Augmented Reality: an Emerging Field in Pediatric Psycho-oncology Requiring Research

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Augmented reality (onwards, AR) technologies are now much more complex and feature a higher number of details thanks to advancements in information and communication technologies (ICTs). Today’s systems can be easily adapted and packaged into smartphone apps which enable a wide range of applications in real and clinical practice. The impact on behavioral health treatments, rehabilitation and healthcare system in general is just beginning to become evident[1] but still, more research providing evidence-based practices is required.

AR has its origins in 1968 when Ivan Sutherland, an American computer scientist, also regarded as the “father of computer graphics”, pioneered the development of the first virtual reality (VR) system[2]. Therefore, VR could be considered as the ancestor of AR. The distinction between them is fairly simple; while VR replaces reality with completely computer-generated world scenarios, AR works in tandem with computer-generated and real world inputs to create environments. Thus, VR is an immersive technology, whereas AR uses technology to enhance or modify users’ perception of their real surroundings. Considering these premises, some authors have proposed “mixed reality” or “extended reality” as equivalent terms[3].

In oncological field, several studies have already pointed out that VR can offer to patients’ a safe environment to carry out a wide range of interventions in different milestones in cancer; from rehabilitation of discharged patients[4], to the support of inpatients during different procedures[5-8]. Most research has found that VR improves patients’ emotional well-being and health-related quality of life, and diminishes anxiety, depression and cancer-related psychological symptoms such as pain[4-8]. However, to our knowledge there are no published studies analyzing the same aspects by using AR and research with this technology has been mainly focused on clinical training (e.g., surgical procedures)[9]. Some of the key issues in implementing clinical AR research, as happens with VR, include theoretical immaturity and ambiguity, a lack of technical standards (i.e., study design, usability, etc.), conducting in vivo research, and high development and implementation costs.

Despite these theoretical and practical challenges, and

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the fact that there are not yet enough evidences to affirm it conclusively, potentialities of AR seem obvious to support and monitor treatments in cancer patients. When focusing on pediatric cancer, it is important to highlight that approximately 300,000 new cases are diagnosed in children and teens under the age of 19 every year worldwide\cite{10}. Despite vast improvement in overall survival, pediatric deaths related to this occurrence are estimated up to 80,000 annually. In addition, suffering is enormous and immeasurable throughout the oncological experience. Even with a bevy of new cancer-directed therapies, children continue to endure distressing symptoms such as pain, fatigue, nausea/vomiting, decreased appetite, anxiety, depression and fear (of treatments, isolation, recurrence, etc.)\cite{11}. Symptoms may arise from the disease itself, or commonly from the treatments prescribed. So, AR may prove especially helpful for young cancer patients influencing psychological and physiological functions.

One pioneering and very attractive initiative using AR in pediatric oncological settings is the Pediatric Brain Tumor Foundation’s “Imaginary Friend Society” project\cite{12}. The Imaginary Friend Society comprises resources such as psycho-educative short films and AR environments. Short films are starred in by a cast of characters; some of them yield from pediatric patients’ own imagination. That means that they can draw and “donate” new characters for the “Society” whenever they want (see Image 1). These imaginary friends, always on the rise thanks to users, explain a wide range of complicated cancer topics in a way that kids can understand, with the final aim of reducing uncertainty and fear during hospitalization. Main topics include explanations of cancer diagnosis and treatments (e.g., *Finding out you have cancer*, *What is cancer*, *What is an MRI?*, Blood transfusions, Radiation, Chemotherapy), explanations of main symptoms that they could experience (e.g., *Losing your head*, *Feeling sad*, *Why am I tired all the time?*), or normalization of some psychological states or also answers to more common questions that might arise during hospitalization and active treatment (e.g., *Feeling angry*, *Who will be taking care of me?*) (see Image 2).

Concerning AR, the “Imaginary Friend Society” app overlays digital images on top of what pediatric patients are seeing in their real world. This technology helps patients to cope most feared situations by feeling accompanied and amused by their preferred heroes or friends (see Image 3). For instance, tapping on a character prompts

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**Image 1.** Billo (Donor: Gabriele Lunardi).


**Image 2.**

Extracted from: [https://www.imaginaryfriendsociety.com/films](https://www.imaginaryfriendsociety.com/films)

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it to share upbeat words of encouragement to lift the spirit of the child (e.g., “You’re stronger than you know”, “I wish I was that strong”). (see Image 4) Being in a hospital suffering from a very severe disease, and going through a painful barrage of invasive procedures such as injections, chemotherapy, radiotherapy, MRIs and other treatments can be especially demoralizing and scary for young patients. AR enables to create a more comfortable environment and provides valuable distraction that fosters and engages patients’ imagination while reducing distress and minimizing the focus on the negative experience that they might be bearing. It is important to highlight that these technologies do not replace professional psychoeducational consultation, as the case of psycho-oncologists’ services and advise. On the contrary, a combination of both resources could enhance outcomes.
to address distress and concerns related to cancer.

**Image 3.**
Extracted from: https://www.imaginaryfriendsociety.com

**Image 4.** Imaginary Friend Society Infographic
Extracted from: httpswww.imaginaryfriendsociety.com

Empirical evidences are needed to measure and quantify real impact not only at short but also at mid-long term of using AR in these settings, as well as acceptance and usability. Therefore, future research should continue to design high quality randomized and pragmatic trials to test this tool. If AR proves cost-effective, healthcare systems could provide more personalized and effective treatment options through new investment in non-pharmacological interventions, such as AR cutting-edge technologies supported and reinforced by behavioral and psycho-educative interventions\(^\text{[13]}\).

Also, research on the possible downside should be carried out too. Some authors speculate there may be a comorbid connection with Internet Gaming Disorder (IGD) increasing symptoms such as anxiety, hyperactivity or even that AR could isolate patients\(^\text{[14]}\). Besides, one could speculate that AR could foster non-adaptive coping skills such as avoidance or disengagement from reality, introducing trouble on separating the virtual world from the real one and hampering long-term adjustment to the oncological process. However, to our knowledge, no research has been carried out to prove these hypotheses.

Although AR technology is becoming mature, its application in specific and sensitive areas such as the one we are dealing with poses a series of challenges basically addressed from artificial intelligence (AI). Within this field, affective computing (AC), defined as “computing that relates to, arises from, or deliberately influences emotions”, is concerned with emotional interactions performed with and through computers\(^\text{[15]}\).

The strong relationship between emotions and human health has been recognized as early as the ancient times with philosophers and scientists such as Socrates and Hippocrates who considered emotions as determinants of human health and diseases. Current research has already demonstrated that emotional state, along with provision of physical security, can lead to health benefits, whereas helplessness and negative emotions, such as stress or depression, have been associated with a weakened human immune system\(^\text{[16,17]}\). Therefore, successful application of AC within AR technologies, might be a powerful tool to recognize and monitor meaningful internal emotional reactions in users and moreover, to reinforce, train and to role model cognitive-behavioural patterns for therapeutic purposes.

Considering all these, future research should be focused on design evidence-based trials to test positive and negative effects of AR in combination with other advance technologies such as AC, in the specific field of pediatric oncology. So far, what is clear is that bringing AR to the forefront might allow multiple applications to healthcare field\(^\text{[18]}\). This is especially relevant for pediatrics because their developmental stage favors the use of this type of technologies due to the absence of technological barriers and a higher acceptance and ease of use among this sample of digital natives.

**References**


ings of the 28th International DAAAM Symposium 2017.


