THE FUTURE OF PSYCHIATRY

DANIEL C. DAHL, M.D.

DISCLOSURES FOR DANIEL C. DAHL, M.D.

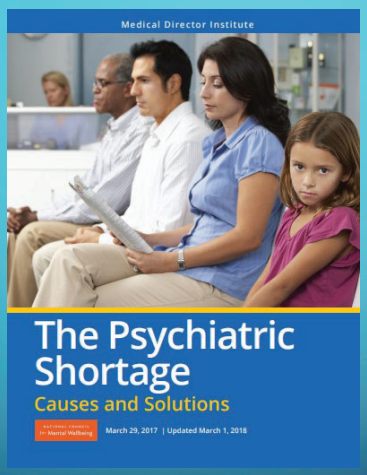
- None

OUTLINE

- A. Introduction
- B. Films predicting the future
- C. Current Situation
- D. Models to address Psychiatry Shortage
- D. Lancet Report
- E. Leaders in the Field
- F. Heads Up Display and Random Musings
- G. Predictions and Discussion

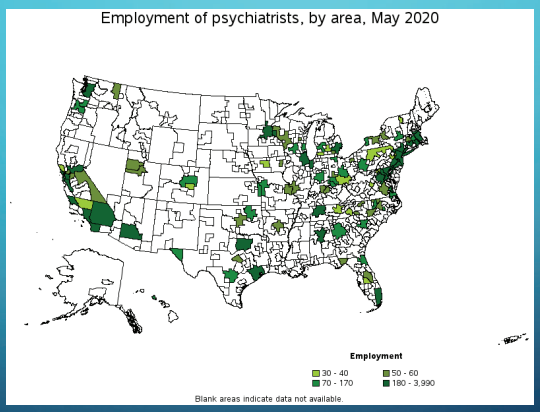
MOVIES ABOUT THE FUTURE

STAR TREK



PSYCHIATRIC-SHORTAGE_NATIONAL-COUNCIL-.PDF (THENATIONALCOUNCIL.ORG)

BUREAU OF LABOR STATISTICS



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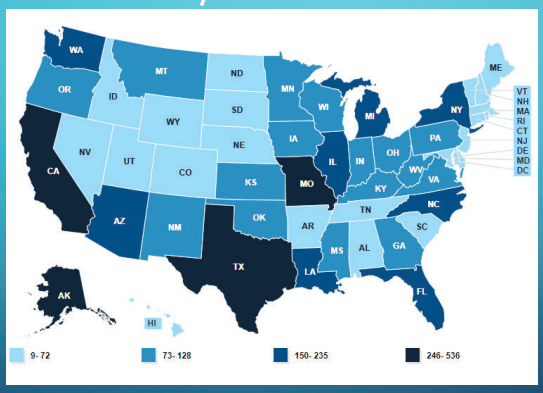
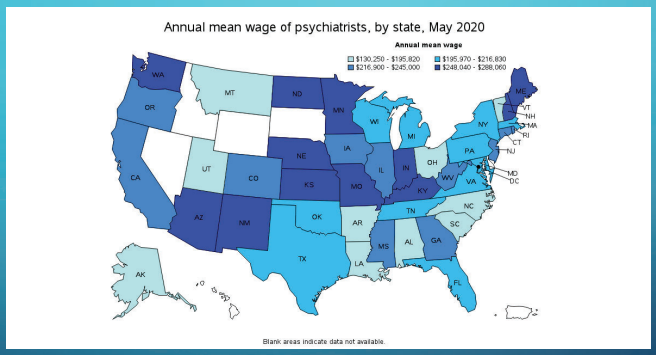
JACKSON & COKER (HEALTH CARE PROFESSIONAL SHORTAGE AREAS)



HTTPS://JACKSONCOKER.COM/RESOURCES/EXCLUSIVE-RESEARCH/WHY-PSYCHIATRIST-SALARIES-ARE-GROWING/

SALARIES



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TOP PAYING STATES

Blank areas indicate data not available.

Top paying states for Psychiatrists:

State	Employment (1)	Employment per thousand jobs	Location quotient (9)	Hourly mean wage	Annual mean wage (2)
North Dakota	30	0.07	0.41	$ 138.49	$ 288,060
Kansas	150	0.11	0.60	$ 135.29	$ 281,410
Minnesota	450	0.17	0.91	$ 133.84	$ 278,380
New Mexico	50	0.06	0.35	$ 128.99	$ 268,290
Nebraska	(8)	(8)	(8)	$ 128.94	$ 268,200

Employment of psychiatrists, by area, May 2020

HTTPS://WWW.BLS.GOV/OES/CURRENT/OES291223.HTM

JACKSON & COKER

- Communities across the United States are feeling the effects of Psychiatric shortages. In fact, **more than half of U.S. counties have no Psychiatrists** at all.
- The National Council for Behavioral Health says there has been a 42% increase in the number of patients going to the emergency room for psychiatric care in the past few years.
- Psychiatrists' salary average was $275,000 in 2020, according to Medscape's Annual Compensation Report. They made 3% more than they did the previous year, even when some specialties saw compensation declines due to complications from the COVID-19 pandemic.
- We expect these salary trends to continue as a large portion of today's Psychiatrists reach retirement age. More than 60 percent of practicing Psychiatrists are over the age of 55.

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Compared to their state populations, the District of Columbia had the highest ratio of psychiatrists per 100,000 population (50.1) and Idaho had the lowest ratio (5.3) (Table 2). The national average was 12.9 psychiatrists per 100,000 state population. The county with the highest ratio of psychiatrists per 100,000 population was Charlottesville City, Virginia (127.4) which had 56 psychiatrists and 45,538 total population.

Table 2: Highest/Lowest Concentrations of Psychiatrists by State and County

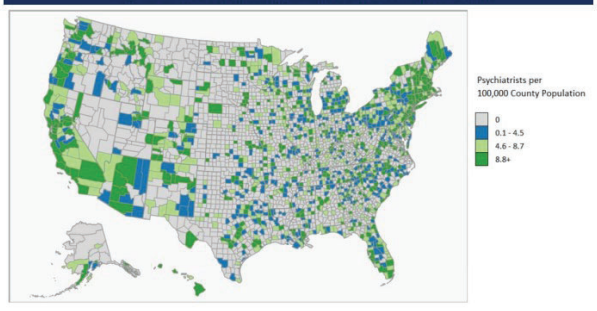
Highest Ratios of Psychiatrists by State (providers/100,000 population)	Lowest Ratios of Psychiatrists by State (providers/100,000 population)	Highest Ratios of Psychiatrists by County (providers/100,000 population)
District of Columbia (50.1)	Arkansas (8.0)	Charlottesville (city), VA (127.4)
Massachusetts (30.0)	Iowa (7.9)	New York, NY (110.2)
New York (25.3)	Nevada (7.8)	Orange, NC (100.9)
Rhode Island (23.5)	Montana (7.5)	Augusta, VA (87.8)
Connecticut (23.4)	Utah (7.4)	Grafton, NH (80.8)
Vermont (23.1)	Wyoming (7.2)	Johnson, IA (80.3)
Maryland (20.4)	Alabama (7.0)	Lincoln, SD (70.0)
Hawaii (18.0)	Indiana (6.6)	Olmstead, MN (65.3)
Maine (17.1)	Mississippi (6.2)	Chatham, NC (64.0)
New Hampshire (15.7)	Idaho (5.3)	Suffolk, MA (62.1)

BEHAVIORAL HEALTH WORKFORCE RESEARCH CENTER
UNIVERSITY OF MICHIGAN

HTTPS://WWW.BEHAVIORALHEALTHWORKFORCE.ORG/WP-CONTENT/UPLOADS/2019/02/Y3-FA2-P2-PSYCH-SUB_FULL-REPORT-FINAL2.19.2019.PDF

Figure 1 shows the relative concentration of psychiatrists per 100,000 population for all U.S. counties. The highest concentrations of psychiatrists could be found along the pacific coast and within the northeast. Large swaths of counties without psychiatrists were found throughout the center, northern, and southern states.

Figure 1. Map of Psychiatrists per 100,000 Population by U.S. County



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Like psychiatrists, CAPs were mostly concentrated on the Pacific coast and within the northeast (Figure 2). Counties without any CAPs were spread throughout most of the middle of the country, predominately in non-metropolitan areas.

Figure 2. Map of Child & Adolescent Psychiatrists per 100,000 Population Under Age 18 by U.S. County

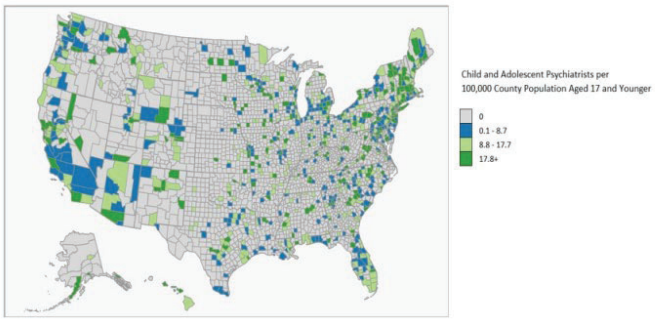

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Figure 3 shows the relative concentration of geriatric psychiatrists per 100,000 population aged 65 and older for all U.S. counties. The highest concentrations of GPs could be found within the northeast.

Figure 3. Map of Geriatric Psychiatrists per 100,000 Population Over Age 64 by U.S. County

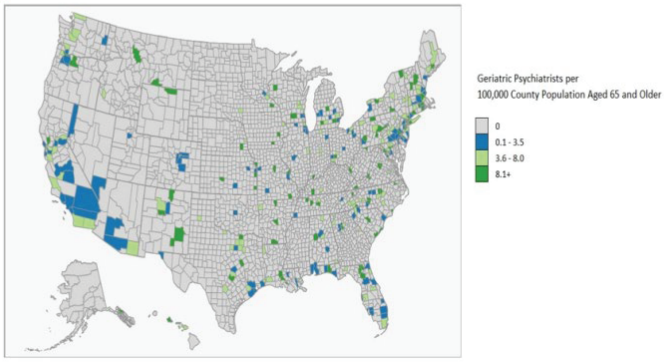

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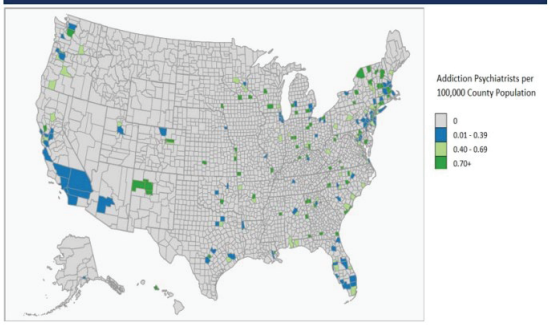
Figure 4 shows the relative concentration of addiction psychiatrists per 100,000 residents for all U.S. counties. The highest concentrations of APs could be found within the northeast.

Figure 4. Map of Addiction Psychiatrists per 100,000 Population by U.S. County



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AAMC: ADDRESSING THE ESCALATING PSYCHIATRIST SHORTAGE (FEBRUARY 2018)

- "The shortage of psychiatrists is an escalating crisis," notes the physician search firm Merritt Hawkins in a 2017 report. "[The gap is] of more severity than shortages faced in virtually any other specialty."
- What's more, the need for treatment is expected to rise as the number of psychiatrists falls. In 2025, demand may outstrip supply by 6,090 to 15,600 psychiatrists, according to a 2017 National Council for Behavioral Health report that explores the shortage's causes and suggests solutions.
- A number of factors fuel the shortage, including a greater awareness of mental health problems that has spurred people to seek treatment. Also, mental health providers frequently are reimbursed less than physical health providers, a 2017 report notes, leaving institutions sometimes struggling to cover salaries. And then there's a retirement drain: More than 60% of practicing psychiatrists are over the age of 55—one of the highest proportions among all specialties, AAMC 2015 data indicate.

HTTPS://WWW.AAMC.ORG/NEWS-INSIGHTS/ADDRESSING-ESCALATING-PSYCHIATRIST-SHORTAGE

AAMC: ADDRESSING THE ESCALATING PSYCHIATRIST SHORTAGE (FEBRUARY 2018)

- **The impacts of the shortage are evident: too little access to treatment for opioid use disorder, high burnout rates among VA psychiatrists, long waits for inpatient beds, and more.**
- **Americans with a mental health condition: Nearly 1 in 5**, reports the Substance Abuse and Mental Health Services Administration.
- **The number of psychiatrists in more than half of U.S. counties: 0**, according to a 2016 *Health Affairs* report.
- **People living in mental health professional shortage areas: 111 million**, according to the U.S. Department of Health and Human Services.
- **Primary care physicians who reported difficulty referring patients for mental health care: 2 out of 3**, the *Health Affairs* report notes. That's twice the number reported for any other specialty.
- **Increase in patients going to emergency departments for psychiatric services** over a recent 3-year period: **42%**, the National Council for Behavioral Health reports.

HTTPS://WWW.AAMC.ORG/NEWS-INSIGHTS/ADDRESSING-ESCALATING-PSYCHIATRIST-SHORTAGE

MOVIES ABOUT THE FUTURE

READY PLAYER ONE (VIRTUAL REALITY TO ESCAPE THE WORLD); ALITA: BATTLE ANGEL (CYBORGS)

SOLUTIONS: RECRUITMENT (NATIONAL COUNCIL FOR MENTAL WELLBEING-2900 MEMBER ORGANIZATIONS)

- High Recruiting Schools
- Strong reputation of the Psychiatry Department
- Longer Clerkships
- Expand GME funding for residencies

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SOLUTIONS: UPDATING PSYCHIATRY RESIDENCY TRAINING

- Competencies for Team skills, Health Care data analysis and the impact of chronic illness on mental illness
- Train in alternative settings including community health centers, large primary care practices utilizing patient-centered medical homes, ACT Teams etc.
- Telepsychiatry exposure
- Rural practices
- Learn to include families

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SOLUTIONS: EXPAND WORKFORCE OF OTHER PROVIDERS

- CRNP projection for 17,900 by 2025
- PAs: 1.3% currently in Mental Health. AAPA estimates 125,847 total PAs by 2026; need more postgraduate programs
- Clinical Pharmacists: estimate for 2,400 by 2025

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SOLUTIONS: INCREASE EFFICIENCY

- Telepsychiatry
- Open Access Scheduling
- Adequate Staff Support (nurses, medical assistants) handling phone calls , routine screening, vital signs, forms referrals, return visits, tracking lab and pharmacy information and making copies.
- Capacity to Share Information: interoperable EMRs at the level of multiple health care systems, pharmacies, ERs, primary care offices etc
- Reduce Excessive Documentation Requirements (treatment and monitoring plans too long)

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SOLUTIONS: INNOVATIVE MODELS OF CARE

- Collaborative Care for Integrating Primary Care and Mental Health
  - This model specifically targets one of the cohorts of diagnostic groupings that account for the 5 percent of the population that consume 50 percent of the health care costs: persons with co-occurring chronic medical conditions and behavioral health conditions
  - Stepped Care
- Reduce stigma in Primary Care Setting
- Early Intervention and Prevention using rating scales (PHQ-9 and GAD-7)
- Colocation of Primary Care and Psychiatry

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SOLUTIONS: INNOVATIVE MODELS OF CARE

- Shift in Culture form the Mental Health Clinic to the Primary Care Setting
- Measurement-based Care looking for gaps in care. Look at patterns of care such as ED use, inpatient admission and pharmacy data. Look at population-base summaries using disease registries. Look at total costs and predictive modeling. Need skills to do this.
- Social Determinants of care such as housing, food insecurity , child welfare and criminal justice. Use teams including peers , family partners and recovery coaches.

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SOLUTIONS: EMERGING TECHNOLOGIES

- On-demand interventions
- Fitbits, apps, texts , websites, smart phones and watches
- Self-administered tests

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SOLUTIONS: REDUCE BURNOUT

- Improve the variety of clinical duties
- Increase connection with other staff
- Teams
- Reduce documentation demands
- Ease of delegating tasks
- Loan forgiveness

PSYCHIATRIC-SHORTAGE_NATIONAL-COUNCIL-.PDF (THENATIONALCOUNCIL.ORG)

SOLUTIONS: FINANCE AND REIMBURSEMENT

- Stakeholders need to address the growing financial gap between rates of reimbursement and the cost of delivering the services, particularly in community mental health centers, and adopt alternative payment mechanisms.
- 40 percent of psychiatrists have chosen cash-only practice
- complaints from patients with commercial, Medicare and/or Medicaid coverage that they cannot find a psychiatrist on their network panel who is willing to accept new patients is strong evidence that current rates offered by payers are significantly below the actual market and insufficient to offer reasonable access to services

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SOLUTIONS: FINANCE AND REIMBURSEMENT

- Medicaid is the major payer of behavioral health nationwide
- Setting psychiatric payment rates below costs strongly incentivizes clinics providing behavioral health to provide no psychiatric services, or as little as possible, as opposed to staffing their clinics consistent with their clinical population's needs
- Prospective Payment Systems (PPS)
- FQHCs and CCBHCs using a cost-based system
- Bundled payments (CCM and chronic care management codes)
- Need to have outcome measures looking at total costs

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SOLUTIONS: REDUCE REGULATORY BARRIERS

- Mental Health Parity and Access: The new Medicaid managed care access rule requires all state Medicaid programs to have a monitoring plan that measures access to care in their fee-for-service programs. The monitoring plan must include comparisons between behavioral health providers and primary care providers in terms of provider to patient ratios, distance to treatment and time to first appointment, payment rates and conclude with a judgment as to whether patient needs are adequately met

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SOLUTIONS: REDUCE REGULATORY BARRIERS

- Confidentiality
- Telepsychiatry
  - Ryan Haight, National License, Interstate Medical Licensure Compact
- Loan Forgiveness (student debt load)

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MOVIES PREDICTING THE FUTURE

MINORITY REPORT AND WESTWORLD (PRECRIME DIVISION PREDICTING AND ARRESTING FUTURE CRIMINALS; FUTURISTIC AMUSEMENT PARK TO GATHER DATA/FIDELITY)

WESTWORLD

- The chaos that ensued once Rehoboam's data is released has dark implications about the information gathering that's already taking place in our real lives. Although reports of companies gathering data on people are already available, the extent of how much data they currently have is still unclear. With our lives getting more reliant on technology, the information gathering will not only continue but get even more invasive. According to *Westworld,* our reliance on technology and the constant information gathering that is happening today will lead us down a dark path where our lives will be dictated by the data that is being gathered on us.

HTTPS://YOUTU.BE/AEEN609NKRS

THE WPA-*LANCET PSYCHIATRY* COMMISSION ON THE FUTURE OF PSYCHIATRY

- Patient and Treatment
- Psychiatry and health-care systems
- Psychiatry and Society
- Mental Health Law
- Digital Psychiatry
- Training

THE WPA-LANCET PSYCHIATRY COMMISSION ON THE FUTURE OF PSYCHIATRY - THE LANCET PSYCHIATRY

THE PATIENT (DEMOGRAPHICS)

- Neuroscience not there yet
- Social Determinants of Care
- Access varies 100-fold
- Demographics (Aging, Urbanization, Natural/Manmade disasters, digital world)

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THE PATIENT: CULTURE AND DIAGNOSIS

- Vast Migrations
- Diagnosis: Assessment of race and ethnicity, language (verbal and non-verbal), religious beliefs, traditions, values and moral thought, family and gender issues, social relations, financial philosophies, and economic status
- Therapeutic Alliance
- Stigma
- Diagnosis will involve new ways of gathering information. May be online ahead of time. No biomarkers so Research Domain Criteria. Measurement based care. Cross cutting measures in DSM 5. Genetic information.

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THERAPEUTIC ALLIANCE

- Clinicians seem persistently forced to rediscover what research has repeatedly reaffirmed: quality treatment is not about compliance—it is based on alliance.
- Telepsychiatry (patient and physician separated)
- Shared decision-making (information available on internet)

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PERSONALIZED OR PRECISION MEDICINE

- For prevention, genomic and other biochemical or physiological analysis in conjunction with assessment of environmental and developmental influences should provide increasingly robust identification of individuals at risk for psychiatric disorders.
- For treatment, personalized medicine aims to match a patient with the most effective treatment for them. (Cytochrome p450, imaging, virtual reality therapy, Reach Vet in VA)

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AREAS OF PROMISE

- Implantable drug reservoirs
- Nanotechnology
- Role of inflammatory processes
- Stem Cells
- Neuroimaging
- Neuromodulation

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SUBJECTIVITY

- Clinician's subjective responses (counter-transference) play a role
- Psychotherapy will endure

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THE PATIENT

- Sub specialization
- Increasing costs and fragmentation
- Shift to Primary Care and a public health model
- Not enough Geriatric Psychiatrists
- China 20,000 Psychiatrists, India has fewer

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HEALTH-CARE SYSTEMS

- Many countries can't afford individual care
- WHO Pyramid model
- Episodic care doesn't work well for mental illness
- Needs led rather than provider led
- Pathways to care marked by delays (engage community partners, train primary care systems in basic mental health, psychiatrist role is entire pathway)
- Stepped Care
- Build alliances with government and colleagues

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HEALTH-CARE SYSTEMS

- Knowledge of Health Economics
- Evidence-based care
- Need Psychiatrist leaders

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PSYCHIATRY AND SOCIETY

- Medical doctors with the title psychiatrist have been part of the profession for about 200 years.
- This tension between therapeutic aspiration and social control has characterized much of the history of psychiatry and can be assumed to continue for at least the next 10 years.
- The role of the psychiatrist has always included the authority to initiate treatment against the will of some patients.

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PSYCHIATRY AND SOCIETY

- UN Convention on the Rights of Persons with Disabilities (CRPD), might be incompatible with coercive treatment.
- Psychiatrists are considered to have a general societal role as the arbiters of mental sanity.
- The role of psychiatrists in societies includes also a general task to stand up for the rights, dignity, and inclusion of people with mental disorders.

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PSYCHIATRY AND SOCIETY

- **Multidisciplinary status**
- Political role (Societal factors such as social inequality, crime, poverty, poor housing, adverse upbringing conditions, poor education, unemployment, and social isolation are related to increased rates of mental disorders.)
- The influence can be stronger when psychiatrists raise their voices in representative professional associations and jointly with other groups in society—eg, those representing patients, families, or other professions.

THE WPA-LANCET PSYCHIATRY COMMISSION ON THE FUTURE OF PSYCHIATRY - THE LANCET PSYCHIATRY

CONVENTION ON THE RIGHTS OF PERSONS WITH DISABILITIES

a. Respect for inherent dignity, individual autonomy including the freedom to make one's own choices, and independence of persons

b. Non-discrimination

c. Full and effective participation and inclusion in society

d. Respect for difference and acceptance of persons with disabilities as part of human diversity and humanity

e. Equality of opportunity

f. Accessibility

g. Equality between men and women

h. Respect for the evolving capacities of children with disabilities and respect for the right of children with disabilities to preserve their identities

CONVENTION ON THE RIGHTS OF PERSONS WITH DISABILITIES (CRPD) | UNITED NATIONS ENABLE

PSYCHIATRY AND SOCIETY

- Working with communities (jobs, schools)
- Social media
- Training

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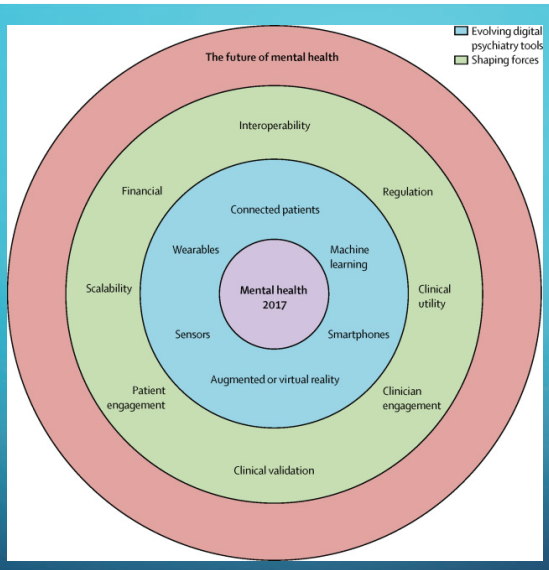

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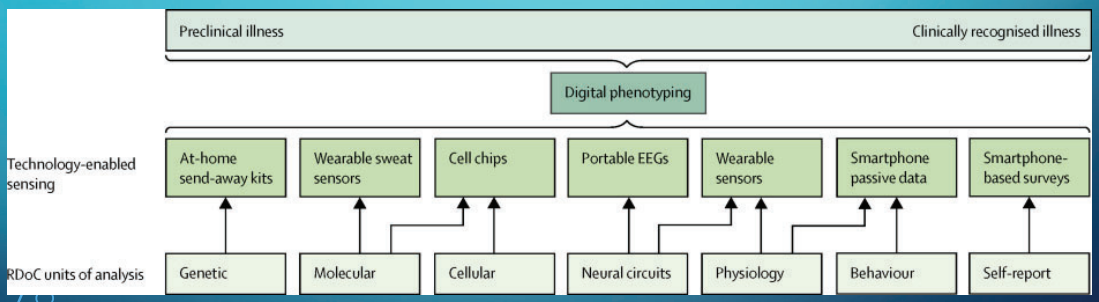

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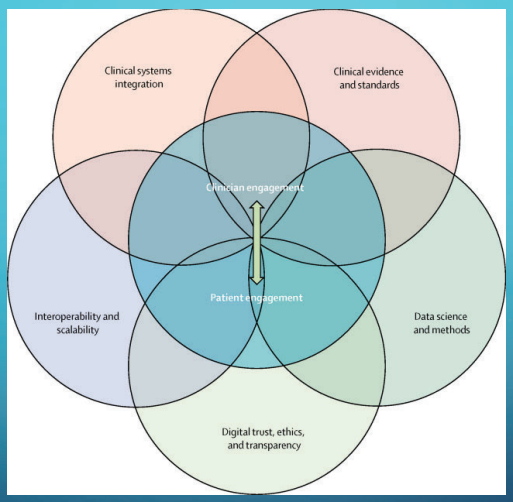


MOVIES ABOUT THE FUTURE

TOTAL RECALL (IMPLANTING PLEASANT MEMORIES AND "SCHIZOID EMBOLISM") AND AVATAR (PARAPLEGIC MARINE UPLOADS CONSCIOUSNESS INTO A SYNTHETIC BODY)

LEADERS IN THE FIELD

- Dr. Joel Yaeger
- Dr. Insel
- Dr. Bertalan Mesko

DR. JOEL YAEGER

- Psychiatry in the Year 2500: Lessons Learned From History
- October 6, 2021
- Joel Yager, MD
- **Psychiatric Times**, Vol 38, Issue 10,

PSYCHIATRY IN THE YEAR 2500: LESSONS LEARNED FROM HISTORY (PSYCHIATRICTIMES.COM)

ASSESSMENT

- AI Tools
- Dynamic biopsychosocial fingerprints (protypical patterns)
- In utero genomic and epigenomic fingerprints
- Massive data stores
- Virtual reality simulations
- High-Definition whole-brain dynamic scans assessing connectivity

PSYCHIATRY IN THE YEAR 2500: LESSONS LEARNED FROM HISTORY (PSYCHIATRICTIMES.COM)

TREATMENT

- Wearable and implantable devices that monitor and administer experiential and direct biological interventions
- AI-based personalized robots
- Individualized game-based treatments using holographic avatars to reenact earlier life events
- Personal health concierge

PSYCHIATRY IN THE YEAR 2500: LESSONS LEARNED FROM HISTORY (PSYCHIATRICTIMES.COM)

DR. JOEL YEAGER

- Neurostimulatory interventions might feature stereotactic membrane–like skullcaps, capable of focusing deep ultrasound and other noninvasive stimuli at precise targets to promote local neogenesis.[15,16] Optogenetic-guided retroviral interventions might enhance and sculpt specific brain nuclei and connection pathways.[17] Umpteenth-generation CRISPR-like genetic interventions might reverse neuropathological processes associated with excessive pruning, dysregulated emotional and attentional centers, impulsivity, habit formation, and craving.[18] Anti-neuroinflammatory agents and neuroplaque removers might inhibit and reverse degenerative and other psychiatric diseases,[19] while individualized biomic brews might enhance healthier microbiomes.[20]

PSYCHIATRY IN THE YEAR 2500: LESSONS LEARNED FROM HISTORY (PSYCHIATRICTIMES.COM)

MOVIES ABOUT THE FUTURE

GATTACA (GENETIC ENGINEERING/EUGENICS. EMBRYOS ALTERED BY GENETIC ENGINEERING ARE "VALID") AND BLADE RUNNER (BIOENGINEERED HUMANS OR REPLICANTS AND THEIR RIGHTS. REPLICANTS CAN REPRODUCE)

DR. TOM INSEL

- The Future of Mental Health, According to Tom Insel - (namisantaclara.org)
- 13 Years as NIMH Director
- Mental Health fell behind
- SMI homeless and incarcerated
- Worked for Google and several mental health startups
- Mindsite News

INSEL-MINDSTRONG

- Proactively detect mental health deterioration early and drive intervention
- Ongoing and passive monitoring
- Digital biomarkers that predict relapse in schizophrenia, Bipolar, ADHD PTSD Depression and Substance Abuse

INSEL

- Can Smartphones Solve the Mental Health Crisis? | Tom Insel | TEDxVeniceBeach – YouTube
- Tom Insel - Digital Phenotyping - YouTube
- Smartphones

The Technology Revolution

	2006	2018
Smartphones	64M	3B
Facebook users	12M	2B
YouTube hrs/day	65K	1.0B
Google searches	250M/day	> 3.5B/day
Apps in App Store	<15K	2M
Analytics	Parametric	Machine Learning

CAN SMARTPHONES SOLVE THE MENTAL HEALTH CRISIS? | TOM INSEL | TEDXVENICEBEACH – YOUTUBE
TOM INSEL - DIGITAL PHENOTYPING - YOUTUBE

Smartphones

A supercomputer in every pocket

	Cray-2 Supercomputer	iPhone
GFLOPS	1.9	300-400
CPU Speed	244MHz	1.85GHz
Memory	?MB	128GB
Weight	2500KG	0.135KG
Cost (2010$s)	$32M	$999

CAN SMARTPHONES SOLVE THE MENTAL HEALTH CRISIS? | TOM INSEL | TEDXVENICEBEACH – YOUTUBE
TOM INSEL - DIGITAL PHENOTYPING - YOUTUBE

Why have we failed to bend the curve?

Imprecise Dx	*Lack of biological validity*
Lack of Engagement	*60% not receiving care*
Quality	*Fragmented, episodic, reactive*
Lack of Measurement	*We don't manage what we don't measure*

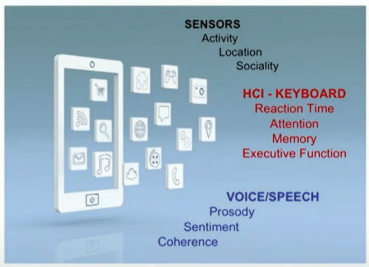
CAN SMARTPHONES SOLVE THE MENTAL HEALTH CRISIS? | TOM INSEL | TEDXVENICEBEACH – YOUTUBE
TOM INSEL - DIGITAL PHENOTYPING - YOUTUBE

MEASURING MOOD, COGNITION, AND BEHAVIOR

WHAT WE DO TODAY	WHAT WE NEED
• Subjective	• Objective
• Episodic	• Continuous
• Clinic-based	• Ecological
• High burden	• Passive

DIGITAL PHENOTYPING

A New Kind of Biomarker

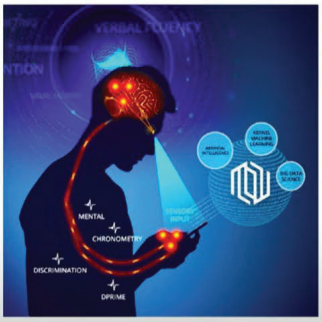


MACHINE LEARNING
Pattern Identification
Feature Extraction

Raw Features → **Digital Biomarkers** → **Digital Phenotype**

N.B. digital phenotype can also include "digital exhaust" (social media posts, search terms, AI personal assistants etc.)

Human-Computer Interaction (HCI): Measuring Brain Function Passively



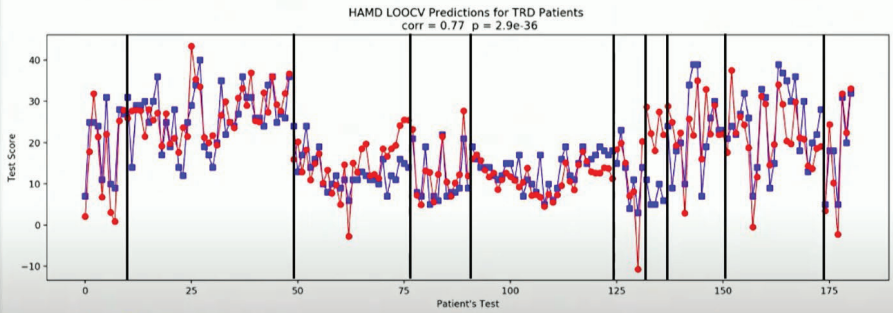
- 45 keyboard and scroll patterns (e.g., latency between space and character, scrolling patterns)
- Time-series of performance measures from each of the 45 patterns
- Apply 23 signal processing transforms to each time-series to derive 1,035 potential digital biomarkers
- Test highest performing biomarkers with 2-fold cross validation and with replication studies to avoid overfitting errors

Validate in clinical trials along three dimensions:

(1) psychometric properties; (2) clinical constructs; (3) neural correlates

Digital Biomarkers and Affective States – Tracking Depression

Source: Unpublished data Mindstrong and Kadima Clinic

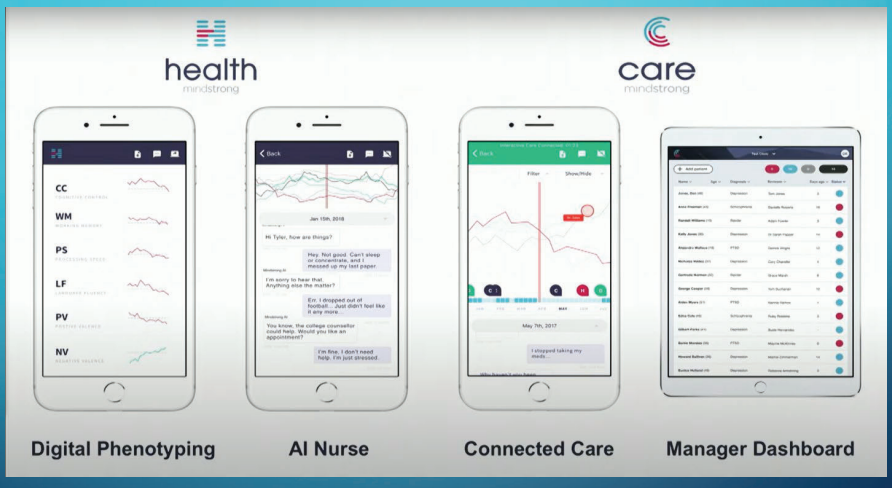


Ketamine treatment of MDD (n = 10, 180 observations)
Overall correlation = 0.77, $p = 2.9 \times 10^{-36}$

MINDSTRONG

- Paradigm Shifting Technology
- What if we can detect symptoms getting worse? What if we can predict it?
- We're measuring human-computer interactions, and using machine learning to develop breakthrough technology.
- This technology is integrated into our care platform to help guide targeted proactive care.

ABOUT US - MINDSTRONG HEALTH



ABOUT US - MINDSTRONG HEALTH

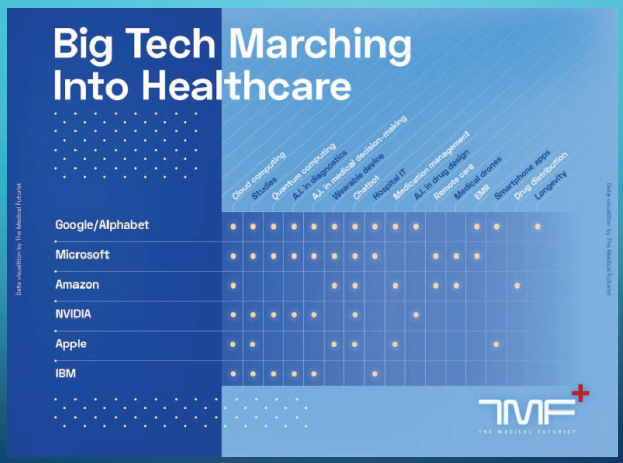
MOVIES ABOUT THE FUTURE

ROBOCOP (POLICE OFFICER HAS HIS CONSCIOUSNESS PLACED IN A ROBO-SUIT) AND HER (FALLING IN LOVE WITH AI)

THE MEDICAL FUTURIST

- Dr. Bertalan Mesko

BIG TECH AND HEALTHCARE



BIG TECH IN MEDICINE: HOW AMAZON, APPLE, MICROSOFT, GOOGLE, IBM & NVIDIA DISRUPT HEALTHCARE - THE MEDICAL FUTURIST

AMAZON

- Pharma Distribution
- 2017 Amazon received drug distribution license in over 10 states
- 2018 Amazon buys PillPack an online pharmacy selling OTC, prescription, and its own line of OTC drugs (Amazon Pharmacy)
- Provides telehealth services for its employees and others (80 million Prime members) through Amazon Care.
- Using Alexa for chatbot-based medical services
- Wearables

BIG TECH IN MEDICINE: HOW AMAZON, APPLE, MICROSOFT, GOOGLE, IBM & NVIDIA DISRUPT HEALTHCARE - THE MEDICAL FUTURIST

APPLE

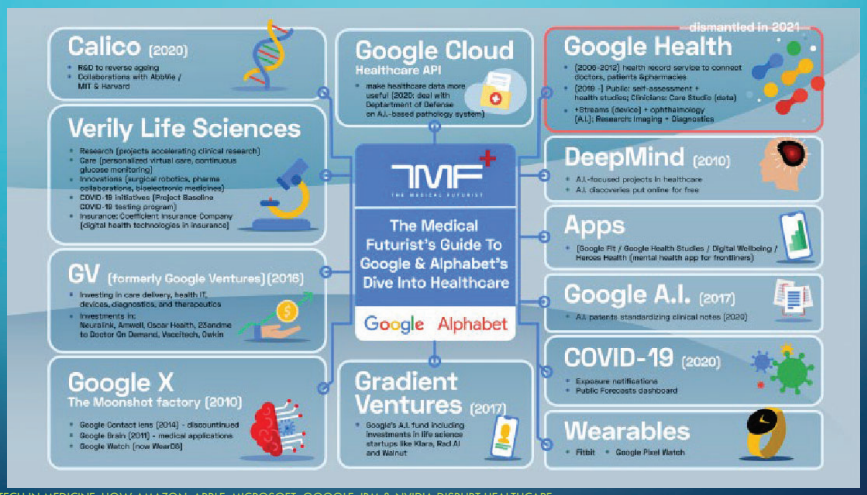
- 1 out of 6 people in US have an iPhone
- Holds the largest share of the global smartwatch market
- Apple's Health app bridges the data gap between patients and doctors
- Cerner supports data transfer

BIG TECH IN MEDICINE: HOW AMAZON, APPLE, MICROSOFT, GOOGLE, IBM & NVIDIA DISRUPT HEALTHCARE - THE MEDICAL FUTURIST

GOOGLE

- 7% of all google searches are health-related (70,000 a minute)
- Acquired DeepMind
- May 2021 HCA Healthcare and Alphabet's Google. Cloud announced a collaboration to develop algorithms to mine patient records
- Dermatology app to diagnose and monitor skin cancer
- Startups Verily and GV

BIG TECH IN MEDICINE: HOW AMAZON, APPLE, MICROSOFT, GOOGLE, IBM & NVIDIA DISRUPT HEALTHCARE - THE MEDICAL FUTURIST



BIG TECH IN MEDICINE: HOW AMAZON, APPLE, MICROSOFT, GOOGLE, IBM & NVIDIA DISRUPT HEALTHCARE - THE MEDICAL FUTURIST

MICROSOFT

- October 2020 launch of Cloud for Healthcare to help with telehealth
- April 2021 acquisition of Nuance (AI-powered speech-tech company) that transcribes doctor-patient conversation into organized medical notes

BIG TECH IN MEDICINE: HOW AMAZON, APPLE, MICROSOFT, GOOGLE, IBM & NVIDIA DISRUPT HEALTHCARE - THE MEDICAL FUTURIST

IBM

- Abandoned Watson AI as physicians were hesitant to adopt.
- Slim lead in quantum computing

BIG TECH IN MEDICINE: HOW AMAZON, APPLE, MICROSOFT, GOOGLE, IBM & NVIDIA DISRUPT HEALTHCARE - THE MEDICAL FUTURIST

NVIDIA

- Diagnostic imaging, robotic surgery and patient monitoring devices
- Clara AI to help radiologists classify images
- 2019 federated learning in healthcare
- Speech recognition software
- Cabmrigdge-1 supercomputer in UK to improve drug design, genomics research and chatbots

BIG TECH IN MEDICINE: HOW AMAZON, APPLE, MICROSOFT, GOOGLE, IBM & NVIDIA DISRUPT HEALTHCARE - THE MEDICAL FUTURIST

PHARMA-DIGITAL THERAPEUTICS

- Digital Therapeutics delver medical interventions directly to patients using evidence-based, clinically evaluated software to treat, manage, and prevent a broad spectrum of diseases and disorders.
- An application, sensor, process or service is combined with an an existing drug adding value. The technology itself can be medicine.

BIG TECH IN MEDICINE: HOW AMAZON, APPLE, MICROSOFT, GOOGLE, IBM & NVIDIA DISRUPT HEALTHCARE - THE MEDICAL FUTURIST

PHARMA-HOW TO COOPERATE WITH BIG TECH

About half of Big Pharma is cooperating with Big Tech

May be the entry door to healthcare for Big Tech

BIG TECH IN MEDICINE: HOW AMAZON, APPLE, MICROSOFT, GOOGLE, IBM & NVIDIA DISRUPT HEALTHCARE - THE MEDICAL FUTURIST

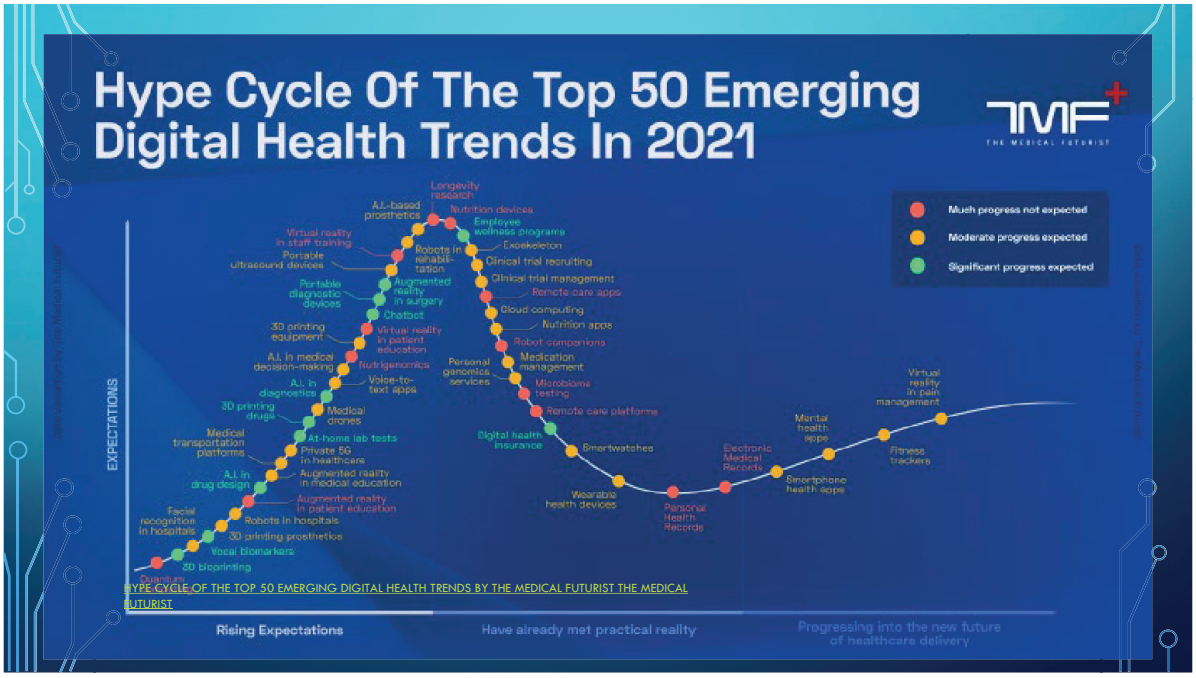
PHARMA-BASED ON EVIDENCE

- Evidence-based medicine takes a long time
- Uptake of new innovations is slow (17year lag from something significant from rigorous research to health practitioners changing patient care and longer to de-adopt unnecessary practices. Need EBM and implementation science)
- Pharma hesitant to invest

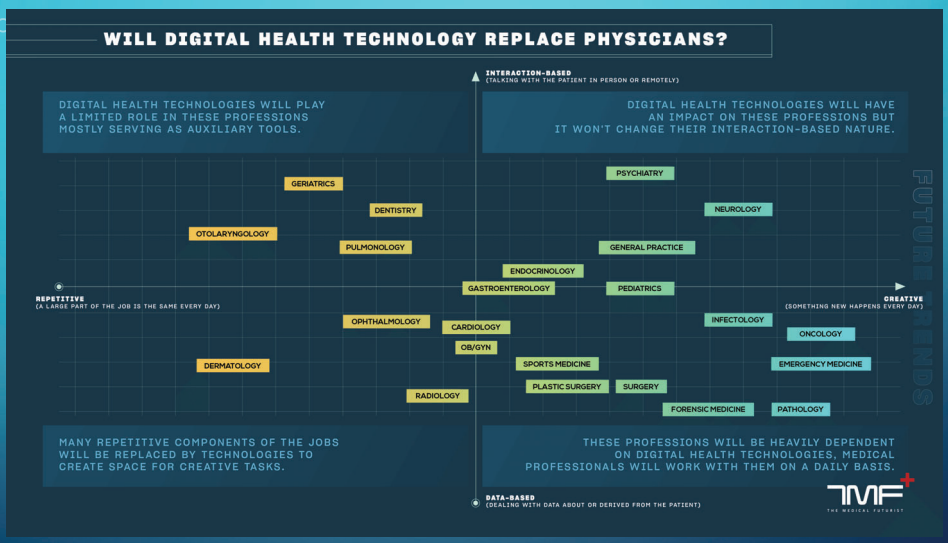
BIG TECH IN MEDICINE: HOW AMAZON, APPLE, MICROSOFT, GOOGLE, IBM & NVIDIA DISRUPT HEALTHCARE - THE MEDICAL FUTURIST

PHARMA-FROM PATIENT-CENTRICITY TO PATIENT DESIGN

- Patient-centered approaches is more principle than practice at present
- Need patient advisory boards



HYPE CYCLE OF THE TOP 50 EMERGING DIGITAL HEALTH TRENDS BY THE MEDICAL FUTURIST THE MEDICAL FUTURIST

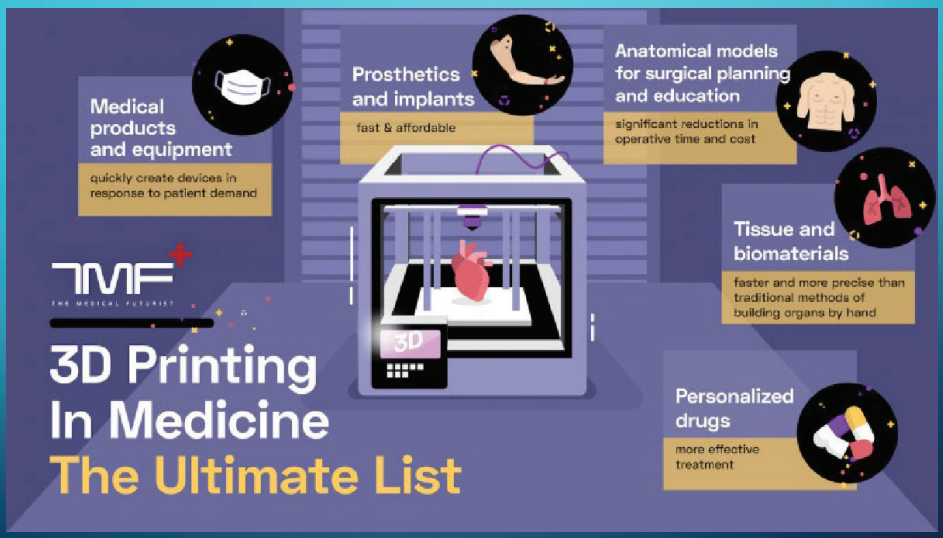


0726_DH_REPLACE_PHYSICIANS_INFOGRAPHIC_V1.PNG (3200×1800) (1712507217.RSC.CDN77.ORG)

3D PRINTING IN MEDICINE AND HEALTHCARE

- Additive manufacturing which means producing 3-D objects from a digital file
- Getting faster
- Revolutionize drug creation and production of medical equipment
- Urgent 3d production of PPE during Covid
- Models for surgical planning and education

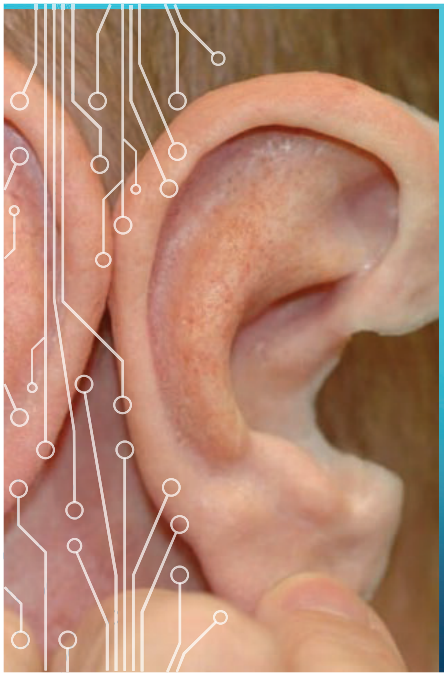
3D PRINTING IN MEDICINE AND HEALTHCARE – THE ULTIMATE LIST IN 2021 - THE MEDICAL FUTURIST



3D PRINTING IN MEDICINE AND HEALTHCARE – THE ULTIMATE LIST IN 2021 - THE MEDICAL FUTURIST

3D PRINTING

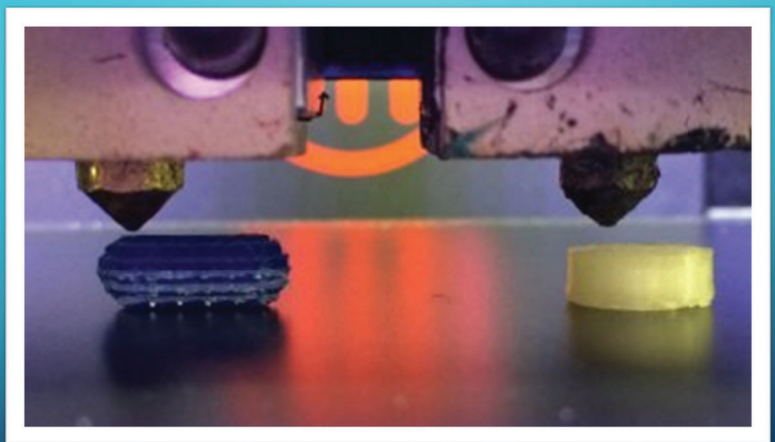
- 2015 The FDA approved the first-ever drug made by 3D printers
- 2021 2nd FDA approval
- 3D printing of multiple medicines on a single pill is already possible (polypill)
- 2020 FabRx released the first pharmaceutical 3D printer to manufacture personalized medication
- DIMAKER can print 28 personalized pills a minute



3D PRINTING-SYNTHETIC ORGANS

- Just tissues at present
- 2014 Organovo bio printed liver tissues
- Synthetic Skin for burn transplants and pharmaceutical testing
- Replicating human ears and noses
- Heart valves
- Bones
- Blood vessels
- Prosthetics and Implants

3D PRINTING IN MEDICINE AND HEALTHCARE – THE ULTIMATE LIST IN 2021 - THE MEDICAL FUTURIST



NATIONAL DIGITAL HEALTH TRANSFORMATIONS HAVE FAILED

- Health IT versus Digital Health (*the cultural transformation of how disruptive technologies that provide digital and objective data accessible to both caregivers and patients lead to an equal level doctor-patient relationship with shared decision-making and the democratization of care)*
- Gary Rule (IT specialist alone (antivirus etc) than Health IT otherwise digital health
- Need a cultural transformation
- Policymakers need to know more about digital health

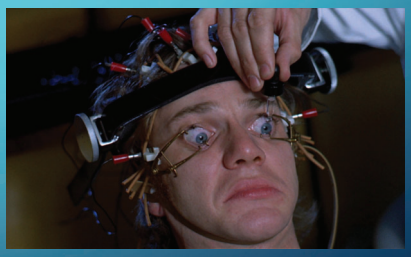
3 REASONS WHY NATIONAL DIGITAL HEALTH TRANSFORMATIONS FAIL - THE MEDICAL FUTURIST

IDEAL HOSPITAL

- Paperless
- Connected to the homes of patients
- Designed not built for a purpose (Patient Room 2020 by NXT Health)
- Patient Design
- Special places for telemedicine (tele-ICU)
- Places for healthcare personnel to relax
- Resolve the issue of alarm fatigue
- Acute care, surgery and large imaging machines

WHAT WOULD THE IDEAL HOSPITAL LOOK LIKE? - THE MEDICAL FUTURIST

MOVIES ABOUT THE FUTURE



THE MATRIX (COMPUTER GENERATED WORLD ROBOTS USE TO KEEP HUMANS SUBDUED. RED OR BLUE PILL)
AND A CLOCKWORK ORANGE (FORCED AVERSION THERAPY)

ERIC KANDEL

Special Article

Biology and the Future of Psychoanalysis: A New Intellectual Framework for Psychiatry Revisited

Eric R. Kandel, M.D.

The American Journal of Psychiatry has received a number of letters in response to my earlier "Framework" article (1). Some of these are reprinted elsewhere in this issue, and I have answered them briefly there. However, one issue raised by some letters deserves a more detailed answer, and that relates to whether biology is at all *relevant* to psychoanalysis. To my mind, this issue is so central to the future of psychoanalysis that it cannot be addressed with a brief comment. I therefore have written this article in an attempt to outline the importance of biology for the future of psychoanalysis.

(Am J Psychiatry 1999; 156:505–524)

FUTURE OF PSYCHOTHERAPY

- Virtual Reality Therapy
- AI counseling
- Paired with more outcome data gleaned from avalanche of data collected about us
- Imaging studies show therapy leads to brain changes
- Paired with psychedelic drugs and rTMS

FUTURE OF PSYCHOTHERAPY

TABLE 1. **Main brain system involved in mediating attachment**

Common therapy element	Neurobiological correlate	Effects
Attachment	Oxytocin	• Mating behavior • Aggression • Maternal bonding • Anxiety in social settings
	Arginine vasopressin	• Displays of aggression • Affiliation • Protection
	Mu-opioid receptor	• Separation anxiety

TABLE 2. **Main brain system involved in mediating empathy**

Common therapy element	Neurobiological correlate	Effects
Empathy	Anterior cingulate cortex, insula	Mirroring of physical pain, emotional distress, and social discomfort
	Superior temporal sulcus	Predicting future behavior of others
	Oxytocin receptor gene	Emotional aspects of empathy
	Arginine vasopressin 1a receptor gene	Cognitive aspects of empathy

THE NEUROBIOLOGY OF PSYCHOTHERAPY (PSYCHIATRICTIMES.COM)

FUTURE OF PSYCHOTHERAPY

TABLE 4. **Main brain system involved in mediating emotion regulation**

Common therapy element	Neurobiological correlate	Effects
Emotion regulation	Prefrontal cortex, posterior parietal cortex, amygdala	Cognitive reappraisal
	Ventral-lateral prefrontal cortex	Suppression

TABLE 3. **Main brain system involved in mediating learning**

Common therapy element	Neurobiological correlate	Effects
Learning	Repeated stimulation in single session	Neurotransmitter release
	Repeated stimulations across multiple sessions	Synaptic connections

THE NEUROBIOLOGY OF PSYCHOTHERAPY (PSYCHIATRICTIMES.COM)

FUTURE OF PSYCHOTHERAPY

TABLE 5. **Main brain system involved in mediating fear extinction**

Common therapy element	Neurobiological correlate	Effects
Fear extinction	Amygdala, ventral-medial prefrontal cortex, rostral anterior cingulate cortex	Fear extinction
	NMDA activation	Enhances fear extinction
	Hippocampus	Provides context for fear extinction

NMDA, *N*-methyl-D-aspartate.

THE NEUROBIOLOGY OF PSYCHOTHERAPY (PSYCHIATRICTIMES.COM)

OXYTOCIN RECEPTOR AND VASOPRESSIN RECEPTOR 1A GENES ARE RESPECTIVELY ASSOCIATED WITH EMOTIONAL AND COGNITIVE EMPATHY

- Empathy is the ability to recognize and share in the emotions of others. It can be considered a multifaceted concept with cognitive and emotional aspects. Little is known regarding the underlying neurochemistry of empathy and in the current study we used a neurogenetic approach to explore possible brain neurotransmitter pathways contributing to cognitive and emotional empathy. Both the oxytocin receptor (OXTR) and the arginine vasopressin receptor 1a (AVPR1a) genes contribute to social cognition in both animals and humans and hence are prominent candidates for contributing to empathy. The following research examined the associations between polymorphisms in these two genes and individual differences in emotional and cognitive empathy in a sample of 367 young adults. Intriguingly, we found that emotional empathy was associated solely with OXTR, whereas cognitive empathy was associated solely with AVPR1a. Moreover, no interaction was observed between the two genes and measures of empathy. The current findings contribute to our understanding of the distinct neurogenetic pathways involved in cognitive and emotional empathy and underscore the pervasive role of both oxytocin and vasopressin in modulating human emotions.

OXYTOCIN RECEPTOR AND VASOPRESSIN RECEPTOR 1A GENES ARE RESPECTIVELY ASSOCIATED WITH EMOTIONAL AND COGNITIVE EMPATHY - PUBMED (NIH.GOV)

META-ANALYSES OF THE NEURAL MECHANISMS AND PREDICTORS OF RESPONSE TO PSYCHOTHERAPY IN DEPRESSION AND ANXIETY

- Psychological therapies resulted in decreased activation in limbic regions: insula and anterior cingulate cortex (ACC)
- Decreased prefrontal activation was found pre-to-post psychological therapy

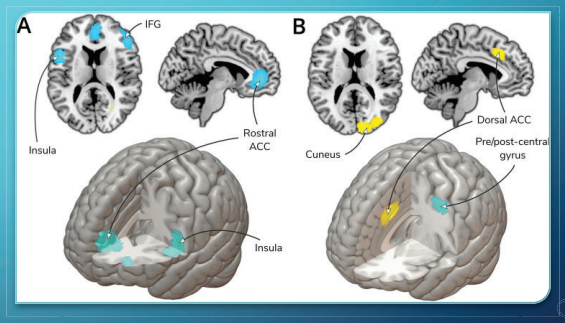


Fig. 2. A) Results of longitudinal meta-analysis showing brain activation change pre-to post-treatment B) Results of prediction meta-analysis, regions predicting symptomatic improvement.

META-ANALYSES OF THE NEURAL MECHANISMS AND PREDICTORS OF RESPONSE TO PSYCHOTHERAPY IN DEPRESSION AND ANXIETY - SCIENCEDIRECT

NEUROBIOLOGICAL MODELS OF PSYCHOTHERAPY

- Collection of Papers
- Psychotherapy changes the brain
- Unconscious is the brain
- Psychotherapy and memory
- How early environmental experience is encoded in the body

NEUROBIOLOGICAL MODELS OF PSYCHOTHERAPY | FRONTIERS RESEARCH TOPIC (FRONTIERSIN.ORG)

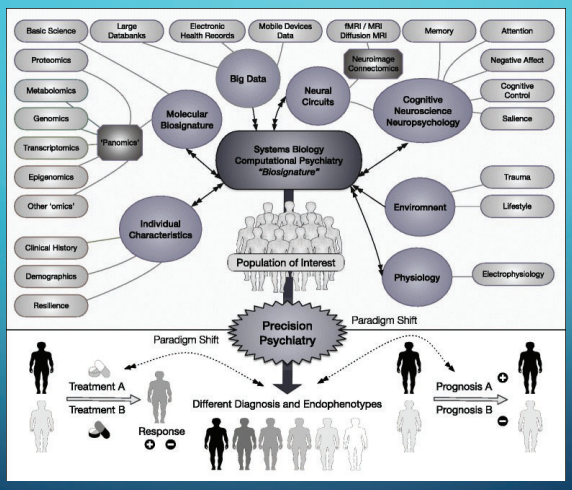
DECIDING ADVANTAGEOUSLY BEFORE KNOWING THE ADVANTAGEOUS STRATEGY

- Deciding advantageously in a complex situation is thought to require overt reasoning on declarative knowledge, namely, on facts pertaining to premises, options for action, and outcomes of actions that embody the pertinent previous experience. An alternative possibility was investigated: that overt reasoning is preceded by a nonconscious biasing step that uses neural systems other than those that support declarative knowledge. Normal participants and patients with prefrontal damage and decision-making defects performed a gambling task in which behavioral, psychophysiological, and self-account measures were obtained in parallel. Normals began to choose advantageously before they realized which strategy worked best, whereas prefrontal patients continued to choose disadvantageously even after they knew the correct strategy. Moreover, normals began to generate anticipatory skin conductance responses (SCRs) whenever they pondered a choice that turned out to be risky, before they knew explicitly that it was a risky choice, whereas patients never developed anticipatory SCRs, although some eventually realized which choices were risky. The results suggest that, in normal individuals, nonconscious biases guide behavior before conscious knowledge does. Without the help of such biases, overt knowledge may be insufficient to ensure advantageous behavior.

DECIDING ADVANTAGEOUSLY BEFORE KNOWING THE ADVANTAGEOUS STRATEGY (SCIENCE.ORG)

MAN-MADE VIRUS TAKES OVER; HUMAN QUALITIES OF HUMANOID AI

PRECISION PSYCHIATRY



THE NEW FIELD OF 'PRECISION PSYCHIATRY' - PUBMED (NIH.GOV)

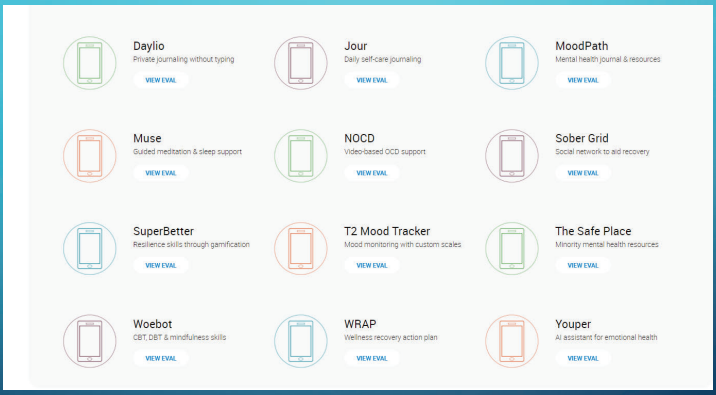
HEADS UP DISPLAY

APPS

- **Best overall:** Moodkit
- **Best for therapy:** Talkspace
- **Best for meditation:** Headspace
- **Best for suicide awareness:** Better Stop Suicide
- **Best for stress:** iBreathe
- **Best for anxiety:** MindShift CBT
- **Best for addiction:** Quit That!
- **Best for boosting your mood:** Happify
- **Best for eating disorders:** Recovery Record
- **Best for OCD:** NOCD

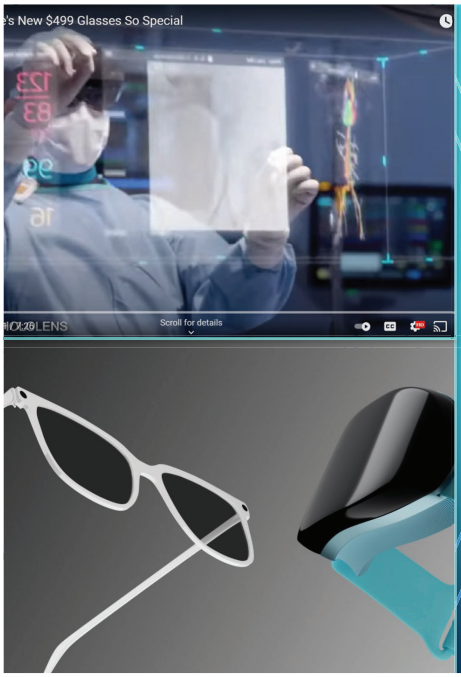
HTTPS://WWW.HEALTHLINE.COM/HEALTH/MENTAL-HEALTH/MENTAL-HEALTH-APPS

APA APP RATING SYSTEM/APP ADVISOR



HTTPS://WWW.PSYCHIATRY.ORG/PSYCHIATRISTS/PRACTICE/MENTAL-HEALTH-APPS

APPLE WATCH



APPLE GLASS/AUGMENTED REALITY

- Augmented Reality
- Virtual Reality
- Mixed

TECHNOLOGY ENABLED CARE

FIGURE.

Imagining Technology-Enabled Care in 2030

"Aaliyah," a 27-year-old woman presents to Dr Sanchez for outpatient treatment of generalized anxiety disorder. This is what her care looks like.

1.
TELEPSYCHIATRY
Aaliyah meets the psychiatrist in person for the first visit, as well as quarterly visits, but most follow-ups are conducted via video. This way, she can make the appointments during the workday without requesting time off.

2.
ASYNCHRONOUS MESSAGING
Aaliyah requests her selective serotonin reuptake inhibitor refills through a portal and asks questions via messaging, such as: "I'm much sweatier since starting sertraline. Is that normal?" She expects a response within 1 business day, but understands this messaging is not for complicated questions or emergencies.

3.
RESCHEDULING
An unexpected work meeting came up that Aaliyah cannot miss. She logs into the practice portal and reschedules the appointment from Tuesday at 2:00 PM to Thursday at 3:30 PM, which is an open slot that works for her schedule.

4.
MEASUREMENT-BASED CARE
Aaliyah fills out the Generalized Anxiety Disorder-7 questionnaire monthly, to track her progress and ensure she is regularly monitoring her symptoms. The results are sent to Dr Sanchez for review and are automatically populated into Dr Sanchez's next clinical note. Dr Sanchez also receives a copy in her inbox.

5.
DIGITAL APPLICATIONS
At some point, Aaliyah develops insomnia and uses the patient portal to ask whether she needs to meet the psychiatrist. Dr Sanchez replies, and suggests she try a free insomnia coach app for 8 weeks. He provides a link to the app and asks her to keep him posted.

TECHNOLOGY-ENABLED CARE: THE FUTURE OF OUR FIELD (PSYCHIATRICTIMES.COM)

AUTOMATED VOICE BIOMARKERS FOR DEPRESSION

- Our analysis of data collected anonymously and online-only demonstrates feasibility in predicting depression severity and the presence of suicidal ideation in the general population.
- Acoustic (88 features), Prosodic (tone, rhythm, intonation, rate, pasue length etc) and linguistic features
- PHQ9 Question 9: Thoughts that you would be better off dead, or of hurting yourself

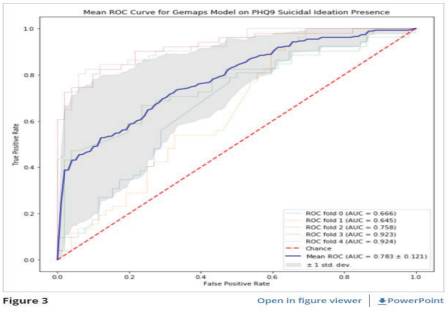


Figure 3 Open in figure viewer | PowerPoint

ROC curve of suicidal ideation presence classification via Geneva Minimalistic Acoustic Parameterization Set (GeMAPS) data. AUC, area under the curve; ROC, receiver operating curve

AUTOMATED VOICE BIOMARKERS FOR DEPRESSION SYMPTOMS USING AN ONLINE CROSS-SECTIONAL DATA COLLECTION INITIATIVE - ZHANG - 2020 - DEPRESSION AND ANXIETY - WILEY ONLINE LIBRARY

AUTOMATED ANALYSIS OF FREE SPEECH PREDICTS PSYCHOSIS ONSET IN HIGH-RISK YOUTHS

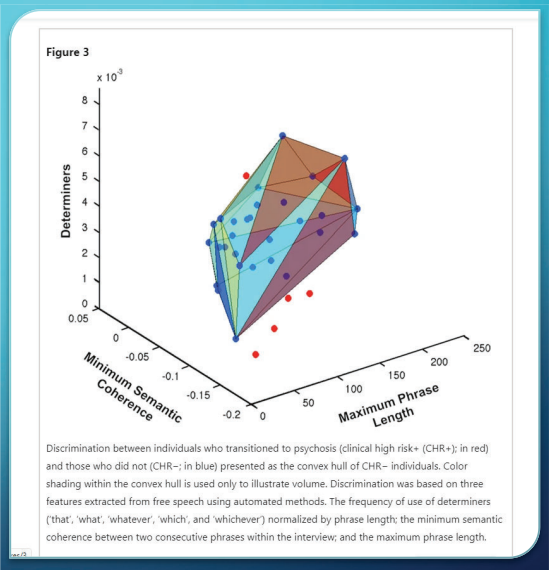
- Results:
- Derived speech features included a Latent Semantic Analysis measure of semantic coherence and two syntactic markers of speech complexity: maximum phrase length and use of determiners (e.g., *which*). These speech features predicted later psychosis development with 100% accuracy, outperforming classification from clinical interviews. Speech features were significantly correlated with prodromal symptoms.
- Conclusions:
- Findings support the utility of automated speech analysis to measure subtle, clinically relevant mental state changes in emergent psychosis. Recent developments in computer science, including natural language processing, could provide the foundation for future development of objective clinical tests for psychiatry.
- 34 help-seeking youths (high risk) 14-27 followed for up to 2.5 years

$$L_i = \frac{1}{N}\sum_{k=1}^{N} l_{ik}$$

AUTOMATED ANALYSIS OF FREE SPEECH PREDICTS PSYCHOSIS ONSET IN HIGH-RISK YOUTHS | SCHIZOPHRENIA (NATURE.COM)

TRANSITION TO PSYCHOSIS

- Red became psychotic



Discrimination between individuals who transitioned to psychosis (clinical high risk+ (CHR+); in red) and those who did not (CHR−; in blue) presented as the convex hull of CHR− individuals. Color shading within the convex hull is used only to illustrate volume. Discrimination was based on three features extracted from free speech using automated methods. The frequency of use of determiners ('that', 'what', 'whatever', 'which', and 'whichever') normalized by phrase length; the minimum semantic coherence between two consecutive phrases within the interview; and the maximum phrase length.

AUTOMATED ANALYSIS OF FREE SPEECH PREDICTS PSYCHOSIS ONSET IN HIGH-RISK YOUTHS | SCHIZOPHRENIA (NATURE.COM)

MACHINE LEARNING ANALYSIS OF LINGUISTIC AND ACOUSTIC CHARACTERISTICS IDENTIFY SUICIDAL SUBJECTS

- Death by suicide demonstrates profound personal suffering and societal failure. While basic sciences provide the opportunity to understand biological markers related to suicide, computer science provides opportunities to understand suicide thought markers. In this novel prospective, multimodal, multicenter, mixed demographic study, we used machine learning to measure and fuse two classes of suicidal thought markers: verbal and nonverbal. Machine learning algorithms were used with the subjects' words and vocal characteristics to classify 379 subjects recruited from two academic medical centers and a rural community hospital into one of three groups: suicidal, mentally ill but not suicidal, or controls. By combining linguistic and acoustic characteristics, subjects could be classified into one of the three groups with up to 85% accuracy. The results provide insight into how advanced technology can be used for suicide assessment and prevention.

A MACHINE LEARNING APPROACH TO IDENTIFYING THE THOUGHT MARKERS OF SUICIDAL SUBJECTS: A PROSPECTIVE MULTICENTER TRIAL - PESTIAN - 2017 - SUICIDE AND LIFE-THREATENING BEHAVIOR - WILEY ONLINE LIBRARY

A MACHINE LEARNING APPROACH TO IDENTIFYING CHANGES IN SUICIDAL LANGUAGE

- This approach explores the stability of suicidal language. When using advanced computational methods, the results show that a patient's language is similar 30 days after first captured, while responses to standard measures change. This can be useful when developing methods that identify the data-based phenotype of a subject.

A MACHINE LEARNING APPROACH TO IDENTIFYING CHANGES IN SUICIDAL LANGUAGE - PESTIAN - 2020 - SUICIDE AND LIFE-THREATENING BEHAVIOR - WILEY ONLINE LIBRARY

A Machine Learning Approach to Identifying the Thought Markers of Suicidal Subjects: A Prospective Multicenter Trial

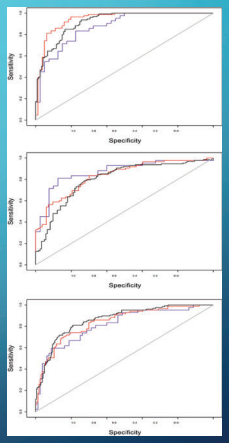


Figure 1 Open in figure viewerPowerPoint
Receiver operator curve (ROC): suicide versus control (upper), suicide versus mentally ill (middle), and suicide versus mentally ill with control. The ROC curves for adolescents (blue), adults (red), and all subjects (black) generated where the nonsuicidal population is controls (top), mentally ill (middle), and mentally ill and controls, using linguistic and acoustic features. The gray line is the AROC curve for a baseline (random) classifier.

(Linguistics and Acoustics)

Suicide & Life Threat Behav, Volume: 47, Issue: 1, Pages: 112-121, First published: 03 November 2016, DOI: (10.1111/sltb.12312)

DONATE YOUR SPEECH

SPEECH EMOTION RECOGNITION | FACEBOOK

FACIAL EMOTION RECOGNITION

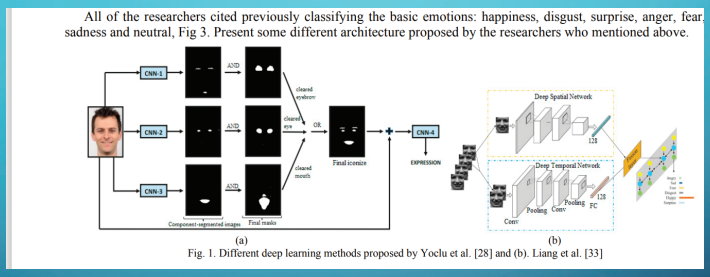


Fig. 1. Different deep learning methods proposed by Yoclu et al. [28] and (b). Liang et al. [33]

Needs More Work.

MAIN.PDF (SCIENCEDIRECTASSETS.COM)

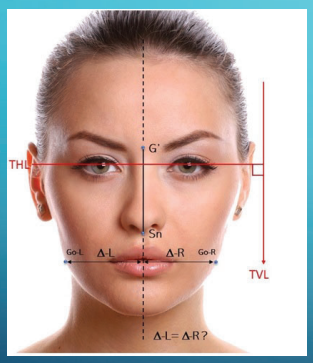
DETECTING HUMAN EMOTIONS ON FACEBOOK COMMENTS

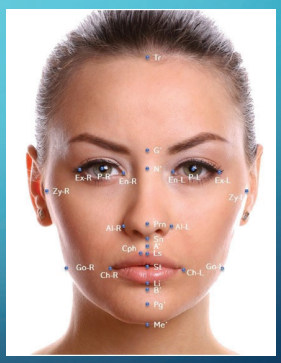
- Human emotion detection plays a vital role in interpersonal relationships. From the early eras, automatic recognition of emotions has been an active research topic. Today, sharing emotions on social media is one of the most popular activities among internet users. However, when it comes to a specific domain like emotion detection in social media, it is still on a research-level. There are less number of applications have been developed to detect emotions online, using online comments and user comments. The aim of this research is to develop a system that identifies human emotions on Facebook comments. Among the different social media platforms, this research specifically focuses on Facebook comments written in the English language to narrow down the problem. The research is based on Semantic analysis, which comes under Natural Language Processing (NLP) and the system development consists of four major steps, including the extraction of Facebook comments via Graph API, preprocessing, classification and emotion detection. To classify the emotions, a classification model was created by using Naïve Bayes Algorithm. When it comes to marketing, emotions are what lead your onlookers to purchase. By using the detected emotions, marketers can promote their campaigns by changing online advertisements dynamically. The results obtained through testing the system show that it is capable of accurately identifying human emotions hidden in Facebook comments with an accuracy level of 80%, making it highly useful for marketing purposes.

DETECTING HUMAN EMOTIONS ON FACEBOOK COMMENTS | IEEE CONFERENCE PUBLICATION | IEEE XPLORE
2020

FACE-EMOTION-DETECTION · GITHUB TOPICS · GITHUB

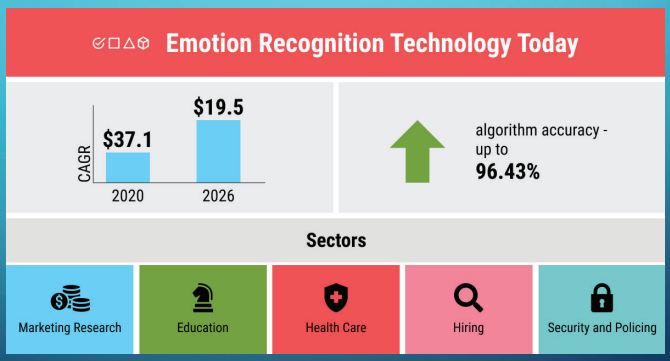
FACIOMETRICS





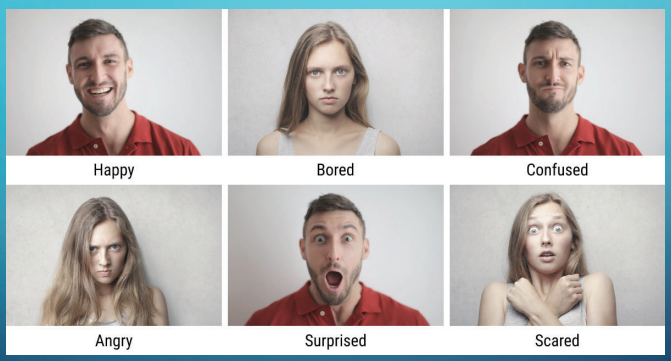
FACIOMETRICS: A PRACTICAL GUIDE FOR OROFACIAL HARMONIZATION (MATHEWSOPENACCESS.COM)

AI EMOTION RECOGNITION



AI IN EMOTION RECOGNITION: CAN AI DETECT EMOTION? (LABELYOURDATA.COM)

EKMAN 6 BASIC EMOTIONS



AI IN EMOTION RECOGNITION: CAN AI DETECT EMOTION? (LABELYOURDATA.COM)

EMOTION CLASSIFICATION

- After pre-processing, the relevant features are retrieved from the pre-processed data containing the detected faces. There are different methods to detect numerous facial features. For example, Action Units (AU), the motion of facial landmarks, distances between facial landmarks, gradient features, facial texture, and more. Generally, the classifiers used for AI emotion recognition are based on Support Machine Vectors (SVM) or Convolutional Neural Networks (CNN). Finally, the recognized human face is classified based on facial expression by assigning a pre-defined class (label) such as “happy” or “neutral.”
-

AI EMOTION AND SENTIMENT ANALYSIS WITH COMPUTER VISION IN 2022 - VISO.AI

AI EMOTION ANALYSIS; VISO COMPANY

- There is a common discrepancy of accuracy when testing in controlled environment databases compared to wild environment databases. Hence, it is difficult to translate the good results in controlled environments (CK+, JAFFE, etc.) to uncontrolled environments (SFEW, FER-2013, etc.). For example, a model obtaining 98.9% accuracy on the CK+ database only achieves 55.27% on the SFEW database. This is mainly due to head pose variation and lighting conditions in real-world scenarios.
- The classification accuracy of different methods of emotion analysis can be compared and benchmarked using a large-scale dataset such as the FI with over 3 million weakly labeled images.
- **Algorithm #1:** SentiBank (Hand-crafted), 49.23%
- **Algorithm #2:** Zhao et al. (Hand-crafted), 49.13%
- **Algorithm #3:** AlexNet (CNN, fine-tuned), 59.85%
- **Algorithm #4:** VGG-16 (CNN, fine-tuned) 65.52%
- **Algorithm #5:** ResNet-50 (CNN, fine-tuned) 67.53%
- **Algorithm #6:** MldrNet, 65.23%
- **Algorithm #7:** WILDCAT, 67.03%
- **Algorithm #8:** WSCNet, 70.07%
-

AI EMOTION AND SENTIMENT ANALYSIS WITH COMPUTER VISION IN 2022 - VISO.AI

REACH VET STATISTICAL MODEL

- Over 60 factors
- • Demographics (e.g., age >= 80, male, married) • Prior suicide attempts • Diagnoses (e.g., depression, diabetes, homelessness) • VHA service utilization (e.g., emergency department visit, psychiatric discharge) • Medications (e.g., antipsychotics, opioids, statins) • Interactions (e.g., anxiety disorder x personality disorder, widowed x male)

POWERPOINT PRESENTATION (AVAPL.ORG)

Variables Included in the REACH VET Model

Demographics
Age >= 80
Male
Currently married
Region (West)
Race/ethnicity (White)
(Non-white)
Service Connected (SC) Disability Status
SC > 30%
SC > 70%

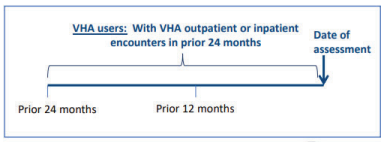
Prior Suicide Attempts
Any suicide attempt in prior 1 month
in prior 6 months
in prior 18 months

Diagnoses
Arthritis (prior 12 months)
(prior 24 months)
Bipolar I (prior 24 months)
Head and neck cancer (prior 12 months)
(prior 24 months)
Chronic pain (prior 24 months)
Depression (prior 12 months)
(prior 24 months)
Diabetes mellitus (prior 12 months)
Systemic lupus erythematosus (prior 24 months)
Substance Use Disorder (prior 24 months)
Homelessness or services (prior 24 months)

VHA utilization
Emergency Dept visit (prior month)
(prior 2 months)
Psychiatric Discharge (prior month)
(prior 6 months)
(prior 12 months)
(prior 24 months)
Any mental health (MH) tx (prior 12 months)
(prior 24 months)
Days of Use (0-30) in the 13th month prior
in the 7th month prior
Emergency Dept visits (prior month)
(prior 24 months)
First Use in Prior 5 Years was in the Prior Year
Days of Inpatient MH (0-30) in 7th month prior
Squared
Days of Outpatient (0-30) in 7th month prior
in 8th month prior
in 15th month prior
in 23rd month prior
Days with outpt MH use in prior month, square

Medications
Alprazolam (prior 24 months)
Antidepressant (prior 24 months)
Antipsychotic (prior 12 months)
Clonazepam (prior 12 months)
(prior 24 months)
Lorazepam (prior 12 months)
Mirtazapine (prior 12 months)
(prior 24 months)
Mood stabilizers (prior 12 months)
Opioids (prior 12 months)
Sedatives or anxiolytics (prior 12 months)
(prior 24 months)
Statins (prior 12 months)
Zolpidem (prior 24 months)

Interactions
Between Other anxiety disorder (prior 24 months) and Personality disorder (prior 24 months)
Interaction between Divorced and Male
Interaction between Widowed and Male

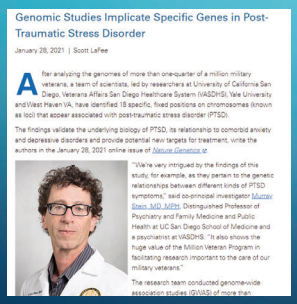


U.S. Department of Veterans Affairs

POWERPOINT PRESENTATION (AVAPL.ORG)

GENETICS

- Large Study Reveals PTSD Has Strong Genetic Component Like Other Psychiatric Disorders (ucsd.edu)



Genomic Studies Implicate Specific Genes in Post-Traumatic Stress Disorder

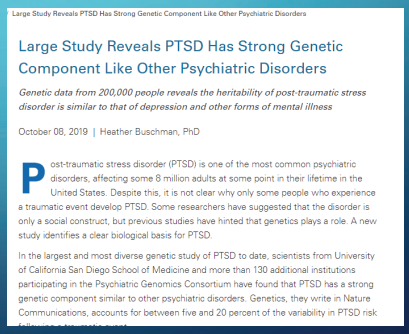
January 28, 2021 | Scott LaFee

After analyzing the genomes of more than one-quarter of a million military veterans, a team of scientists, led by researchers at University of California San Diego, Veterans Affairs San Diego Healthcare System (VASDHS), Yale University and West Haven VA, have identified 16 specific, fixed positions on chromosomes (known as loci) that appear associated with post-traumatic stress disorder (PTSD).

The findings validate the underlying biology of PTSD, its relationship to comorbid anxiety and depressive disorders and provide potential new targets for treatment, write the authors in the January 28, 2021 online issue of *Nature Genetics*.

"We're very intrigued by the findings of this study, for example, as they pertain to the genetic relationships between different kinds of PTSD symptoms," said co-principal investigator Murray Stein, MD, MPH, Distinguished Professor of Psychiatry and Family Medicine and Public Health at UC San Diego School of Medicine and a psychiatrist at VASDHS. "It also shows the huge value of the Million Veteran Program in facilitating research important to the care of our military veterans."

The research team conducted genome-wide association studies (GWAS) of more than



Large Study Reveals PTSD Has Strong Genetic Component Like Other Psychiatric Disorders

Large Study Reveals PTSD Has Strong Genetic Component Like Other Psychiatric Disorders

Genetic data from 200,000 people reveals the heritability of post-traumatic stress disorder is similar to that of depression and other forms of mental illness

October 08, 2019 | Heather Buschman, PhD

Post-traumatic stress disorder (PTSD) is one of the most common psychiatric disorders, affecting some 8 million adults at some point in their lifetime in the United States. Despite this, it is not clear why only some people who experience a traumatic event develop PTSD. Some researchers have suggested that the disorder is only a social construct, but previous studies have hinted that genetics plays a role. A new study identifies a clear biological basis for PTSD.

In the largest and most diverse genetic study of PTSD to date, scientists from University of California San Diego School of Medicine and more than 130 additional institutions participating in the Psychiatric Genomics Consortium have found that PTSD has a strong genetic component similar to other psychiatric disorders. Genetics, they write in Nature Communications, accounts for between five and 20 percent of the variability in PTSD risk

GENETICS OF DEPRESSION

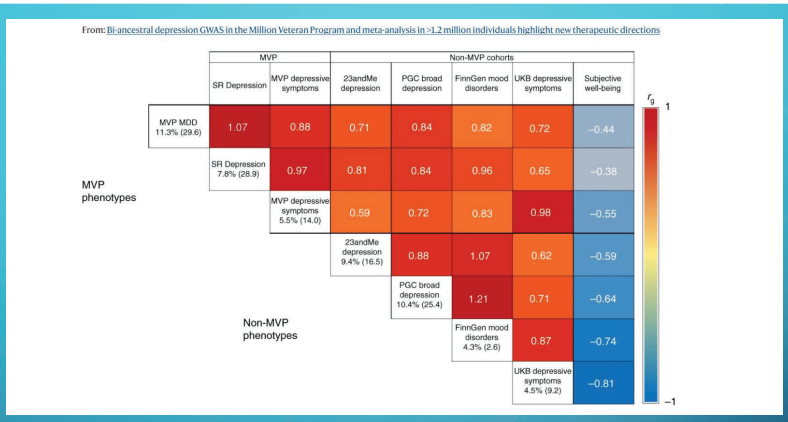
- Major depression is a debilitating psychiatric illness that is typically associated with low mood and anhedonia. Depression has a heritable component that has remained difficult to elucidate with current sample sizes due to the polygenic nature of the disorder. To maximize sample size, we meta-analyzed data on 807,553 individuals (246,363 cases and 561,190 controls) from the three largest genome-wide association studies of depression. We identified 102 independent variants, 269 genes, and 15 genesets associated with depression, including both genes and gene pathways associated with synaptic structure and neurotransmission. An enrichment analysis provided further evidence of the importance of prefrontal brain regions. In an independent replication sample of 1,306,354 individuals (414,055 cases and 892,299 controls), 87 of the 102 associated variants were significant after multiple testing correction. These findings advance our understanding of the complex genetic architecture of depression and provide several future avenues for understanding etiology and developing new treatment approaches.

GENOME-WIDE META-ANALYSIS OF DEPRESSION IDENTIFIES 102 INDEPENDENT VARIANTS AND HIGHLIGHTS THE IMPORTANCE OF THE PREFRONTAL BRAIN REGIONS | NATURE NEUROSCIENCE

BI-ANCESTRAL DEPRESSION GWAS IN THE MILLION VETERAN PROGRAM AND META-ANALYSIS IN >1.2 MILLION INDIVIDUALS HIGHLIGHT NEW THERAPEUTIC DIRECTIONS

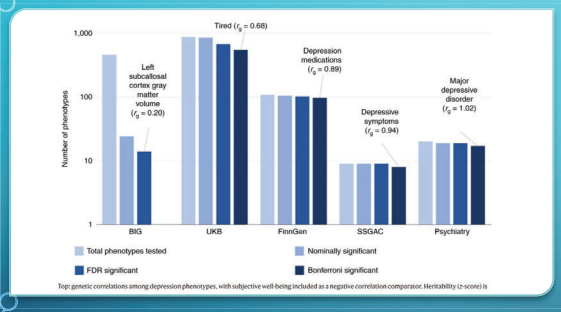
- Major depressive disorder is the most common neuropsychiatric disorder, affecting 11% of veterans. Here we report results of a large meta-analysis of depression using data from the Million Veteran Program, 23andMe, UK Biobank and FinnGen, including individuals of European ancestry (n = 1,154,267; 340,591 cases) and African ancestry (n = 59,600; 25,843 cases). Transcriptome-wide association study analyses revealed significant associations with expression of *NEGR1* in the hypothalamus and *DRD2* in the nucleus accumbens, among others. We fine-mapped 178 genomic risk loci, and we identified likely pathogenicity in these variants and overlapping gene expression for 17 genes from our transcriptome-wide association study, including *TRAF3*. Finally, we were able to show substantial replications of our findings in a large independent cohort (n = 1,342,778) provided by 23andMe. This study sheds light on the genetic architecture of depression and provides new insight into the interrelatedness of complex psychiatric traits.

BI-ANCESTRAL DEPRESSION GWAS IN THE MILLION VETERAN PROGRAM AND META-ANALYSIS IN >1.2 MILLION INDIVIDUALS HIGHLIGHT NEW THERAPEUTIC DIRECTIONS | NATURE NEUROSCIENCE



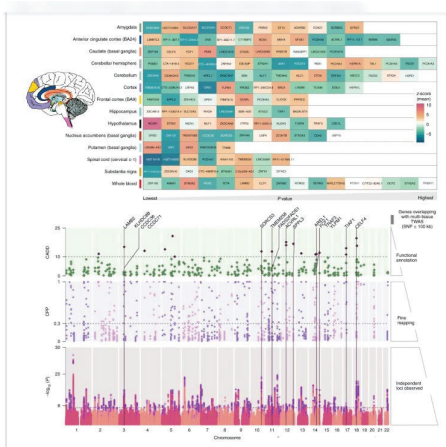
Top: genetic correlations among depression phenotypes, with subjective well-being included as a negative correlation comparator. Heritability (z-score) is given along the left axis of the matrix for each depression phenotype. Values within the matrix represent r_g. All correlations are significant after Bonferroni correction for multiple comparisons (0.05/28 = $P < 0.0018$). The largest P value was for the correlation between FinnGen and UKB depressive symptoms ($P = 4.06 \times 10^{-5}$). P values and 95% CIs are reported in Supplementary Table 6

FIG. 2: GENETIC CORRELATION. | NATURE NEUROSCIENCE



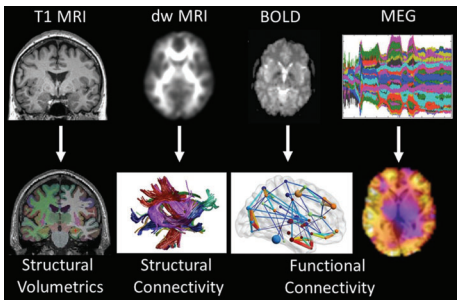
- Bottom: summary of genetic correlations between MDD-META and 1,457 phenotypes from large-scale genetic studies of mental health and behavior. The Psychiatry category contains phenotypes from the PGC, the GWAS & Sequencing Consortium of Alcohol and Nicotine Use, the MVP and the International Cannabis Consortium. The labels “Tired” and “Left subcallosal cortex gray matter volume” represent UKB Field ID 2080 and BIG Field ID 0078, respectively. P values are two sided.

FIG. 2: GENETIC CORRELATION. | NATURE NEUROSCIENCE



- Top: tissue-based gene association study. The genes were tested using MetaXcan for 13 brain tissues and whole blood from GTEx v8. The genes were compared across tissues to identify best representative tissues for each gene using SMultiXcan. Genes are arranged in order from left to right by respective tissue-specific *P* value, with the lowest value on the left. The color scale for the gene matrix is based on mean *z*-score. The values are reported in Supplementary File 2. Bottom: SNP prioritization using fine-mapping and functional scoring. Bottom row, Manhattan plot showing each genomic risk locus in violet. Middle row, Each locus was fine-mapped, and the CPP on the *y* axis is shown for SNPs from the causal set. The SNPs that had CPP ≥ 0.3 (30%) were annotated using CADD scores. Top row: The SNPs with CADD ≥ 10 are highlighted in purple; these SNPs were positionally mapped to 107 genes within 100 kb. Only positional genes overlapping with multi-tissue TWAS results (Supplementary Fig. 1) are annotated with vertical lines. Details of the prioritized SNPs are reported in Supplementary File 2.

BI-ANCESTRAL DEPRESSION GWAS IN THE MILLION VETERAN PROGRAM AND META-ANALYSIS IN >1.2 MILLION INDIVIDUALS HIGHLIGHT NEW THERAPEUTIC DIRECTIONS | NATURE NEUROSCIENCE

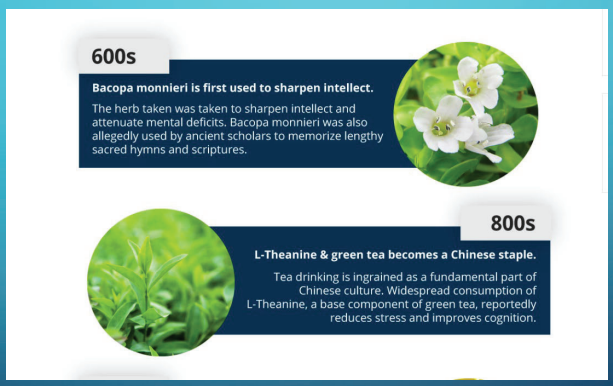


NEUROIMAGING

- Quantitative Neuroimaging
- Brain Circuitry
- Connectome
- Anatomic, functional and metabolic
- Imaging Genomics
- Big Data
- AI
- Outcome Research

BIR PUBLICATIONS

SMART PILLS

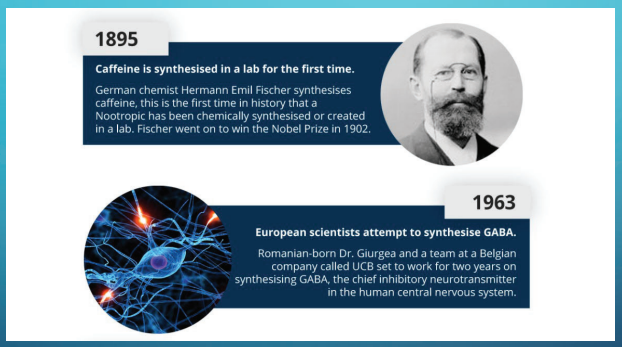


A HISTORY OF COGNITIVE ENHANCERS INFOGRAPHIC | LUCID

NOOTROPICS

A HISTORY OF COGNITIVE ENHANCERS INFOGRAPHIC | LUCID

NOOTROPICS



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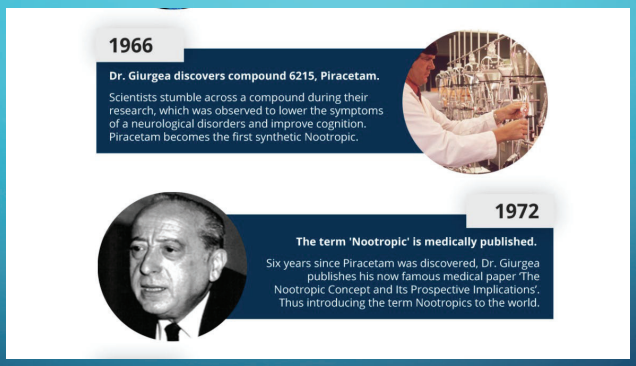

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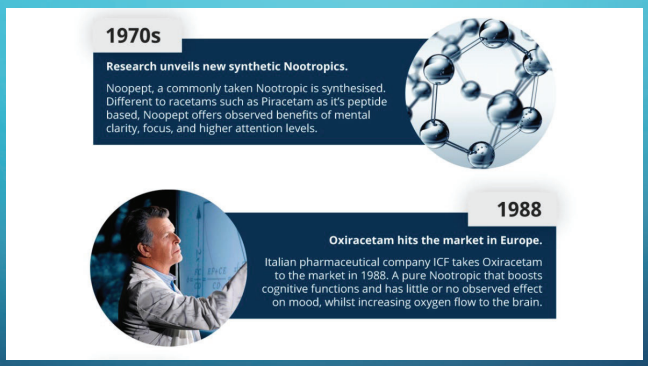
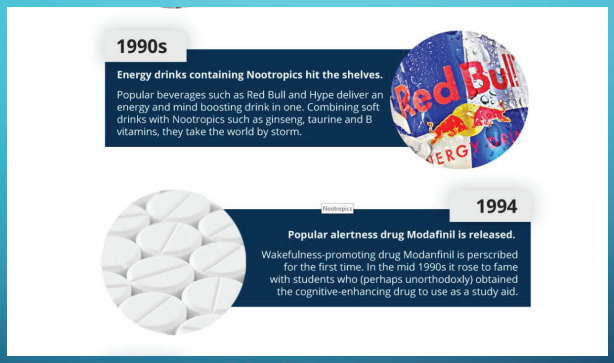


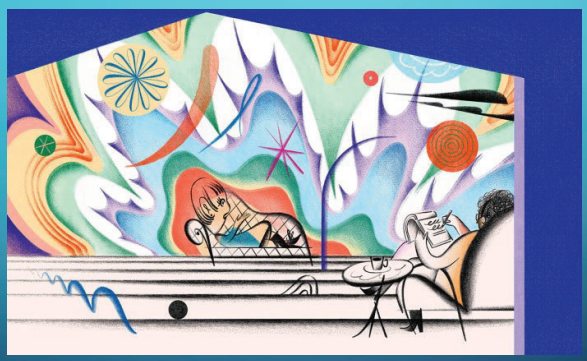
A HISTORY OF COGNITIVE ENHANCERS INFOGRAPHIC | LUCID

NOOTROPICS



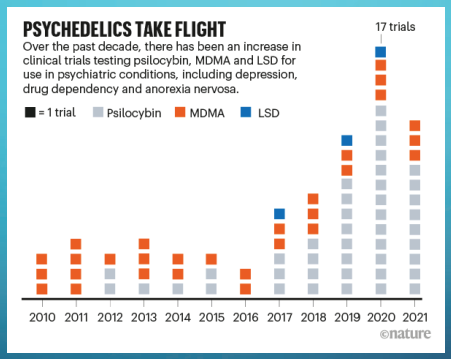
A HISTORY OF COGNITIVE ENHANCERS INFOGRAPHIC | LUCID

PSYCHEDELICS



HOW ECSTASY AND PSILOCYBIN ARE SHAKING UP PSYCHIATRY (NATURE.COM)

PSYCHEDELICS



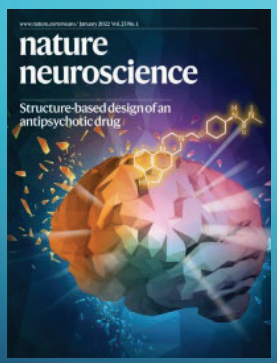
HOW ECSTASY AND PSILOCYBIN ARE SHAKING UP PSYCHIATRY (NATURE.COM)

PSYCHODELICS

- According to Doblin, phase 3 trial results[1] examining 3,4-methylenedioxy-methamphetamine (MDMA)-assisted therapy for posttraumatic stress disorder (PTSD) look promising, as echoed by a number of publications, including *The New York Times*[2] and *Scientific American*.[3] By the study's end, two-thirds of the MDMA group no longer qualified for a PTSD diagnosis after 3 MDMA sessions. There was a small p value (0.0001), a large effect size (0.91 and 2.1), no site-to-site variability, a good safety profile, and results were replicated from phase 2 trials. The 12-month follow up results will be available next year.

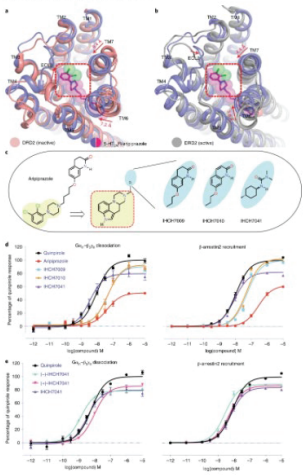
PSYCHEDELICS: PSYCHIATRY OF THE FUTURE (PSYCHIATRICTIMES.COM)

STRUCTURE BASED DESIGN

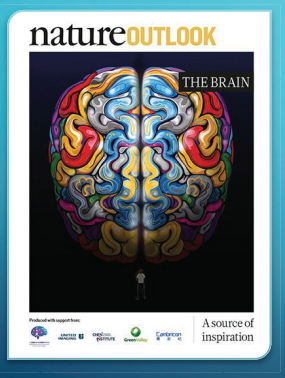


STRUCTURE-BASED DESIGN OF A NOVEL THIRD-GENERATION ANTIPSYCHOTIC DRUG LEAD WITH POTENTIAL ANTIDEPRESSANT PROPERTIES | NATURE NEUROSCIENCE

Fig. 4: Structure-guided design of selective DRD2 partial agonist.



THE BRAIN



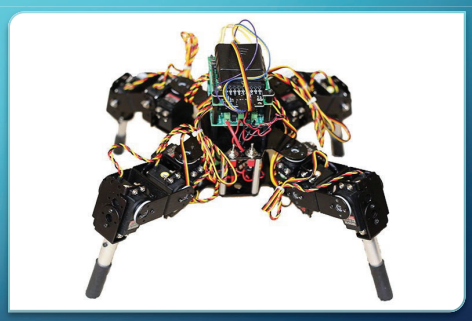
- Connectome: map of the connections
- Biological basis of consciousness
- Evolution
- Understanding the brain informs AI research and vice versa

DOI: HTTPS://DOI.ORG/10.1038/D41586-019-02206-2

BRAIN EVOLUTION

- 2010 Draft of Neanderthal genome
- Brain organoids (thousands to millions of cells)
- Can track Neanderthal gene variants in modern humans and pinpoint genes and developmental processes and test in brain organoids using CRISPR

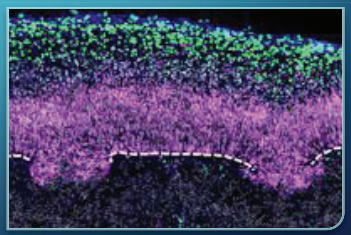
DOI: HTTPS://DOI.ORG/10.1038/D41586-019-02210-6



Brain organoids are capable of controlling walking robots in the lab.Credit: Muotri Lab/UC San Diego

BRAIN ORGANOIDS

- Embodiment
- 4 gene different than Neanderthal brain
- 29:40 robot walking
- Simulates midbrain, hippocampus, pituitary, hypothalamus and cerebellum
- Gene editing, single cell sequencing bring new possibilities for disease modeling (DISC1, NDEL1 and FGFR1 for Schizophrenia)



HTTPS://WWW.EXPLORATORIUM.EDU/VIDEO/BIOFUTURES-ALYSSON-MUOTRI-GROWING-BRAIN-ORGANOIDS-LAB

SHOU Y, LIANG F, XU S AND LI X (2020) THE APPLICATION OF BRAIN ORGANOIDS: FROM NEURONAL DEVELOPMENT TO NEUROLOGICAL DISEASES. *FRONT. CELL DEV. BIOL.* 8:579659. DOI: 10.3389/FCELL.2020.579659

CONSCIOUS AND UNCONSCIOUS

- Lau's team is attempting to reprogram the unconscious using an fMRI-based technique that rewards people for activating specific brain regions. In a double-blind trial, the researchers challenged 17 people to make a dot on a computer screen bigger, using any mental strategy[2]
- A hallucination created by a machine-learning algorithm that simulates altered visual perception.Credit: Keisuke Suzuki/Univ. Sussex

DOI: HTTPS://DOI.ORG/10.1038/D41586-019-02207-1

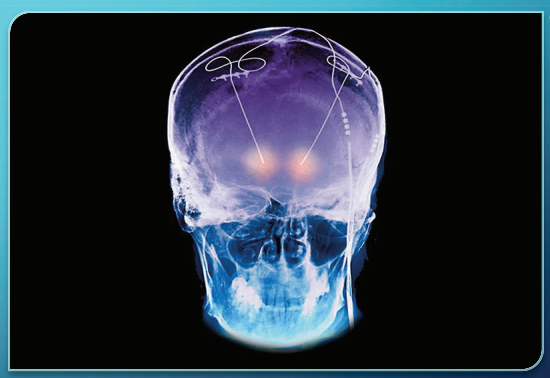
BRAIN COMPUTER INTERFACES

- Radical symbiosis
- Read brain activity vs. writing to it
- Facebook, Kernel, Neuralink
- Bidirectional coupling coming
- Neuroethics

NATURE **571**, S19-S21 (2019)
DOI HTTPS://DOI.ORG/10.1038/D41586-019-02214-2

DBS

- US FDA approved DBS for Parkinson's in 1997
- Now used for OCD and Epilepsy
- Investigated for Depression
- Some become hypersexual, loss of agency (How much is me?)



DOI: HTTPS://DOI.ORG/10.1038/D41586-019-02214-2

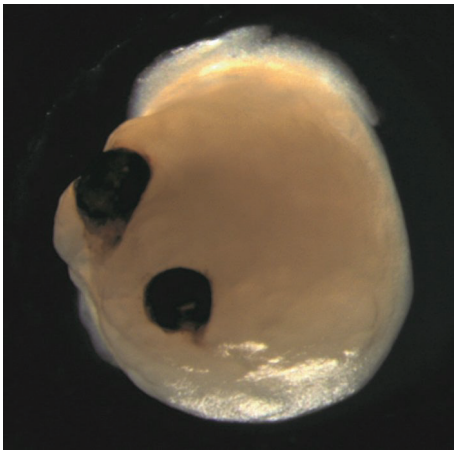
EVOLUTIONARY INTELLIGENCE RACE

- Combination
  - Computer and add brain
  - Human and add computer
- Carbon based
- Silicon based/Quantum Computing

BRAIN CHIPS

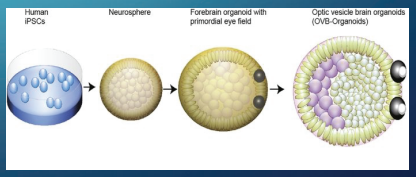
HUMAN NEURONS CONNECTED TO A COMPUTER (FIRST CYBORG?)

GROWING HUMAN NEURONS CONNECTED TO A COMPUTER - YOUTUBE



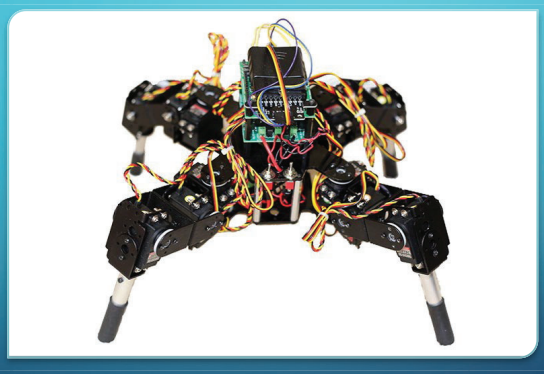
GROWING HUMAN BRAINS

- Human-derived brain organoid grown in dishes developed bilateral symmetrical optic cups that responded to light when retinol added .



SCIENTISTS GREW STEM CELL 'MINI BRAINS', THEN, THE BRAINS SORT-OF DEVELOPED EYES (SCIENCEALERT.COM)

BRAIN CONTROLLING WALKING ROBOT

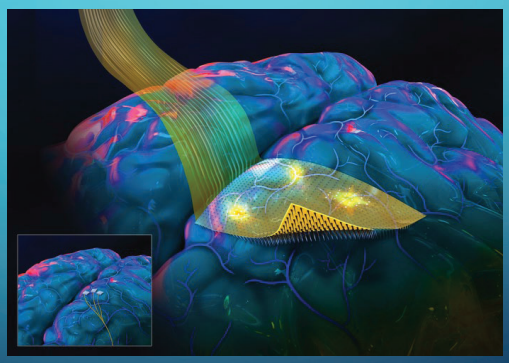


Brain organoids are capable of controlling walking robots in the lab.Credit: Muotri Lab/UC San Diego

RAT NEURONS GROWN ON A COMPUTER CHIP FLY A SIMULATED AIRCRAFT

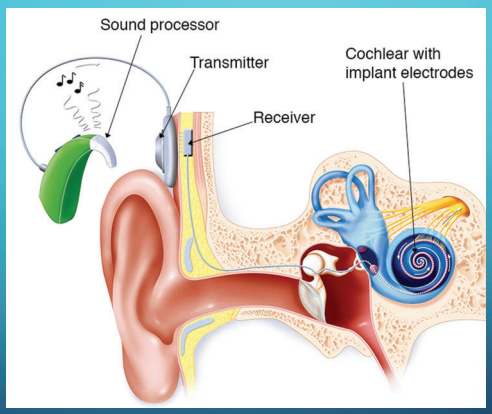
RAT NEURONS GROWN ON A COMPUTER CHIP FLY A SIMULATED AIRCRAFT - YOUTUBE

BRAIN COMPUTER INTERFACE WITH FLEXIBLE BACKING



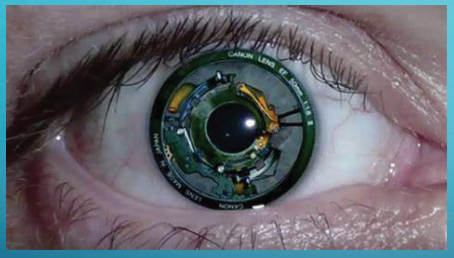
ARTISTIC ILLUSTRATION OF A NEW [IMAGE] | EUREKALERT! SCIENCE NEWS RELEASES; A NEW BRAIN-COMPUTER INTERFACE WITH A FLEXIBLE BACKING (UCSD.EDU)

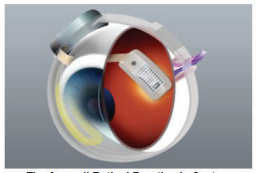
COCHLEAR IMPLANTS



COCHLEAR IMPLANTS - BING IMAGES

BIONIC EYE IMPLANT (ONE FDA APPROVED-ARGUS II)





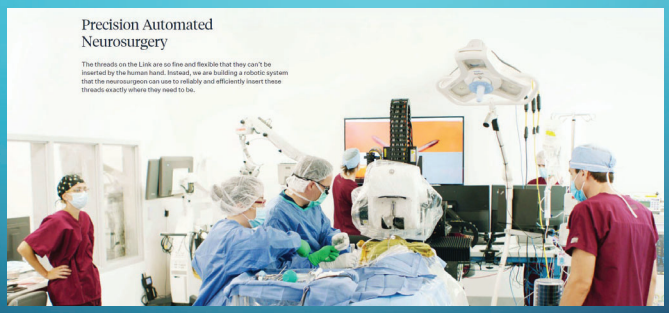
The Argus II Retinal Prosthesis System consists of a tiny eyeglasses-mounted camera and a transmitter that wirelessly sends signals to an electrode array that is implanted onto the damaged retina of a blind person.

VISUAL IMPLANTS HUMANS - BING IMAGES; EYE IMPLANTS: BIONIC EYES, LENSES AND PROSTHETIC EYES (ALLABOUTVISION.COM)

NEURALINK

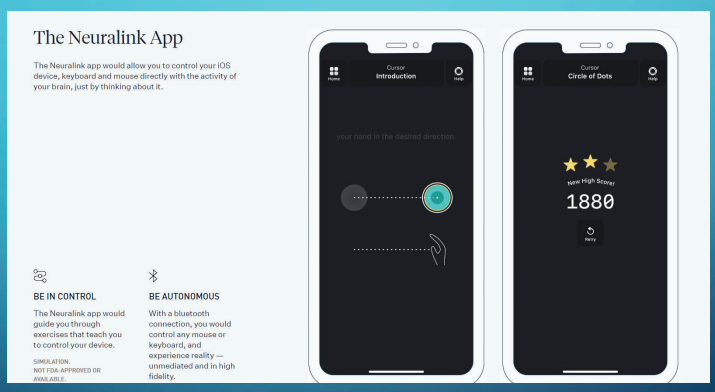
APPROACH - NEURALINK

NEURALINK



APPROACH - NEURALINK

NEURALINK



APPROACH – NEURALINK (1024 ELECTRODES/BRAIN COMPUTER INTERFACE)

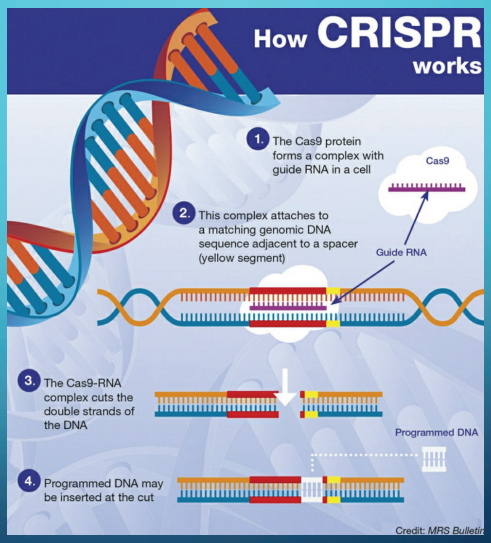
WATCH ELON MUSK'S NEURALINK MONKEY PLAY VIDEO GAMES WITH HIS BRAIN - YOUTUBE

HACKING THE GENOME AND BUILDING BETTER BRAINS

CRISPR (CLUSTERED REGULARLY INTERSPACED SHORT PALINDROMIC REPEAT)

GENETIC ENGINEERING - THE ODIN (THE-ODIN.COM)

CRISPR



CRISPR - BING IMAGES

CRISPR FIRST TO LOOK FOR

- A CRISPR treatment that involves inserting DNA to repair or replace a faulty sequence, in essence "pasting" in new material, is still a big challenge.
- Polygenic CRISPR
- A trial where CRISPR tools are used to turn genes on and off without editing the DNA sequence. These strategies, known as CRISPR activation and inhibition, don't require making breaks in a patient's DNA, so they might be safer. But, it's unclear how long their effects would last in humans.
- A treatment that uses base editing. Base editing uses CRISPR components to directly change single DNA letters without making breaks in the DNA. For diseases caused by single-letter changes to DNA, base editors may be a safer editing option than CRISPR.

CRISPR CLINICAL TRIALS: A 2021 UPDATE - INNOVATIVE GENOMICS INSTITUTE (IGI)

UNNATURAL SELECTION

- https://youtu.be/WIlVh7H6nvI
- The teaser zooms in on the stomach-stabbing self-experimentations of biohackers like Josiah Zayner and Aaron Traywick. But the show's cocreators, Joe Egender and Leeor Kaufman, say DIY Crispr is just one subplot in the larger narrative about what happens when nature can be minutely controlled, when humans might even preside over their own evolution. Their cameras also follow scientists like Jennifer Doudna and Kevin Esvelt and the first patients in an experimental gene therapy trial to treat hereditary blindness. "Our main hope is to create a discussion around these technologies," says Egender. "People might come away excited. Or they might be scared. But at least that means they're talking and learning and understanding what's coming."

NETFLIX'S 'UNNATURAL SELECTION' TRAILER MAKES CRISPR PERSONAL | WIRED

ETHICS OF GENE EDITING (10% OF POPULATION WITH GENETIC CONDITION 24% CARRIERS)

- Genome editing is a powerful, scientific technology that can reshape medical treatments and people's lives, but it can also harmfully reduce human diversity and increase social inequality by editing out the kinds of people that medical science, and the society it has shaped, categorize as diseased or genetically contaminated--people like us who are understood as having bad genes. But we should be reminded that bad genes don't necessarily lead to bad lives, just as good genes don't necessarily lead to good lives. If CRISPR is put to use to eliminate rather than to treat genetic difference, we as a society would essentially instrumentalize this moralistic and reductionist assumption.

THE DARK SIDE OF CRISPR - SCIENTIFIC AMERICAN

2001: A SPACE ODYSSEY (HAL DOESN'T WANT TO BE TURNED OFF) AND FOUNDATION (PSYCHOHISTORY AND MATH)

NUMBER OF BRAIN CONNECTIONS

- 100 hundred billion neurons
- One thousand trillion synapses working in parallel
- Better than the fastest supercomputers executing one quadrillion operation per second
- Largest simulation ran 4 million neurons of the macaque visual system

HTTPS://WWW.NATURE.COM/ARTICLES/D41586-019-02209-Z

CHALLENGES TO BRAIN SIMULATION

- Scale
  - 4 million cell simulation
- Complexity
  - European Human Brain Project and the Allen Institute
  - Hope is for principles
- Speed
  - Best simulations run in less than real-time. Brain develops over years.
- Integration
  - Simulations lack representation of consciousness and may have limited use in understanding Psychiatric Illness

DOI: HTTPS://DOI.ORG/10.1038/D41586-019-02209-Z

BRAIN VS COMPUTER

- Brain is slower
- But is massively parallel and has
- Use-dependent modification of connection strength
- Now used in computing

Table 1

Properties	Computer	Human Brain
Number of Basic Units	Up to 10 billion transistors	~100 billion neurons; ~100 trillion synapses
Speed of Basic Operation	10 billion/sec.	< 1,000/sec.
Precision	1 in ~4.2 billion (for a 32-bit processor)	~1 in 100
Power Consumption	~100 watts	~10 watts
Information Processing Mode	Mostly serial	Serial and massively parallel
Input/Output for Each Unit	1–3	~1,000
Signaling Mode	Digital	Digital and analog

a) Based on personal computers in 2008.

b) The number of transistors per integrative circuit has doubled every 18–24 months in the past few decades; in recent years the performance gains from this transistor growth have slowed, limited by energy consumption and heat dissipation.
References: John von Neumann, The Computer and the Brain (New Haven: Yale University Press, 2012); D. A. Patterson and J. L. Hennessy, Computer Organization and Design (Amsterdam: Elsevier, 2012).

HTTPS://NAUTIL.US/ISSUE/59/CONNECTIONS/WHY-IS-THE-HUMAN-BRAIN-SO-EFFICIENT

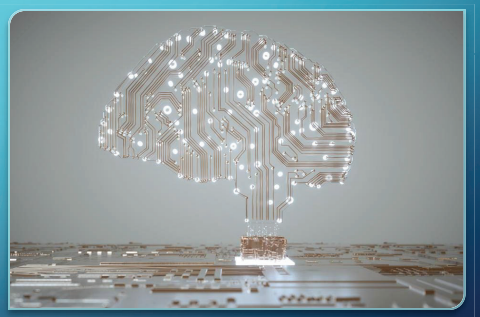
CALCULATIONS

- Brain operates at 1 exaflop or a billion billion calculations per second
- Fastest computer globally is in China Tianhe-w
- 54.902 petaFLOPs
- Human Brain Project has goal of exascale computing (Europe) https://www.humanbrainproject.eu/en/ Neuromorphic Computing

Prefix	Abbreviation	Order of magnitude (as a factor of 10)	Computer performance	Storage capacity
giga-	G	10^9	gigaFLOPS (GFLOPS)	gigabyte (GB)
tera-	T	10^{12}	teraFLOPS (TFLOPS)	terabyte (TB)
peta-	P	10^{15}	petaFLOPS (PFLOPS)	petabyte (PB)
exa-	E	10^{18}	exaFLOPS (EFLOPS)	exabyte (EB)
zetta-	Z	10^{21}	zettaFLOPS (ZFLOPS)	zettabyte (ZB)
yotta-	Y	10^{24}	yottaFLOPS (YFLOPS)	yottabyte (YB)

FORBES

- The fuse has been lit



HTTPS://WWW.FORBES.COM/SITES/FORBESTECHCOUNCIL/2020/01/02/A-WORLD-RUN-BY-INTELLIGENT-MACHINES-HOW-CLOSE-ARE-WE/?SH=463DF2FC4088

WIKIPEDIA AND QUANTUM COMPUTING

- 17 June – Austrian, German and Swiss researchers present a two 19-inch rack quantum computing demonstrator, the world's first quality standards-meeting compact quantum computer.[327][328]
- 7 July – American researchers present a programmable quantum simulator that can operate with 256 qubits,[329][330] and on the same date and journal another team presented quantum simulator of 196 Rydeberg atoms trapped in optical tweezers[331]
- 25 October – Chinese researchers reported that they have developed the world's fastest programmable quantum computers. The photon based *Jiuzhang 2* is claimed to be able to calculate a task in one millisecond, that would otherwise had taken a conventional computer 30 trillion years to complete. And *Zuchongzhi 2* is a 66-qubit programmable superconducting quantum computer that is claimed to be the current world's fastest quantum computer that can run a calculation task one million times more complex than Google's Sycamore, as well as being 10 million times faster.[332][333]

QUANTUM COMPUTING - WIKIPEDIA

NIH QUANTUM COMPUTING

- Superposition: simultaneously exist in multiple states (low = 0, high = 1) and described by probabilities
- Entanglement: quantum entities created such than no one of them can be described without referencing the others, even at a distance
- Likely will deliver tremendous speeds but only for specific types of problems

HTTPS://WWW.NCBI.NLM.NIH.GOV/BOOKS/NBK538701/

FORBES QUANTUM COMPUTING

- IBM plans to deliver a 1,121-qubit computer by 2023
- Classical computers will not be able to simulate a 1,000-qubit computer
- Debugging is an issue and algorithms won't be verified (?magic)
- Enterprise deployments will accelerate
- Better chemistry simulations
- Good job market for quantum engineers
- Less sharing of knowledge

HTTPS://WWW.FORBES.COM/SITES/FORBESTECHCOUNCIL/2021/12/22/WHAT-TO-EXPECT-FROM-QUANTUM-COMPUTING-IN-THE-NEXT-TWO-YEARS/?SH=31532A8F3527

RAY KURWEIL AND THE SINGULARITY/ARTIFICIAL GENERAL INTELLIGENCE

- Chess
- Go (AlphaGo the AlphaGo Zero (system played itself))
- Multilayered neural nets
- Biology hard to simulate, only as good as simulation
- Driving has real world data
- Brain is a hierarchy of pattern recognition through repeating modules of 100 neurons (hidden Markoff Model)
- Reading comprehension now at average adult level
- Longevity escape velocity

HTTPS://RESEARCH.AIMULTIPLE.COM/ARTIFICIAL-GENERAL-INTELLIGENCE-SINGULARITY-TIMING/

RAY KURWEIL/SINGULARITY

- Director of Engineering at Google
- has predicted that computers will achieve humanlike intelligence by 2029 and achieve singularity in 2045, which, he says, "is when we will **multiply our effective intelligence a billion fold by merging with the intelligence we have created.**"Jan 2, 2020

HTTPS://RESEARCH.AIMULTIPLE.COM/ARTIFICIAL-GENERAL-INTELLIGENCE-SINGULARITY-TIMING/

CONCLUSIONS/PREDICTIONS

- More CRNPs/PAs part of the team
- More Collocated/Collaborative Care
- Rise of Digital Health in all areas of Medicine with 10% of physicians working for Google, Amazon or Apple in 10 years. 50% in 20 years.
- Therapy will become a bigger part of Psychiatry
- Heads Up Display for Clinicians

CONCLUSIONS/PREDICTIONS

- AI part of each medical visit in 10 years
- Full genome available on all patients within 10 years driving drug development and prescribing
- 3D pills acting on 10+ sites within 10 years
- Neuralink type chips commonplace in 10 years
- Non-compliance decreased through taxes and insurance rates

CONCLUSIONS/PREDICTIONS

- Individual quantum computer available to public in 10 years.
- Psychedelic drugs in common use
- Addiction to Virtual Reality commonplace
- Cures for common medical illnesses in 25 years with average lifespan of 125 years
- Designer life commonplace in 20 years

CONCLUSIONS/PREDICTIONS

- Ability to upload consciousness to robot body in 25 years
- Mentats (enhanced brain development in certain individuals in 20 years)
- Some combination of humans and computers wins the Intelligence Race (we are chipped already with our cell phones)

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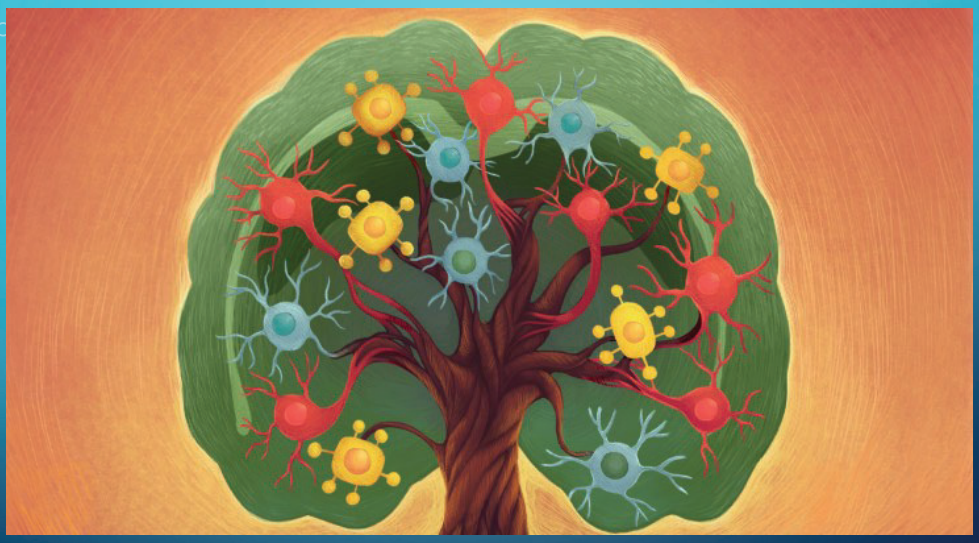

NATURE NEUROSCIENCE