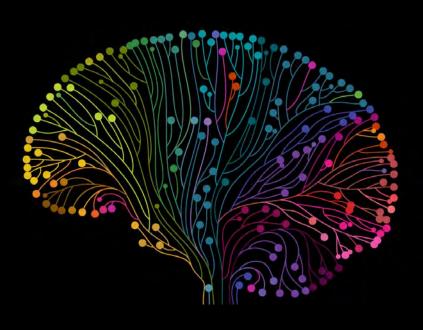
Virtual Reality & Augmented Reality Systems

The Impact on Clinical Care

Walter Greenleaf PhD









Medical VR/AR Systems – Overall Status and Opportunity



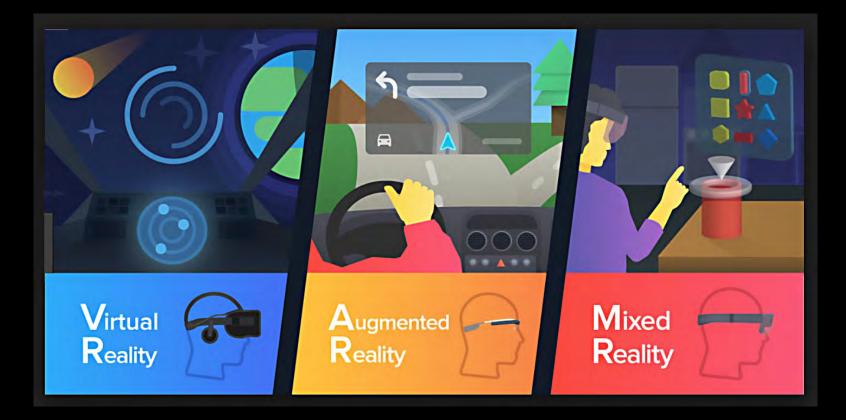
Current technologies and concepts are founded on more than 30 years of research and development

Recent changes in cost and access make clinical VR systems affordable

After years of study and use by early adopters – validated systems are moving out into mainstream healthcare

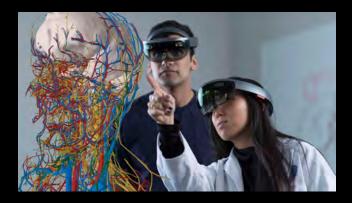
On the horizon - enhanced, ubiquitous, informative and integrated

+ AR + MR = XR







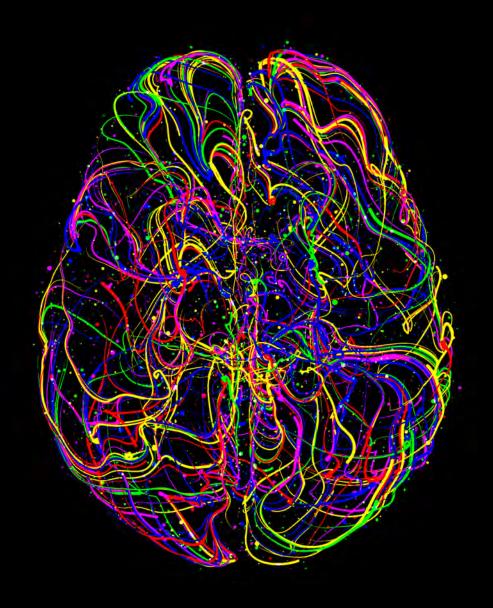


Extended Reality

Immersive Systems

VR/AR systems are currently used for -

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

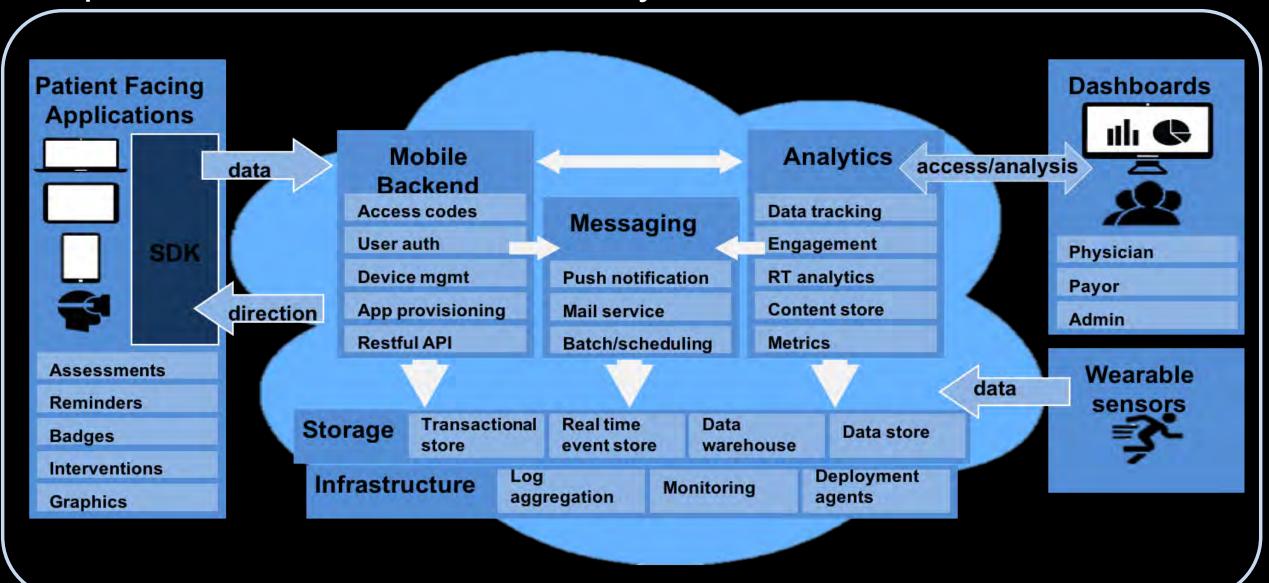


Digital Health Revolution

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



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



Virtual Reality & Augmented Reality Technology



Immersive Systems



Other Dimensions of Sensory Input - Enhanced Immersion







9 scent actuators with interchangeable cartridges Library of over 250 scents Custom scent creation





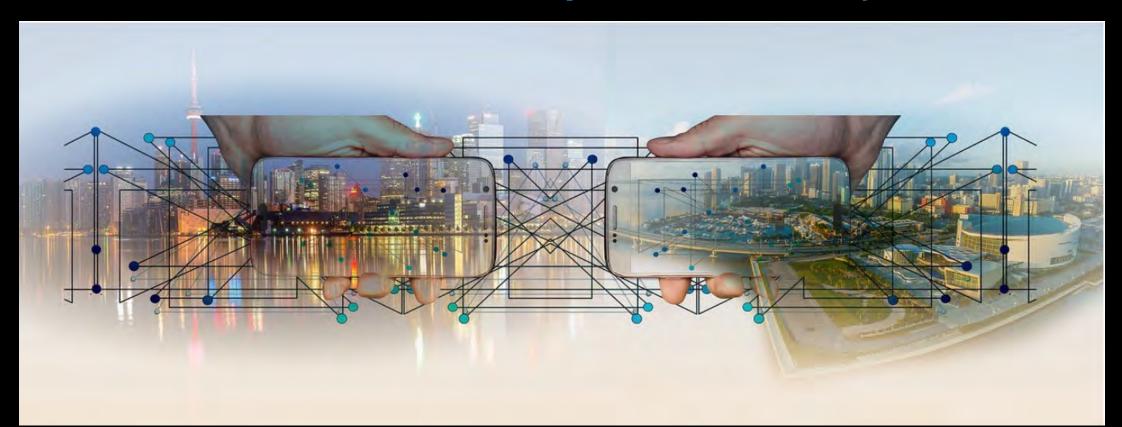
Aaron Wisniewski

Virtual Humans For Education, Training, Support



"Smart Avatar" with a virtual voice, image and mannerisms via AI

5G connections will surpass one billion by 2023



Single-digit millisecond latencies with Edge Computing Cloud-Rendered AR and VR content Real-time Analytics for Machine Learning, Predictive Modeling

Virtual Worlds – Multiuser Immersive Experiences





Cloud-based 3D real time rendering



VR Technology Has Evolved

1987

First general purpose and commercially available VR systems.

SCIENTIFIC AMERICAN

OCTOBER 1987 \$2.50

The next revolution in computers, the subject of this issue, will see power increase tenfold in 10 years while networks and advanced interfaces transform computing into a universal intellectual utility.



Wind Glove gives a computer user the semation of handling objects on the screen the image of the hand minus the user's movements.



































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

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More Than 327 Clinical Application Areas

Targeting Multiple Clinical Sectors and Specific Indications

Acute Pain	Addiction Medicine	ADHD	Anxiety Management	Autism Spectrum Disorder	Chronic Pain
Cognitive Assessments	Depression	Disability Solutions	Emergency Medicine	Medical Education &Training	Ophthalmology
Orthopedics	Palliative Care	Patient Education	Phobias PTSD	Physical Medicine and Rehabilitation	Preventive Medicine
Respiratory Medicine	Senior Care	Stroke & TBI	Surgical Procedure Planning	Surgical Skill Training	Uncomfortable Procedure Distraction

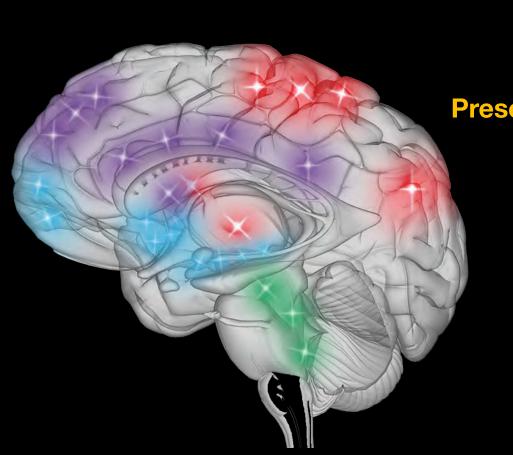
Clinical VR/AR Systems Have Impact



Learning & Retention



Muscle Memory





Presence & Context



Motivation/Engagement

Increased Cognitive Engagement Improved Clinical Adherence

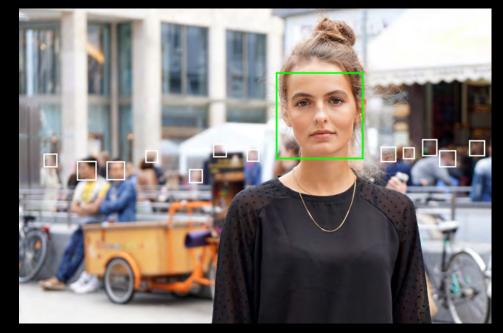
High Dropout Rates for Mental Health Apps

More than 1/2 of the participants in mental health app studies drop out in week #1

Lack of engagement is the primary reason

High dropout rates present a threat to the validity of RCTs of Mental Health Apps







Dropout rates in clinical trials of smartphone apps for depressive symptoms: A systematic review and meta analysis December 2019 Journal of Affective Disorders 263 Current Examples of XR Systems Applied to Clinical Care

Functional Training

Objective Assessments

Improved Interventions

Facilitated Adherence

Distributed Care Delivery

Prevention and Wellness



Medical Education and Training

- **Clinical Skill Training**
- Surgical Skill Training
- Interpersonal Skill Training
- Use of Equipment and Tools
- Team Training: Emergency Department Surgical Team

Hospital-Wide Emergency Response Training and Rehearsal







VR simulation to train medical students and staff to respond in high-stakes, low-frequency pediatric emergencies.

Pediatric Resuscitation









Virtual Standardized Patient Simulators

Standardized patient simulators offer medical educators a powerful way to enhance both technical and interpersonal skills.

Increasing the effectiveness of therapy skills of psychologists

Enabling prospective nurses to master giving an effective patient history and coaching interview

Allowing pediatric healthcare providers to train in scenarios involving a parent and an elementary-age child

Enhancing the debriefing skills of a surgical team



Preparation and Training for Difficult Situations



Improving the communication skills of a doctor delivering a negative diagnosis



VR/AR Technology Provides for Objective Assessments

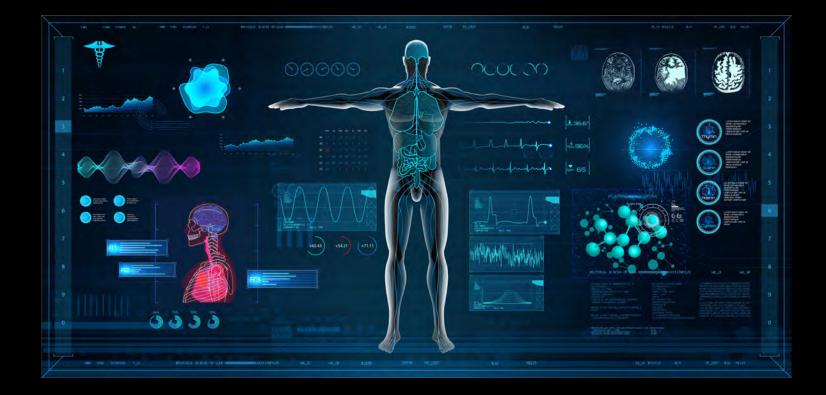
- **Functional Training**
- **Objective Assessments**
- Improved Interventions
- **Facilitated Adherence**
- **Distributed Care Delivery**
- **Prevention and Wellness**



Improved Assessments

Activities of Daily Living Assessments

Physical Medicine – OT / PT



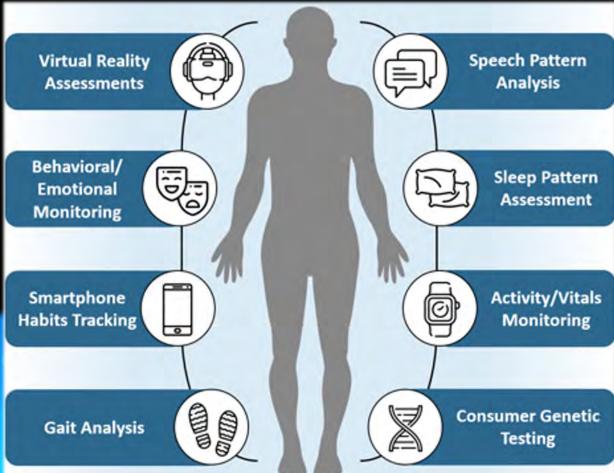
OBJECTIVE ASSESSMENTS

Cognitive Function

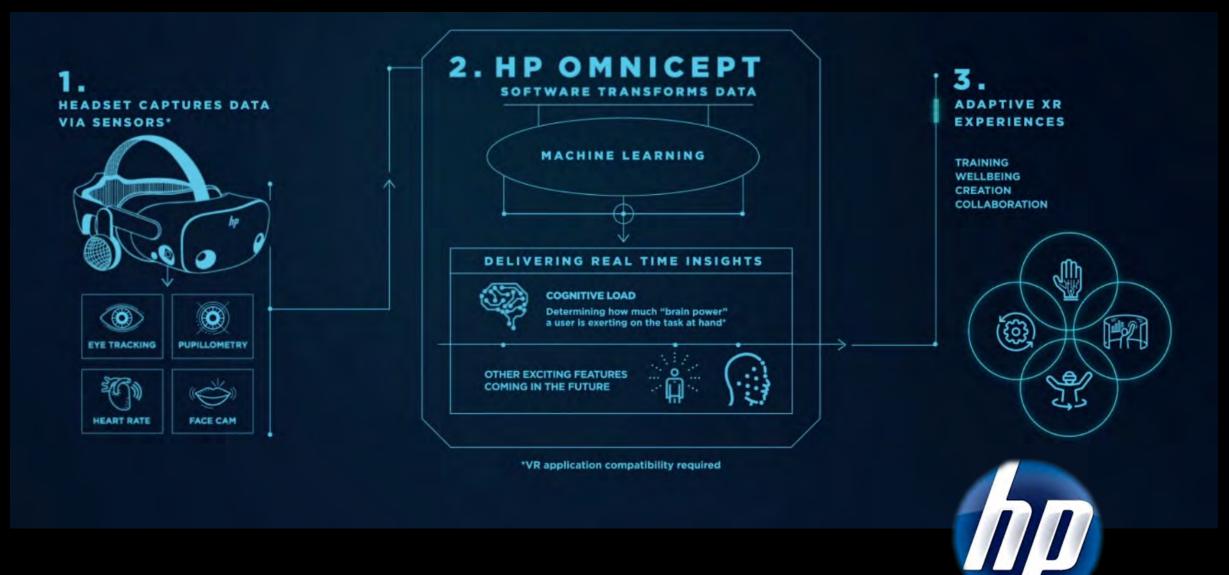
Neuropsychological Assessments

Behavioral Medicine Psychology, Psychiatr**y**





Uncovering the signals that index cognitive load



XR Technology Provides for Improved Clinical Interventions

Functional Training

Objective Assessments

Improved Interventions

Facilitated Adherence

Distributed Care Delivery

Prevention and Wellness



Preoperative Planning & Image Guided Surgery









New Approaches to Physical Medicine & Rehabilitation



Stroke and Traumatic Brain Injury

Physical / Occupational Therapy

Neuro Cognitive Rehabilitation





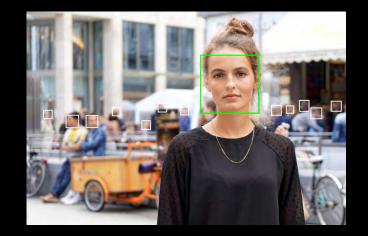
NEURO REHAB VR





Urgent Need for New Approaches to Mental Healthcare









Virtual environments are used clinically to treat mental and behavioral health problems

Generalized Anxiety Disorder Phobias Addictions Social Anxiety Disorder

Depression

Chronic Pain

Autism Spectrum Disorder

ADHD

Obsessive Compulsive Disorder Anger Management Schizophrenia







VR/AR 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



PTSD, Phobias, 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



XR Systems to Support Therapy For Addictions

Refusal skill training Risk avoidance training Situational confidence training





HEALTH AND WELLNESS

- Promote Exercise & Weight Management
- Stress Management
- Mood and Resilience

- Disability Solutions
- Addressing Isolation
- Grief Counseling







In Summary

Medical VR/AR Systems – Overall Status and Opportunity



Current technologies and concepts are founded on more than 30 years of research and development

Recent changes in cost and access make dynamic assessment and intervention systems affordable

After years of study and use by early adopters – validated systems are poised to move to the mainstream

On the horizon - enhanced, ubiquitous, informative and integrated





