

# A novel virtual reality MRI simulator (VR-MRI) to prepare pediatric patients for MRI scans

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## Introduction

Currently there are around **100 million MRI** procedures completed each year.

- **2 million** MRI procedures are terminated yearly due to claustrophobia. MRI termination rate of unseated children reaches 47% (aged 2-7 years)
- General anesthesia (GA) is often required to achieve immobility and has a **morality rate of 2.4-3.3** per 10,000 in developing nations.
- Children with developmental disabilities are 3 times more prone to **hypoxia** under GA. GA is also a significant financial burden.

## Objectives

- Develop a highly implementable & **interactive** virtual reality MRI Simulator
- Attenuate **anxiety** and **claustrophobia** in MRI patients through VR simulation. Decrease necessitation of GA.
- Evaluate the effectiveness of this novel VR-MRI relative to standard preparatory material for MRI preparation, as measured by subjective user feedback

## Materials and Methods



### IIElevenLabs

- The apps content was curated in the Unity 3D Game Engine (version 2021.3.26)
- Built using Open XR 1.7.0 and XR Interaction Unity Toolkit 2.3.2
- Nova UI Framework package was used to design interfaces
- Oculus Integration was used to access hardware specific functionality.
- Eleven Lab was used for Speech Synthesis
- 360 Tour MRI environment was recorded and captured by a 360 camera

## Results

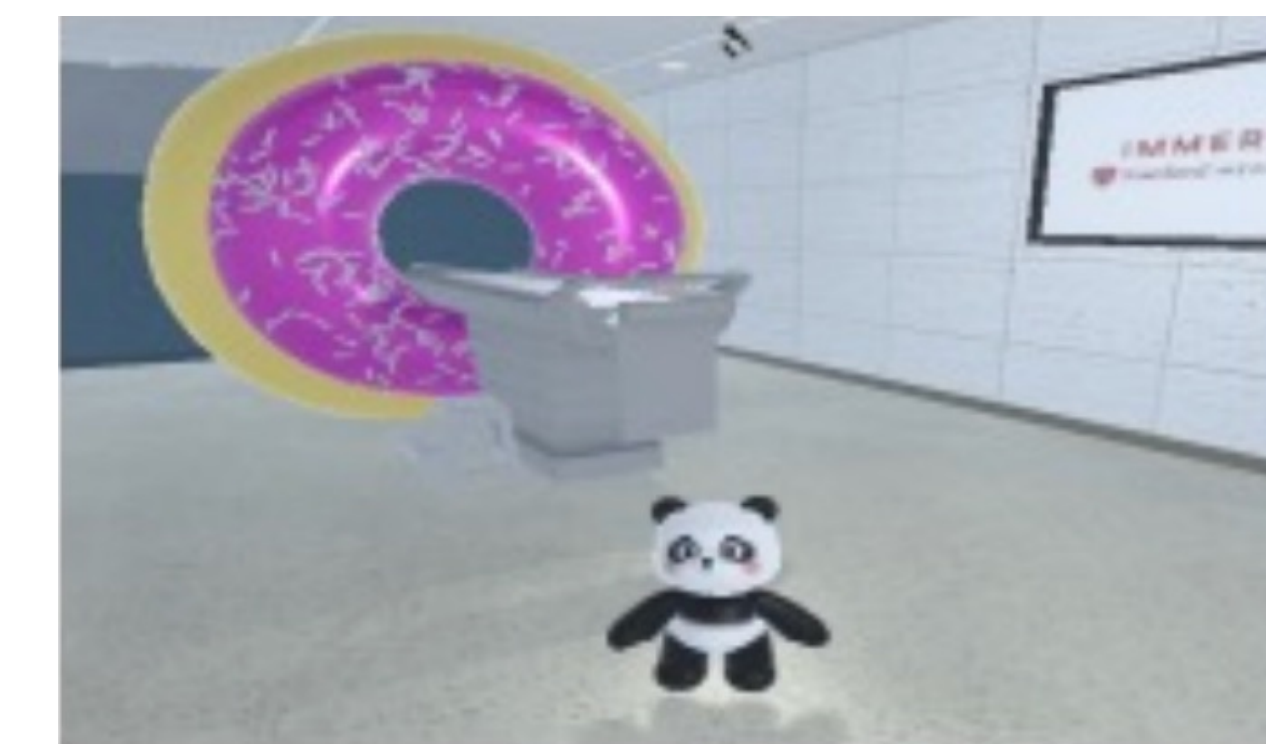
### Experience 1—360 Tour

The 360-video was designed to help the user feel comfortable about the hospital environment, and the necessary steps preceding the MRI scan.



### Experience 2—MRI Simulation

The virtual MRI simulation experience aimed to decrease anxiety level, claustrophobic feeling, and the need for conscious sedation



### Experience 3—Breathing

The breathing and meditation section serve as a mindfulness-based virtual therapy to decrease the user's anxiety and increase comfortability.



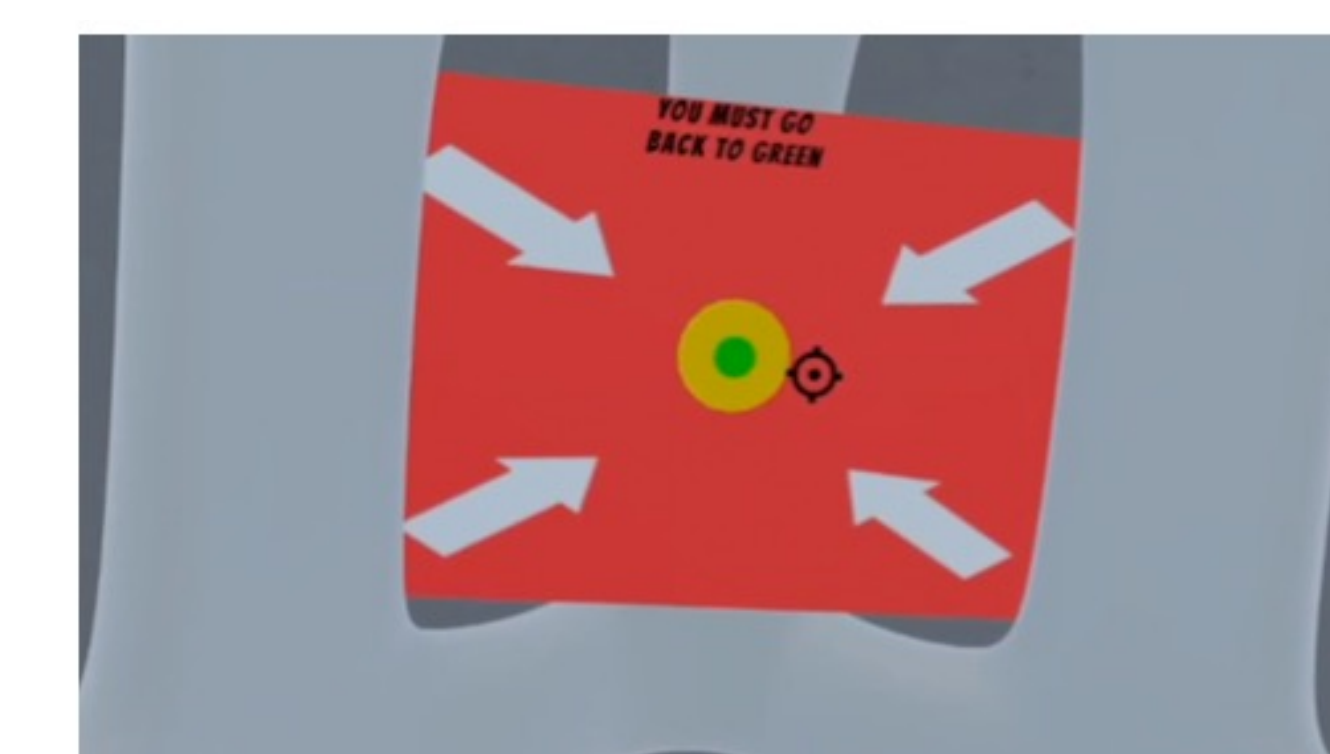
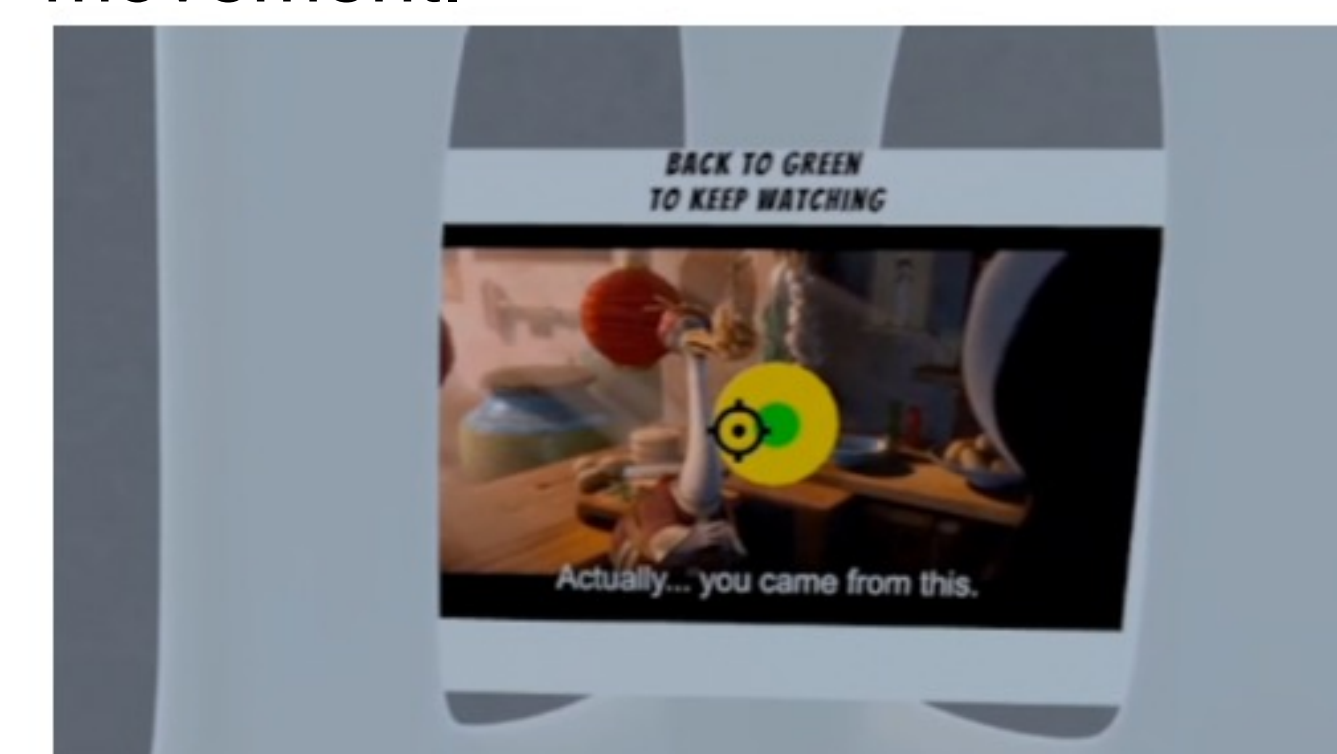
### Experience 4—Hold-Still

To train the user to hold still and playfully simulate the real MRI experience, we designed a hold-still game with interactive elements.



### Interactive Hold-Still Element

When positioned inside the MRI bore and surrounded by the head coil, the user would see a movie clip playing on a screen attached to the head coil. The movie will pause or disappear based on the severity of user's head movement.



### REFERENCES

- 1) Gonzalez, L. P., Pignaton, W., Kusano, P. S., Mòdolo, N. S., Braz, J. R., & Braz, L. G. (2012). Anesthesia-related mortality in pediatric patients: a systematic review, *Brazil*, 67(4), 381-387. [https://doi.org/10.6061/clinics/2012\(04\)12](https://doi.org/10.6061/clinics/2012(04)12)
- 2) Judith Enders, Elke Zimmermann, et al. Reduction of claustrophobia during magnetic resonance imaging: methods and design of the "claustro" randomized controlled trial. *B M C medical imaging*.
- 3) Kristina L Malisza, Toby Martin, Deborah Shiloff, and Dickie CT Yu. Reactions of young children to the MRI scanner environment. *Magnetic resonance in medicine*, 64(2):377-381, 2010.

### Figure 4 – Comparison of self-reported overall preferences

	Standard Material	VR-MRI	Same
Which experience felt more immersive? (n)	0	14	0
Which experience felt more fun? (n)	0	14	0
Which experience are you more satisfied with? (n)	0	12	2
Which experience better prepared you for future MRI? (n)	1	12	1
If you could do VR, which experience do you prefer? (n)	0	12	2

### Figure 5 – Mean rank in post-experience survey

	Standard Material		VR-MRI <sup>a</sup>		Z	p	r
	Mean	SD	Mean	SD			
How anxious did you feel?	1.50	1.092	1.14	.363	-1	.317	.27
How engaging was this experience?	2.64	1.336	4.79	.426	-3.09	.002**	.83
How satisfying was this experience?	2.71	1.490	4.64	.633	-2.86	.004**	.76
How prepared do you feel for future MRI?	3.86	1.406	4.64	.497	-2.12	.034*	.57
I agree that I remembered to hold still.	4.14	1.231	4.86	.363	-2.06	.039*	.55
I agree that I remembered the noise.	3.79	1.528	4.79	.426	-2.14	.033*	.57

<sup>a</sup>VR-MRI: virtual reality magnetic resonance imaging

\*P < .05. \*\*P < .01.

## Conclusion

Statistically significant differences were found in all questions except for anxiety level

Limitations:

- 1 Self-reported survey data
- 2 Relatively small sample size on adult volunteers not actual patients

Next Steps:

- 1) Larger-scale RCT on real hospital patients (pediatric +adult)
- 2) Evaluate effectiveness via actual MRI success rate post VR-MRI
- 3) Integrate hold-still game to actual MRI machine