Hi! We're researchers at the National Insititutes of Health (NIH) who use virtual reality in health and medical research. We're here to answer your questions about how VR is being used in to better human lives – ask us anything!

NIH$_AMA^1andr/ScienceAMAs^1$

[1]Affiliation not available

April 17, 2023

Abstract

Virtual reality, one of the most rapidly expanding areas of tech and gaming, is also playing important roles in the arenas of medicine and health – and for good reason! The ability to simulate experiences expands opportunities for biomedical researchers, clinicians and patients in ways that previously seemed limited to the imaginations of sci-fi writers. Patients can now reduce stress through VR experiences, doctors can practice surgical techniques through simulated experiences, and medical students can practice bedside manner in different scenarios in a virtual world. These experiences are just the tip of the iceberg on what can be done to improve our medical care and well-being with VR. Here at NIH, researchers are using VR to study a host of research questions. For example: How can VR be used to better our response to emergencies during natural disasters? In what applications is VR used for rehabilitation after brain trauma, and how can we improve upon this? Can VR be used to improve the way doctors talk to their patients about genetics? Will patients better understand how to take care of themselves by participating in VR scenarios powered by PubMed articles? Can we use VR to communicate with patients in a way that helps them understand and adhere to healthy living strategies? We've gathered our experts and are here to answer any questions you might about virtual reality in health and medicine! Ask us anything! Your hosts today are: Susan Persky, Ph.D., Head of the Immersive Virtual Environment Testing Area, and Associate Investigator in the Social Behavioral Research Branch at the National Human Genome Research Institute. My research applies virtual reality tools to understand how genetics will change the interactions we have in medical settings, in society, and within our families. Patti Brennan, RN, Ph.D., Director, National Library of Medicine (NLM). Before I came to NIH I created the Living Environments Lab which used a c6 CAVE to accelerate design of home care technologies (http://www.vizhome.orghttp://www.vizhome.org/) At NIH, our Advanced Visualization Branch in the National Institute of Nursing Research (NINR) will use VR/AR to improve patients' self-care and self-management skills. Victor Cid, M.S., Senior Computer Scientist, Disaster Information Management Research Center at the NLM. I conduct and manage research and development activities to support the work of emergency responders and managers before, during and after disaster situations. Among my projects, I develop virtual reality simulations to train emergency professionals, and explore the opportunities that immersive virtual environments can offer for professional development, collaboration, and as platforms for outreach and innovation. John Ostuni, Ph.D., Staff Scientist, National Institute of Neurological Disorders and Stroke (NINDS). My research focuses on developing virtual experiences for use with medical research. William Kistler, M.A., Lab Manager of the Immersive Virtual Environment Testing Area at NHGRI. My Master's research focused on the human perception of motion and exploring its basic limits via stimuli created in virtual reality. Currently, my work is in support of social and behavioral researchers seeking to augment their own research with virtual reality tools. Jeremy Swan, B.A., Biovisualization Specialist with the Computer Support Services Core at the Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD). My duties include helping investigators communicate their science and use emerging technologies in their research by producing graphics, diagrams, 3D prints, VR apps, photos, videos, websites and applications. UPDATE: Thanks all for the wonderful questions! We had a great time answering them and

can’t wait to do this again in the near future. Cheers, Reddit-ers!

the WINNOWER

REDDIT

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NIH_AMA R/SCIENCE

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These experiences are just the tip of the iceberg on what can be done to improve our medical care and well-being with VR. Here at NIH, researchers are using VR to study a host of research questions. For example:

How can VR be used to better our response to emergencies during natural disasters?

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Will patients better understand how to take care of themselves by participating in VR scenarios powered by PubMed articles?

Can we use VR to communicate with patients in a way that helps them understand and adhere to healthy living strategies?

We've gathered our experts and are here to answer any questions you might about virtual reality in health and medicine! Ask us anything!

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READ REVIEWS

WRITE A REVIEW

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Several questions:

1) Can you expand on the use of VR in TBI-related recovery? What specific advantages are VR posited to have over (for example) a multimodal, engaging, computerized task.

2) "Cognitive Training" has been something of a hot topic recently, both in terms of improving cognitive function in healthy persons, and restoring function is cognitively compromised persons. Where does VR fit into this picture? Are you aware of any groups conducting cognitive training trials in VR environments?

3) To what degree should we (or do you) conceptualize "VR" as being digital? Would the use of a physical system/model, designed to mimic the human body, be commonly construed as "VR" technology? Would CPR-practice dummies that mimic the resistance and flexion of human rib-cages be regarded as VR?

TestPilotBeta

Hello this is John from NINDS to answer your second question. I am not totally convinced regarding the use of typical cognitive training as a preventive measure, although I do believe it can improve or restore certain abilities (at least up to that person's memory potential). My main concern with cognitive decay is isolation and lack of social situations. So if we were to consider social "training" as part of cognitive training, then virtual reality will be very useful. Soon the elderly will be able to put on a VR headset and engage with other people. The type of social interaction and social navigation required to spend time with friends and new acquaintances in varying types of environments will be a very popular and very useful form of cognitive training.

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TestPilotBeta

Hi, I'm Victor from the National Library of Medicine, part of the National Institutes of Health. I can your third question (the other questions are being tackled by my colleagues at the moment and we'll get to them soon!) VR is not a new concept, and it has been used in contexts that don't involve high-tech. For

instance, the first written use of the term dates back to the mid-20th century. One could argue that a book is a form of virtual reality, since it can transport the reader's mind into a different reality. However, in the way we used the term today, it generally refers to (technology-assisted) immersive virtual reality, and the goal of this VR is to transport as many of your senses as possible into that other reality. The current notion of VR is tied to the concept of "presence", in the sense that the technology attempts to make the VR user feel he/she is physically transported into the simulated experience, something that is more difficult to do with just a dummy.

Salutations, it is great to know this is available for inquiry.

First question: I have a cousin that is afflicted with Wolf-Hirschhorn syndrome, a rare genetic disorder caused by a partial deletion of the short arm of chromosome 4. I figured VR displays could be used as a way of studying the sections of chromosome that have become harmful. Is there a way VR can be used to better study genetic disorders and errors in chromosomes to assist in genetic research?

Second Question: In what ways can VR be used to improve the way doctors talk to their patients about genetics and family histories rife with certain harmful genetic conditions?

Third Question: How would VR be effective for helping elderly patients with damaged senses for sight and/or hearing?

PurveyorOfKnowledge0

Hi, this is Jeremy. I'm not an expert in genetics, but bioinformaticians often use tools like "R" to process and visualize genetic data. While there are infinite ways to use VR in studying genetics, I would probably start with R and then convert to VRML through a tool called vrmlgen: https://cran.r-project.org/web/packages/vrmlgen/index.html (which Nicholas Polys at Virginia Tech had recently suggested). Then it could be converted to X3D to bring it into a more current file format. Another approach Dr Polys suggested was using Matlab, which also exports X3D and HTML5 plots. Additional materials for developing apps in VR can be found here: http://vrhackathon.web3d.org/resources/

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PurveyorOfKnowledge0

Second question! This is Jeremy. Doctors often use apps which allow reviewing medical images with patients on an iPad, toggling layers of muscle, organs and bone, and marking up various regions of interest. These types of patient doctor interaction through visualization are certainly translatable to VR, just as a genetic counselor might use data through 2D charts and graphs via a web browser, interacting with a graphical user interface. The real advantage to VR would be interacting with 3D data and images. How effective it is to visualize data in stereo is an open question (as far as I'm aware). There are limitations of 3D graphics as pointed out in Bang Wong's article in Nature Methods:

https://www.nature.com/articles/nmeth.2151 but it would be interesting to see if these limitations were consistent in VR.

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PurveyorOfKnowledge0

To answer your third question: Hi, this is John. I'm not sure how helpful VR will be with helping elderly patients with damaged senses since it is a technology that is very sense dependent.
But it will be very useful in helping with the isolation that occurs with these types of illness.

The reason Facebook purchased Oculus for 2 billion dollars in 2014 is that it is widely believed that VR will soon be a major social platform. These patients will be able to put on a VR headset and visit their friends and family without leaving the house. Also, many senses can be replaced and filtered in virtual reality so speech can become text, english text can become spanish text, lighting can be altered, audio can be changed/filtered, etc.

One last thought is that a properly designed VR experience can show people what is it like to be elderly with damaged senses. Experiences involving empathy have been shown to positively affect people's thoughts on the elderly and on the disabled.

During the Olympics, a commercial (https://www.ispot.tv/ad/weRr/samsung-mobile-human-nature-song-by-the-killers) has been running in which VR is used during rehab for a young woman with a prosthetic leg.
Question 1. Is this technology currently being used as therapeutic intervention? And, if so, how successful is it? Question 2. Do you see potential for such therapies to be helpful in other mobility disorders, for example, in Parkinson's disease or parkinson-like brain disorders?

CoffeeChat2

This is Patti from NLM -- I, too, was really excited about the Olympics ad showing the woman learning to use a prosthetic leg but instead of seeing herself in a physical therapy department, she was walking on a beach. So as I understand Head Mounted Devices (HMD), the advantage is that one blocks out all 'real world stimuli' and can have rich visual experiences -- like walking on the beach -- but it is really impossible to see through an HMD and actually detect parts of one's own body. Sometimes animations can be mapped to an actual limb, so as the participant moves the limb they get the visual cues -- there are some new devices that don't require advanced tracking , and I see great promise with the VIVE and other 'through the glass' Augmented reality devices.

I am completely unaware of any VR experience stimuli where one could actually feel water lapping over one's feet -- sounds pretty cool to me, tho!

How accessible might this technology be for people living in remote parts of low-income countries?

Jojuj

Hello I'm John from NIH/NINDS. In many ways VR can be considered the great equalizer. For example, students can put on a VR headset and find themselves in a classroom with a highly skilled educator. The same educator that a non-rural, high-income student would experience. They can go on realistic fields trips and have experiences that normally would not be available to them. Unfortunately, VR is dependent on network access and I am concerned that this will limit the usefulness of VR for low-income, rural areas.

I'm intrigued by the idea of pubmed-based VR scenarios. Do any of these already exist?

sooozjee

This is Patti Brennan from NLM -- I am a nurse and an industrial engineer. I am really committed to helping patients take better care of themselves -- there's lots of good information in the articles in the PubMed index (pubmed.gov) and over 5M full text articles in PubMed Central (https://www.ncbi.nlm.nih.gov/pmc/) but it's written for professionals and one must read several articles to get a full understanding of what to do about a specific problem.

As a starting point we will have nurses and patients read the articles and create short plays - we plan to use Head Mounted Devices to display scenarios that we create scenarios that have participants walk through a situation - using visual cues and behavioral challenge tasks to practice and learn new information.

In the past we have used full-scale CAVEs (CAVE Automated Virtual Environments) in which we depicted full-scale models of houses - we had patients 'walk through' the virtual house, pointing out places where they might do a bandage change or practice a new exercise. We also wanted them to point out where they would store information.

We learned a lot -- health happens all over the house -- VR gives us the chance to recreate real environments at scale, leveraging proprioception experiences so people get a sense of being in a real place. We also learned that people do best in VR when they are given a specific task to do.

How could researchers use VR to encourage healthy behavior in the public or in patients?

BurgerInk

This is Susan from NHGRI. This is an area with a lot of active research. In our lab, we've explored how VR education related to health risks can increase motivation to improve dietary and physical activity behavior. We've also developed a VR-based buffet as an outcome measure, but have an eye toward potential deployment as a tool to help parents practice making health choices for their children. Some of this research is available here: https://www.ncbi.nlm.nih.gov/pubmed/29277518 https://www.ncbi.nlm.nih.gov/pubmed/26850762 Beyond that, other researchers such as those at the VHIL at Stanford https://vhil.stanford.edu/ have developed situations where watching our avatars exercise or eat healthy foods have encouraged those behaviors in research participants. A really interesting new study shows that eating virtual donuts may help people feel satiated and reduce real donut eating afterward. This work is all still in the research phase, but certainly some companies are entering the space too with VR physical activity platforms. I'm less familiar with the evidence base there, but if people (or the technology) or the technology can get us past the sweaty VR displays, I could definitely see these being motivating. There are also several products related to relaxation, biofeedback and meditation. Relaxation in particular seems like a promising area for VR technology.

When will I start to see VR as a part of my health and medical care?

PsychologicalVacant

This is Patti from NLM -- VR could be a part of it today! Distraction scenarios are quite helpful in helping patients better tolerate chemotherapy or handle treatments of severe burns. And we shouldn't overlook the enjoyment of game playing as a part of work-life balance!

It's important to think about VR as a process of devising a scenario, creating or capturing relevant images, planning the pathway through then presenting the entire packet to the participant. There is health and medical care value in all of these steps, so it is likely that to have VR in the background of some health care experiences even though you can't see them or experience them -- for example, in our vizHOME project (www.vizHOME.org) we used LIDAR to create full-scale 3D replica of ordinary households and then could explore them in a CAVE or through an Head Mounted Device (HMD). We also figured out how to improve post-hospital home care planning by using the full scale model to identify health assets and hazards in the home, marking them up, then inserting the manipulable 3D Model into the patient's record as a document and home care planning tool (https://healthit.ahrq.gov/ahrq-funded-projects/virtualized-homes-tools-better-discharge-planning). Check it out!

I'm intrigued by the idea of pubmed-based VR scenarios. What kind of pubmed articles would lend themselves to VR scenarios? To what end?

Another question, is there evidence that experiences in VR will change people's health IRL?

sooozjee

You submitted the first part of this question twice, I believe (see above), but I'll answer it again :) This is Patti Brennan from NLM -- I am a nurse and an industrial engineer. I am really committed to helping patients take better care of themselves -- there's lots of good information in the articles in the PubMed index (pubmed.gov) and over 5M full text articles in PubMed Central (https://www.ncbi.nlm.nih.gov/pmc/) but it's written for professionals and one must read several articles to get a full understanding of what to do about a specific problem.

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To answer your second question, there is some pretty interesting evidence that immersive VR experiences can influence attitudes and beliefs, and in some cases provide a safe complement to usual care for stroke rehab and physical therapy (http://www.cochrane.org/CD008349/STROKE_virtual-reality-stroke-rehabilitation)

One of the best summary articles about VR changing health is actually pretty old -- Maria Sanchez-Vivex and Mel Slater wrote a great piece in Nature 2005 (https://www.nature.com/articles/nrn1651) that provides a good summary of their experiences with VR and phobia and other anxieties.

Karen Chen from our group in Wisconsin explored how VR delivered through head mounted devices helped in chronic neck pain and kinesiophobia (http://ieeexplore.ieee.org/document/7707355/?reload=true). The visual stimuli delivered helped 'encourage' people to use neck muscles to get greater range of motion.

We believe that there could be whole new areas explored with VR and Augmented Reality that rely less on psychomotor training or noxious stimuli desentization -- consider for example how immersion in an unstructured environment with pleasant shapes and colors might stimulate imagination and therefore lead a person to gain skill in framing problems in new ways so they don't fall back on old ways.

What sorts of technical challenges have you encountered in establishing virtual scenarios for use in medical/clinical research and do you have any success stories to share in how you have overcome these challenges?

PrettyExplanation

This is Patti from NLM. I am more experienced in creating clinical scenarios not biomedical or biological virtual reality experiences. What I do know is that the more complex the real world that is desired to be mimic-ed, the more complex it is to create the VR scenario. Biological models have chemical and electrical structures that can be modeled then displayed without extensive attention to the context. In our work recreating actual households, we employed a LiDAR scanner to obtain a point cloud of the interiors of the households, then ran the point cloud through a pipeline process that resulted in a full-scale immersion (J Biomed Inform. 2015 Oct;57:53-61. doi: 10.1016/j.jbi.2015.07.007. Epub 2015 Jul 11.)

There are a few other issues to contend with -- one is portability of the scenario -- if it is designed to be displayed in a CAVE, generally the scenario can is highly tailored to that particular display space. The HMD's offer a more portable platform, provided the scenario is developed for portability.

Another important consideration is control over objects in VR. Often wands or instrumented gloves are used, sometimes eye-tracking or muscle tension signals can be used to move objects. It becomes a task of mapping the human behavior, the visual cues, and the display environment. We find effective design of experiments (like factorial design) are really helpful in ferreting out design issues.

And following onto Patti's answer, this is Victor: Not an application for medical/clinical research, but related: one problem I faced was that it can be expensive and time consuming to prototype a 3D scenario such a hospital setting and then share it among geographically-distributed collaborators, and even users. We used Second Life to do this very successfully, rapidly and at a very low cost. New similar platforms such as High Fidelity and Sansar offer similar capabilities to create 3D content rapidly and inexpensively, and this content can be immediately shared with others to see across the Internet.

What type of research, from your experience, is best facilitated using immersive or augmented technology? What challenges over real-world research are cheaper/easier/faster within the use of these immersive/augmented technologies?

PrettyExplanation

Hello, this is John from NINDS. Many people consider VR as a simulator for reality. But it is also

important to think about VR as a simulator for non-reality. In VR you can create an experience limited only by your creativity. What's interesting about this is that your body/brain only know about reality and will react to any non-reality situation with a response based in reality. For this reason, you can fool your brain with illusions, such as the illusion of being somewhere else, the illusion of owning another body and the illusion of being a participant in an experience that isn't real. You can ask so many interesting questions when you realize this. For example, how will someone react if they were in a body of a different race, gender or age? How will someone react to an experience of shooting someone? How will someone react to seeing someone suffering? And the most important question: how will these experiences change them? Because these types of VR experiences do change people.

As far as challenges are concerned, VR has a big advantage for any research involving non-real environments (as mentioned above), but also for research involving environments that could be dangerous to the subject. NIH is extremely concerned about the safety of their research subjects so controlled, safe, simulated environments may open up new research opportunities.

This is Patti - I am really excited about VR as an experimental medium and as an experimental context. As a medium, we can use VR to create and re-create visual stimuli for a wide range of behavioral and cognitive testing. As an experimental context, VR permits us to insert a person into a specific recreated place that is very controlled - we can change light, sense of open-ness, etc and and examine the impact of context on behavior and actions.

Good morning! Has anyone studied the scope of genetic counselling by VR for patients in rural communities with no easy access to a genetic counsellor?

bloodMD

This is Susan from NHGRI. To my knowledge VR approaches for provision of genetic counseling have not been explored. As you may know the approach that is most discussed currently is telephone-based counseling for rural and distributed patient populations. Some tech-oriented solutions will certainly be needed given the numbers of genetic counselors in the workforce versus the amount of genetic information that will need to be conveyed. We are doing some work in our lab (yet to be published) that compares VR to internet-based approaches for provision of genetic information (related to common health conditions in this case). These approaches fall somewhere in the middle between face-to-face and telephone-based consultations, but do seem to have some promise. In the near term, video conference may be a more realistic solution, however, VR approaches could also bring more of a 'human' element into the encounter. VR-based approaches may also allow counselors to bring models and enhanced educational content into the encounter.

Will the VR software developed at NIH be shared as open source for use by other researchers?

nessie10

This is Victor from NLM. I can only speak about my work at NLM/SIS/DIMRC (see above to untangle the acronyms!): we plan to make most of our VR applications freely available for anybody to use (and I presume other NIH developers may want to do the same, but not everybody can). However, we will probably not make the source code widely available for several reasons. One of them is that we often use commercial products as part of our applications, and we are not allowed by the copyright owners to share the code. A second reason is that there could be security risks associated with allowing other people to access our source code. For example, sharing the source code could make easier for someone with ill intentions to take one of our products, embed malicious code in it, and distribute it as an NIH product.

Thanks for the AMA!

Common is the phase "from bench to bedside" in genetics and genomics. With the portability and ease of access to VR, do you expect a rapid influx of the technology into the homes of those who may benefit from it? The tech is rather pricey, however, so how does the field expect to overcome this?

raiden3212

Jeremy from NICHD - Yes, just as the smartphone has become more common than Personal Computers in the home, the prices of VR and portable VR solutions are dropping rapidly as processors become more efficient and smaller, and the economies of scale help to drastically reduce costs. 5 years ago, a head mounted display would cost around $20,000. Now a comparable VR headset (Vive) is available for around $600 or $400 for the Oculus Rift, which have both reduced prices significantly since they were initially offered. Also, once a headset is in a household for the purpose of gaming, it could also be used for therapeutic purposes. The ability to convert a smartphone to a VR headset with an inexpensive viewer is another way to offer accessibility.

While there is a great deal of promise for the benefits of VR, (and augmented reality) such as overlaying medical data on top of a patient during a medical procedure via a heads up display, there may also be negative side effects of using VR which also need to be studied.

This is Susan from NHGRI - to follow on to what Jeremy is saying, I also think it may be a bit of a chicken and egg problem. Right now the primary focus of VR is gaming. As VR grows in for social activities, education, health and in other sectors, other segments of the population may be more likely to invest in higher-end headsets, and/or be motivated to at least engage in VR using mobile phone approaches. But of course those appealing applications need to exist to drive adoption.

Hi everyone, what are your feelings about Chris Fortney? Is he as amazing and awesome as everyone says??

No but really - this questions is for everyone, and I'm especially interested in Victor's thoughts on it. Where do you see the future of VR going as far as simulation in medical research? Are we ham-stringed by the current capabilities of the HTC Vive, or is the potential already there for meaningful, useful simulation as an alternative to real world training?

cfortney92

Hello Chris! This is Victor. As you know, the technology is evolving rapidly past the HTC Vive capabilities (wireless VR, 4K resolution HMDs, tracking, etc.). Haptics is also progressing and has applications for medical research (suits, sensors and actuators of many kinds, etc.). As AI starts to play a bigger role in VR, I think we may see some revolutionary applications, not only in medical research. I'm particularly intrigued by the progress in collaborative VR experiences, where researchers can come together virtually to collaborate in research. That is also being done already, but I believe we are just at the beginning of the actual potential of that medium. Something we experimented with a while ago was interacting with real-life information tools from within VR (we used a virtual world application for that), and we could see some evidence that anything you can do in your computer and the Internet you can do in VR, therefore chances are that any developments in computing and networking will enhance the capabilities of VR.

One project I'm currently working on involves training hospital staff on some particular procedures. We found that VR can enhance their training significantly. In the context of that project we found, for example, that VR enhances engagement, allows a far more realistic representation of the training scenario, simplifies peoples' attendance to training exercises (they can do it in their PJs from home),

and reduces certain risks of conducting exercises in the real setting (e.g., simulating the management of a disaster in a hospital realistically may affect the real hospital activities), among others. I'm very optimistic about the potential of VR for medical research and education.

This is Jeremy, I'm sure you're aware of the many surgical simulators (because I've sent you links!) I'm certain that the combination of haptics and virtual reality will quickly be adopted as a regular part of medical training, especially since the alternative (using animals or cadavers) is so expensive.

Do you see a future where VR can be combined with telemedicine? Give the doctor the experience of being in the room with you?

p1percub

Hi, this is Victor from NLM. Yes, I can. It will be some time until VR will be as good as a face-to-face meeting with your doctor, but for many purposes VR can provide enough tools for a doctor to do his/her job. VR can provide the same experience provided by today's telemedicine platforms (video, audio, haptics…) and also provide both, the doctor and the patient, with additional information/visualization tools that can enhance the remote interactions. Doctors can today collaborate doing surgery remotely via VR, for example (although the patient is not in VR). For instance, take a look around 13 minutes into this video: https://exponential.singularityu.org/medicine/an-avatar-in-your-o-r-redefining-human-interaction-in-surgery-with-shafi-ahmed/