 more honeybees to produce more honey today!


Level 1
Trial 1
This time you play, the game WILL INFORM your teacher of how much time you were able to wait.


Level 3
Trial 2
LOOK at how the bees are working.

Inhibitory Control Game - ***RE♻Stroop***

Working Memory Game - ***WorM***



Appendix 2

Sustained Attention Game - ***Mushroom Hunters***

Game name	Mushroom Hunters
Area/s of intervention covered (working memory, inhibitory control, attention shifting, cognitive flexibility, delay of gratification, emotion naming, emotion intensity level rating, emotion understanding or emotion regulation strategies).	Sustained attention (This task is very similar with the one with the RED BALL). - The Comprehensive Continuous Task is designed to improve the function of Sustained Attention by training the cognitive system to activate and maintain attention at an optimal level for prolonged periods of time while simultaneously inhibiting the response system. The task is based on a continuous performance test (CPT). The task involves a long series of stimuli presented (mostly) sequentially with the participant instructed to respond as fast as possible only when a pre-specified target (e.g., brown mushroom) is presented, while withholding responses to other stimuli (e.g., flowers, small branches, butterflies (targets) appearing on the screen).

Complete description of the functionality (include any interval, time or random element description that will be necessary)	In this task, participants had to respond to the appearance of mushroom (target) while maintaining focus and inhibiting responses to other appearing objects (level 1). The mushroom will be only present in 30% of the trials. (Action takes place in the forest – on a pathway). In level 2 participants had to respond when the target mushroom appears within other stimuli from the forest, (flowers, small branches, butterflies) Action takes place in the forest – on a pathway. Static distractors may appear on the right and on the left on the alley and can either be positioned far away from the targets or close to the target. In level 3 participants had to respond when the target mushroom appeared within other stimuli, (2 more types of mushrooms). The number of such items is randomly chosen (between 1 and 4) and they are randomly positioned in the 4 possible positions in the right or left way of the alley. The three types of mushrooms will differ in their color but they have the same shape. Each trial is presented for 500 msec and is separated from the next by an interval of either 1000, 1500, 2000, or 2500 msec (randomly selected). The stimulus types are randomly intermixed.

Objectives of the game	To help the farmer to pick eatable mushrooms. Story for the child: In this farm we also have a small forest in which you can pick some mushrooms. In your way through the forest you can find, flowers, butterflies, and small branches, but you only need to collect the mushrooms.	
Type of stimuli (describe what should contain each of the stimuli used in the game)	You will find 3 types of mushrooms, ones that are good mushrooms, which you need to collect them, some poisoned mushrooms and some mushrooms that grow only if you use pesticides. Pesticides are not good for the plants nor for our health. Be careful to pick only the mushrooms that are edible and good for our health.	
	Stimuli	**Description**

Mushrooms

Flowers, small branches, butterflies

3 different types of mushrooms

Level I:

1. Single target (central), 30%, 60 trials, with simple distractors (only the trees)

2. Single target (central), 30%, 60 trials, with simple distractors – adding more tricky distractors

3. Single target (central), 30%, 60 trials, static distractors - adding more tricky distractors

4. Single target (central), 30%, 60 trials, static distractors - adding more tricky distractors Level II

5. Flowers, small branches, butterflies + target (close), 30%, 60 trials, static distractors (far)

6. Flowers, small branches, butterflies + target (close), 30%, 60 trials, static distractors (far)

7. Flowers, small branches, butterflies + target (far), 30%, 60 trials, static distractors (close)

8. Flowers, small branches, butterflies + target (far), 30%, 60 trials, static distractors (close)

9. Flowers, small branches, butterflies + target (central), 30%, 60 trials, static distractors (central)

10. Flowers, small branches, butterflies + target (central), 30%, 60 trials, static distractors (central)

Level III

	11. 3 different types of mushrooms + target (close), 30%, 60 trials, static distractors (far) 12. 3 different types of mushrooms + target (close), 30%, 60 trials, static distractors (far) 13. 3 different types of mushrooms + target (far), 30%, 60 trials, static distractors (close) 14. 3 different types of mushrooms + target (far), 30%, 60 trials, static distractors (close) 15. 3 different types of mushrooms + target (central), 30%, 60 trials, static distractors (central) 16. 3 different types of mushrooms + target (central), 30%, 60 trials, static distractors (central)

Description of modes of playing (if necessary)	Mode	Way of playing
	Similar with the game with the red ball	

Detailed list of levels of difficulty and what should change in each one		
	Level	Specific changes in the game for that level
	Level 1: only one type of mushrooms presented on the pathway	
	Level 2: flowers, small branches, butterflies presented on the pathway	Add flowers, small branches, butterflies
	Level 3: three types of mushrooms presented on the pathway	Add three types of mushrooms

Custom options: changes to consider to adapt the game to the user			
	Option	Change in the game	
	-		
List of variables to be measured during the game	Variable	What does it measure?	Which element measure it? (Software/Device (which))
	Reaction Time	The time between target stimuli appears until the child touches the screen	Tablet

Correct answers	The number of correctly identified target stimuli EXTRA: How many times the child responded correctly when the target was on the left of the screen and how many times the child answered correctly when the target was on the right of the screen	Tablet
Omission errors	The number of omitted target stimuli	Tablet
Commission errors	The number of times the participant presses the tablet/button when the target is not presented	

Complete description of conditions to increase the level of difficulty (if necessary)	Visual path	From right to left, from up to down, organized – disorganized, fixations	Eye-tracker
	Variables to consider		Condition to increase the level
Feedbacks used in the game (consider is necessary immediate feedback during the game or final feedback at the end of the game)	Feedback		Conditions
	The feedback will be provided at the end of the game – the farmer will have a basket with all the mushrooms collected.		
Data to be recorded about the game and the user's performance	Data (if the data is a previous defined variable, you can use the name of the variable)		What it measure?

Game name	Reflex - Going to the Farmers Market
Area/s of intervention covered (working memory, inhibitory control, attention shifting, cognitive flexibility, delay of gratification, emotion naming, emotion intensity level rating, emotion understanding or emotion regulation strategies).	PRIMARY CONCEPT: Cognitive flexibility. Refers to the ability to adaptively switch between different cognitive tasks or mental sets, adapting thoughts and behaviour according to changing task demands (FitzGibbon et al., 2014). This game is based on the WCST (Heaton et al. 1993), which is an instrument commonly regarded as ‘‘the gold standard executive function task’’ (Ozonoff et al. 2005, p. 532). It promises to be a highly sensitive indicator of executive functions, especially such as mental flexibility, planning, and set maintenance. SECONDARY CONCEPT: Sustained attention, this construct is a latent one commonly linked with Cognitive flexibility, and studies have highlighted that problems with attention may affect the ability to grasp the sorting principle during WCST test sessions. It will be interesting to assess how much this secondary concept interferes with this task.

Complete description of the functionality (include any interval, time or random element description that will be necessary)	Successful performance in this game requires the participant to first determine the correct sorting principle on the basis of verbal and visual feedback, and then to maintain this sorting principle until a new sorting rule and set of key images is provided. The participants are shown sets of key images with differing shape/item, number and colour and are asked to sort different items (that are on top of a table) along an unspecified dimension (e.g., shape). Participants are not told the sorting rule but are provided with in game feedback as to whether a given match is correct or incorrect. There is no time limit for the completion of this game nor the presentation of stimuli (items). In case there is a lack of response (trying to match an item with a key image) after 10 secs, a verbal and visual cue is provided – "try matching the image". If after 10 more secs the participant has still not made a match, the correct Key image for the match is highlighted, the verbal/visual cue ("try matching the image") is heard/seen again and the response for this trial is marked as a "no response error" on the final scoring. Each set of key images (2, 3 or 4) is shown to the participant and the participant starts sorting items until reaching 10 consecutive correct sorting matches. When those are reached, the key images change and the sorting rule changes as well. Every time a match is tried, the participants are given feedback on the accuracy of their match. When a match is done incorrectly, the participant gets to try again, but their response is only scored once for the first time the match is tried and is marked as an error. The game ends when the participant successfully sorts six times 10 consecutive correct sorting matches or progresses through 90 sorting items.

The level of the game is increased after 3 consecutive trials (playing this game) when the game is played and the score of correct responses is equal to or higher than 90%.

Sorting rules
Shape (item): Fruit / Vegetables / Flowers
Colours: Yellow, Black, Purple, Green, orange
Number: 1-5

Level 1: 2 Key images (any combination of 2: number, colour and **FRUIT**)
Level 2: 3 Key images (any combination of 3: number, colour and **VEGETABLES**)
Level 3: 4 Key images (any combination of 4: number, colour and **FLOWERS***)*

List of shape items:
Level 1 - Fruit*: Grape, orange, banana, pineapple, pear*
Level 2 - Vegetables: *Mushroom, onion, courgette, pepper, eggplant*
Level 3 - Flowers: *Cactus, roses, tulips, daisies, potos*

Scoring:
As in the standard scoring for the WCST,

1. Number of **trials** administered
2. Number of **categories** completed (The number of categories where a specific rule applies)
3. Number of trials taken to complete the **first category**
4. Total number of **correct responses**
5. **Non-perseverative errors** (when children make mistakes because they haven't understood that the sorting rule has changed)
6. No response Errors
7. Total errors
8. **Failure-to-maintain-set** (calculated by counting the number of times a participant fails to sort images by the sorting rule after at least **five** images in a row are **correctly** sorted. FMS is a reflection of errors made as images 6-10 in a maintained category are sorted. If any of images 6-10 are sorted incorrectly, then he or she has failed to maintain set)

9. **Total number of errors** (The sum of perseveration and non-perseveration errors is the total number of errors).

10. Mean response time

11. Data from the eye tracker software:
    a. **Visual path** - From right to left, from up to down, organized – disorganized, fixations, linked with the # of trial
    a.

<table>
<tr><td>Objectives of the game</td><td colspan="2">Successful performance in this game requires the participant to first determine the correct sorting principle on the basis of verbal and visual feedback, and then to maintain this sorting principle until a new sorting rule and set of key images is provided.</td></tr>
<tr><td rowspan="2">Type of stimuli (describe what should contain each of the stimuli used in the game)</td><td>Stimuli</td><td>Description</td></tr>
<tr><td colspan="2">Both key images and items consist of pictures of 1 to 4 fruit, vegetables or flowers, varying in 4 different colours (yellow, brown, black and purple).</td></tr>
<tr><td>Description of modes of playing (if necessary)</td><td>Mode</td><td>Way of playing</td></tr>
</table>

The images of products are placed on the top of the table. The crates have the "key images" in them.

Instruction given orally and visually to the participant by the farmer (social agent):
"Rain is important for crops and plants to grow. In our farm, no chemicals are allowed to make them grow. "

(Participants should hear these instructions at the same time as a speech bubble pops up coming out of the participants' avatar that is placed next to a crate)

Instruction given orally and visually to the participant by the farmer (social agent):
"There are # items in front of you. We are getting ready to go to the farmers' market but we still need a few things before we can leave. Think about which items to take. Please match an item on the table with the item in the crate by selecting the one on the table that should go into the crate. Try and figure out the special rule our farmer is using. We need to take well-organized crates to the market to get customers, so you will have to try to organize the crates. But do not worry, I will help you along the way."

After these instructions the game starts, and the participant sees the first set of key images on the screen.

The farmer (social agent) instructs the player to start the game.

Instruction given orally and visually to the participant by the farmer (social agent):

"You can start organizing the crates to take to the market."

Every time a match is tried, the farmer (social agent) gives verbal and visual (a speech bubble) feedback:

- If the match was **correct** - **“correct” or “well done”.**
- If the match is **incorrect** - **“try again”.**

When a match is done incorrectly, the participant gets to try again, as many times as needed until a correct match is provided for that item.

Detailed list of levels of difficulty and what should change in each one		
	Level	Specific changes in the game for that level
	Level 1: 2 Key images (any combination of 2 item categories)	
	Level 2: 3 Key images (any combination of 3 item categories)	
	Level 3: 4 Key images (any combination of 4 item categories)	
Custom options: changes to consider to adapt the game to the user	Option	Change in the game

List of variables to be measured during the game	Variable	What does it measure?	Which element measures it? (Software/Device (which))
	Cognitive Flexibility		Log File Data
	Sustained attention		Eye tracking software
Complete description of conditions to increase the level of difficulty (if necessary)	Variables to consider	Condition to increase the level	
Feedbacks used in the game (consider is necessary immediate feedback during the game or final feedback at the end of the game)	Feedback	Conditions	
	Final feedback given by the farmer (social agent) as the goods are being loaded into the truck): "Well done, you did it! We are now ready to go the Farmers' Market!"		

Data to be recorded about the game and the user's performance	**"Well done!" at the end.**	
	Data (if the data is a previous defined variable, you can use the name of the variable)	What does it measure?
	(please see scoring details above)	Log files must record every movement the player makes in terms of drag and drop and also the eye movement of the player. It is important to understand whether the player looks directly at the correct items or whether the player hesitates and looks at other items.

Delay of Gratification Game - **BEeHOLD**

Game name	**BEeHOLD – The delay of gratification game**
Area/s of intervention covered (working memory, inhibitory control, attention shifting, cognitive flexibility, delay of gratification, emotion naming, emotion intensity level rating, emotion understanding or emotion regulation strategies).	**PRIMARY CONCEPT:** Delayed Gratification - the extent to which one can resist the temptation of an immediate reward and wait for a larger reward later. It is a self-regulatory skill (Duckworth et al., 2013) that predicts positive outcomes. By 3 years of age, children begin to show marked improvements on delay tasks that require them to do such things as wait for a snack or gift, slow down motor activity, or speak in a lower voice (Kochanska et al., 2000). As they enter the preschool years, children show continued improvements in impulse control tasks like "Simon Says" (Jones et al., 2003) and in the use of effective strategies in tasks requiring them to delay gratification for longer durations (Mischel et al., 1989). These developments reflect what Kopp (1989) has referred to as the balance between self-defined needs and social expectations during the preschool years. **SECONDARY CONCEPT:** Self-regulation. Self-regulatory skills are comprised of both inhibitory and excitatory capacities such that individuals might need to actively suppress or delay their responses in some circumstances and/or initiate or activate their behavior to respond to other situational demands. The ability to delay gratification is one of the skills that may support individuals' self-regulation, impacting how they adapt across many different contexts. **TERCIARY CONCEPT:** inhibitory control. Delayed gratification involves the use of inhibitory control To restrain a dominant, or desired response and execute a subdominant response instead (Rothbart et al., 2004). Previous studies using this paradigm have hypothesized that the length of time a participant can wait for the preferred reward is indicative of willpower or self-control, particularly in relation to food (Reynolds & Schiffbauer, 2005). There is

a strong correlation between readiness to delay gratification and subsequent scholastic success (Casey et al., 2011). The delay of gratification has a long-lasting and positive contribution, even after accounting for students' cognitive performance and other non-cognitive skills measured at age 10–11 years (Li, 2022). If intervention developers hope to generate the kinds of improvements associated with the original marshmallow study, it is likely to be more fruitful to target the broader cognitive and behavioral abilities related to gratification delay (Watts et al., 2018). Patience, which we define as the "ability to tolerate delay" (Barragan-Jason et al., 2018), is a broader concept than simply choosing whether or not to delay for a larger reward (Barragan-Jason et al., 2019). Rather, this concept also encompasses behavioral (e.g., how we wait) and contextual (e.g., social/non-social; with/without gratification) factors that influence whether or not an individual displays patience (Barragan-Jason et al., 2018). Recent perspectives on patience recommend that its measurement should take into account relevant behavioral and contextual factors (Barragan-Jason et al., 2019).

Typically the outcome measure for the delay of gratification task is the time spent waiting for the larger reward, however, this measure has limitations. For example, there is no clear guidance in the literature for how long children should wait before receiving the larger reward. Wait times that are too short are likely to produce data that lack sufficient individual variability, and thus may be limited in their predictive power. On the other hand, wait times that are too long may lengthen experimental protocols and capture child level temperament characteristics beyond self-control (e.g., persistence). In addition, using "wait time" as an outcome limits the use of this task with younger children. As originally developed, Mischel and Ebbeson's task was intended to assess self-control in preschool age groups(Mischel, Shoda, & Rodriguez, 1989). Due to improvement in self-regulatory skills with development, by age 5 years most children will wait for a larger, delayed reward (Mischel, Shoda, & Rodriguez, 1992). As a result, studies that have used this task with older children have adapted the task by increasing the number of trials and/or waiting period to receive the larger reward (Gearhardt et al., 2017; Wilson, Andrews, & Shum, 2017; Wulfert, Block, Santa Ana, Rodriguez, & Colsman, 2002). A key limitation with this adapted approach is that it lengthens the

time of the experimental protocol which may not be practical in all testing scenarios. An alternative approach to wait time is to identify behaviors children exhibit during the task (Lundquist et al., 2019). For example, children can stay still or fidgeting, can remain silent or talk (Lundquist et al., 2019). Fidgeting has been defined as moving any body part for more than one second and included moving of the head, swinging of feet under table, and playing with hands (Lundquist et al., 2019).

Recent studies have shown that children with ADHD are more likely to abandon efforts to wait, especially when wait times were extended and when expected rewards failed to appear (Furukawa et al., 2023).

COVARIATES TO CONSIDER, according to the literature:

TEMPTATION: Previous studies identified common strategies used by children during this task, such as looking at or away from the reward (Mischel & Mischel, 1987; Mischel & Ebbesen, 1970; Power et al., 2016; Schlam et al., 2013). The ability to avoid looking at the target food has been described as a behavior that helps extend waiting time (Mischel & Ebbesen, 1970; Power et al., 2016). Work assessing delay of gratification in older children (6-12 year-olds) has shown that on average, they tend to have longer wait times, however, individual variability in performance exists in that children who spend more time focused on the food reward tended to end the task early (Rodriguez, Mischel, & Shoda, 1989). Therefore, the attentional strategies employed during the delay period may help to characterize individual differences (Lundquist et al., 2019).

SOCIAL NORMS: Young children will wait nearly twice as long for a reward if they are told their teacher will find out how long they waited - awareness of what other people value. The children waited longer in the teacher and peer conditions even though no one directly told them that it's good to wait longer (Fengling Ma et al., 2020).

	DISTRACTION: Not thinking about a reward enhances the ability to delay gratification, rather than focusing attention on the future reward (Mischel et al., 1970; Mischel et al., 1989). **DOUBT vs TRUST**: There is evidence that children wait less if the person providing the reward is untrustworthy (Doebel & Munakata, 2018; Doebel et al, 2020). **OBSERVED BEHAVIOR TO CONSIDER:** Still vs Fidgeting and Silent vs Talking.
Complete description of the functionality (include any interval, time or random element description that will be necessary)	**Time to complete each trial for each level:** 60 seconds for the beekeeper to appear (Scheres et al., 2010). There are 3 levels with 3 trials each. 9 x 60 = 540 seconds (9 min total), (which is below the 12 min total used in a complete task by Wilson et al., 2011).
Objectives of the game	Successful performance in this game requires the participant to: Wait for the beekeeper in order to press the button/honey pot, so as to receive the greater reward, as opposed to clicking immediately on the button/honey pot in order to get the instant reward.

Type of stimuli (describe what should contain each of the stimuli used in the game)	**Stimuli - COVARIATES**	**Description**
	TEMPTATION **SOCIAL NORMS** **DISTRACTION** **DOUBT**	**TEMPTATION:** The honey pot appears. **SOCIAL NORMS:** We tell the children the game will inform their teacher of how long they waited. **DISTRACTION:** Bees working. **DOUBT:** Creating doubt about whether they will receive the reward.
Description of modes of playing (if necess	**Mode**	**Way of playing**

The children get audio and visual instructions:

"Magic Golden Honey can make your EcoFarm healthy because it is a Super Food! It has important nutrients that will make your Farm shine like gold! If it shines like gold, it will attract more honeybees that make more honey for your farm to be shinier and healthier!"

The game should show example video of clicking on the button without the beekeeper and getting the smaller reward of 5 bees. Then show another video of waiting for the beekeeper and getting 2 pots of honey and one glowing area of the farm for a day.

LEVEL 1 TRIAL 1 - INSTRUCTIONS

The children are then instructed through audio and visual instructions of the following:

"If you click on the golden button now, you get 1 pot!

	1 pot attracts 5 more honeybees to produce more honey today!" **"If you wait for the beekeeper in order to click on the golden button, you get 2 pots! 2 pots make 1 area of the farm shine like gold and you attract 10 more honeybees to produce more honey today!"** **"This time you play, the game <u>WILL INFORM</u> your teacher how much time you were able to wait."** **"<u>LOOK</u> at how the bees are working."** **LEVEL 1 TRIAL 2 - INSTRUCTIONS** The children are then instructed through audio and visual instructions of the following: **"If you click on the golden button now, you get 1 pot!** **1 pot attracts 5 more honeybees to produce more honey today!"**	

"If you wait for the beekeeper in order to click on the golden button, you get 2 pots! 2 pots make 1 area of the farm shine like gold and you attract 10 more honeybees to produce more honey today!"

"This time you play, the game <u>WILL NOT</u> inform anyone of how much time you were able to wait."

"<u>LOOK</u> at how the bees are working."

LEVEL 1 TRIAL 3 - INSTRUCTIONS

The children are then instructed through audio and visual instructions of the following:

"If you click on the golden button now, you get 1 pot!

1 pot attracts 5 more honeybees to produce more honey today!"

"If you wait for the beekeeper in order to click on the golden button, you get 2 pots! 2 pots make 1 area of the farm shine like

gold and you attract 10 more honeybees to produce more honey today!"

"This time you play, the game <u>WILL INFORM</u> your teacher of how much time you were able to wait."

LEVEL 2 TRIAL 1 - INSTRUCTIONS

The children are then instructed through audio and visual instructions of the following:

"If you click on the golden button now, you get 1 pot!

1 pot attracts 5 more honeybees to produce more honey today!"

"If you wait for the beekeeper in order to click on the golden button, you get 2 pots! 2 pots make 1 area of the farm shine like gold and you attract 10 more honeybees to produce more honey today!"

"This time you play, the game <u>WILL NOT</u> inform anyone of how much time you were able to wait."

LEVEL 2 TRIAL 2 - INSTRUCTIONS

The children are then instructed through audio and visual instructions of the following:

"If you click on the golden button now, you get 1 pot!

1 pot attracts 5 more honeybees to produce more honey during Spring!"

"If you wait for the beekeeper in order to click on the golden button, you MAY or MAY NOT get 4 pots! 4 pots make 1 area of the farm shine like gold and you attract 20 more honeybees to produce more honey during Spring!"

"This time you play, the game WILL NOT inform anyone of how much time you were able to wait."

"LOOK at how the bees are working."

LEVEL 2 TRIAL 3 - INSTRUCTIONS

The children are then instructed through audio and visual instructions of the following:

"If you click on the golden button now, you get 1 pot!

1 pot attracts 5 more honeybees to produce more honey during Spring!"

"If you wait for the beekeeper in order to click on the golden button, you <u>MAY or MAY NOT</u> 4 pots! 4 pots make 1 area of the farm shine like gold and you attract 20 more honeybees to produce more honey during Spring!"

"This time you play, the game <u>WILL NOT</u> inform anyone of how much time you were able to wait."

LEVEL 3 TRIAL 1 - INSTRUCTIONS

The children are then instructed through audio and visual instructions of the following:

"If you click on the golden honey now, you will get 1 pot!

1 pot attracts 5 more honeybees to produce more during Spring!"

"If you wait for the beekeeper in order to click on the golden honey, you get 4 pots! 4 pots make 1 area of the farm shine like gold and you attract 20 more honeybees to produce more honey during Spring!"

"This time you play, the game <u>WILL</u> inform your teacher of how much time you were able to wait."

LEVEL 3 TRIAL 2 - INSTRUCTIONS

The children are then instructed through audio and visual instructions of the following:

"If you click on the golden honey now, you get 1 pot!

1 pot attracts 5 more honeybees to produce more honey during Spring!"

"If you wait for the beekeeper in order to click on the golden honey, you <u>will</u> 4 pots!

4 pots make 1 area of the farm shine like gold and you attract 20 more honeybees to produce more honey during Spring!"

"This time you play, the game <u>WILL NOT</u> inform anyone of how much time you were able to wait."

"<u>LOOK</u> at how the bees are working."

LEVEL 3 TRIAL 3 - INSTRUCTIONS

The children are then instructed through audio and visual instructions of the following:

"If you click on the golden button now, you get 1 pot!

1 pot attracts 5 more honeybees to produce more honey all year!"

"If you wait for the beekeeper in order to click on the golden button, you <u>MAY or MAY NOT</u> get 6 pots! 6 pots make your entire farm shine like gold and you attract 30 more honeybees to produce more honey all year!"

	"This time you play, the game <u>WILL NOT</u> inform anyone of how much time you were able to wait." ----------	

Detailed list of levels of difficulty and what	**Level – depends on the covariates**	**Specific changes in the game for that level**

should change in each one	**LEVEL 1:** **TRIAL 1:** NO TEMPTATION WITH SOCIAL NORM WITH DISTRACTION NO DOUBT **TRIAL 2:** NO TEMPTATION NO SOCIAL NORM WITH DISTRACTION NO DOUBT **TRIAL 3:** NO TEMPTATION WITH SOCIAL NORM NO DISTRACTION NO DOUBT	**No temptation** = Golden Button **Temptation** = Golden Honey Pot **No social norm** = The player is told game will not inform anyone of waited time. **Social norm** = The player is told game will inform teacher of waited time. **No distraction** = No bees during trial Distraction = The presence of bees working during trial **No doubt** = Children are told they will get the honey pots. **Doubt** = Children are told they may or may not get the honey pots.

	LEVEL 2: **TRIAL 1:** NO TEMPTATION NO SOCIAL NORM NO DISTRACTION NO DOUBT **TRIAL 2:** NO TEMPTATION NO SOCIAL NORM WITH DISTRACTION WITH DOUBT **TRIAL 3:** NO TEMPTATION NO SOCIAL NORM NO DISTRACTION WITH DOUBT		
	LEVEL 3:		

	TRIAL 1: WITH TEMPTATION WITH SOCIAL NORM NO DISTRACTION NO DOUBT **TRIAL 2:** WITH TEMPTATION NO SOCIAL NORM WITH DISTRACTION NO DOUBT **TRIAL 3:** WITH TEMPTATION NO SOCIAL NORM NO DISTRACTION WITH DOUBT	

Custom options: changes to consider to adapt the game to the user	**Option**		**Change in the game**
List of variables to be measured during the game	**Variable**	**What does it measure?**	**Which element measure it?** **(Software/Device (which))**
	Delay of gratification	Delay of gratification	Tablet, eye tracker, wearables
Complete description of conditions to	**Variables to consider**		**Condition to increase the level**

increase the level of difficulty (if necessary)	Wait time – the exact amount of time that was waited in each trial. Was able to delay gratification (no = 0, yes = 1) in each trial.	Level increases after these requirements are met: 1.
Feedbacks used in thegame (consider is	**Feedback**	**Conditions**

necessary immediate feedback during the game or final feedback at the end of the game)	**LEVEL 1 TRIAL 1 – FEEDBACK** If the child was not able to wait, the following audio and visual feedback appears: **“YOU GOT 5 BEES TO MAKE HONEY TODAY!”** If the child was able to wait, the following audio and visual feedback appears: **“CONGRATULATIONS! YOU GOT 2 POTS! THIS AREA OF YOUR FARM IS GLOWING TODAY!”** **LEVEL 1 TRIAL 2 – FEEDBACK** If the child was not able to wait, the following audio and visual feedback appears: **“YOU GOT 5 BEES TO MAKE HONEY TODAY!”** If the child was able to wait, the following audio and visual feedback appears: **“CONGRATULATIONS! YOU GOT 2 POTS! THIS AREA OF YOUR FARM IS GLOWING TODAY!”** **LEVEL 1 TRIAL 3 – FEEDBACK** If the child was not able to wait, the following audio and visual feedback appears: **“YOU GOT 5 BEES TO MAKE HONEY TODAY!”** If the child was able to wait, the following audio and visual feedback appears: **“CONGRATULATIONS! YOU GOT 2 POTS! THIS AREA OF YOUR FARM IS GLOWING TODAY!”**

Data to be recorded about the game and the user's performance		
	Data (if the data is a previous defined variable, you can use the name of the variable)	**What it measures?**

	Performance data is gathered with a tablet - **Fixation time, eye position and eye movement data is measured with the eye tracker -** **Fixation time:** (since individuals usually fixate on something in our surroundings consciously) (Negi & Mitra, 2014) - · Negative contribution to learning - if eyes stare at a stimuli below 150ms (short or ambient fixations) = 0 · Negative contribution to learning - if eyes stare at a stimuli above 1000 ms (very long fixation) = 0 · Positive contribution to learning - if eyes stare at a stimuli between 300ms and 500ms = 1 **Eye position:** if the eyes gaze at the incorrect stimuli = 0; if eyes gaze at the correct stimuli = 1 **Eye movement:** if eyes move directly from one correct stimuli to another = 1; if eyes move indirectly from one correct stimuli to another through incorrect stimuli = 0,5; if eyes move directly from one incorrect stimuli to a correct stimuli = 0,5;	**Performance data** is necessary to acquire the score from the game that will inform about the child's capacity to delay gratification when considering the various covariates. **Fixation time, eye position and eye movement data** is necessary to acquire information about the child's visual focus during performance and to correlate it with performance data and heart rate data. Eye movement may help identify whether the child was still or fidgeting. Teacher notes can also help identify this type of behavior.

	if eyes move directly from one incorrect stimuli to another incorrect stimuli = 0. **Heart rate data is measured with wearables.** (Wu et al., 2019) Greater change in heart rate (anger and fear) = 0 None to little change in heart rate (neutral and happiness) = 1 None to little change in heart rate variability (avoidance motivation – happiness and anger) = 0 Greater change in heart rate variability (approach motivation – fear and neutral) = 1	**Heart rate and heart rate variability data** is necessary to acquire information about possible emotional arousal and motivation in the child and to correlate this with the performance and heart rate data.

		Greater heart rate variability has been linked to approach motivation with the emotions of happiness/amusement and anger. Lower heart rate variability has been linked to avoidance motivation with the emotion of fear or neutral. Greater heart rate has been linked to anger and fear. Lower heart rate has been linked to neutral emotions and happiness/amusement. (Wu et al., 2019)

	Teacher observation of children's behavior during the wait period	To identify whether children were still or fidgeting and whether they were silent or talking.

Inhibitory Control Game - ***RE♻Stroop***

Game name	- ***RE♻Stroop*- Cleaning up the garden by recycling task**
Area/s of intervention covered (working memory, inhibitory control, attention shifting, cognitive flexibility, delay of gratification, emotion naming, emotion intensity level rating, emotion understanding or emotion regulation strategies).	Interference control is operationalized as the ability to suppress stimuli that may interfere with a response (Cragg, 2016). Behavioral inhibition—defined as the ability to stop mid-task to regulate behavior or complete a non-dominant response—is supported by independent processes that are both reactive and proactive. Reactive inhibition measures the speed of the stopping process whereas proactive inhibition, or proactive slowing, involves strategic response slowing in order to complete more challenging tasks while maintaining accuracy (Van Hulst et al., 2018; Verbruggen & Logan, 2008, 2009). Finally, motivational inhibition gauges avoidance of losses in activities that include feedback or reward contingencies (Cassotti et al., 2014). The fundamental idea is creating agreement (via congruent stimuli [C]) or conflict (via incongruent stimuli [IC]) between values of the target feature (recycle bin color) and the distractor feature (recycle bin color/types of trash) when responding to the target feature (Algom et al, 2022). Hence, Stroop Effect = MRT (IC) – MRT (C).

Complete description of the functionality (include any interval, time or random element description that will be necessary)	The child has to clean up the garden and recycle the trash that he/she picks up from the ground. The child sees the respective recycle bins for each of the trash (including a bin for plastic, glass, paper, cardboard, and general waste). They must decide if they have the appropriate trash for the correct bin. All of the recycling bins appear with the respective name of trash to put inside. If they place the mouse over the bin, they can hear the word spoken out loud. Children must identify the correct type of trash in the bin. In a typical Stroop task set-up, the numbers of congruent and incongruent trials are matched (e.g., congruent/ incongruent) (Parris et al., 2022). A typical Stroop task takes between 20 and 40 min to complete and includes 4 conditions, each of which contains 36 stimuli (Adams, & Jarrold, 2009). In the current study we will include three levels of difficulty with 12 stimuli each (six congruent condition and six incongruent conditions per level of difficulty). Participants will be told that they will see two images in each trial and will be instructed to press the 'F'-key on their keyboard to select if the color of the recycle bin corresponds to the trash to recycle or the 'J'-key for the situation where the color of the recycle bin does not correspond to the trash to recycle. Participants will undergo two short practice trials to get familiarized with the task and with the two response keys. Correct responses will be followed immediately by the next trial, whereas incorrect responses will receive error feedback ("Oops, this is incorrect! Remember, you need to correspond the color of the recycle bin to the type of trash to recycle.") with a 5-s interval before the next trial begins (Brody et al., 2022). Congruent condition and incongruent condition tasks will be alternatively shown. Each task is preceded by a 10-s rest period during which the participants stare at a white circle in the middle of the screen. Numbers of correct and incorrect responses, mean reaction times, and percentage of trials with no answer should be assessed for each task in each session (Yasumura et al., 2014).

<table>
<tr><td>Objectives of the game</td><td colspan="2">To measure inhibition with figures of recycling bins and the respective trash to include in it. The objective of the player is to present a reduced reaction time (and a lower discrepancy between congruent and incongruent stimuli), and to get as many items in the correct bins as possible. Therefore, the player must also be aware of all of the trash that is around the farm.</td></tr>
<tr><td rowspan="4">Type of stimuli (describe what should contain each of the stimuli used in the game)</td><td>Stimuli</td><td>Description</td></tr>
<tr><td colspan="2">4 Recycling bins (blue, yellow, and green).

Different types of trash to recycle (Plastic, paper and glass)</td></tr>
<tr><td colspan="2"></td></tr>
<tr><td colspan="2"></td></tr>
<tr><td rowspan="2">Description of modes of playing (if necessary)</td><td>Mode</td><td>Way of playing</td></tr>
<tr><td colspan="2">Children are instructed by the farmer (social agent) that they must clean the farm and recycle as much as possible, putting the objects in the correct bin. The player walks through the farm picking up litter and fills up a bag. Then, the player walks over to the recycling bins and general waste bin to dispose of the trash.

Players get to see an example and then get two practice trials (which are not counted for points).</td></tr>
</table>

	The game starts once the trials are over.	
Detailed list of levels of difficulty and what should change in each one	Level	Specific changes in the game for that level

	Level 1 1 congruent stimuli and 1 incongruent stimuli 12 trials total with 6 congruent stimuli and 6 incongruent stimuli	
	Level 2 2 congruent stimuli and 2 incongruent stimuli 12 trials total with 6 congruent stimuli and 6 incongruent stimuli	Change in the bins (opened or closed) Change in the number of the bins and items.
	Level 3 3 congruent stimuli and 3 incongruent stimuli 12 trials total with 6 congruent stimuli and 6 incongruent stimuli	

Custom options: changes to consider to adapt the game to the user			
	Option		Change in the game
List of variables to be measured during the game	Variable	What does it measure?	Which element measure it? (Software/Device (which))
	Inhibition	Inhibition	Log files recorded from the game itself.

Complete description of conditions to increase the level of difficulty (if necessary)		Eye tracker to see if the player looks immediately at the right stimuli or if he/she is confused looking both at the incorrect and the right stimuli.
	Variables to consider	Condition to increase the level
	More stimuli appear as the level od difficulty increases. Children must touch the key that corresponds to the correct stimuli.	
Feedbacks used in the game (consider is necessary	Feedback	Conditions

immediate feedback during the game or final feedback at the end of the game)	If the answer is correct, children receive a coin to shop at the store for their eco-farm. a. If the answer is incorrect, children receive the “Oops, this is incorrect! Remember, you need to correspond the color of the recycle bin to the type of trash to recycle.” b. After three error attempts, the system agent explains the instruction and the correct correspondence between the color of the recycle bin and the type of trash. The number of interactions with the agent are recorded. Then, a message appears: “Let’s try again”. Another sequence of bins is then presented.	We need the device to have speakers so the children know colors are being verbalized.

Data to be recorded about the game and the user's performance		
	Data (if the data is a previous defined variable, you can use the name of the variable)	What it measures?

	Children's reaction time can be measured to understand how long it took them to respond.	The time it takes the player to get the correct answer from the moment he/she is in front of the stimuli.
	We will take into consideration:	
	a. Number of correct answers (items in the correct bins).	The correct answers which correspond to clicking on the correct option/ stimuli.
	b. The reaction time in each trial (assuming trial was correct).	
	c. If the child is looking at the correct bin, as they on the correct stimuli. (eye tracker).	The visual focus of the player – whether they look immediately at the correct bin, or whether they hesitate.
	d. If all of the trash in the farm was picked up.	If the player was attentive enough to all of the trash that needed to be picked up.

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Working Memory Game - ***WorM***

Game name	WorM
Area/s of intervention covered (working memory, inhibitory control, attention shifting, cognitive flexibility, delay of gratification, emotion naming, emotion intensity level rating, emotion understanding or emotion regulation strategies).	Working memory (updating) Updating -the ability to dynamically modify the content of memory according to task requests (Morris & Jones 1990) (Caretti et al, 2010)

Complete description of the functionality (include any interval, time or random element description that will be necessary)	The task of the child is to pick up the yellow peppers as they ripe, while considering the order. They tap the peppers. Also, they will have to sort the good from the bad peppers, by clicking on the left key for the good peppers that go into the crate and then to the market and the right key for the peppers with a worm, that need to be salvaged, cut and cleaned. These peppers will get into pepper sauce or pickled peppers. 9 pepper plants are in the vegetable garden (the lot is 16X16 cm). The peppers change colors from green to yellow (1 second), gradually, one by one in a random order. The pepper turns from green to yellow and back to the color from the start The child sorts the peppers by clicking on the left and right keys. The plants with green peppers remain until 500 ms after the sequence was completed. Then a black screen is presented 15 seconds. Then, the screen with the veggie garden. On this screen the child will touch each pepper plant in the order it turned yellow. For each sequence of 2-7 there will be 5 trials per each sequence length. Times and task sequence from Macizo, P. , Soriano, M. F., Paredes, N. (2016). The difficulty level increases by increasing the number of tomatoes in the sequence: Level 1: 2 peppers (5 trials for 2) Level 2: 3 peppers (5 trials for 3) Level 3: 4 peppers (5 trials for 4) Alternatives: ordered or non-ordered lot; with or without criss- crosses

Objectives of the game	To train working memory span. Children have to sort the good from the bad peppers so none will be wasted. While doing this, they have a concurrent task. Also, they need to remember the sequence of locations from which they are supposed to pick up the ripe peppers.	
Type of stimuli (describe what should contain each of the stimuli used in the game)	Stimuli	Description
	Pepper plant with only one green fruit	
	Pepper plant with only one yellow bell pepper	
	Pepper plant with only one yellow bell pepper that has a worm	
	Background: Veggie garden with 9 pepper plants	
Description of modes of playing (if necessary)	Mode of playing	Way of
	Single player	

Task: This is a lot from the farmer's veggie garden. On this lot the farmer planted yellow peppers. They are about to ripe and the farmer needs to pick them up as they ripe, so no peppers will be wasted and there will less weight for the pepper plant. However, not all peppers are good, as the farmer does not use pesticides. Therefore, some peppers have worms. This does not mean they are not edible. They will be cleaned and cut, and the good parts will be used for pickled or for pepper sauce. Whenever you see the

pepper to be good, you put it in the crate by pressing the left key. When it is a bad pepper, you put it in the basket that goes to the kitchen. After you sorted them, click on each pepper plant to pick the peppers in the order they got ripe.

Detailed list of levels of difficulty and what should change in each one		
	Level	Specific changes in the game for that level
	Level 1:	Five sequences of 2 items
	Level 2	Five sequence of 3 items
	Level 3:	Five sequences of 4items
Custom options: changes to consider to adapt the game to the user	Option	Change in the game
	Maybe adjust the times of exposure for children with neurological disorders	

List of variables to be measured during the game			
	Variable	What does it measure?	Which element measure it? (Software/Device (which))
	Correct answers in the right order	The correct recall of items in the right order	Tablet
	Correct answers not in the right order		
	span	The number of items recalled in the correct order. When 2 out of 3 trials are completed…	Tablet
	Longest sequence	Number of items recalled	Tablet
	Response time	The time between the answer screen appearance and the touch of the first location	Tablet
	Exploration patterns during	Up- down, left- right, organized or disorganized	Eye- tracker

	presentation and when giving the answer		
	Exploration patterns during the blank screen	Gaze fixation, eye movements	Eye- tracker
Complete description of conditions to increase the level of difficulty (if necessary)	Variables to consider	Condition to increase the level	
	Number of items to remember in the right order in a given sequence	When he/ she answers 3 out of 5 correctly from the previous sequence.	
Feedbacks used in the game (consider is necessary immediate feedback during the game or final feedback at the end of the game)	Feedback	Conditions	
	At the end of the game, the number of peppers the child has gathered into the crate and some jars with pickled peppers and pepper sauce from the bad peppers.	The more they answer correctly, the more peppers will be in the crate and in the pickle jars.	
Data to be recorded about the	Data (if the data is a previous defined variable, you	What it measure?	

game and the user's performance	can use the name of the variable)
	Number of correct answers
	Span
	Longest sequence

Emotion Naming Game - **EMOeggi**

Game name	**EMOeggi- Eating sustainably – A nest egg for the World**
Area/s of intervention covered (working memory, inhibitory control, attention shifting, cognitive flexibility, delay of gratification, emotion naming, emotion intensity level rating, emotion understanding or emotion regulation strategies).	Area of intervention: Emotion naming / recognition Emotion Naming / Recognition is defined as the ability to identify emotions in oneself and others (Baron-Cohen et al., 1985, 1986). Emotion Recognition is an essential part of social development and is considered to be a basic ability that underlies more complex emotional understanding and social skills (Jones et al., 2011). A group of components entitled "external" is considered in this task according to Pons and Harris (2005). This is the easiest level of emotion understanding according to the authors. It focuses on external aspects of emotions, including the recognition of facial expressions (Recognition), understanding of the impact of situational causes on emotions (Cause), and understanding of the impact of associated external events or reminders on emotions (Reminder).

Complete description of the functionality (include any interval, time or random element description that will be necessary)	The game begins by providing the following information in the format of a short film: ***Eggs are among the animal food, which have the lowest carbon emission and thus are a more environmental-friendly choice when it comes to food from animals. Eggs have a lower carbon emission than other animal food. Due to increased feed efficiency, advancements in hen housing and manure management, egg farms now use less water and energy on a daily basis and release less polluting emissions. Every aspect of the egg production process, from cultivating feed to raising the laying hens, has led to a reduced environmental footprint. The following activities focus on eggs.*** In all levels there are three market stalls with a farmer each (salesmen). Each market stall features a situation, representing an emotion. The farmers represented in the situation have a neutral face initially. There are 3 faces, representing different emotions on the screen. Each of them is the correct face for each situation. The participant must correspond the face with each of the farmers by dragging and dropping the correct face onto the farmer. **LEVEL 1 - HAPPINESS, SADNESS & DISGUST** *Recognition of emotions* on the basis of the facial expression. The child is asked: - **How is each farmer feeling?** Response options with emojis to make correspondence: Happy, Sad or Disgusted. Understanding *causes of emotion.* - **Why are the farmers feeling like that?** Response options with arrows pointing to different things (a stall full of shinny eggs; a stall full of big vegetables; a stall full of broken eggs; a stall with small vegetables; a stall full of rotten eggs; and a stall with rotten vegetables). The child chooses an option for each farmer.

<table>
<tr><td>Objectives of the game</td><td colspan="2">Successful performance in this game requires the participant to:

1. Choose/recognize the appropriate emotions for the farmers and customers.
2. Choose the correct cause for the emotions the farmers and customers are feeling.
3. Choose the correct reminders for the emotions felt by farmers and customers.</td></tr>
<tr><td rowspan="4">Type of stimuli (describe what should contain each of the stimuli used in the game)</td><td>Stimuli</td><td>Description</td></tr>
<tr><td>Shinny eggs, Broken eggs, Rotten eggs, Eggs hatching chicks, Very small eggs, An egg thief, Certified Big Biological eggs, Big eggs</td><td>See Complete description of the functionality</td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td rowspan="4">Description of modes of playing (if necessary)</td><td>Mode</td><td>Way of playing</td></tr>
<tr><td>See Complete description of the functionality</td><td>See Complete description of the functionality</td></tr>
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Detailed list of levels of difficulty and what should change in each one		
	Level – depends on the complexity of the emotions	**Specific changes in the game for that level**
	Level 1: Happiness, Sadness, Disgust	Happy due to shinny eggs, Sad due to broken eggs, Disgust due to rotten eggs
	Level 2: Surprise, Anger, Fear	Surprise due to eggs with hatching chicks, Angry due to very small eggs to sell/buy, Fear of stealing eggs.
	Level 3: Pride, Envy, Disdain	Pride due to selling /buying certified biological eggs; Envy due to observing another farmer selling / other clients buying biological eggs; Disdain due to observing another farmer selling / other clients buying very small eggs.
Custom options: changes to	**Option**	**Change in the game**

consider to adapt the game to the user			
List of variables to be measured during the game	**Variable**	**What does it measure?**	**Which element measure it?** **(Software/Device (which))**
	Emotion naming	Emotion recognition / emotion naming	Tablet, eye tracker, wearables
Complete description of	**Variables to consider**	**Condition to increase the level**	

conditions to increase the level of difficulty (if necessary)	*Recognition of emotions* on the basis of the facial expression. Understanding *causes of emotion.* Understanding of *associated external events or reminders* of emotion.	Level increases after both these requirements are met: 1. Choose/recognize the appropriate emotions for the farmers and customers. 2. Choose the correct cause for the emotions the farmers and customers are feeling. 3. Choose the correct reminders for the emotions felt by farmers and customers.
Feedbacks used in the game	**Feedback**	**Conditions**

(consider is necessary immediate feedback during the game or final feedback at the end of the game)	**For both farmers and customers** At the end of recognition of emotions on the basis of facial expressions - For correct options: You are right! That's how they feel! For incorrect options: Try and look again. At the end of understanding causes of emotion - For correct options: You are right! That's why they feel that way! For incorrect options: Think again about why they are feeling this way. At the end of understanding associated external events or reminders of emotion - For correct options: You are right! Those are the remembrances that made them feel that way! For incorrect options: Think again about what they remembered!	

Data to be recorded about the game and the user's performance		
	Data (if the data is a previous defined variable, you can use the name of the variable)	**What it measure?**

	Performance data is gathered with a tablet - Recognition of emotions on the basis of the facial expression: 0 = incorrect; 1 = correct. Understanding causes of emotion: 0 = incorrect; 1 = correct. Understanding of associated external events or reminders of emotion: 0 = incorrect; 1 = correct. **Fixation time and eye position data is measured with the eye tracker -** **Fixation time:** (since individuals usually fixate on something in our surroundings consciously) (Negi & Mitra, 2014) - · Negative contribution to learning - if eyes stare at a stimuli below 150ms (short or ambient fixations) = 0 · Negative contribution to learning - if eyes stare at a stimuli above 1000 ms (very	**Performance data** is necessary to acquire the score from the game that will inform about the child's capacity to recognize/name emotions on the basis of the facial expression; understand causes of emotion; and understand of associated external events or reminders of emotion. This information will be correlated with fixation time data and heart rate data. **Fixation time and eye position data** is necessary to acquire information about the child's visual focus during performance and to correlate it with performance data and heart rate data.

	long fixation) = 0 · Positive contribution to learning - if eyes stare at a stimuli between 300ms and 500ms = 1 **Eye position:** if the eyes gaze at the incorrect stimuli = 0; if eyes gaze at the correct stimuli = 1 **Heart rate data is measured with wearables.** (Wu et al., 2019) Greater change in heart rate (anger and fear) = 0 None to little change in heart rate (neutral and happiness) = 1	**Heart rate data** is necessary to acquire information about possible emotional arousal in the child and to correlate this with the performance data. Greater heart rate has been linked to anger and fear. Lower heart rate has been linked to neutral emotions and happiness/amusement. (Wu et al., 2019)

Game name	**IntensEMO- Avoid food waste: Feed the hens and grab the eggs!**
Area/s of intervention covered (working memory, inhibitory control, attention shifting, cognitive flexibility, delay of gratification, emotion naming, emotion intensity level rating, emotion understanding or emotion regulation strategies).	Area of intervention: Emotion Intensity level rating. The intensity of an emotion may be defined as the magnitude or strength of the experienced or expressed emotion (Frijda et al., 1992, Sonnemans & Frijda, 1994). Accordingly, differences in emotion intensity may occur due to different cognitive appraisals. In fact, emotional intensity may be determined by concerns, appraisals, regulation and individual differences (Sonnemans & Frijda, 1995). Moreover, steepness at onset, skewness and number of peaks may be considered as characteristic features (Ramsey & Silverman, 2005). **For these reasons, it is important to put an intensity thermometer of the "happy" emotion at the beginning of each level of the game. To understand the level of concern, the child can be asked at the beginning of the game, "How well do you need to learn to play the game?" The child may respond on a scale from 0 = I don't need to learn to play the game well, to 5 = I need to learn to play the game very well. To understand what appraisal the child makes of the game, he/she is asked at the end of each level: "Did you like to play this game?" The child can also be asked about his/her own performance: "Did you play well?"**

Complete description of the functionality (include any interval, time or random element description that will be necessary)	The game begins by providing the following information in the format of a short film: ***Eggs are among the animal food, which have the lowest carbon emission and thus are a more environmental-friendly choice when it comes to food from animals. Eggs have a lower carbon emission than other animal food. Due to increased feed efficiency, advancements in hen housing and manure management, egg farms now use less water and energy on a daily basis and release less polluting emissions. Every aspect of the egg production process, from cultivating feed to raising the laying hens, has led to a reduced environmental footprint. The following activities focus on eggs.*** Firstly, (story/animation) a farmer will appear and says: "I need your help to feed hens in order to collect their eggs, to feed the children of a local school. We will need a lot of eggs! Can I count on your help?" Secondly, the scenario changes to a chicken barn, and the same farmer appears and says that their task is to feed the hens (they are very hungry) and then collect the eggs that will fall, with the least waste possible. Time to complete the task: 1 minute per level – 3 minutes total Level 1 – collect 10 eggs – 60s Level 2 – collect 20 eggs – 60s Level 3 – collect 30 eggs – 60s There are always 10 hens in the barn, but they are not always hungry. Only the hens that are making sounds and movements are hungry, and the child must feed them. The hens get hungry at random time (for example, each 2s to 5s a hen gets hungry and the

	child must feed the hen). The total time of the task is the same in all levels. The difficulty of the task increases with the number of eggs to collect. The difficulty of the game in terms of emotion intensity increases as more emotions appear to rank in terms of intensity.

Objectives of the game	Successful performance in this game requires the participant to: 1 – rate the emotion intensity after completing the level (whether they collect all the eggs or not).
Type of stimuli (describe what should contain each of the stimuli used in the game)	The hens that need to be fed are making sounds and movement, and they stop after being fed. After the hen eats, it will get fat (it's a sign that the hen will lay an egg shortly). They lay an egg that needs to be collected. The egg laying can vary, random time, 2s to 5s. The avatar collects the eggs into a basket, and if the egg is not collected, it falls and breaks (and an auditive stimulus of sadness is heard). After 1 minute or after collecting all the eggs, the participant is asked: "Rate the intensity of the emotion." Display thermometers portraying an emotion each: Level 1 – scale containing 1 emotion – children have to drag the button up or down on the thermometers. Level 2 – 2 scales containing an emotion each - children have to drag the button up or down on the thermometers. Level 3 – 4 scales containing an emotion each - children have to drag the button up or down on the thermometers. Rating two emotions is more difficult than rating one, and rating four

emotions is more difficult than rating two.

	Stimuli	**Description**
Description of modes of playing (if necessary)	**Mode**	**Way of playing**
	Feed the hens.	The avatar has to feed the hens, by grabbing corn and giving it to them.
	Grab the eggs.	The avatar has to grab the eggs that are falling from the hens.

Detailed list of levels of difficulty and what should change in each one	Rate the intensity of the emotion.	Dragging the intensity of the emotion(s) displayed on the screen.
	Level	**Specific changes in the game for that level**
	Level 1: although the child feeds the hens, each hen only gives 1 egg each time it is fed.	Each hen only gives 1 egg each time it is fed.

Custom options: changes to consider to adapt the game to the user	Level 2: The child feeds the hens, and each hen gives 2 egg each time it is fed.	Each hen gives 2 egg each time it is fed.
	Level 3: The child feeds the hens, and each hen gives 3 egg each time it is fed.	Each hen gives 3 egg each time it is fed.
	Option	**Change in the game**
	If the child fails to grab all the eggs in each level, he/she is offered the opportunity to repeat the level, but the first attempt is the one that counts for our internal assessment.	

List of variables to be measured during the game	**Variable**	**What does it measure?**	**Which element measure it?** **(Software/Device (which))**

	Emotion intensity	The emotion intensity that the child chooses, depends on whether they have collected few eggs or many eggs.	Tablet
Complete description of conditions to increase the level of difficulty (if necessary)	**Variables to consider**	**Condition to increase the level**	
		Level increases after both these requirements are met: 1 – the participant collects all the eggs 2 – the participant rates the emotion intensity after completing the game	
Feedbacks used in the game (consider is necessary immediate feedback during the	**Feedback**	**Conditions**	
	A clapping noise (auditive stimulus)	Each time the child successfully grabs an egg.	

game or final feedback at the end of the game)	A sentence appears on the screen (very good!)	Each time the child successfully grabs an egg.
Data to be recorded about the game and the user's performanc	**Data (if the data is a previous defined variable, you can use the name of the variable)**	**What it measure?**

e	**Performance data is gathered with a tablet -** **Level 1** – *Performance in the game* Let one or more eggs fall = 0 Did not let any eggs fall = 1 *Emotion Intensity* Child does not register emotion intensity on the thermometer: 0 = incorrect Child registers emotion intensity on the thermometer: 1 = correct **Level 2** – *Performance in the game* Let one or more eggs fall = 0 Did not let any eggs fall = 1 *Emotion Intensity* Child does not register emotion intensity on both thermometers: 0 = incorrect Child registers emotion	**Performance data** is necessary to acquire the score from the game that will inform about the child's capacity to register emotion intensity. This information will be correlated with fixation time data and heart rate data.

	intensity on both thermometers: 1 = correct **Level 3** – *Performance in the game* Let one or more eggs fall = 0 Did not let any eggs fall = 1 *Emotion Intensity* Child does not register emotion intensity on all four thermometers: 0 = incorrect Child registers emotion intensity on all four thermometers: 1 = correct **Fixation time, eye position and eye movement data is measured with the eye tracker -** **Fixation time:** (since individuals usually fixate on something in our surroundings consciously) (Negi & Mitra, 2014) -	**Fixation time and eye position data** is necessary to acquire information about the child's visual focus during performance and to correlate it with performance data and heart rate data.

	• Negative contribution to learning - if eyes stare at a stimuli below 150ms (short or ambient fixations) = 0 • Negative contribution to learning - if eyes stare at a stimuli above 1000 ms (very long fixation) = 0 • Positive contribution to learning - if eyes stare at a stimuli between 300ms and 500ms = 1 **Eye position:** if the eyes gaze at the incorrect stimuli = 0; if eyes gaze at the correct stimuli = 1 **Heart rate data is measured with wearables.** (Wu et al., 2019) Greater change in heart rate (anger and fear) = 0 None to little change in	**Heart rate data** is necessary to acquire information about possible emotional arousal in the child and to correlate this with the performance data. Greater heart rate has been linked to anger and fear. Lower heart rate has been linked to neutral emotions and happiness/amusement. (Wu et al., 2019)

	heart rate (neutral and happiness) = 1	

Emotion Understanding Game - ***EMOwizz***
Initial development

- Emotion understanding task
- Three levels of difficulty
- Understand basic emotions in others (joy, sadness, fear, anger)
- Understand more elaborated emotions in others (surprise, pride, disgust, contempt/ disdain, envy)
- Understanding your own emotions
- 3 different situations for each type of emotion
- The children can choose between some emoji. When they press the correct icon the emotion is verbalized.

First level Understand basic emotions in others:

Emotion	S1	S2	S3
joy	**The farmer washes the pig with the hose. The pig now gleams with cleanliness. How does the farmer feel?**	**The farmer gives the horse apples and carrots, which are his favourite. How does the horse feel?**	**The farmer wakes up in the morning and sees that the most beautiful flowers have sprouted in his garden. How does the farmer feel?**
sadness	**The farmer's cat is limping. He's got a thorn in his paw. How does**	**It hasn't rained today either, and the trees are very thirsty for water. How does the**	**The farmer finds a picture of his grandparents when they lived on this**

	the farmer feel when he sees it?	farmer feel when he sees that it hasn't rained today either?	farm. How does the farmer feel?
fear	The farmer has to step over a plank placed over a hole. How does it feel?	The farmer has a beautiful garden with tomatoes, peppers, beans, aubergines. He tends the garden, it's warm. Suddenly the sky darkens, turns leaden, a cold, strong wind blows. What if hail comes? How does the farmer feel?	A mouse comes out of the barn after stealing some wheat berries and bumps into the family cat, who licks his lips. How does the mouse feel?
anger	A bee stings Ferdinand the bullfrog. He picks it up and bangs his head on the fence. How is Ferdinand feeling?/ His milking machine has broken down. No more milk comes out.	There are also two very stubborn goats on the farm. One of them hits the other goat as they are grazing. The goat fights back and horns his opponent. How do they feel?	The farmer carries the crates of tomatoes to the car to take them to the market. The bottom of the crate breaks off and all the tomatoes fall to the ground and get squashed. How does the farmer feel?

Level 2. Understand complex emotions in others

Emotion	Situation1	Situation 2	Situation 3
surprise	The farmer opens the door in the morning and on the doorstep he finds a kitten on a cloth.	The farmer looks for eggs in the nest. The hens lay there. But one day the farmer wants to put on his shoes and finds an egg in his hat.	He goes to bed at night, the rose bush has buds. In the morning, when he goes out, even more astonished, the rose is full of large brightly coloured flowers.
pride	He picked the potatoes and is proud to have the most bags.	The farmer has a horse that can jump over obstacles and when it gallops it seems to fly. How does the farmer feel when his horse wins the competition?	His boy helps him on the farm with all the chores. The father pats him on the shoulder and shakes his hand
disgust	The farmer takes his family for a picnic by the lake. He has just smeared a slice of delicious buttered peach, when a toad full of mud jumps out of the pond onto his slice.	The farmer collects the eggs. He reaches into the nest and catches a rotten egg that smells very bad.	A friend of the farmer's wants to help him and is given the job of cleaning the pig pen, cleaning out the droppings first with a shovel, then with a water hose. He doesn't like the smell!

contempt	Two roosters fight, and one of them wins. This one looks contemptuously at the loser./ He walks down the street. An older boy stops him. The boy falls to the ground. The older boy looks contemptuously at the fallen one.	The farmer's neighbour puts on weedkiller and is out of work. He looks contemptuously at his neighbour who is weeding.	The neighbour puts on chemical fertiliser to have a good crop of apples and looks with contempt at his neighbour because his neighbour's apples are smaller and some with worms.
envy	There are two cats on the farm. One of them thinks the other has better food and more of it.	The farmer's rooster sings Cock-a-doodle-do extraordinarily beautifully. The neighbour's rooster is a bit hoarse. It doesn't like the fact that the Spur is crowing so beautifully!	Grivei looks at the cat in the house, who sits in the warmth, has food, and is always lolling around idly.

Level 3. Understanding your own emotions/ feelings. How are you feeling? (the avatar will perform the actions)

Emotions	**S1**	**S2**	**S3**
joy	He has to wash the pig. Every time he presses the button, another stain goes. The pig shines. How are you feeling?	He's pulling carrots out of the garden and they're all beautiful. How do you feel?	He pets the cat and it's purring. How does it feel?

sadness	The dog is your pet. You throw him a toy and the dog brings it to you. The third time he throws the toy, the dog steps on a nail and starts crying.	You ride the bike by pressing a key in front to the right. Slowly, a wheel goes flat.	Tie up some tomatoes. Then a strong wind comes and knocks them to the ground.
fear	You're walking down the street, you keep going forward and suddenly there's a loud bark from somewhere. How does it feel?	You walk down the hall. The lights are out because of a storm. You grab a flashlight. You walk with it, look left, look right. Suddenly the flashlight goes out and you go forward in the dark.	You're with friends. You're playing. Suddenly, one of them comes up with the idea of climbing up the side of a ladder. You don't like the idea. How do you feel?
anger	His ball breaks and he starts to stop jumping, climbing less and less. He can't hit it anymore.	She washes the pig, takes it to the pen, then turns on the hose and her water stops.	She has to find all the eggs hidden in the nest. As she does this, a background noise grows in intensity.
surprise	Open a round packet and out of it, after opening several layers of paper, comes a bunny.	He walks down the street and finds an apple. He wants to eat it and the apple is fake. The child brought it outside to play.	He enters a room. Out of the hifding place come his parents, his colleagues, his friends and they sing him Happy Birthday.

pride	Place some wooden planks on top of each other and build a beautiful chickenhouse according to the model.	Grandma lost the rake and is upset. Where is the rake? Look for it carefully. She discovers it.	Mom won a marathon prize and appeared on TV. Well done! How do you feel about your father winning?
disgust	The child eats outside. He has a slice of pizza. Takes another slice and eats it. Then he finds a slice with a fly on it.	Walk on a plank over the dung ditch. Walk, walk, walk. Then you slip and fall into the dung pit.	The cat fell into the dung hole and hurt himself. You'll have to pick it up, pet it.
contempt	A mini-contest of picking up the apples. He wins. Another child fails to finish.	Go to the market. You pass an egg stall. As you pass it, someone else comes along and drops them. He says you're guilty.	A tractor race. You at the wheel. The rule... don't take the shortcut. The fellow goes. Nobody sees him. He wins. What do you feel?
envy	He/she enters the competition. He/she must place 5 boxes on top of each other as quickly as possible. The teammate succeeds faster. He wins a medal, confetti, a surprise gift.	He/she goes to the market and gets a sandwich and the next one gets a bigger one for the same price.	You get a small tractor to plough with. The neighbour gets one too, a big tractor that ploughs faster.

Emotion Regulation Game - **EMO*ve***

Game name	EMOve - Choose the adaptative strategy – Help the farmer get magical powers.
Area/s of intervention covered (working memory, inhibitory control, attention shifting, cognitive flexibility, delay of gratification, emotion naming, emotion intensity level rating, emotion understanding or emotion regulation strategies).	Emotion regulation refers to the processes by which individuals manage their emotional experiences. It involves the ability to control and direct emotions in a way that is consistent with one's goals and values, and to modify or change emotions that are interfering with daily functioning. We will use the following adaptive emotional regulation strategies: emotional awareness, emotional acceptance, social support seeking, cognitive reappraisal, relaxation, and problem-solving and maladaptive strategies: emotional non-awareness, suppression, avoidance, rumination, venting, and low-solution oriented.

Complete description of the functionality (include any interval, time or random element description that will be necessary)	In this task the participants will have to choose the adaptative emotion regulation strategy depending on the situation. Learning level · 12 emotion regulation strategies will be presented for 10 seconds to the participant, as small animations (see appendix 1) – divided into 2 categories: helpful and not helpful Level 1: make the distinction between adaptative and maladaptive emotion regulation strategies. - The presented categories will appear on the screen as small animations and the child needs to sort them into 2 categories: helpful and not helpful. Present one situation in which one farmer has all his plans on the ground because of the heavy rain. The child needs to show the farmer the helpful situations. Level 2: help the farmer gain magic powers – by choosing the right strategies. - 4 stressful situations will be presented to the child (2 from sadness and 2 from anger), after each stressful situation, all the 12 emotion regulation strategies will appear on the sides, the child will have to drag and drop the strategies that he/she considers helpful. - They will receive positive feedback if they choose a helpful strategy and “try again” feedback if they choose a not helpful strategy (the strategies will be illustrated as small circles with pictures) The pictures need to be adapted starting from the situations. Level 3: get your own magical power. Suggested magical powers: can stop the rain, has bigger strength in his muscles, can make the vegetables grow faster, can be very quick in building something. This level will have measure children’s emotions (anger and sadness).

<table>
<tr><td>Objectives of the game</td><td>To help the farmer to feel better.

Story for the child:

Sometimes the farmer and people in general feel sad, angry, scared, envy, disgusted or desperate. The things we do or the way we think can help us feel better. We will present you some things that you can do to feel better or some thoughts that you may have – things that you can imagine so that to make you feel better.</td></tr>
<tr><td rowspan="4">Type of stimuli (describe what should contain each of the stimuli used in the game)</td><td>Stimuli | Description</td></tr>
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Detailed list of levels of difficulty and what should change in each one	Level	Specific changes in the game for that level	
Custom options: changes to consider to adapt the game to the user	Option	Change in the game	
	-		
List of variables to be measured during the game	Variable	What does it measure?	Which element measure it? (Software/Device (which))

	Reaction Time	The time between target stimuli appears until the child touches the screen	Tablet
	Correct answers	The number of correct strategies chosen	Tablet
	Errors	The number of maladaptive strategies chosen	Tablet
	Visual path	From right to left, from up to down, organized – disorganized, fixations	Eye-tracker
Complete description of conditions to increase the level of difficulty (if necessary)	Variables to consider	Condition to increase the level	
Feedbacks used in the game	Feedback	Conditions	

(consider is necessary immediate feedback during the game or final feedback at the end of the game)	The feedback will be provided every each task.	
Data to be recorded about the game and the user's performance	Data (if the data is a previous defined variable, you can use the name of the variable)	What it measure?