

Iva: A Playful Humanoid Robot with Educational Flare for Little Patients

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Abstract: Traditional child patient care needs human workers, who are limited due wage shortage and other factors. Using technologies such as robotics may be a viable alternative as a care assistant to improve child patients' wellbeing, especially when the UK government is encouraging robotics and artificial intelligence innovation. Literature found positive implications for the use of robotics for child patients, such as social humanoid robots providing emotional support and helping child patients reduce pain, which allows for more possibilities of using social humanoid robots to explore serving child patients. This research aims to develop an effective solution to entertain and comfort child patients who have been negatively impacted by the threatened and declining social care sector. The researchers introduced a new design of the robot - Iva: a playful humanoid robot with educational flare for little patients. Iva is based on the NAO robot's hardware and equipped with various sensors and abilities, such as tactile sensors, facial detection and speech and object recognition, enabling it to interact with children through interactive activities. Iva can perform conversation, games, shows, exercises and more activities, based on the thinking of the child patients' needs and preferences, forms of expression and programming workflow. The whole process emphasised user friendliness and ethical considerations, including data privacy and informed consent. The design, development and testing have been conducted in the novel EUREKA Tokku Zone to ensure ethical integrity. Preliminary testing in a laboratory setting shows all the functions of Iva work correctly for providing multiple interesting activities to let child patients play and relax. In terms of Iva's performance, she is a meaningful robot that contributes to a more positive and supportive environment for children during hospitalisation. Future work contains improvements of Iva's program for a more accessible experience, and the test in the real hospital setting within the Tokku Zones in Wales.

Keywords: Child Patients, Child-Robot Interaction, Hospital Robots, Healthcare Robot, Social Robots, Robot Programming

1. Introduction and Background

In recent years, the use of robotics in healthcare and social environments has grown steadily, with humanoid robots becoming more common in roles that support interaction, learning, and new types of user experiences (Broadbent, Stafford and MacDonald, 2009; Belpaeme et al., 2018). These technologies can offer fresh ways to share information, promote engagement, and encourage participation especially in situations where more traditional approaches may not be as effective or appealing (Mubin et al., 2013). One such example is Iva, a humanoid robot designed with a playful and educational approach, created to offer engaging and accessible social experiences. Aimed at a wide range of users, including young adults, Iva provides a unique platform for informal learning and interaction (Tanaka and Matsuzoe, 2012). While interest in social robots continues to expand, there is still relatively little research on how people respond to these technologies and how well they can support meaningful engagement (De Graaf, Allouch and Klamer, 2015). This study looks at how users initially react to Iva, with a focus on their sense of engagement, perceived usefulness, and the potential value of the robot in informal educational settings.

1.1 Research Aim and Objectives

This research aims to create a supportive and enjoyable way to entertain and comfort child patients, particularly those affected by the strain on the social care sector. This research has the following objectives:

- Build rationale and gauge a deeper understanding of the robotic intervention to yield appropriate methods to entertain and educate child patients.
- Plan and delegate tasks and workflow effectively based on the functions and methods to be used in this research.
- Design, implement and test the program of the robot.
- Summarise findings and reflections and conclude the work.

1.2 Traditional Care Situations for Child Patients

Child patients are traditionally entertained and comforted by social care workers, who have had their sector under impact for decades. A 2019 UNISON conference claimed that “A decade of austerity has ravaged social care”, reporting that its workforce is “almost universally underpaid, largely undervalued and often exposed to exploitation” (UNISON, 2019). Thomas et al. (2025) showed that the nursing shortages are becoming a serious problem in the UK. As of September 2023, there was a shortage of 42,000 social care workers in the UK’s National Health Service (NHS) (Bazeer, Kelly and Buchan, 2024). With the waiting lists reaching a record 4.46M as of November 2020 and almost 200,000 patients having to wait longer than 52 weeks for routine treatment (Perry, 2021). Focus is being drifted elsewhere than on the entertainment and comfort of child patients, care that is a part of an already struggling sector, comes as no surprise. McLaughlin et al. (2024) got the result that the salary is the most important factor for child and family social workers to work on this, while England is facing labour shortages in social work for children and families. From this, it is evident that there is an urgent need for greater solutions than the traditional method to protect the well-being of child patients now more than ever, which has prompted the perfect opportunity for robotic intervention.

1.3 How Robots Help with Child Patients

Robotics and Artificial Intelligence (AI) are becoming more advanced and helping in healthcare scenarios, especially for elderly people and children (Carpenter, Sharma and Sengupta, 2024). The 2019 Remote Applications in Challenging Environments (RACE) report unveiled the recent change in perception and openness to investment in robotics. The report claims a lack of robotic investment has even been “acknowledged by the UK Government in their Made Smarter Review and the next few years will see significant investment in robotics” (Department for International Trade, 2019). The UK Research and Innovation (UKRI) invests and supports robotics and AI, partnered with the Engineering and Physical Sciences Research Council (EPSRC), illustrating great opportunity to develop solutions whilst backed by government funding and the UKRI Challenge Fund has provided £45.5 million to support hubs in robotics and AI (UKRI, 2025). Or, Ng and Goh (2025) described that the social robots are doing great work on reducing children’s pressure and anxiety in hospitals when they are undergoing medical procedures. These robots can be programmed to perform actions and interact with children. To deepen understanding of the international horizon, existing solutions with use cases relative to this project’s research problem have been analysed below. Robin is a humanoid robot which can give lovely facial expressions (Paplu et al., 2023). Robin was piloted at three Armenian hospitals to over 100 children with a self-report questionnaire finding that “joyfulness” was increased by more than 26% whilst stress was reduced by 34% (Kart, 2020), indicating strong positive reception. MEDi is a humanoid robot helping children in hospitals (Onuoha et al., 2024), created and programmed on a SoftBank NAO robot (SoftBank Robotics, 2021). MEDi can be programmed to teach child patients (Lee-Krueger et al., 2021) and reduce children’s pain and fear (Farrier, Pearson and Beran, 2020). Nishat et al. (2025) used the same type of the robot to entertain children before doing surgeries. This showed these kinds of robots can reduce children’s pain in hospitals. In Dubai, researchers also showed these robots can entertain children (United Arab Emirates University, 2022). Alhashmi et al. (2021) found that Students felt comfortable interacting with the robot and wanted the robot for fun activities. Huggable is a robot which can be hugged, as its name and was developed by the Massachusetts Institute of Technology (MIT). It was piloted at Boston Children’s Hospital, improving the experience of the hospital and addressing child patients’ emotional needs (Logan et al., 2019). Akiyoshi et al. (2024) built an autonomous dialogue system using the hug functions and showed that it can reduce people’s negative thoughts. Humanoids UK Government consulted the national experts to produce the Rapid Technology Assessment guide for trends, risks and future directions for researchers to address the current gaps (UK Government, 2025).

2. Methods

2.1 Design and Development Approach

This study reports the design and development of Iva: A Playful Humanoid Robot with Educational Flare for Little Patients, implemented on the NAO humanoid platform (Aldebaran Robotics, NAO V5 Blue) using the Choregraphe environment (version 2.1). No child participants were involved; the system was prepared for future deployment with trained healthcare staff to facilitate interactions for paediatric patients, aligning with best practices in child–robot interaction design (Belpaeme et al., 2018; Robinson et al., 2021).

2.2 Technical Implementation and Internal Testing

Interaction behaviours, walking, dancing, a flag card game, stretching, and push-ups, were scripted using Choregraphe's visual programming, with sensor inputs (touch, vision, audio) enabling responsive engagement. Safety parameters were configured to ensure compliance with environment constraints (e.g., joint limits, movement speeds), in line with recommendations for social robots in healthcare (Broadbent et al., 2009). Internal functional testing by the research team verified reliability, timing, and speech accuracy, following an iterative debugging cycle as described in human–robot interaction prototyping literature (Kanda and Ishiguro, 2013).

2.3 Workflow Documentation and Planned Evaluation

The workflow was broken down into stages, illustrated in Figure 1. Figures 2 and 3 show the interaction flow and sensor-based functions, respectively. Future evaluation will be conducted with healthcare staff in clinical environments, following institutional ethics approval, to assess operational usability and integration into care routines (Wang et al., 2017).

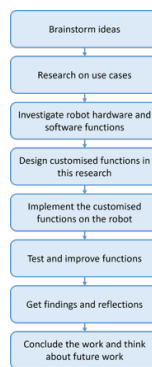


Figure 1: The workflow diagram showing the workflow in the research

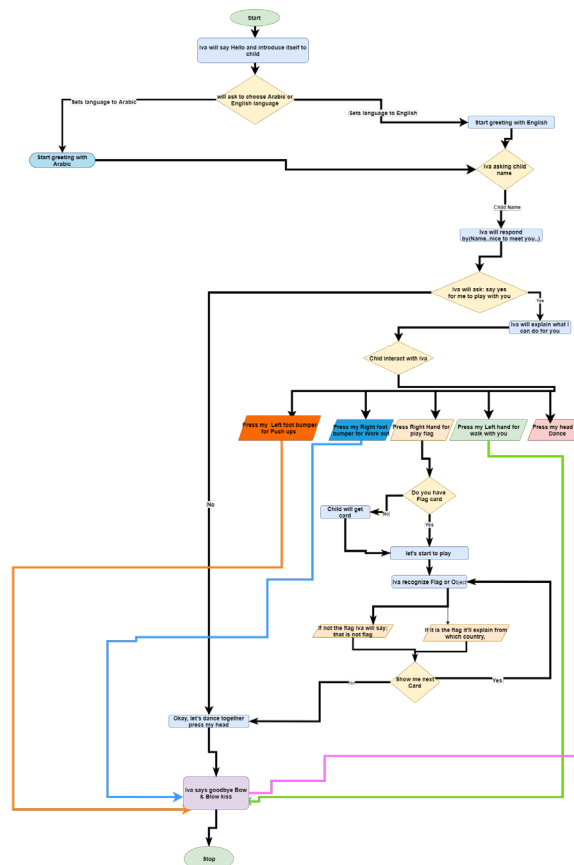


Figure 2: Iva's program flow and interactions with child patients

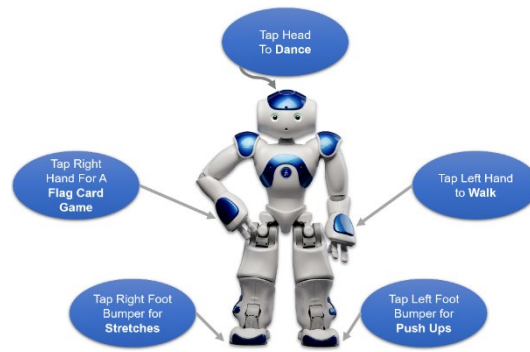


Figure 3: Iva's sensors used in the project

2.4 Ethical Concerns

Emotional child safety is important to maintain. As customised texts can be put into Iva's program, the languages Iva speaks need to be ensured not to upset or threaten users, especially when interacting with child patients. Children may be anxious or sensitive when talking about certain themes. Ensuring that no offensive words or actions are performed by Iva is important, especially since different social and cultural backgrounds need to be considered. These words and actions also need to suit children's ages and reduce the potential for misinterpretation.

The 'Three Laws of Robotics' (Asimov, 1942) was considered along with advice delegated by leading UK university roboticist professors as procured by the UKRI (EPSRC, 2021). One ethical consideration made, which also ties in with legality, is privacy. Privacy would need to be ensured, especially with regards to data retention and facial detection to enable GDPR compliance, privacy of the users and prevent third-party misuse, which would be of most importance, being that the users of Iva are primarily children. The Tokku Zone was introduced for balancing innovation with safety, ethical and legal issues (Hu and Chew, 2024). In EUREKA Robotics Centre, there is EUREKA Tokku RT Zone as one of the Tokku Zones, providing highly ethical concerns and protections when working on this research.

3. Design and Implementation

To provide functions to children, the software, Choregraphe, is used for programming Iva. Iva is supported in programming with Python. Python can give more options in programming and make it more flexible, however, Choregraphe provides rapid development and easier enhancement when discussing with users. Figure 4 shows the whole program of Iva. There are different sections, A to G, in the program that show different functions within the whole Iva's abilities.

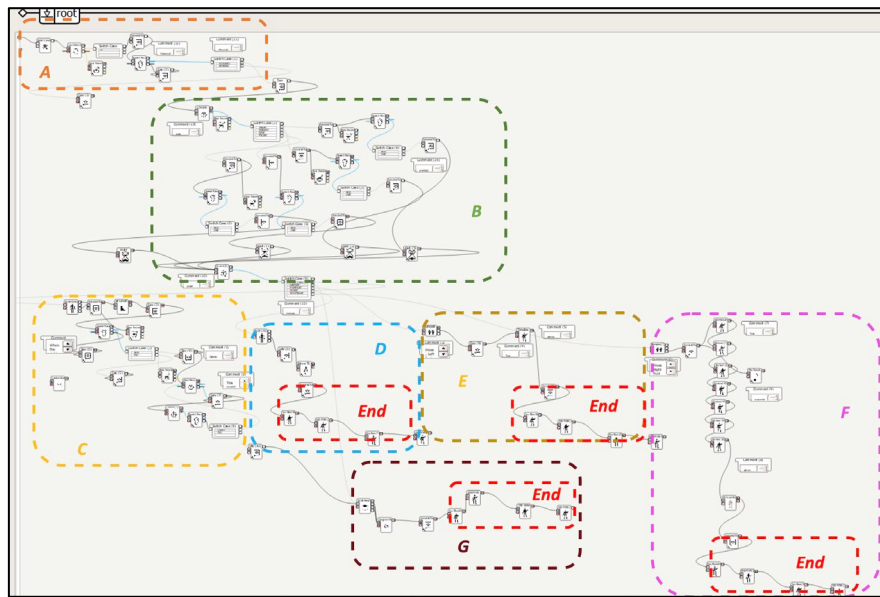


Figure 4: The program of Iva in Choregraphe with sections marked from A to G

Figure 5 shows the details of sequence A, which is the startup of the whole program and executed when a user comes into Iva's recognition range. Facial and speech recognition are used as triggers. The introduction begins when an unmasked face appears in front of Iva, using Iva's awareness of users with her animated eyes, which have LED colours that change, and the movement of head and arms, which make Iva more realistic. There are two languages provided, which lets users choose between English and Arabic and use Iva's speech recognition when talking to Iva and to get responses.

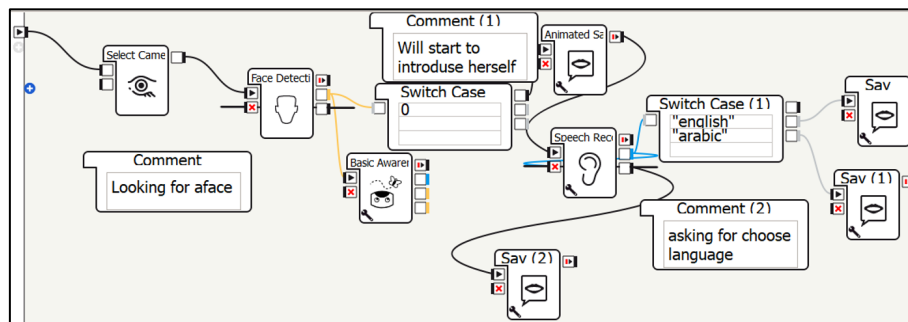


Figure 5: Choregraphe Sequence A – Introduction

Figure 6 shows the details of sequence B, which is the introductory sequence. It begins once the user chooses one of the languages. Iva will ask for the user's name at first and offer different functions to see what the user would like to do. If the user responds "yes" to Iva, Iva will speak to list the functions she can offer and introduce how the user can operate her. For the functions, the user can tap Iva's head to let her dance, hold her left hand to let her walk, hold the right hand for playing the card game together, push the left foot for push-ups, and push the right foot for stretches.

Figure 7 describes the sequence C, the card game using Iva's tactile sensor, speech and vision. The card game only starts after the user pushes the right foot to confirm that the user wants to play with Iva. First, Iva will ask if the user has a card. After the user says "yes", Iva will let the user show a card to her. She uses visual recognition to see the colours and patterns on the flag and tries to check which country or region it stands for. Once determined, she will say the result and ask for another flag card if you have one.

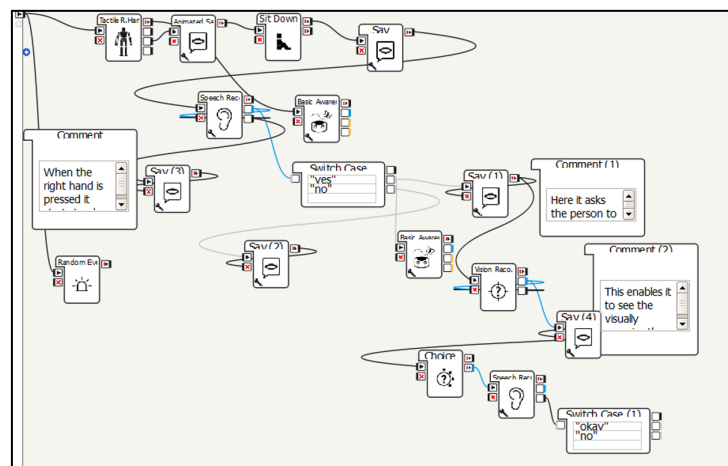


Figure 8 is the sequence D for walking. It starts when the user holds Iva's left hand. Iva will respond and start walking on the floor.

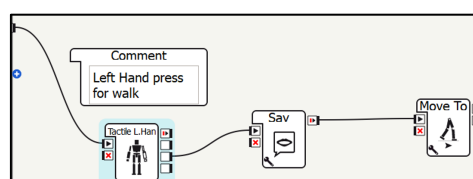


Figure 8: Choregraphe Sequence D – Walking

Figure 9 shows the sequence E for push-ups. When the left tactile sensor detects it being pushed, Iva will say a short speech and then start to do the push-up. She will finish and stop after a few seconds.

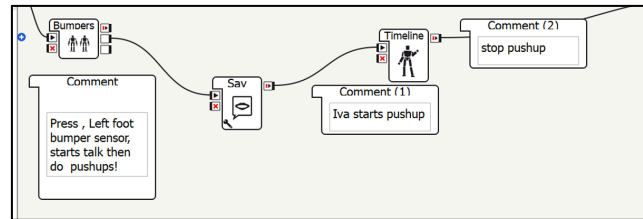


Figure 9: Choregraphe Sequence E – Push-up

Figure 10 shows the details in sequence F, which are the slow stretches that Iva does. When the right tactile sensor detects a push, Iva will do some slow stretches. The music will be played during the stretches, and the user can follow these actions together with Iva.

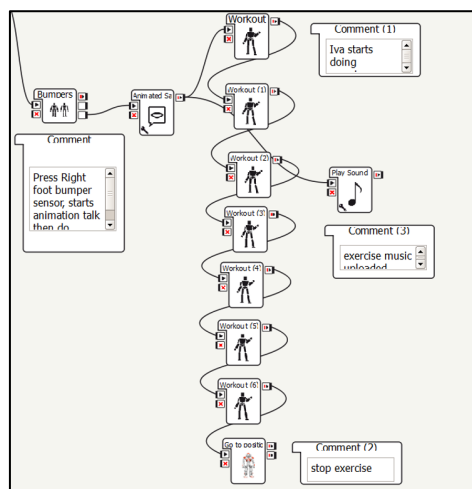


Figure 10: Choregraphe Sequence F – Slow Stretches

Figure 11 shows the details of sequence G, dancing. When the user taps Iva's head, she will dance, which will show different kinds of actions for each part of the body. The song Gangnam Style by Psy is chosen for its popular, upbeat, and all-ages rhythm that bring joy to the children.

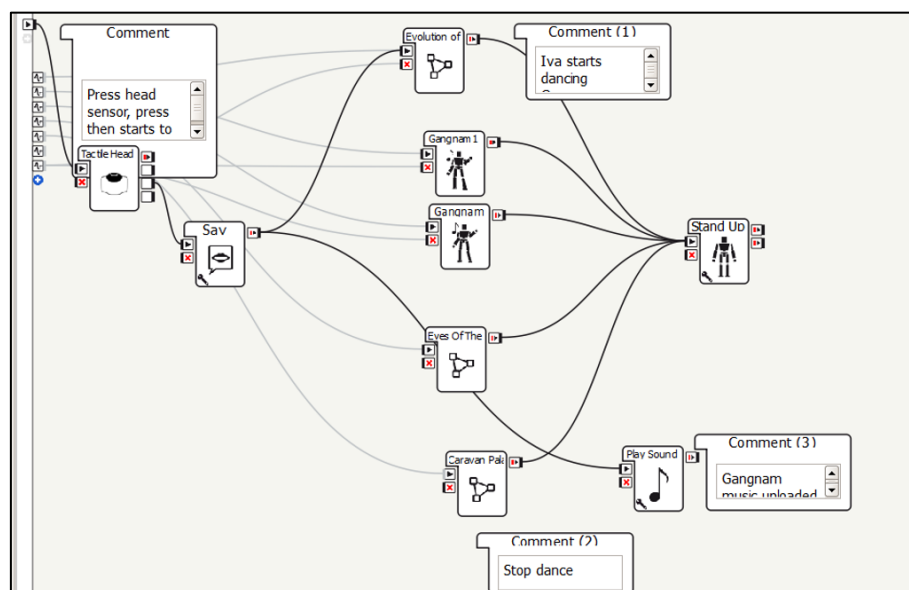


Figure 11: Choregraphe Sequence G – Dancing

Figure 12 is one of the “end” sequences, which are located at the end of sequences D, E, F and G. In these sections, Iva will say goodbye to the user and offer well wishes. These are designed to let the user not be pressured to keep interacting with Iva if they have had enough.

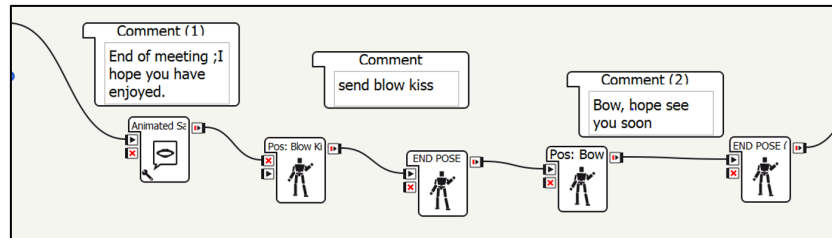


Figure 12: Choregraphe Sequence “End” – Saying Goodbye

4. Findings

This preliminary study explored the use of Iva, a playful humanoid robot, to support social interaction and engagement among young adults. Participants, aged 18 to 22, took part in individual sessions within the EUREKA Tokku RT Zone.

4.1 Observed Engagement with Iva’s Activities

Participants engaged with Iva through a range of interactive activities, including simple conversations, a flag card game, walking, dancing, and light stretching exercises. Overall, engagement levels were positive, with most participants showing sustained interest. Three out of Four completed all activities without requiring prompts, and four expressed verbal feedback such as “interesting”, “fun”, or “novel” suggesting a generally favourable experience.

4.2 Initial Hesitancy and the Role of Playfulness

Four participants initially showed signs of hesitation, such as minimal speech or reserved body language. However, their level of engagement noticeably increased once Iva initiated the dancing activity, which involved upbeat music and expressive movements. This shift highlights the potential of playful design features to act as effective icebreakers, helping to ease initial reluctance and promote interaction. Figure 13 shows how people talk with Iva using Iva’s speaking and hearing functions. Figure 14 indicates three of the different ways to let people enter, confirm or make decisions on Iva’s functions using Iva’s sensors. Iva can do card picture recognition and respond fast when people show different cards to Iva (as Figure 15). Figure 16 shows Iva dancing and doing push-ups performing actions vividly and sympathetically.



Figure 13: A user talking with Iva

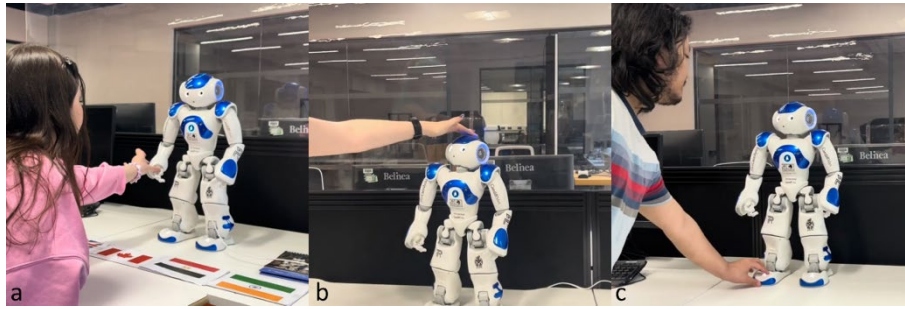


Figure 14: A user giving command to Iva using sensors – (a) hand touching, (b) head touching, (c) foot bumper pressing



Figure 15: Iva recognising cards with the country's flags on them during the card game - Learning National Flags

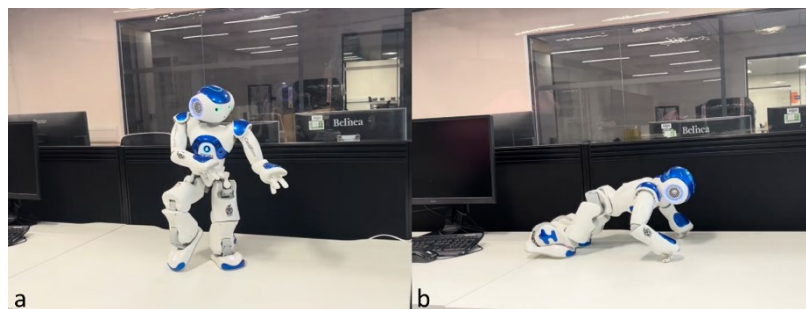


Figure 16: Iva (a) dancing and (b) pushing-up - Learning a dance and exercises

4.3 Accessibility and Comfort with Interaction

Iva has friendly and easy-to-use interactions that children can understand and interact with. As an example, a child who just had a shoulder surgery cannot do push-ups but can play card games with Iva or enjoy her dancing. Although all participants interacted with Iva in English, there were variations in their comfort levels during the early stages of the session. Some appeared more confident than others in responding to Iva's prompts, but overall, participants adapted quickly and were able to follow the activities with minimal difficulty. This suggests that Iva's design and language use were generally accessible to this age group.

4.4 Challenges in Card Game Interaction

The research has a very physical, hands-on nature, which brought some difficulties when programming and testing Iva. While the flag card game was generally well received, two participants had difficulty understanding Iva's initial instructions and required clarification. In most instances, the robot's visual recognition system performed reliably, with an estimated accuracy rate of 90%. However, occasional delays in processing disrupted the flow of the interaction and slightly impacted the overall experience.

4.5 Qualitative Feedback and Anecdotal Observations

Informal feedback from participants was mostly positive. One participant described the interaction as “a unique experience” and found Iva “quite interesting”. While anecdotal, comments like these offer insights into how humanoid robots may provide novel and engaging social encounters for young adults.

4.6 Reflections

In critical reflection, the Arabic language in Iva was limited, while the development and testing were conducted in the UK, Arabic or more languages can be extended in Iva in further support. In the UK, there are also some foreigners who speak English as a second or third language. In most cases, it is better to let Iva speak in the user’s native language. Letting Iva chat and perform in multiple languages will make more people feel more comfortable, especially for child patients. This can help some nervous child patients feel more at home as well if Iva, a robot companion, speaks their home language. When Iva asks a question, it would be more accessible to let the user choose from more options. If Iva asks a question that only supports a yes or no response, the user cannot get accurate feedback at every time. Allowing a non-verbal response can make users more comfort to talk with Iva. In other cases, for someone who is finding it difficult to speak, such as a patient with difficulty or just has had a surgery, giving Iva more ways to get feedback and communicate, such as nodding or shaking head, can let the user to interact with her easier. This can put more attention on letting the user experience Iva’s activities and company without worrying about speech or more control. In this case, the game Iva offers can also be enhanced. Iva’s card game does not require speaking, except when asking if the user wants to play. However, the user is required to hold up cards to interact with her in the game. This can sometimes be more common as most of the users are child patients in the hospital. It is difficult for those who have limited mobility in their arms. Providing alternative ways to entertain users, such as getting Iva to tell jokes to amuse users or play verbal games, would allow more people to enjoy Iva’s functions and abilities.

Lighting can interfere with facial recognition. While attempting object and facial recognition, sometimes it was difficult to keep the robot focused on the user or presented objects. This was due to the robot focusing on bright lights, which in part interfered with its ability to visualise the users’ eyes as well. This issue was mitigated through experimenting with different lighting for different use cases.

4.7 Limitations

The study took place in a controlled laboratory setting, which does not fully reflect real-world social contexts. Additionally, the small sample size limits how widely the findings can be applied. The absence of a control group also makes it difficult to determine whether any changes in engagement were directly caused by interacting with Iva. Another limitation was the difficulty interpreting accents, speech impediments, or quiet voices. This impacted engagement with Iva.

5. Future Work and Conclusions

Based on the findings, building multiple languages will significantly improve the user experience and let more users enjoy Iva around the world. This can be simply worked on and tested within the research in the future. An improved game can also be redesigned to enhance the accessibility and experiences of users who have difficulties. After testing Iva in the lab, a more realistic test, such as letting child patients use Iva in a hospital, is planned in the future. Currently, we have developed Tokku Zones in Cardiff and Vale Health Board in Wales. These can be the places for deploying and testing Iva to provide relevant real-life integration feedback from child patients, patients or medical staff. More users’ data and feedback can be used to improve and modify Iva’s current functions and experiences and create new thoughts and ideas. Moreover, with the use of Iva in the hospital, more functions for patient care rather than entertainment and education, such as fall detection or management for some cases, can be integrated into such a practical robot-like Iva (Wei et al., 2023).

Through the research and investigation of the status of traditional child patient care and theory, and the use of robots in healthcare scenarios, it is important to enhance the child patients’ experience. Research shows that robot assistants like Iva are invaluable in care facilities and hospitals, within the lab-controlled environment and demo in hospitals. From 2025-2028, Iva will be integrated into the paediatrics department for field evaluation. It is expected that Iva will give companionship to children, staff of various ages and offer distraction from a stressful environment in the hospitals. We have designed Iva for child patients to play and be educated by designing and implementing friendly and interesting conversations, actions, interactions and games, which provide different ways to improve children’s experiences when they spend time in hospital. A variety of sensors were used when programming Iva, including but not limited to camera (vision), microphone (listening), speaker (speech), tactile

sensors (interactive touches) and motion sensors. This allowed children of various ages to be able to interact with Iva, test Iva in EUREKA Tokku RT Zone in Wales, in an ethically and legally protected. We would propose that Iva is a caring assistant who works as a companion in hospitals, assisting children with patient enhancement experiences, fun educational interaction during the long wait, and distraction procedures in the healthcare assessment and treatment.

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Ethics Declaration

This preliminary study received ethical approval from the Cardiff Metropolitan University Ethics Committee before it began, ensuring all research procedures met institutional ethical standards. This study did not involve any human participants, including children, and no data was collected from individuals during this phase.

AI Declaration

The researchers declare that they did not use AI in any aspect of the writing of this paper.

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Appendices

Iva's programme files running on Choreographe software and codes for Python used in this research:
<https://github.com/AveenNajm/Iva-Humanoid-Robot>