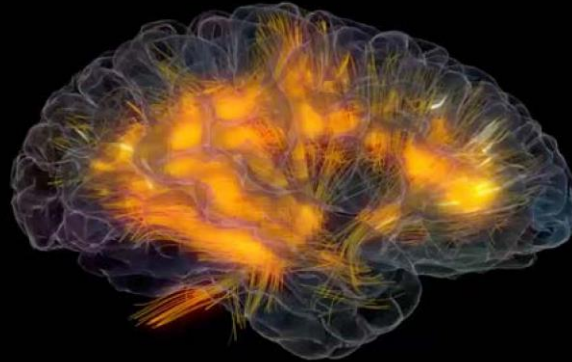


***Virtual Reality and Healthcare:  
The Past, The Present, and The Future***

# *Virtual Reality and Healthcare: The Past, The Present, and The Future*

Walter Greenleaf PhD



Stanford  
University  
**VIRTUAL HUMAN  
INTERACTION**  
— L A B —



**Stanford**  
HEALTH CARE



National Mental Health Innovation Center

UNIVERSITY OF COLORADO **ANSCHUTZ MEDICAL CAMPUS**

# My Academic Affiliations



BRAINSTORM

The Stanford Laboratory for  
Brain Health Innovation and  
Entrepreneurship



Stanford  
University  
**VIRTUAL HUMAN  
INTERACTION**  
— L A B —



**Stanford**  
HEALTH CARE

**VR-IT**

Stanford Virtual Reality  
Immersive Technology Clinic



National Mental Health Innovation Center

UNIVERSITY OF COLORADO **ANSCHUTZ MEDICAL CAMPUS**

# My Non-Academic Affiliations





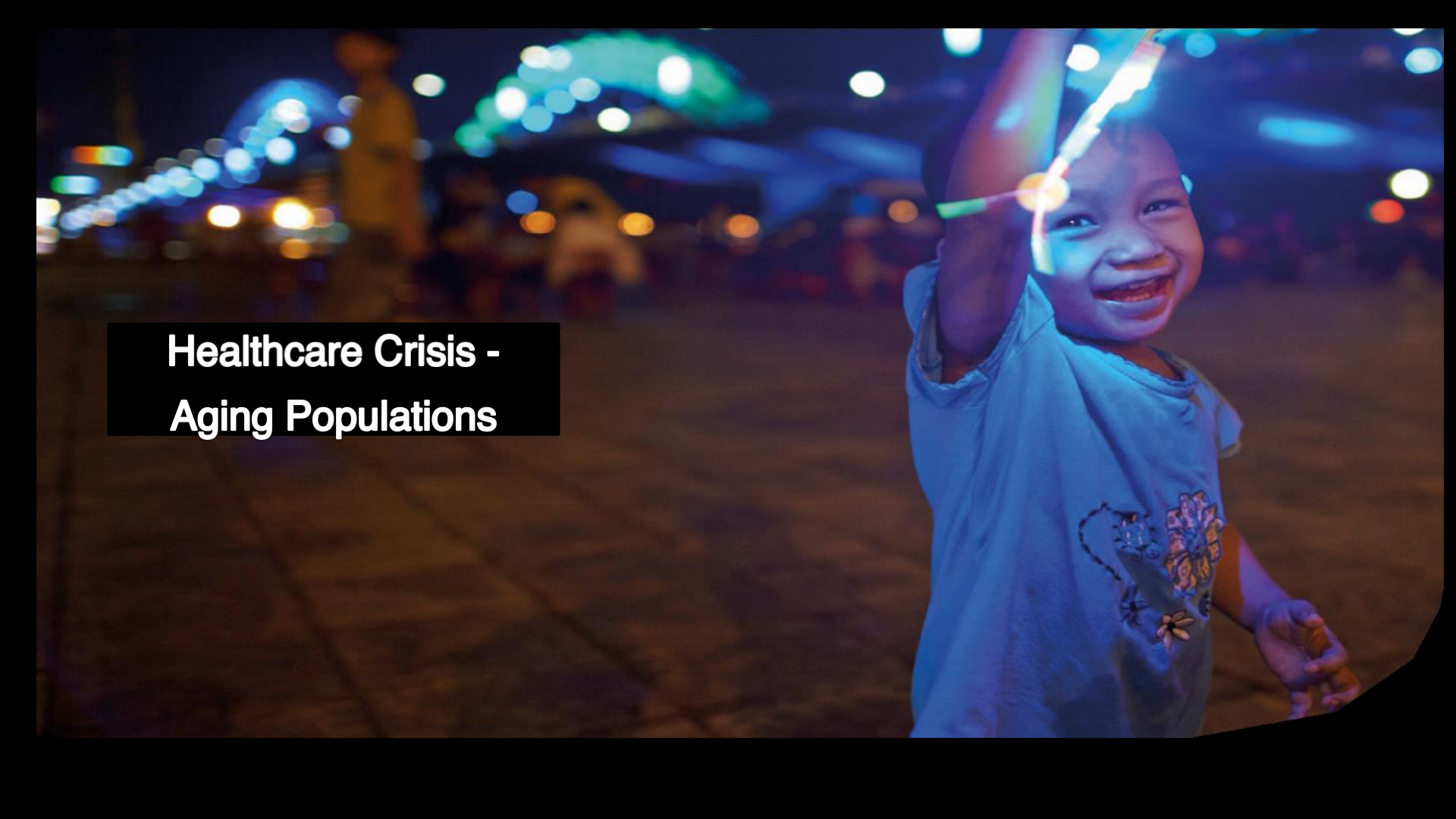
**Political Conflict**

**Global Warming**

**Depletion of Resources / Pollution**

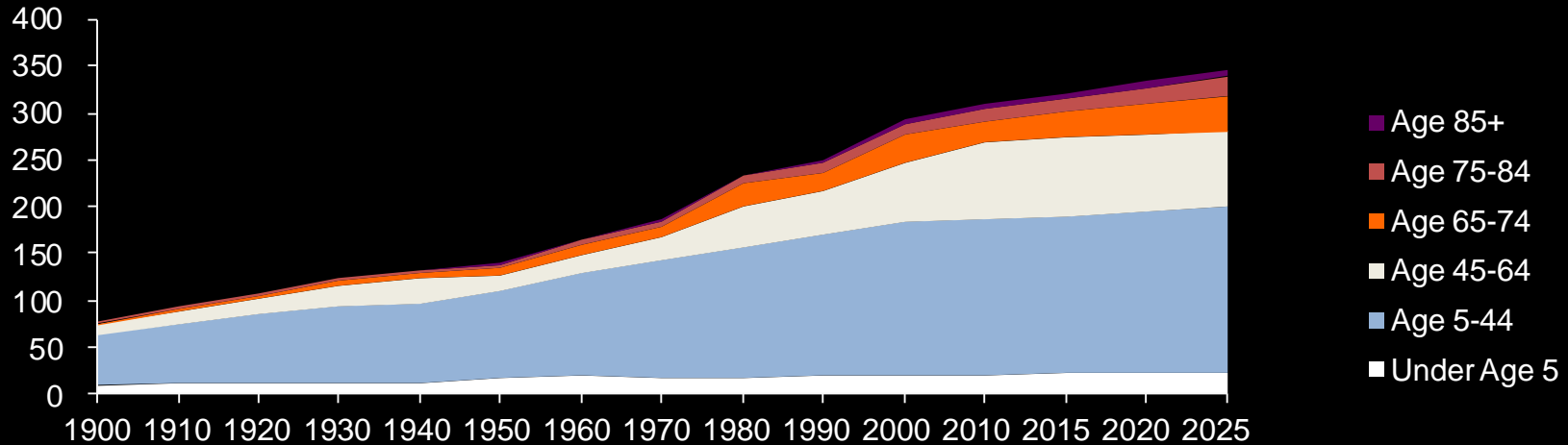
**Healthcare Crisis - Aging Populations**



A young child is the central focus, smiling broadly and holding up a string of colorful, glowing lights. The child is wearing a light-colored t-shirt with a small graphic. The background is a dark, out-of-focus night scene with various bokeh lights in blue, green, and yellow, suggesting a festive or outdoor nighttime setting. The overall mood is joyful and celebratory.

## **Healthcare Crisis - Aging Populations**

# Healthcare Crisis: Aging Populations







---

**Transforming HealthCare with Technology**

# Digital Health Revolution

- Mobile Health / eHealth
- Wearable Sensors
- Patient Centered
- Leverages Internet:  
social, quantitative, collaborative

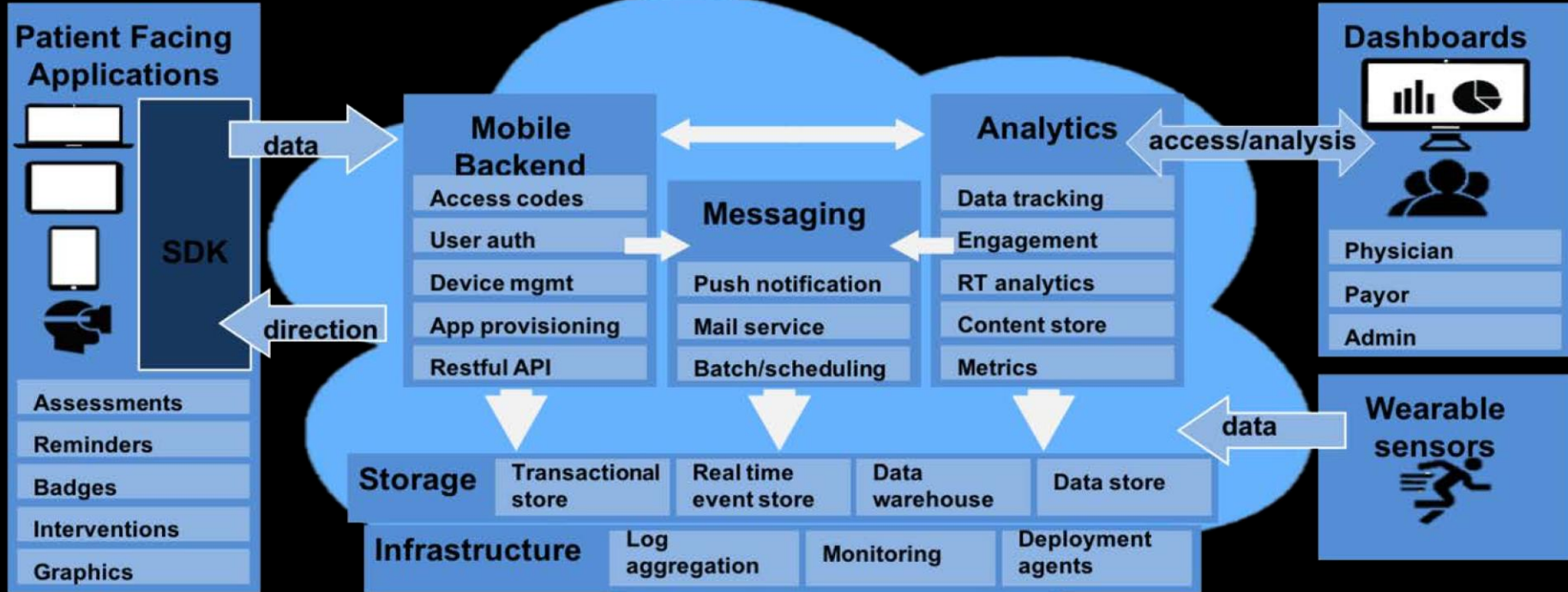


# Every Medical Device Reinvented





# Digital Health Platforms deliver interventions to patients, and parse data for enhanced analysis



# Digital Health Revolution

## Medical Applications of Virtual Reality & Augmented Reality Technology





# Medical Applications of Virtual Reality Technology

Although entertainment, social connection and gaming will drive the initial adoption of VR technology, the deepest and most significant market for VR will be in clinical care and in improving health and wellness.



# Now is the time for VR & AR

VR technology is now affordable,  
scalable and accessible



Samsung - GearVR



Sony – PlayStation VR



Facebook - Oculus



Microsoft - HoloLens



HTC - Vive



Google - DayDream



# AR MR XR Technology

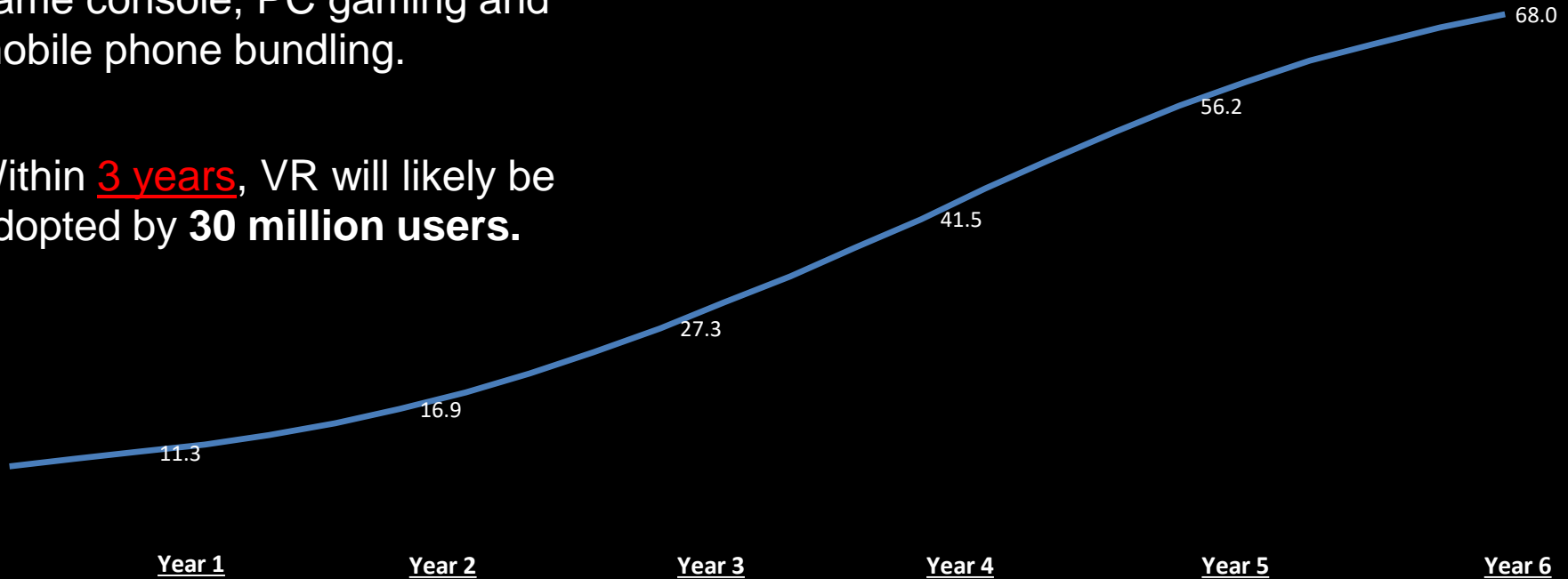




Within 6 years, VR will likely be adopted by **70 million users**

Initial adoption will be driven through game console, PC gaming and mobile phone bundling.

Within 3 years, VR will likely be adopted by **30 million users**.

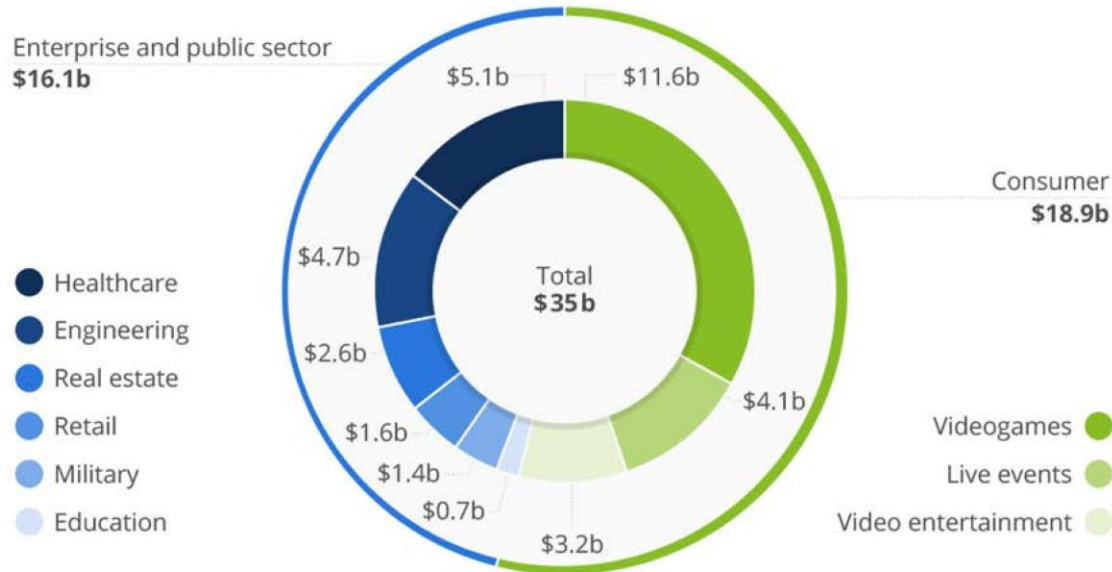




Within 6 years, VR will likely be \$35B Market

## The Diverse Potential of VR & AR Applications

Predicted market size of VR/AR software for different use cases in 2025\*



\* Base case scenario

BUSINESS INSIDER

Source: Goldman Sachs Global Investment Research



statista

The Medical  
VR / AR  
Market  
Segment is  
projected to be  
\$5.1 B in 2025

## My Journey....



# Treating Post Traumatic Stress With Virtual Reality

2008 Sichuan  
Earthquake





# Treating Post Traumatic Stress With Virtual Reality



2017 Mexico City  
Earthquake





# Academic research has indicated that Virtual Reality can effectively treat a wide variety of clinical problems – ranging from addictions, to stroke, to PTSD

Development and early evaluation of the Virtual Iraq/Afghanistan exposure therapy system for combat-related PTSD

Albert "Dag" Himes<sup>a</sup>, Julian Glover<sup>a</sup>, Robert J. Allen<sup>a</sup>, David L. Gidycz<sup>a</sup>, and Rick Glaser<sup>a</sup>

<sup>a</sup>Department of Psychiatry, University of Colorado, Denver, Colorado, USA

Abstract

Background: Virtual Reality (VR) exposure therapy (VRET) is a promising treatment for PTSD. The Virtual Iraq/Afghanistan (VIA) system was developed to provide a safe and controlled environment for exposure to combat-related stimuli. The purpose of this study was to evaluate the development and early evaluation of the VIA system.

Methods: A total of 10 participants were recruited from a local veterans' clinic. They were exposed to the VIA system for a period of 4 weeks. The system was evaluated using a series of questionnaires and interviews.

Results: The results of the study showed that the VIA system was well-received by the participants. They reported a decrease in PTSD symptoms and an increase in quality of life. The system was also found to be effective in reducing the need for medication.

Conclusions: The VIA system is a promising treatment for PTSD. It provides a safe and controlled environment for exposure to combat-related stimuli. Further research is needed to evaluate the long-term effectiveness of the system.

Behaviour Research and Therapy xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Behaviour Research and Therapy

journal homepage: www.elsevier.com/locate/brat

ELSEVIER

The Difference Between Relative and Absolute Digital

Abstract

Background: The difference between relative and absolute digital is a topic of increasing importance in the field of digital marketing. This paper explores the difference between relative and absolute digital and its implications for digital marketing strategy.

Methods: A series of experiments were conducted to measure the difference between relative and absolute digital. The results showed that relative digital is more effective than absolute digital in terms of reaching the target audience.

Results: The results of the study showed that relative digital is more effective than absolute digital in terms of reaching the target audience. This is because relative digital is more targeted and more relevant to the target audience.

Conclusions: The study found that relative digital is more effective than absolute digital in terms of reaching the target audience. This has important implications for digital marketing strategy.

The Use of Virtual Reality in the Treatment of PTSD

Abstract

Background: Virtual Reality (VR) is a promising tool for the treatment of PTSD. This paper explores the use of VR in the treatment of PTSD and its effectiveness.

Methods: A series of experiments were conducted to evaluate the use of VR in the treatment of PTSD. The results showed that VR was effective in reducing PTSD symptoms.

Results: The results of the study showed that VR was effective in reducing PTSD symptoms. This was because VR provided a safe and controlled environment for exposure to traumatic stimuli.

Conclusions: The study found that VR is an effective tool for the treatment of PTSD. Further research is needed to evaluate the long-term effectiveness of VR.

Virtual Superheroes: Using Superpowers in Virtual Reality to Encourage Prosocial Behavior

Robert S. Taylor<sup>a</sup>, Thomas L. Griffiths<sup>a</sup>, Jeremy M. Bailenson<sup>a</sup>

<sup>a</sup>Department of Psychology, University of California, Santa Barbara, Santa Barbara, California, USA

Abstract

Background: Virtual Reality (VR) is a promising tool for the treatment of PTSD. This paper explores the use of VR in the treatment of PTSD and its effectiveness.

Methods: A series of experiments were conducted to evaluate the use of VR in the treatment of PTSD. The results showed that VR was effective in reducing PTSD symptoms.

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Prevention

Abstract

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Conclusions: The study found that VR is an effective tool for the treatment of PTSD. Further research is needed to evaluate the long-term effectiveness of VR.

Article Info

Keywords:

Self-regulation

Neuroimaging

Virtual reality

Depression

Obesity

Behavior change

Abstract

Precision medicine models for personalizing achieving sustained behavior change are largely outside of current clinical practice. Yet, changing self-regulatory behavior is fundamental to the self-management of complex lifestyle-related chronic conditions such as depression and obesity – two top contributors to the global burden of disease and disability. To optimize treatment and address these barriers, behavior change and self-regulation must be better understood in relation to their neurobiological underpinnings. Here, we present the conceptual framework and protocol for a novel study, "Engaging self-regulation targets to understand the mechanisms of behavior change and improve mood and weight outcomes (ENGAGE)". The ENGAGE study integrates neuroscience with behavioral science to better understand the self-regulation related mechanisms of behavior change for improving mood and weight outcomes among adults with comorbid depression and obesity. We collect many of these self-regulation targets (attention, cognition, and self-reflection) in multiple settings: neuroimaging and behavioral lab-based measures, virtual reality, and passive smartphone sampling. By connecting human neuroscience and behavioral science in this manner within the ENGAGE study, we develop a prototype for elucidating the underlying self-regulation mechanisms of behavior change outcomes and their application in optimizing intervention strategies for multiple chronic diseases.

# 270 Medical VR/AR Companies

## 20 Clinical Sectors

**Phobias / PTSD**

**Stress Management /  
Relaxation**

**Surgical Training /  
Planning**

**Physical  
Rehabilitation**

**Pain & Difficult  
Procedure  
Management**

**Exercise**

**Cognitive  
Rehabilitation**

**Optical  
Rehabilitation**

**Addictions**

**Neuropsychological  
Assessments**

**Cognitive Training  
Wellness**

**Sports Medicine**

**Disability Solutions**

**Speech Therapy**

**Autism Spectrum  
Disorder**

**Mood Disorders**

**Patient Education**

**Preventive Health**

**ADHD**

**Senior Care**

# Investments in VR Health Startups



TRIPP



BehaVR



mindmaze



appliedVR™







## Why Now?

Over 30 years of academic research and over 3000 studies demonstrate that VR can improve behaviors, attitudes, and health

Until now, the technology was expensive, bulky, and difficult to use. Today, we have the advancements to bring VR to scale in healthcare.

# VR and AR technology will *significantly* impact Medical Care

- Prevention and Wellness
- Objective Assessments
- Functional Training
- Improved Interventions
- Facilitate Adherence
- Distributed Care Delivery



# Medical Training

- Clinical Skill Training
- Surgical Skill Training
- Interpersonal Skill Training
- Use of Equipment and Tools
- Team Training - eg: Emergency Department, Surgical Team
- Emergency Response Training and Rehearsal
- Facilitate Empathy





# Surgical Training

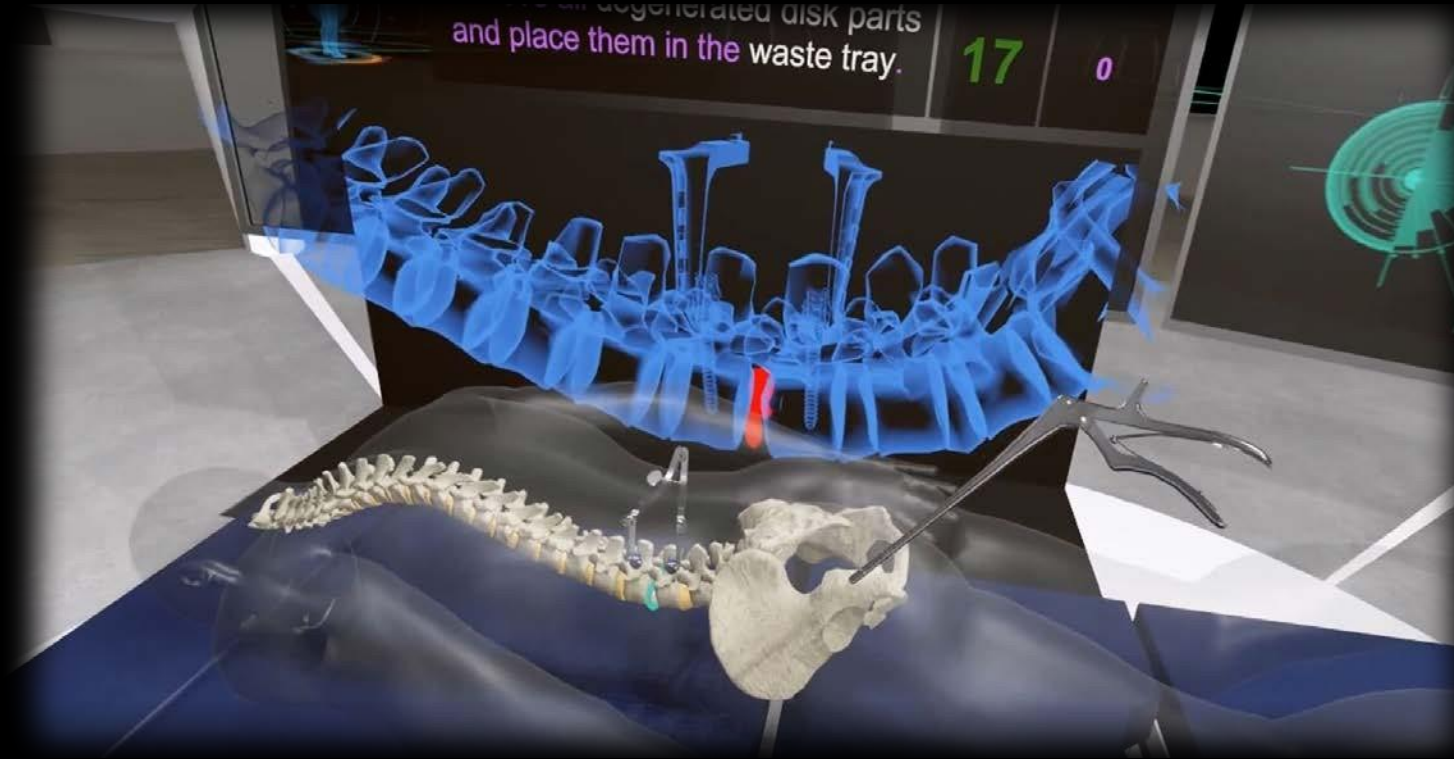
Knee  
arthroscopy  
simulator



# Surgical Procedure Training



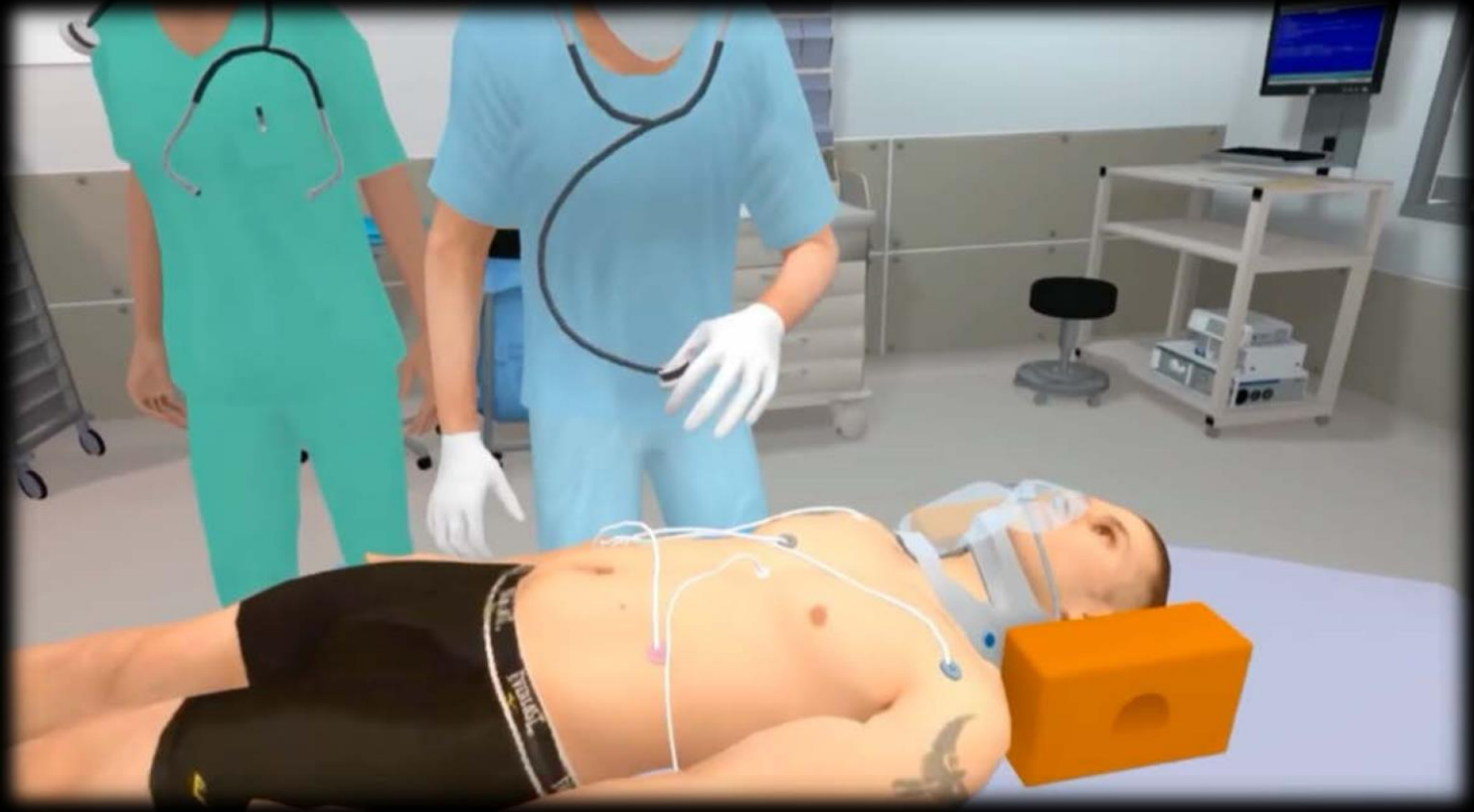
# Medical Device Training



# Virtual Patients for Clinical Skill Training



# Team Training







Todd Chang, MD  
Joshua Sherman, MD



CHLA Emergency Department

# Disaster Preparation

Multi-Department Training and Rehearsal

Situation Awareness

Stress Inoculation

Staff Training – Team Training

Rehearsal for Unusual Situations

AR - Data Fusion, Situation Awareness



# Clinical Training

Empathy for the Patient Experience





# Patient Education & Informed Consent



# Anatomy and Physiology Training

- Response to the acute shortage of human cadavers
- Allows for repetitive training and self-study
- More detailed examination of micro-features of organs, tissue etc.
- Integration of text, video and other media to further enhance learning



# Preoperative Planning & Image Guided Surgery



# DIAGNOSTIC ASSESSMENTS

- Medical Image Review
- Neuropsychological Assessments
- Activities of Daily Living Assessments
- Physical Medicine – OT / PT
- Behavioral Medicine – psychology, psychiatry





# New Approaches for Cognitive Assessment

## Standardized Environments for Neurocognitive Evaluation

Migrates traditional paper and subjective evaluations to a more sophisticated level.

Provides robust assessments that can challenge cognitive skills in a more **natural, standardized, objective and reproducible manner.**







# New Approaches for Cognitive Assessment

## Standardized Environments for Neurocognitive Evaluation



ORIGINAL RESEARCH  
published: 06 December 2017  
doi: 10.3389/fpsyg.2017.02116



### A Public Database of Immersive VR Videos with Corresponding Ratings of Arousal, Valence, and Correlations between Head Movements and Self Report Measures

Benjamin J. Li<sup>1\*</sup>, Jeremy N. Bailenson<sup>1</sup>, Adam Pines<sup>2</sup>, Walter J. Greenleaf<sup>1</sup> and Leanne M. Williams<sup>2</sup>

<sup>1</sup> Department of Communication, Stanford University, Stanford, CA, United States, <sup>2</sup> Department of Psychiatry and Behavioral Sciences, School of Medicine, Stanford University, Stanford, CA, United States

#### OPEN ACCESS

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**Received:** 08 September 2017  
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**Citation:**  
Li BJ, Bailenson JN, Pines A,

Virtual reality (VR) has been proposed as a methodological tool to study the basic science of psychology and other fields. One key advantage of VR is that sharing of virtual content can lead to more robust replication and representative sampling. A database of standardized content will help fulfill this vision. There are two objectives to this study. First, we seek to establish and allow public access to a database of immersive VR video clips that can act as a potential resource for studies on emotion induction using virtual reality. Second, given the large sample size of participants needed to get reliable valence and arousal ratings for our video, we were able to explore the possible links between the head movements of the observer and the emotions he or she feels while viewing immersive VR. To accomplish our goals, we sourced for and tested 73 immersive VR clips which participants rated on valence and arousal dimensions using self-assessment manikins. We also tracked participants' rotational head movements as they watched the clips, allowing us to correlate head movements and affect. Based on past research, we predicted relationships between the standard deviation of head yaw and valence and arousal ratings. Results showed that the stimuli varied reasonably well along the dimensions of valence and arousal, with a slight underrepresentation of clips that are of negative valence and highly arousing. The standard deviation of yaw positively correlated with valence, while a significant positive relationship was found between head pitch and arousal. The immersive VR clips tested are available online as supplemental material.

**Keywords:** virtual reality, database, immersive VR clips, head movement, affective ratings

#### INTRODUCTION

TABLE 1 | Continued

ID	TYPE	Description	Length [s]	Valence	Arousal
40	VR Killers	Various up-close shots of killers	101	6.07	4.00
41	Tighter jet parade course	Viewer takes the perspective of a tighter jet pilot in command of an airplane	102	6.50	4.73
42	Cute killers battle	Video clip showing four killers playing with one another	80	6.94	4.13
43	Aliso the first Swedish baby goes VR	Various shots of an infant in outdoor environments	136	7.33	3.44
44	Conquer the magic ramp	Viewer takes the perspective of a telematic sports participant and goes down a huge slope before keeping across a gap	86	5.29	6.43
45	Jay's rebellion	Virtual environment of a field with flowers and butterflies	119	5.63	2.00
46	Explosive the event with M60	Various shots of popular board destinations	197	6.59	4.29
47	Puppy blow xl	Viewers watch puppies compete in a mock football match	192	7.44	4.70
48	Hill festival of robes	Journalistic clip on a popular festival in India	173	6.60	4.50
49	Index first over 360 Wedding Video	Various shots of an Indian wedding	201	7.27	4.30
50	Hippies first found out for a day	Viewers get up close with some puppies	80	7.47	3.36
51	Resonance: a jump VR Video	An experimental film that follows the journey of a wide player	275	6.39	3.15
52	Spinal flying	Viewer follows a speed way pilot as he glides past mountains	154	6.70	7.42
53	Tommorrows 2014	A highlights reel of the events of a popular music festival	265	5.93	5.40
54	As it is	A trailer for a documentary on the history of the Grand Canyon	154	7.00	4.67
55	New York City Jump	Journalistic clip on the popular spots in New York City	144	5.88	4.21
56	Dark Impulse assembles the mobile burger	A time lapse clip on the setting up of a temporary airplane hanger	129	5.90	3.80
57	Los Angeles du center & Warehouse	A promotional clip for a condominium, where viewers get to explore the features and interior	87	5.75	3.25
58	Spangler Lawn	A view of people spending an afternoon relaxing in a courtyard	98	5.09	3.27
59	Slaking Planks High End	A journalistic clip on the features of the planet Pluto	463	6.00	4.31
60	Fluxion begins acoustic rehearsal	Viewer takes the perspective of a tighter jet pilot involved in airshow rehearsal	120	5.73	4.30
61	Kodak SP8000 View	A view of a yacht out at sea	39	6.10	5.10
62	Maple Coastline	Viewer takes the perspective of a telematic sports participant keeping off a ramp	117	6.17	7.17
63	WOL: Investigation & Launch of COBES film	Documentary film on the planning and execution of medical launches	634	6.34	5.93
64	Surrounded by elephants	Viewer has an up-close experience with elephants in a field	196	5.94	5.56
65	Kidnapped	A short comedy where viewer takes the perspective of a kidnapper victim in a case of mistaken identity	406	4.83	3.25
66	Great Horned Owl Shark Encounter	Viewer gets an up-close experience with sharks in the sea	134	6.17	6.67
67	Canyon Swell	Viewer experiences swinging over an open canyon	154	5.38	6.88
68	Jetboise 360	Short action film depicting a jetboise from various closed circuit cameras and how the output was captured	339	4.40	6.70
69	Walk the tight rope	Viewer experiences walking a tight rope over a canyon	151	6.46	6.91
70	Tank Out	Viewer experiences snorkeling and surfing on a barren beach	205	7.10	4.80
71	Loch Ness Boat	Viewer gets an up-close experience with a tiger on a coastline	40	5.58	5.25
72	Hallo Underwater's Entrance	Viewer experiences a sports entertainment event at a packed stadium	122	5.36	5.57
73	Through Mowgli's Eyes	A short film where the viewer observes a conversation between an ape and a boy	93	6.27	6.18





# New Approaches for Cognitive Assessment

## Standardized Environments for Neurocognitive Evaluation

Behaviour Research and Therapy xxx (xxxx) xxx-xxx



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**The ENGAGE study: Integrating neuroimaging, virtual reality and smartphone sensing to understand self-regulation for managing depression and obesity in a precision medicine model**

Leanne M. Williams<sup>a,b,\*</sup>, Adam Pines<sup>b</sup>, Andrea N. Goldstein-Piekarski<sup>a,b</sup>, Lisa G. Rosas<sup>a,d</sup>, Monica Kullar<sup>a</sup>, Matthew D. Saccher<sup>a</sup>, Olivier Gevaert<sup>a</sup>, Jeremy Bailenson<sup>e</sup>, Philip W. Lavori<sup>g</sup>, Paul Dagum<sup>h</sup>, Brian Wandell<sup>i</sup>, Carlos Correa<sup>a,i</sup>, Walter Greenleaf<sup>j</sup>, Trisha Suppes<sup>a,i</sup>, L. Michael Penny<sup>k</sup>, Joshua M. Smyth<sup>l</sup>, Megan A. Lewis<sup>j</sup>, Elizabeth M. Venditti<sup>m</sup>, Mark Snowden<sup>n</sup>, Janine M. Simmons<sup>o</sup>, Jun Ma<sup>o</sup>

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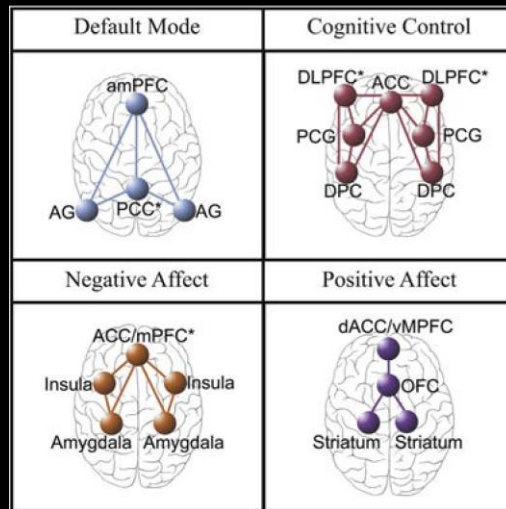
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### ARTICLE INFO

**Keywords:**  
Self-regulation  
Neuroimaging  
Virtual reality  
Depression  
Obesity  
Behavior change

### ABSTRACT

Precision medicine models for personalizing achieving sustained behavior change are largely outside of current clinical practice. Yet, changing self-regulatory behaviors is fundamental to the self-management of complex lifestyle-related chronic conditions such as depression and obesity – two top contributors to the global burden of disease and disability. To optimize treatments and address these burdens, behavior change and self-regulation must be better understood in relation to their neurobiological underpinnings. Here, we present the conceptual framework and protocol for a novel study, “Engaging self-regulation targets to understand the mechanisms of behavior change and improve mood and weight outcomes (ENGAGE)”. The ENGAGE study integrates neuroimaging with behavioral science to better understand the self-regulation related mechanisms of behavior change for improving mood and weight outcomes among adults with comorbid depression and obesity. We collect assays of these self-regulation targets (emotion, cognition, and self-reflection) in multiple settings: neuroimaging and behavioral lab-based measures, virtual reality, and passive smartphone sampling. By connecting human neuroscience and behavioral science in this manner within the ENGAGE study, we develop a prototype for elucidating the underlying self-regulation mechanisms of behavior change outcomes and their application in optimizing intervention strategies for multiple chronic diseases.



**VIRTUAL HUMAN  
INTERACTION**  
LAB

# BioMarkers - Cognitive and Emotional State

Collecting and analyzing emotional and physical responses in VR



# Improved cognitive function assessment at the primary care level – using AR and smartphone sensors

10 minute test

Diagnostic accuracy of 94%

FDA Class II Medical Device



Continuous data of everyday functions  
250 features assessed at 300Hz  
3D trajectory neuromotor parameters



# Virtual environments are **currently used** clinically

Here are a few examples -

- Stroke and Traumatic Brain Injury
- Physical / Occupational Therapy
- Acute and Chronic Pain Mitigation



# Virtual environments are used clinically to treat several important **mental and behavioral health problems**

- Post-Traumatic Stress Disorder
- Generalized Anxiety Disorder
- Social Anxiety Disorder
- Depression
- Mild Cognitive Impairment
- Autism Spectrum Disorder
- ADHD



# Virtual environments are used clinically to treat several important **mental and behavioral health problems**

- Generalized Anxiety Disorder
- Phobias
- Obsessive Compulsive Disorder
- Anger Management
- Eating Disorders
- Schizophrenia



# New Approaches to Mental Health



National Mental Health Innovation Center

UNIVERSITY OF COLORADO **ANSCHUTZ MEDICAL CAMPUS**

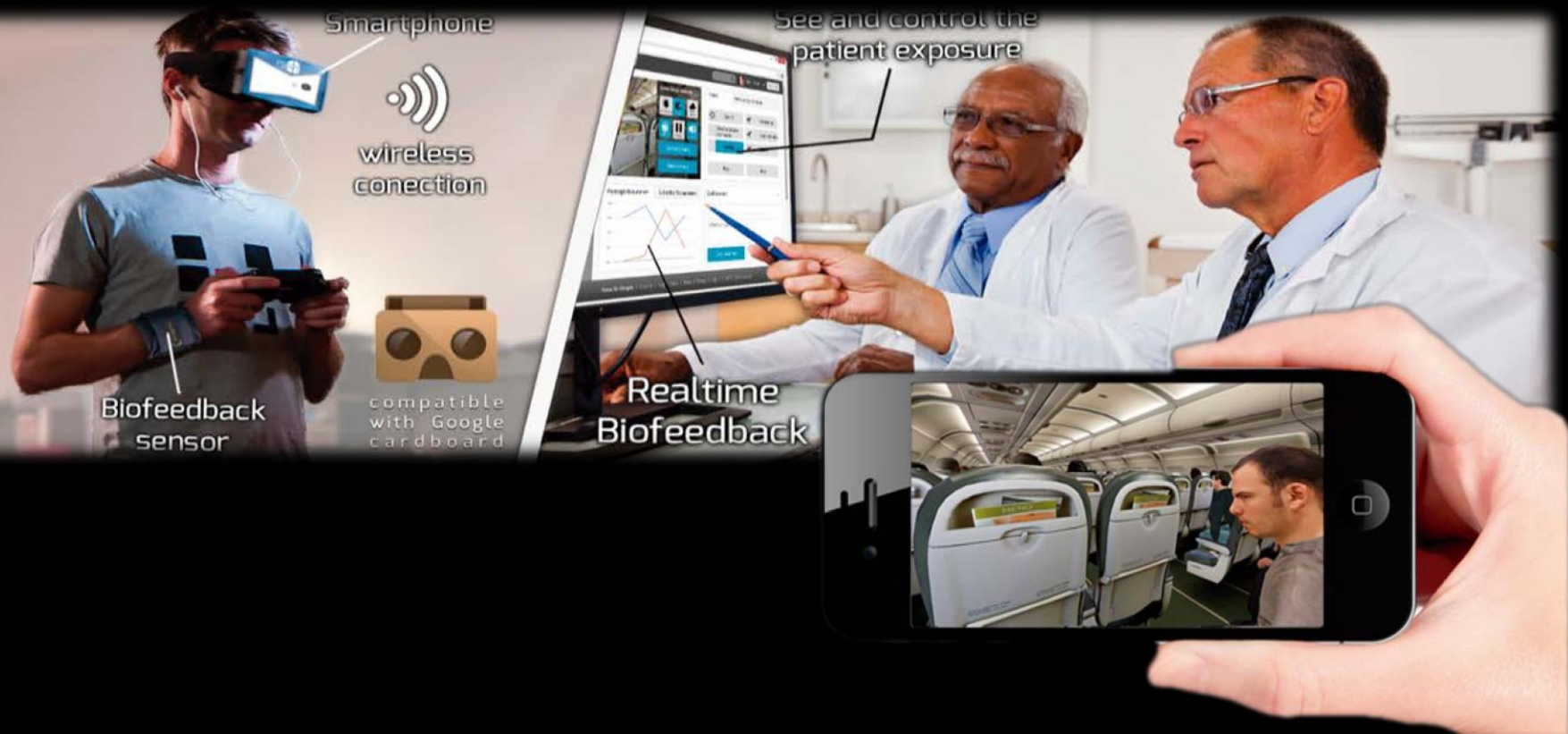
# HEALTH AND WELLNESS

- Improve Cognitive Function
- Promote Exercise & Weight Management
- Stress Management
- Mood and Resilience
- Disability Solutions
- Addressing Isolation
- Grief Counseling



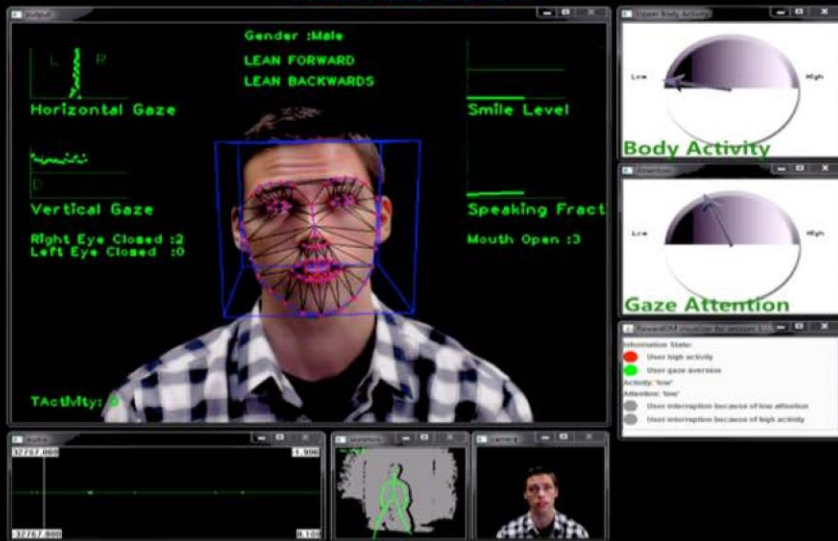


# Portable Telemedicine Platform



# Virtual Humans For Training, Confidential Interaction, and Telemedicine Support

## MultiSense



## SimSensei



# Virtual Humans For Training, Confidential Interaction, and Telemedicine Support



“Smart Avatar” with a **virtual voice**,  
**image and mannerisms via AI**

# Preparation and Training for Difficult Situations





# Some Examples





# PTSD, Phobias, and Anxiety Disorders

- Exposure-based treatments can be conducted in the safety and comfort of an office setting
- Effective tools for treating a variety of clinical problems, in particular anxiety and addictive disorders
- Fully immersive environments, which include the use of a head mounted display, 3D sound, tactile stimulation via shaking platform, and olfactory stimulus are used for PTSD therapy



# Palliative and Hospice Care



# Cognitive Assessments for ADHD

- Enhanced Continuous Performance Test (CPT) in a real-world classroom environment
- Can introduce visual and auditory distractions during CPT administration
- More familiar for children than traditional PC-Based CPT
- Performance and response times more closely approximate true classroom
- Can become a skill building platform



# RISK AVOIDANCE TRAINING

Refusal skill training, Situational Confidence





# Virtual Hospital Tours Used To Relieve Pre-procedure Anxiety



# VR for Pain Distraction

## Clinical Research and Validation

Interactive virtual environments significantly reduce pain from as much as 44% during the most painful procedures  
(ex: burn wound treatment)

Diverts patient attention away from perceiving and feeling pain; (selective attention theory)

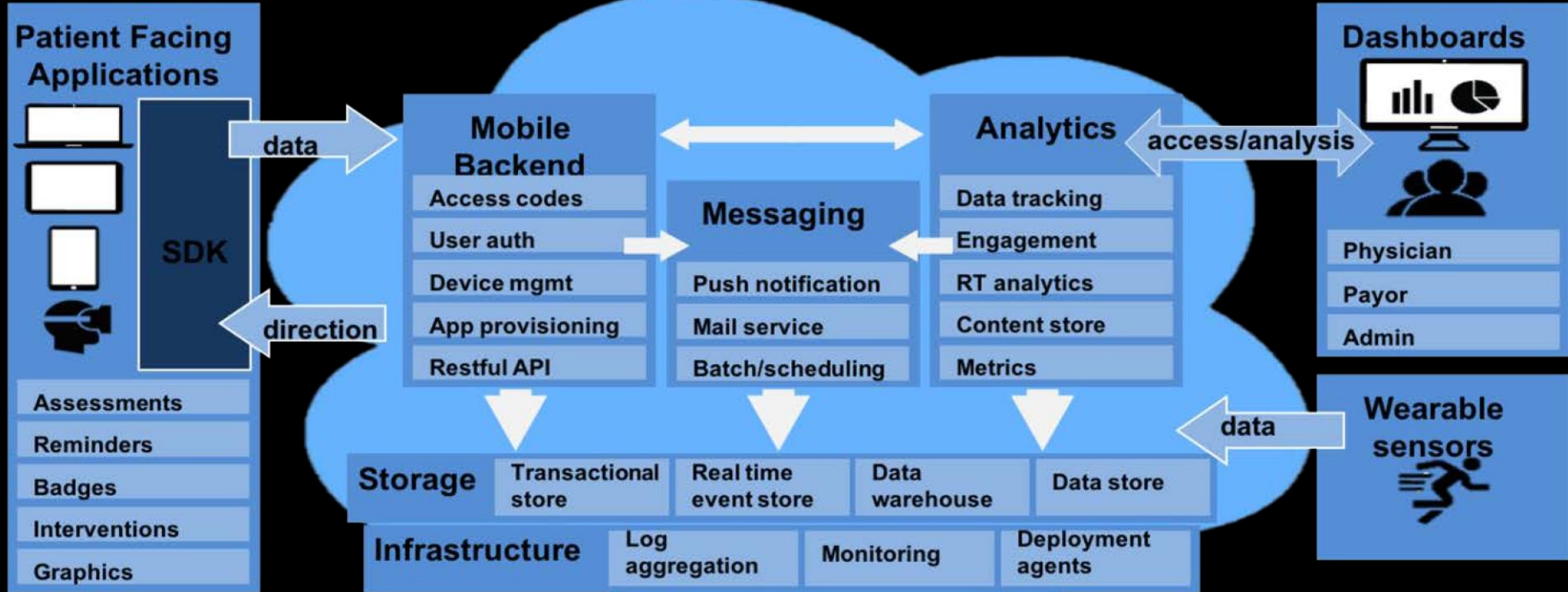
Decreases pain-related brain-activity

Reduces need for anesthesia, opioid medication

No pharmacological side effects



# Digital Health Platforms deliver interventions to patients, and parse data for enhanced analysis



# VR & AR - A Key Part of a **Combination Therapy** Digital Health Platform



+



=



Medication with  
clinical benefit

Patient-facing software  
designed to enhance  
medication efficacy

***eFormulation-***  
pharmaceutical  
product with  
enhanced efficacy

# A Fully Integrated, Closed Loop Solution for Mental Health and Wellness - Enabled on a Mobile, Digital Health Platform

Miniaturized, programmable,  
low power electronic  
architecture w/extensive therapy  
delivery options



## Wearable Stimulator

- Wireless
- Personalized
- Treatment Anytime
- Discrete



## Digital Health Platform

- Health Monitoring
- Voice Monitoring
- Emotional Monitoring
- Patient Monitoring



## Digital Therapies

- VR
- Music
- Mindfulness
- Telemedicine
- Virtual Therapist



eQuility



# The Neuroscience of How VR Promotes Behavior Change



# The Neuroscience of How VR Promotes Behavior Change

VR can promote behavior change by taking advantage of the way our brain's learning and reward systems function

VR systems can:

Activate neuroplastic change via reward systems

Shorten the reward feedback loop – show progress

Leverage mirror neuron systems

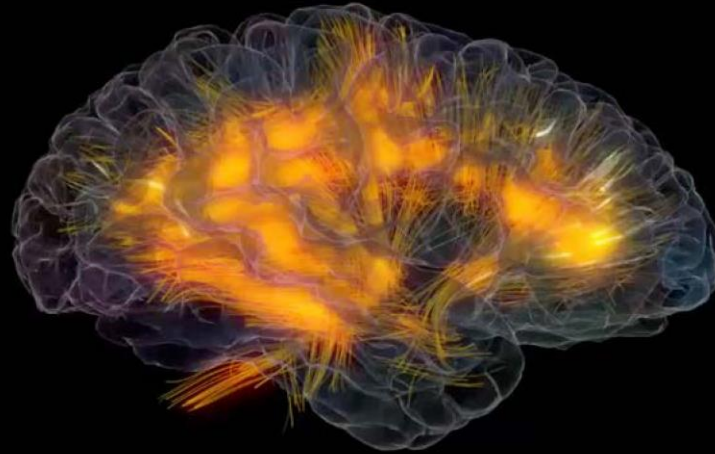


# Neuroscience Rationale

It is necessary to activate the associated brain system  
to enable neuroplasticity

Repetition is required

It is critical to engage the  
brain's reward systems



# Leveraging Mirror Neurons



Ability to change attitudes and behavior after “being” one’s future self.



# Your Future Self



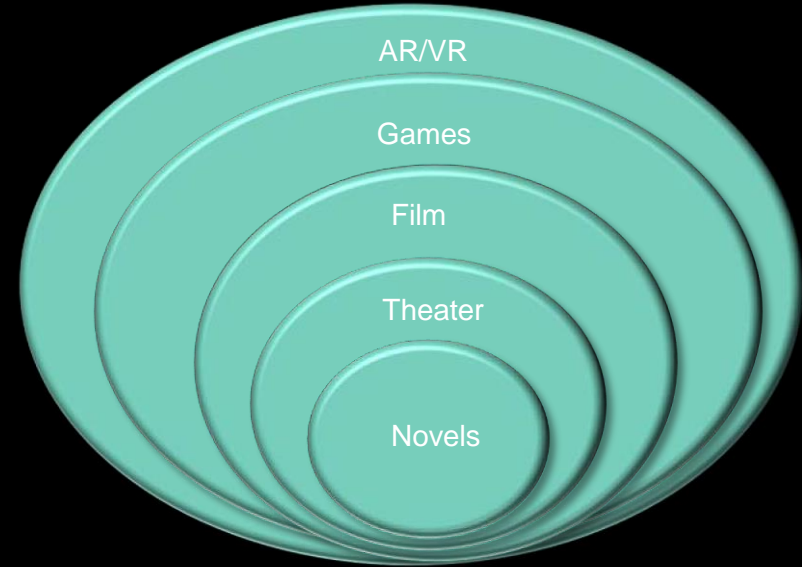
Students interacted with 3-D avatars of future self.

Participants who interacted with future self put more than twice as much money into retirement account.



# Why Use Interactive / Immersive Systems for Health?

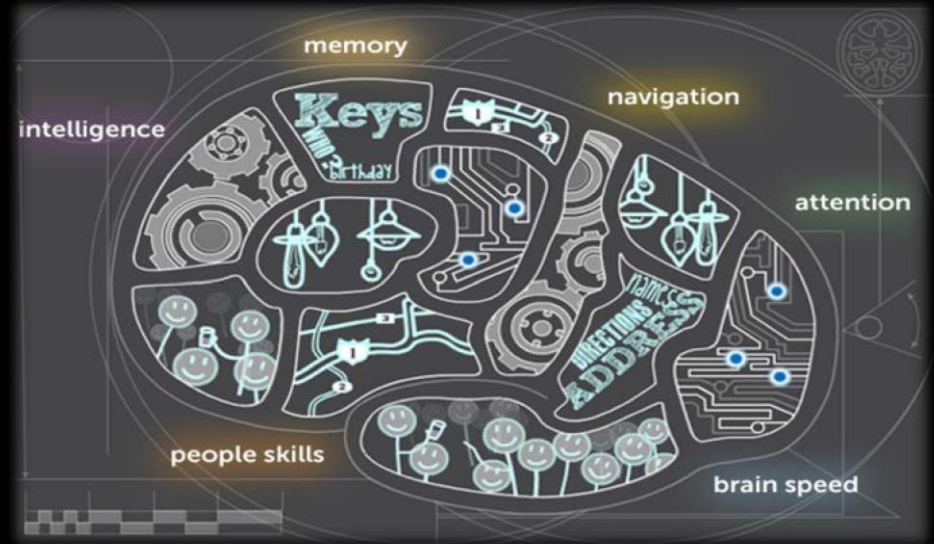
- **Active Involvement:** AR/VR systems provide patients with immersive experiences that make them feel more involved in their care.
- **Feedback:** behavior is reinforced by direct, immediate and relevant feedback that reinforces positive behavior.
- **Engaging and Motivating:** gives patients something to control and can provide immediate rewards. (Contingency Management)
- **Social Connections:** provide and enhance social resilience. (Social Physics)
- **Cost Effective:** Systems extend the effect of therapy while reducing the cost of face-to-face contact.



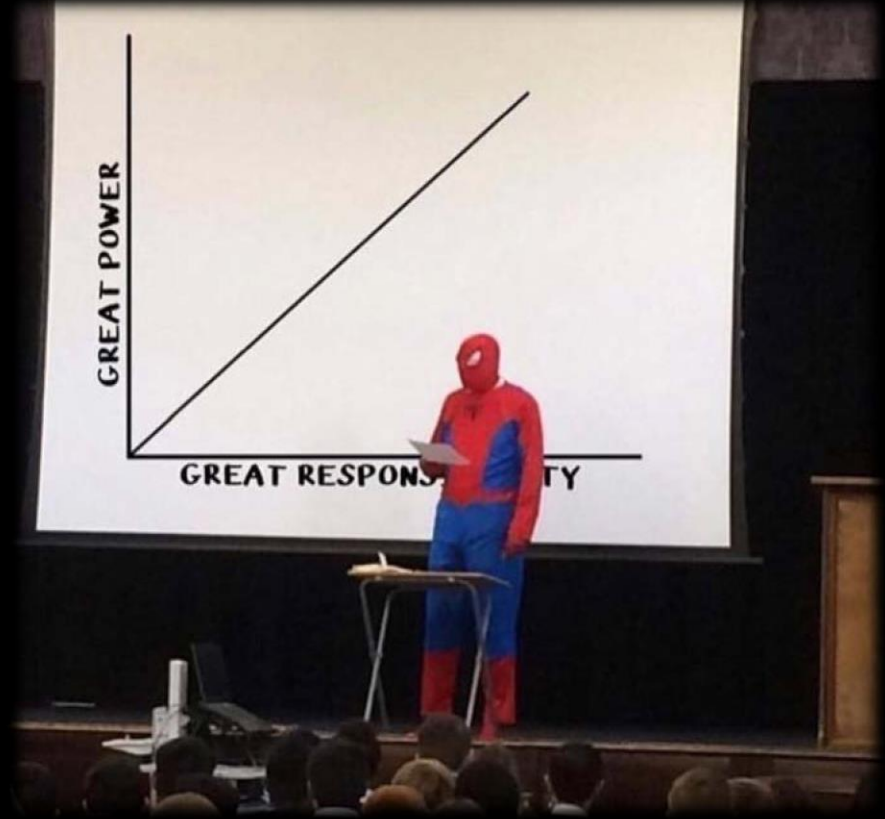
# Wired for Narrative Stories

## Research shows that STORY:

- Provides superior retention (memory and recall)
- Provides improved understanding
- Creates context and relevance
- Creates empathy
- Makes readers/listeners pay attention
- Enhances the creation of meaning



**What Are The Constraints?**  
**What are the gating-steps to adoption?**



# No Clear Technology Path – Too Many Options

Rapid evolution = fears of obsolescence

Mobile / PC-Based vs. All-in-One

Which platform will prevail?

Graphics-based vs. 360 video

Concerns over infrastructure needs

Lack of IT support





# Research Gaps

Body of literature is expanding with encouraging results,  
But remains insufficient

Available research varies by condition treated

Lack of randomized controlled trials

Population-specific studies

Obsolete platforms and equipment

Small sample sizes



# Perception of VR as a Gaming Platform



# Products need to be aligned with healthcare system needs

Full practices – no need to attract new patients

Evidence-based treatments are already available



What is the financial and time benefit?

Does it interfere with the clinic workflow?

A young child is the central focus, smiling broadly and holding up a string of colorful, glowing lights. The child is wearing a light-colored t-shirt with a small graphic. The background is a dark, out-of-focus night scene with various bokeh lights in blue, green, and yellow, suggesting a festive or outdoor nighttime setting. The overall mood is joyful and celebratory.

# Healthcare Crisis - Aging Populations



# Virtual Environments and Senior Care

Improved Assessments and Diagnostics

Addressing Isolation and Loneliness

Acute and Chronic Pain

Depression and Anxiety Disorders

Physical and NeuroRehabilitation

Design for Disabilities

Post-Discharge Follow-up

Staff Training: not just procedures, but empathy



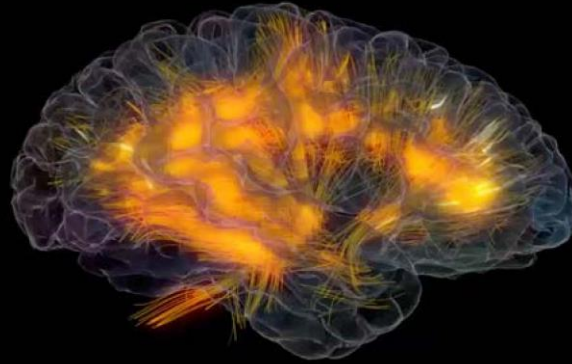
# Digital Health Technology For Medicine



- Current technologies and concepts are founded on more than *30 years of research and development*
- Recent changes in cost and access make digital health technology affordable
- Digital health technology is currently used for prevention, evaluation, treatment and chronic disease management
- *After years of validation and use by early adopters – validated systems are poised to move to the mainstream*
- On the horizon: enhanced, ubiquitous, informative and integrated

# *Virtual Reality and Healthcare: The Past, The Present, and The Future*

Walter Greenleaf PhD



Stanford  
University  
**VIRTUAL HUMAN  
INTERACTION**  
LAB



**Stanford**  
HEALTH CARE



National Mental Health Innovation Center  
UNIVERSITY OF COLORADO **ANSCHUTZ MEDICAL CAMPUS**