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Virtual And Augmented Reality To Support The Emotional Wellbeing Of Hospitalised Children

Realtà virtuale e aumentata per sostenere il benessere emotivo dei bambini ospedalizzati

Call

Recent research highlights the potential of immersive virtual reality (VR) in improving the psychological adaptation to hospitalization and the quality of life for pediatric patients (Tennant et al., 2021; Comparcini et al., 2023). Hospitalization often causes fear and agitation in children, affecting their well-being and that of their families. Addressing this through early familiarization with the hospital, creating a playful care setting, and fostering trust with medical staff is crucial. A project in the Pediatric Oncohaematology department aims to enhance the well-being of patients aged 3 to 10 years using VR and Augmented Reality (AR) applications inspired by "The Little Prince". This includes early VR exploration of the hospital, collaborative VR for educational activities and games with peers and medical staff, VR for pain therapy with pleasant scenarios, and AR with 3D characters from "The Little Prince". The protocol involves a pedagogical investigation using an adapted version of Kellner's Symptom Questionnaire (1982; 1987) to assess anxiety, hostility, relaxation, and sociability. The project also examines patients' skills, technology usage habits, and preferences to personalize the experience. Preliminary results from a qualitative-quantitative study with a control group of non-hospitalized children highlight similarities, differences, and the educational potential of these technologies in hospital settings. This research aims to improve the hospital experience for pediatric patients through innovative technological interventions.

Keywords: hospitalised children; augmented reality; virtual reality

Recenti ricerche evidenziano il potenziale della realtà virtuale immersiva (VR) nel migliorare l'adattamento psicologico all'ospedalizzazione e la qualità di vita dei pazienti pediatrici (Tennant et al al., 2021; Comparcini et al., 2023). L'ospedalizzazione spesso causa paura e agitazione nei bambini, che si ripercuotono sul loro benessere e su quello dei caregivers. Per tale motivo è necessario familiarizzare con l'ospedale predisponendo ambienti di cura ludici e promuovendo atteggiamenti di fiducia verso il personale sanitario. Il progetto attivato presso un reparto di Oncoematologia Pediatrica mira a migliorare il benessere dei pazienti di età compresa tra i 3 e i 10 anni attraverso l'utilizzo di applicazioni di realtà virtuale (VR) e realtà aumentata (AR) ispirate a "Il Piccolo Principe". L'obiettivo è migliorare il benessere dei piccoli pazienti con esperienze di esplorazione VR precoce dell'ospedale, reparti arricchiti in AR con personaggi 3D del Piccolo Principe, sessioni VR di gioco collaborativo con i pari e con il personale sanitario e terapia del dolore con scenari immersivi piacevoli. Il protocollo prevede un'indagine pedagogica attraverso la compilazione della versione adattata del Symptoms questionnaire di Kellner (1982; 1987) per valutare ansia, ostilità, rilassamento e socievolezza dei bambini ospedalizzati. Il progetto esamina anche le competenze, le abitudini di utilizzo della tecnologia e le preferenze dei pazienti al fine di personalizzare al meglio l'esperienza. I risultati preliminari di uno studio quali-quantitativo con un gruppo di controllo di bambini non ospedalizzati evidenziano le somiglianze, le differenze e il potenziale educativo di queste tecnologie in ambiente ospedaliero.

Parole chiave: bambini ricoverati | realtà aumentata | realtà virtuale

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Introduction

Paediatric hospitalisation can induce negative emotions such as anxiety, fear, hostility both in young patients and in their families. There is a need for accompanying approaches to reduce so-called 'procedural' anxiety in children, i.e. discomfort related to medical treatment (Nunns et al., 2018). Recent studies (McQueen et al., 2012; Ahmadpour et al., 2019) have demonstrated the distracting effect of virtual and augmented reality during medical treatment: in fact, stimulation of the senses allows for a shift in concentration and/or the development of skills to modulate the processing of pain sensations. For this reason, the collaboration of a voluntary association, a local hospital and two university departments led to the Piccolo Principe project, which aims to implement virtual and augmented reality applications to improve the hospitalisation experience of children aged 3 to 10 years in the paediatric oncohaematology ward. Following the integrating framework of the story of the "Little Prince" by Antoine de Saint-Exupéry, various applications and technologies are being designed to allow children to discover the ward and the medical staff in a playful setting close to the world of children to reduce anxiety and to distract themselves from medical treatment as a "pain therapy". Contextual conditions are modified to facilitate acceptance and difficulty resulting from the hospitalisation condition (WHO, 2001). Specifically, the following are being designed by the engineering team:

- a VR and 3D modelling (Fig.1) application of preview insight into the ward to be explored using a simple cardboard visor (Fig. 2) to reduce anxiety about the unknown and preview hospital environments. In the case of unplanned hospitalisation (e.g. emergency admission) this application can be used directly in the hospital during triage or waiting times

Fig. 1. Spherical photo of department entrance for 3D modelling

Fig. 2. Cardboard viewer

- VR application of collaborative games that will allow children, via a MetaQuest VR visor (Fig. 3), to interact with other users who can be other children in the ward or medical staff. The virtual interaction environments will be inspired by the journey of the Little Prince. These gamification activities aim to increase positive relationships and a sense of trust and community in the hospital ward.

Fig. 3. Meta Quest 2 viewer

- VR pain therapy application that will allow children to practise relaxation based on the mindfulness protocol with relaxing scenarios and music or to perform entertaining activities such as listening to music or an audiobook to distract themselves from the ongoing medical therapies (e.g. chemotherapy) by having immersive experiences that are pleasant for the patient
- Social robots to engage children socially (interactions), emotionally (needs identification) and educationally (anxiety and stress coping)

Methodology

In this project, the university's pedagogical team is responsible for conducting a context analysis, structuring the technological intervention, and, finally, evaluating the outcomes. A protocol was implemented to assess and monitor emotional variables and technological preferences in children up to 10 years of age who were not hospitalised (baseline group), hospitalised but not using AR and VR technologies (control group), and hospitalised children exposed to Little Prince technologies (experimental group). The exploration of emotions is aimed at a pre- and post-test verification to assess the effectiveness of the protocol on the improvement of quality of life and the reduction of anxiety and apprehension, while the investigation of the habits of use of the technologies is aimed at defining a technological development project plan adapted to the patients' expectations and satisfaction. The qualitative-quantitative protocol is divided into two parts. The first one consists of the implementation of a questionnaire adapted from the Symptom Questionnaire QS (Fava et al., 1983; Kellner, 1987) which was administered in precedent research to adolescents and children (Neidhardt et al., 1992) and to cancer patients (Orlandi et al., 2007). More specifically, selected variables (the Anxiety and Hostility Symptom Scale) have been used. The items were adjusted according to the patient and the difficult situation faced by them and their families. The second part of the protocol was specifically designed to explore skills, user habits, and preferences for the use of technology in the hospital setting. For patients aged between 3 and 8 years, the questionnaire is filled in by the caregiver, while older children complete it on their own. In the first part, they are requested to dichotomously choose if the 15 proposed adjectives reflect the patient's state of mind in the two weeks preceding the giving of the test. In the second part, there are open and closed questions concerning possessed and well-known technological devices, use habits, earlier experience with virtual and/or augmented reality systems, and preferences on the availability of technologies in the hospital environment.

The questionnaire is submitted to three samples of children up to 10 years of age: the baseline group (non-hospitalised children), the control group (hospitalised children who have not used and will not use the technological apps included in the project), and the experimental group formed by the children involved in the project and who will use the apps developed by the engineers. The latter group will also use the questionnaire at the time of discharge. A further action of the pedagogical team involves the definition of a set of playful collaborative activities to be carried out remotely in a virtual environment where patients can meet and interact in a fun way during hospitalisation in order to enhance this experience. The games designed are in the process of being evaluated for feasibility by the engineering group, but an overview is provided in Table 1.

Category and Age Range	Obj	N.Players	Levels	Time	Environment	Description	Helps	Scores
VR Puzzle 3/5 years	Combine pieces to form the image	2	3 (9, 12, 21 pieces)	No time limit	Little Prince's Planet (Lvl 1), Planet Earth (Lvl 2)	Image of Little Prince and the Rose (Lvl 1), Little Prince and the Fox (Lvl 2)	Positive sound feedback, visual help with colors, view complete image	Collaborative game, indication of time taken
VR Puzzle 6/10 years	Combine pieces to form the image, challenge or collaborate	2	2 (30, 50 pieces)	Undefined time	Little Prince's Planet (Lvl 1), Planet Earth (Lvl 2)	Image of Little Prince and the Rose (Lvl 1), Little Prince and the Fox (Lvl 2)	Positive sound feedback, visual help with colors, view complete image	In challenge option: win by finishing the level first
Memory Card 3/5 years	Form pairs of identical cards with Little Prince characters	2	3 (6, 8, 10 cards)	No time limit	Starry background	Flip cards, establish who makes the first move, remember positions of matching figures	Personally color figurines before playing	Turn-based, whoever finds more matching cards wins
Memory Card 6/10 years	Form pairs of identical cards with Little Prince characters	1-2 + 1 adult	3 (12, 16, 20 cards)	Undefined time	-	Flip cards, remember positions of figures, game ends when cards are finished	Little Prince help to find the second matching figure	Whoever finds more matching cards wins
Object Hunt 3/5 years	Competitive object hunt, help Little Prince find missing plane parts	2	6 levels (mazes, hidden object hunt)	Winner finishes first	Various asteroids and Earth	Find missing pilot plane parts, meet new characters on different planets	Up to 3 hints from Little Prince	Whoever finishes all levels first wins
Lego Building 6/10 years	Help Little Prince find missing plane parts, collaborative	2 + 1 adult	6 levels	No time limit	Various asteroids and Earth	Build missing plane parts with Lego, collaborate, view complete image	Collaboration in construction, decide on which planet to land	-

Table 1: Set of VR activities

The activities are designed to have as little physical exertion as possible in order not to impact the physical state and ongoing treatment (e.g. presence of IVs) and to manually use the Meta Quest 2 visor controller (Fig. 4). For this, the following have been designed: collaborative puzzle games in immersive environments with Little Prince scenarios; competitive memory games with card matching; treasure hunts guiding young players through mazes and object searches, teaching them to work as a team.

Fig. 4. Meta Quest 2 controller

The working group of the pedagogical area will also define the relationship protocol of the 'Pepper robot' for interaction with the ward and patients, to make this technological resource functional to pro-

mote a better quality of life in the hospital, exploring and responding to the socialisation and entertainment needs of patients and supporting the ward staff. This contribution only reports the data relating to the first sample, i.e. children who have not had and will not have experience of hospitalization and which will serve as a baseline comparison for the other two groups. This sample is particularly important because, in addition to offering an element of comparison, it offers a snapshot of children's technological choices and preferences.

Results

The launch of the Little Prince project involved a series of phases. The initial chapter saw the establishment of a dynamic and dedicated project team that brought together diverse skills and perspectives to synergize efforts.

Guided by a commitment to evidence-based practices, the pedagogical team studied and examined the literature. This phase involved deepening existing research and exploring technological interventions in paediatric health care. The synthesis of this knowledge became the compass that guided the project toward best practices and new approaches.

The first key step was the design and implementation of a comprehensive exploration protocol. In addition to the design of the framework, its translation into tangible applications was verified, designed to transcend the conventional boundaries of paediatric care-in fact, the administration also includes a group of nonhospitalized children. The protocol aims not only to assess emotional variables, but also to understand the technological preferences of the young participants. The last step of these preparatory steps led to formal acceptance of the project by the hospital's Ethics Committee. This approval represented not only a nod to the ethical soundness of the project, but also a recognition of its potential to contribute significantly to the well-being of young patients. The Ethics Committee's green light served as a trailblazer, paving the way for implementation of the project within the hospital. At the same time, the web questionnaire for non-hospitalized children was sent to the reference group composed of individuals of similar age to the experimental group but without previous hospitalization experience. This group provided a valuable reference point for future comparison. Their responses, untainted by the impact of hospitalization, provided a baseline perspective for assessing the influence of the project on the hospital experience. The sample of 42 children composed mainly of males (54.8%) aged 3-10 years indicated their experiences and preferences. 20 children aged 8 to 10 years (47.6%) responded to the questions, and in addition, the responses of parents who were given the task of representing the opinions of children aged 3 to 7 years were analyzed. Figure 5 provides a visual representation of the plurality of respondents.

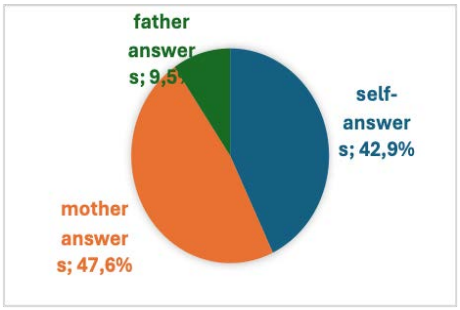
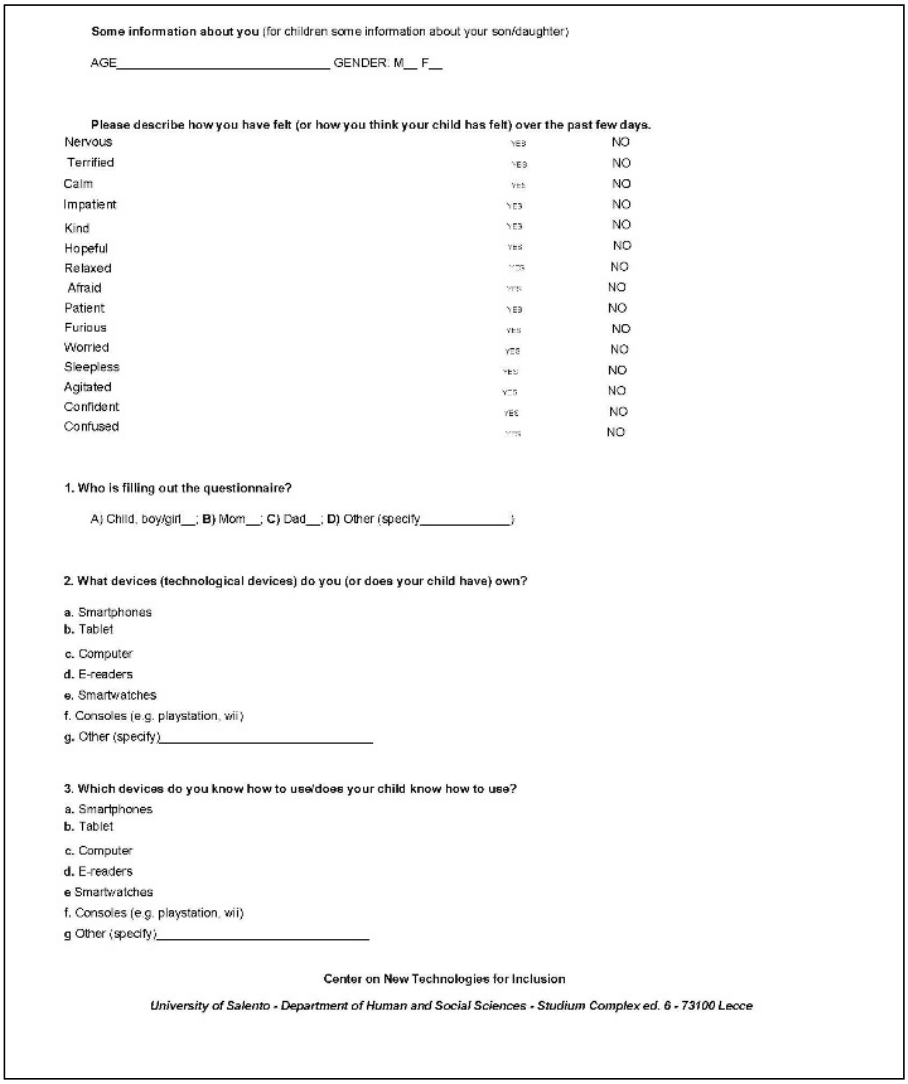


Fig. 5. Questionnaire fillers

Kellner's symptom questionnaire (Fava et al., 1983; Kellner, 1987) was appropriately customised to the purpose, age of participants and investigation setting. For this reason, 15 items were chosen from the sub-scales of symptoms (anxiety and hostility) and well-being (relaxation and sociability) (Table 2). The protocol is presented in the Fig.6 and Fig.7.

Symptom		*Well-being*	
Anxiety	**Hostility**	**Relaxation**	**Sociability**
Nervous	Confused	Calm	Kind
Terrified	Furious	Relaxed	
Afraid	Impatient	Patient	
Sleepless	Worried	Confident	
Agitated		Hopeful	

Table 2: Items selected by Kellner's questionnaire



Some information about you (for children some information about your son/daughter)

AGE_____ GENDER: M__ F__

Please describe how you have felt (or how you think your child has felt) over the past few days.

Nervous	YES	NO
Terrified	YES	NO
Calm	YES	NO
Impatient	YES	NO
Kind	YES	NO
Hopeful	YES	NO
Relaxed	YES	NO
Afraid	YES	NO
Patient	YES	NO
Furious	YES	NO
Worried	YES	NO
Sleepless	YES	NO
Agitated	YES	NO
Confident	YES	NO
Confused	YES	NO

1. Who is filling out the questionnaire?

A) Child, boy/girl__; **B)** Mom__; **C)** Dad__; **D)** Other (specify_____)

2. What devices (technological devices) do you (or does your child have) own?

a. Smartphones
b. Tablet
c. Computer
d. E-readers
e. Smartwatches
f. Consoles (e.g. playstation, wii)
g. Other (specify)_____

3. Which devices do you know how to use/does your child know how to use?

a. Smartphones
b. Tablet
c. Computer
d. E-readers
e Smartwatches
f. Consoles (e.g. playstation, wii)
g Other (specify)_____

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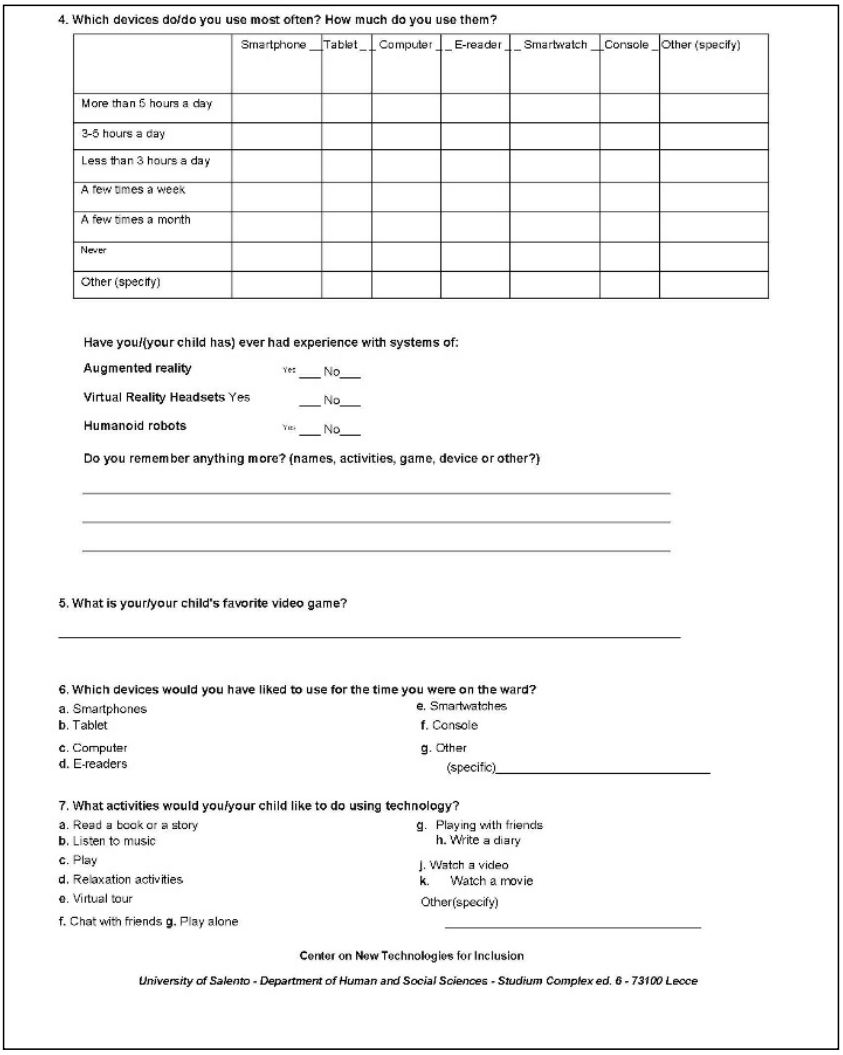
Fig. 6. Pedagogical protocol for assessing socio-emotional variables and technology enjoyment pt.1



4. Which devices do/do you use most often? How much do you use them?

	Smartphone	Tablet	Computer	E-reader	Smartwatch	Console	Other (specify)
More than 5 hours a day							
3-5 hours a day							
Less than 3 hours a day							
A few times a week							
A few times a month							
Never							
Other (specify)							

Have you/(your child has) ever had experience with systems of:

Augmented reality Yes ___ No___

Virtual Reality Headsets Yes ___ No___

Humanoid robots Yes ___ No___

Do you remember anything more? (names, activities, game, device or other?)

5. What is your/your child's favorite video game?

6. Which devices would you have liked to use for the time you were on the ward?

a. Smartphones
b. Tablet
c. Computer
d. E-readers
e. Smartwatches
f. Console
g. Other (specific)

7. What activities would you/your child like to do using technology?

a. Read a book or a story
b. Listen to music
c. Play
d. Relaxation activities
e. Virtual tour
f. Chat with friends
g. Play alone
h. Write a diary
j. Watch a video
k. Watch a movie
Other(specify)

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Fig. 7. Pedagogical protocol for assessing socio-emotional variables and technology enjoyment pt.2

It was found that the largest part of the sample of non-hospitalised children did not exhibit symptoms of anxiety, such as feeling nervous (66.7%), terrified (90.5%), afraid (85.7%), sleepless (81%), agitated (73.8%) (Fig. 8). Regarding the symptoms concerning hostility (Fig.9), the participants reported feeling worried (73.8%), impatient (50%), furious (85.7%) and confused (73.8%). Instead, most of the children reported feeling: hopeful (78.6%), patient (59.5%), calm (81%), relaxed (69%), kind (83.3%), and self-confident (81%) (Fig. 10).

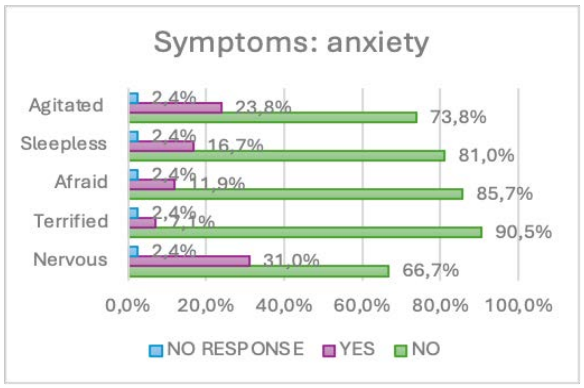

Fig.8. Symptom anxiety in baseline sample (non-hospitalised)

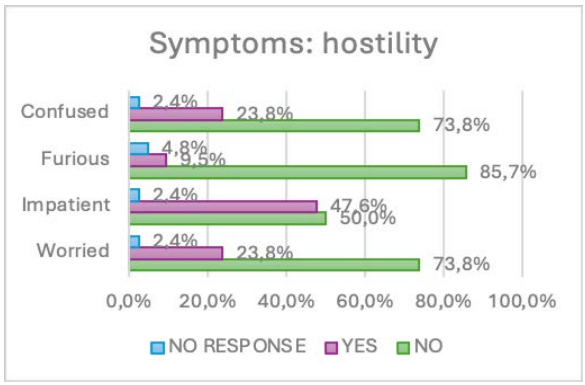

Fig. 9. Symptom hostility in baseline sample (non-hospitalised)

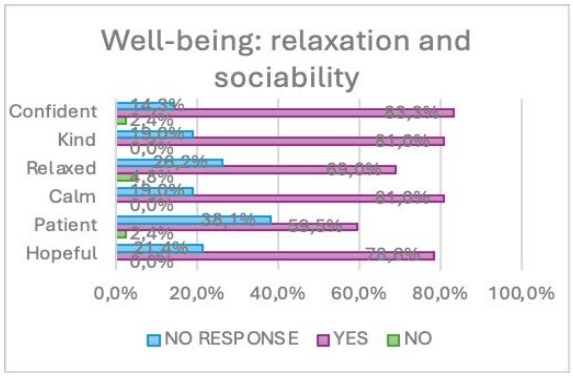

Fig. 10. Well-being: relaxation and sociability in baseline sample (non-hospitalised)

A question was made to understand the children's use habits of technology in their ordinary lives: six major devices were included in the survey: the smartphone, the computer, the tablet, the e-reader, the smartwatch, and the console (e.g. PlayStation, Wii, etc.). The results revealed that most children have a tablet (57.1%) and a smartphone (47.6%) and only 7.1% declared that they did not possess any technological devices but were able to use some of these devices. Also, almost all the children can use a smartphone (95.2%) and a tablet (83.8%). About the children's time spent using technological devices daily it does not exceed 5 hours in a day, for less than 3 hours in a day concern especially smartphones (36%) and tablets (30%); similarly, the use of devices a few times a week (tablet 23%, smartphone 11%); while usage from 3 to 5 hours a day is related to smartphones (22%) and consoles (12%). Computers get a higher rating for use a few times a month (29%) and 15% of children claim they never use smartwatches

and e-readers. For some information on children's preferences, useful for the formulation of hospital care protocols, a question was asked about children's preferences for video games: Roblox (14%), Minecraft (11%), Fortnite (7%); FIFA (7%). The common factor of games is the online platform, where players can interact with friends or other users remotely. In the survey, children were asked if, in addition to popular technological devices, they were familiar with or had experience with Augmented Reality (AR), Virtual Reality (VR) viewers and humanoid robots, and it was found that the majority had no experience with Augmented Reality (95.2%), Virtual Reality viewers (83.3%) and humanoid robots (88.1%) (Fig. 11). The children who said they knew and had experience with such technologies were requested to specify the technology used, of which 10% indicated that they did not remember; 10% had experience with the robotic device and 5% had used virtual reality goggles. Who had to interface with the humanoid robots declared that they had had this experience in the classroom situation and that the activities were mainly: the presentation of Nao and Pepper – two robots that are quite widespread on the IT market - to the class and the imitation of their movements and dances. Asked about their preference for devices they would use during an eventual hospital stay (Fig.12), the majority indicated that they would like to use smartphones (39%) and tablets (33%). The final question concerned their preference of device use (Fig.13): the majority would like to play games (16.7%), watch a video (16.7%) or listen to music (15.5%).

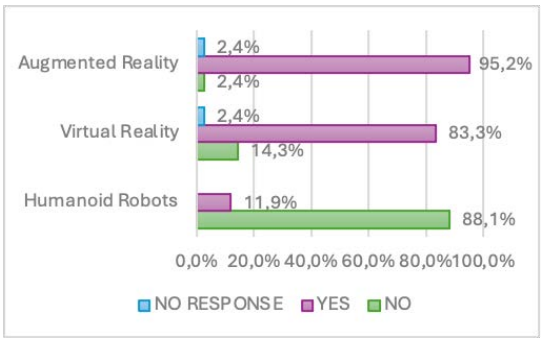

Fig. 11. AR, AV, Robot familiarity and experience in baseline sample (non-hospitalised)

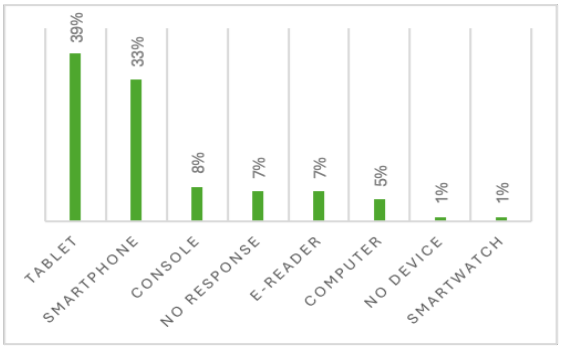

Fig. 12. Preferred devices for possible hospitalization in baseline sample (non-hospitalised)

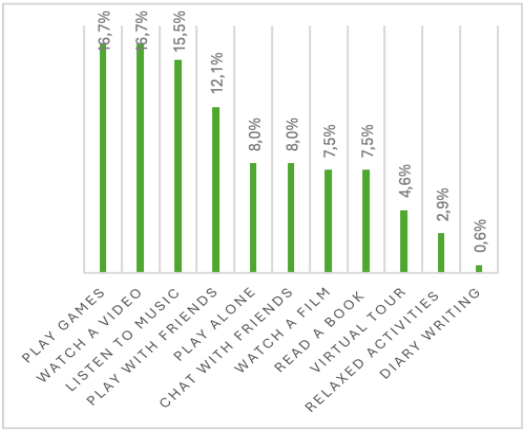

Fig. 13. Preferred activities with devices for possible hospitalization in baseline sample (non-hospitalised)

Conclusion

The Little Prince project aims to address the intricate emotional landscape that children and their families encounter during the daunting experience of hospitalisation. By leveraging the transformative potential of virtual and augmented reality, the project hopes to alleviate procedure anxiety and transform the hospital journey for children aged 3 to 10 in the oncohaematology hospital ward. This challenging project includes a spectrum of advanced applications, including virtual previews of hospital wards, collaborative interactive games, pain management interventions and the integration of social robots to foster holistic engagement - socially, emotionally, and educationally. A meticulous and complete protocol was created to assess emotional variables and discern technological preferences, mapping relevant comparisons between different groups: non-hospitalised children, hospitalised children without exposure to AR and VR, and those actively immersed in Little Prince technologies. The initial results from the non-hospitalised group were illustrative, showing a notable absence of anxiety symptoms and a marked affection for tablets and smartphones. These devices, deeply embedded in everyday life, emerge as preferred channels for entertainment, particularly gaming, suggesting a potential transfer of these preferences into the realm of potential hospital stays. The questionnaire revealed a high level of familiarity and habitual use of tablets and smartphones, a tendency that is rooted in early exposure in familiar contexts and the intuitive nature of touch-screen interfaces, similar to interactions with traditional toys. It is interesting to note that a significant finding relates to limited previous experience with emerging technologies such as augmented reality (AR), virtual reality (VR) or humanoid robots. Despite the evolving scenario in which immersive reality becomes an integral part of standard care for hospitalised patients, current evidence underlines the importance of adapting technology development plans in harmony with the specific needs and expectations of users. These fundamental understandings have not only informed, but also directed the trajectory of collaborative activities within virtual environments, strategically designed to optimise the hospital experience for young patients. Now, the pedagogical team is moving through the ongoing phases, upcoming steps include the extension of the questionnaire to control and experimental groups, with follow-up evaluations to verify the longitudinal impact of the project. However, the journey is not without challenges: the lengthy bureaucratic procedures for project approval in the hospital setting, especially concerning minor participants, are a critical obstacle. Recognising these challenges, the project remains resistive and adaptive, fully committed to its wider goal of leveraging technology to enhance the well-being and experiences of hospitalised children. By providing for continuous evolution and improvement based on emergent insights, the Little Prince project embodies a guiding light of innovation in paediatric healthcare. All developments will be investigated and discussed in future work.

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