Simon Says Remastered

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Introduction

Playing games is a key component of children's physical and cognitive development. By engaging in simple ludic activities from a young age, research has shown how toddlers build crucial cognitive and social skills, such as dexterity, imagination as well as emotional strength (Ginsburg, 2007). These abilities are not only relevant in the context of early children's development, but keep supporting the shaping of the individual at later stages in life. In the earlier phases, an important role in cognitive development is played by memory, a key factor in everyone's day-to-day life. Starting from 5-12 months of age, toddlers begin to rely on working memory to develop attentional and, later on, reading abilities for instance (Reynolds & Romano, 2016; du Plessis, 2022).

Over the years, learning impairments such as dyslexia have been associated with reduced working memory abilities (Cleaver, 2020). While targeted programs are being constantly updated to aid children in need of extra support, we believe that a lot can be done at the family level, in the household.
By simply gifting the children with socially interactive games such as the one we propose in our report, we believe that young toddlers could practice their working memory skills while having fun. Furthermore, research has shown how Theory of Mind (ToM) plays a key role in social interactions, making it one of the most important tools for children to build their internal representation of the environment around them (Tuning in to Others: How Young Children Develop Theory of Mind, 2016). Recently, Zhang et al. (2019) showed how children-robot interaction successfully elicited false belief attribution in typically developing (TD) children as well as exploring how such mapping might not be equally observed in children with an autism spectrum disorder (ASD). The authors point out how this difference between TD and ASD should be taken into account when building social agents.

Of equal relevance is the preservation of the aforementioned cognitive skills during the transition from childhood to adulthood: given the increased complexity of the social interactions an individual faces, while progressing through life, the maintenance of such cognitive tools is of great importance. Furthermore, the transitioning of an individual to a geriatric stage might come with a higher risk of a decrease in mental performance, again calling for ongoing preservation of key cognitive skills such as working memory (Borella et al., 2017).

Given the literature, it is becoming clear how the deployment of socially oriented robots might assist in the development of crucial cognitive skills for toddlers, such as working memory, as well as allowing maintenance of such skills in older stages of life. Furthermore, the overall difference in speed at which individual toddlers might develop these cognitive skills highlights how such robots might assist in the "personalization" of a learning path that will fit the individual toddler and their needs at a specific point in time. This would hopefully translate into new generations of adults who will keep valuing the role of cognitive functions in everyday life.

Such observations motivated us to implement a simple version of the game "Simon says", given its widespread reputation as a fun toddler game across cultures and nations. Without the presupposition of developing a fully autonomous agent addressing the many (positive) challenges that children's pedagogy as well as psychology pose to technology and education every day, we present this report as a blend of our interest in the presented literature together with a hands-on implementation of a simple autonomous agent.

Theoretical implementation

Our implementation of "Simon Says Remastered" is picking up on the above mentioned cognitive factors by creating a playful environment to train one's working memory and mental state attribution. Several components are incorporated in the game to train these cognitive skills. Most visibly is the embodiment, predominantly the smiley face of the agent Simon.

The smiley face is the main social component of the game and also functions as an inviting feature to start the game. It has been proven that smiley faces create joy, form a type of communication over facial expressions, and set the emotions of a player to a certain extent (Stark & Crawford, 2015; Huang et al., 2008). Furthermore, to start a game session, Simon expects a high five, which activates - in technical terms - the distance sensor. Hereby, the term high five helps to introduce a friendship relation the player should have to Simon, since it is a rather informal way to say "hello", having a positive and motivating connotation, which in turn loosens up the game (http://makiperformance.com/power-high-five/, 2017).

In later steps, this established relation encourages and motivates the player. The embodiment, kept in a blue color scheme, aids the player to attribute emotions to Simon, which in turn enhances the relationship between Simon and the player. In color theory, blue is associated with attributes such as intelligence, confidence, and trust (https://www.bourncreative.com/meaning-of-the-color-blue/, 2016). Simons embodiment therewith subconsciously comforts the user just by its appearance. Supportingly, we as humans are prone to feel emotions for objects as soon as they show some type of embodiment (Clore & Huntsinger, 2009). As a result, we feel an obligation to play the game right and to keep a happy face on Simon consistently to uphold the positive emotion from the game onset.

In case the player loses, Simon temporarily shows a sad face indicating the loss and thereby attributing this mental state to Simon, which teaches the player that Simon will be sad if they lose the game. Consequently, ToM gets trained, and children, one of the main target player groups, can answer questions about Simon's feelings in certain states of the game.

Besides the embodiment, Simon governs major interaction components, essentially the clicking board with buttons and lights. The lights are of different colors supporting the memorizing process. The perception of color is known to assist working memory (Allred & Flombaum, 2014). Thus, other key determinants for memory preservations are integrated to ensure multifaceted cognitive skills training.

In summary, "Simon Says Remastered'' is a game that quickly permits to see Simon as a friend one can trust and be encouraged by. Conversely, the players get motivated easier, which boosts their willingness to proceed with the game even if they lose and further train their memorizing as well as emotional categorization skills (especially toddlers) passively and playfully.

Practical implementation

Simons' embodiment, as a social, interactive, and happy agent, is implemented by an LED matrix, showing a happy face by default (see Appendix A, picture 2 and Appendix B, lines 56-59 and 95). The game is started by giving Simon a "high five", meaning that the player places their hand within 10 cm of the ultrasonic distance sensor (see Appendix A, picture 1 and Appendix B, lines 63-81). When the human hand is close enough to the sensor, the four LED lights (red, yellow, green, and blue) all light up five times simultaneously, accompanied by "beeping" sounds, produced by the Piezo Buzzer, indicating that the game is about to begin (see Appendix A, video (0.14-0.20) and Appendix B, line 126-135 and 141).

Once the game starts, Simon produces random light sequences using the four lights (see Appendix B, lines 164-177). Within two seconds, the player then has to reproduce the sequences by pressing the correct buttons (see Appendix A, picture 3, and video (0.20-0.22)), corresponding to the colored lights. If the player successfully presses the correct buttons, Simon shows the user the next sequence, based on the previous one by simply increasing the length of the sequence by one extra light. If the user makes a mistake by either being too slow or pressing the wrong button the game ends. This is shown by Simons' face on the LED matrix becoming sad and the LED lights blinking up five times, accompanied by sounds (see Appendix A, video (0.38-0.42) and Appendix B, lines 182-191 and 255-257).

Following this, the correct sequence is shown to clarify to the user where their mistakes were (see Appendix B, lines 164-177 and 185). Afterwards, Simon will become happy again and waits for the next player to give him a high five to start a new game.

The image in Appendix C shows the full schematics of the hardware used for the social robot.

Discussion

This report has focused on documenting the implementation of a simple version of the game "Simon says". Given the literature linking the development and maintenance of certain cognitive skills with the support of socially interactive games, a theoretical background was laid to then introduce our practical implementation of the game.

Following a demonstration of our game implementation to a young adult public, an overall encouraged and motivated attitude towards the robot was noticed. Feedback from the users conveyed that a scoreboard could be implanted in the game, not only to keep a game score between Simon and the player, but among different players. From a cognitive perspective, this could increase motivation in attempting to recall a longer sequence. Since the main goal of the game is not to reach a certain score, but to improve one's own, a scoreboard could be beneficial in keeping track of one's improvement. Nevertheless, this component might be treated with caution in cases the game is played by children since the importance of obtaining a higher score could exaggerate responses to high/low scores and therefore cause arguments.

Furthermore, we could advance our incorporated sound which has not been of great importance so far and just functioned as a small extra indicator of the game state. A more elaborate sound structure could bring the communication between the player and Simon to a higher level by also fully capturing the auditory channel of the player. In further advancement, sounds could be varied depending on the targeted player. For instance, young players may prefer other sounds than older players. In addition to the color component, the sound could also help to maintain the working memory throughout the sequence replication (Ferreri et al., 2015).

Finally, considering a sale of "Simon says Remastered" on the market in the future, it would be necessary to work on a better ensemble of all components to ensure a safe playing environment. Especially when considering children as the players of the game, it is important that all the wires and circuits are secured and that nothing will get easily broken by accident. A game that lacks in function or does not work quickly could cause frustration and consequently discourage the user from using the game again. The current design of the game functions as an optimal basis and has been positively perceived by test players.

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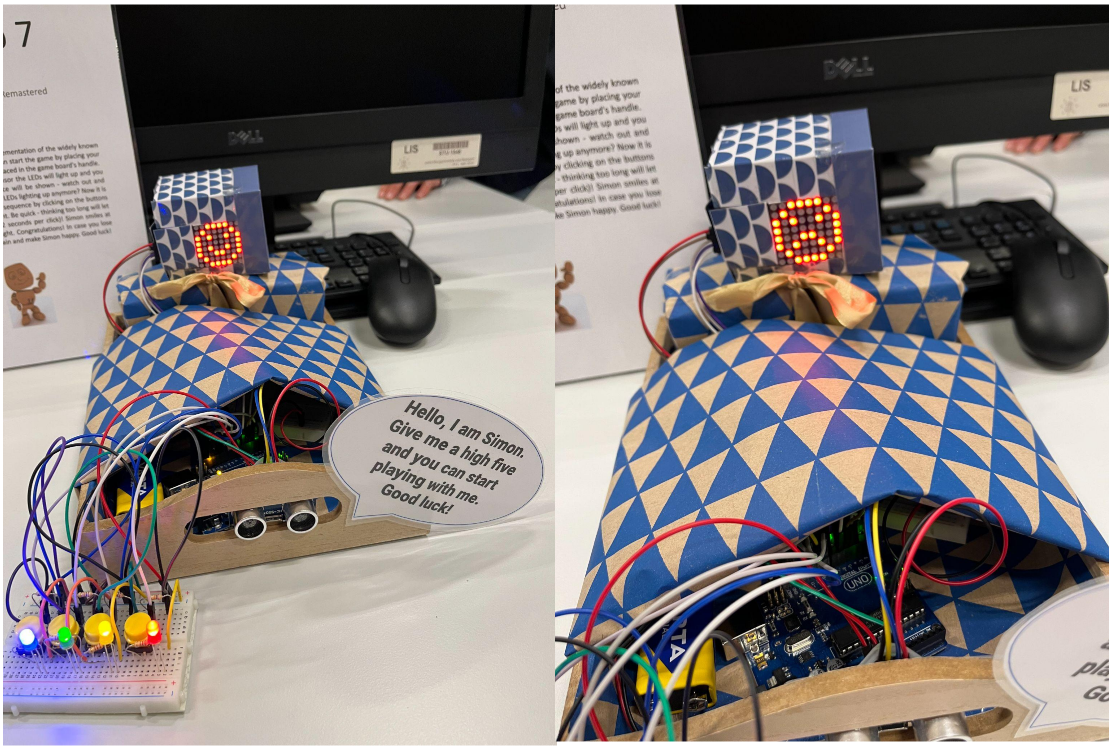
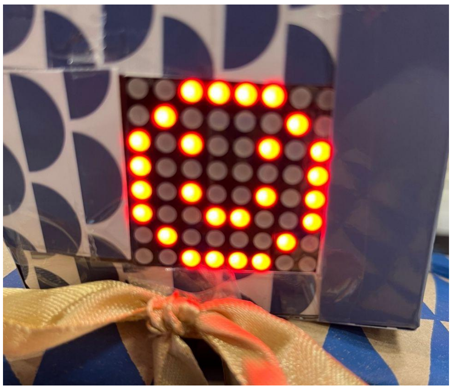
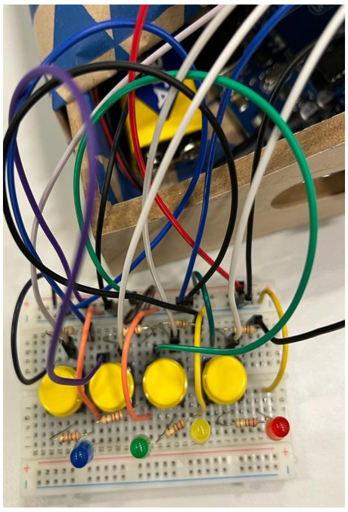
Appendix A



Picture 1: The complete setup of the agent (breadboard including lights and buttons, the distance sensor in the handle, wiring hidden in the agents body, the smiley (happy on the left, sad on the right) face of the agent)



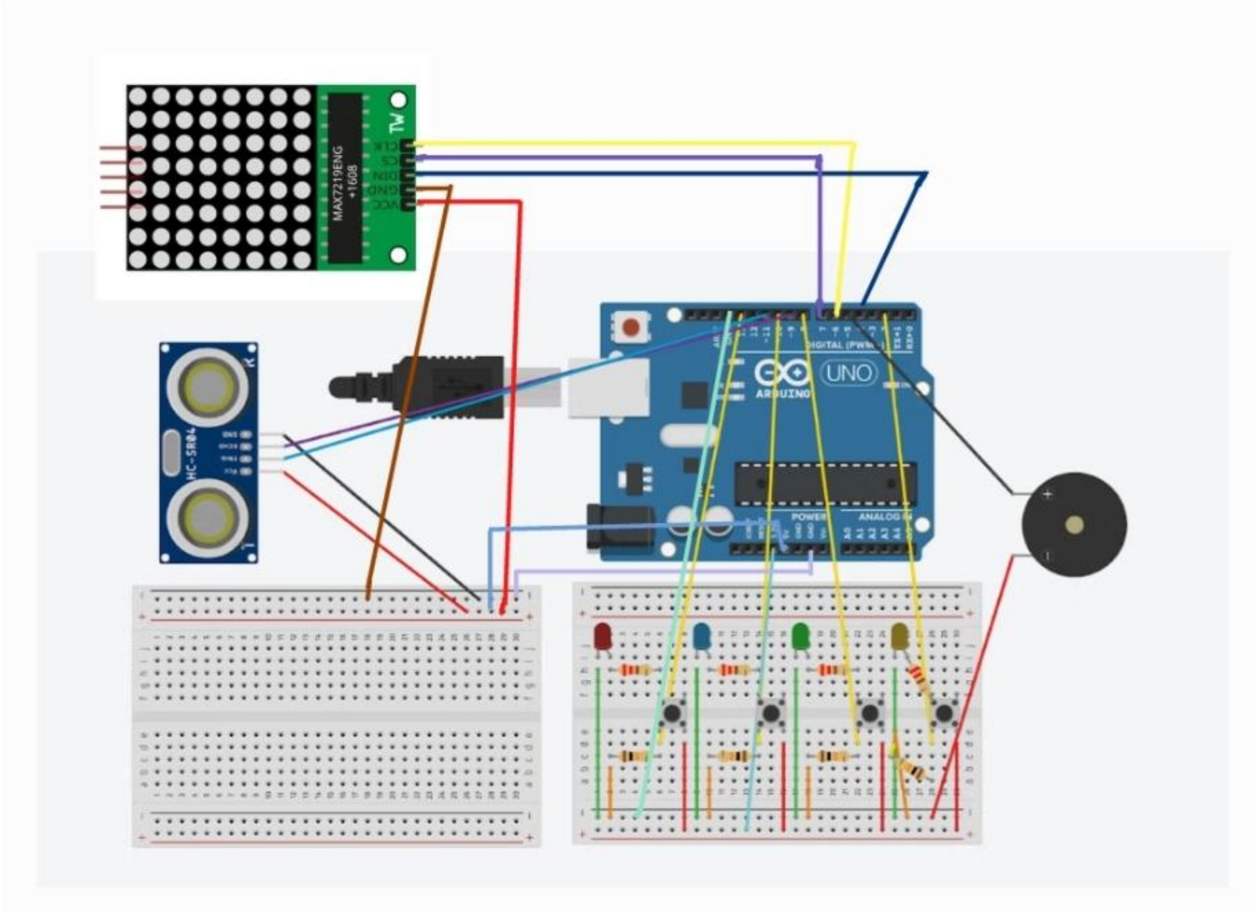
Picture 2: The smiley face (happy) in close up



Picture 3: The breadboard, including lights and buttons in close up

Video 1: see Canvas submission

Appendix C



Schematics of our game “Simon Says Remastered”, created with Tinkercad (https://www.tinkercad.com/)