

Technology and Our Minds in 2018  
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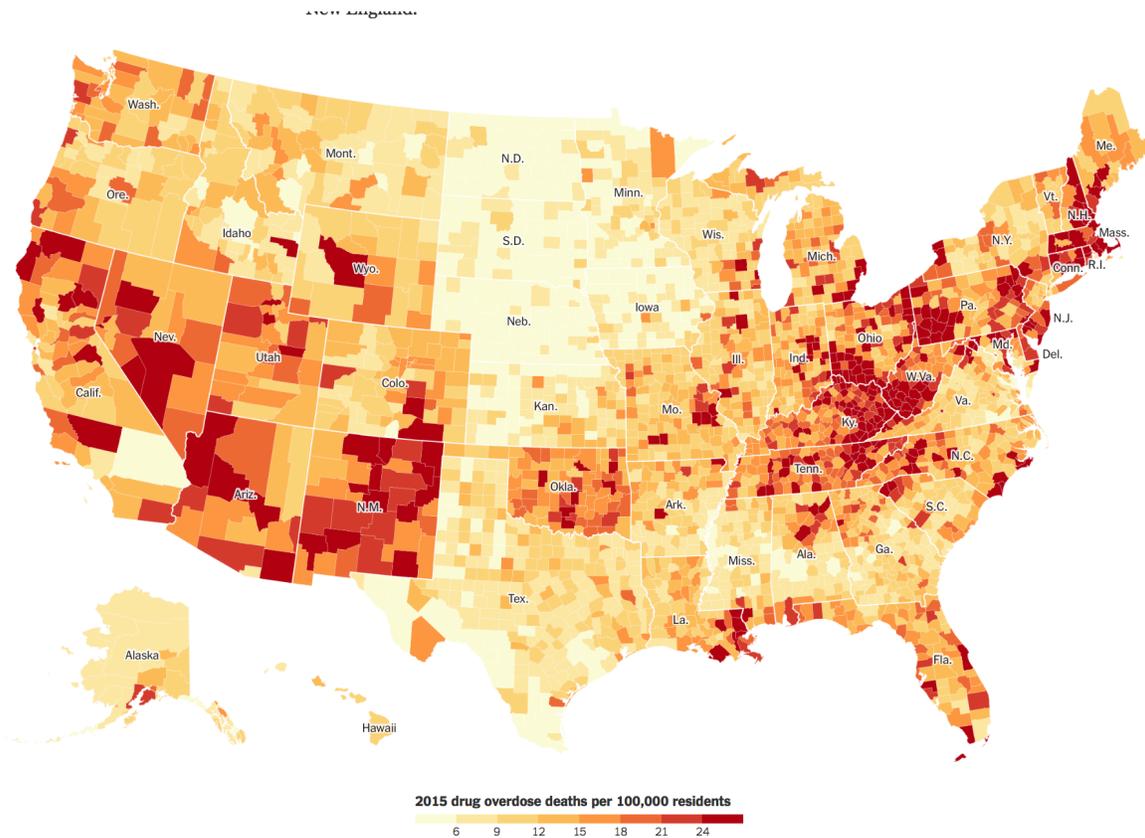
In my past presentations I have tried to apply this time with learning something that will also benefit me and family. I presented a history of the political situation in Burma and then the risk of and consequence of youth contact sports and concussions. Today, I would like to share some of my experiences this past year and how this has changed my view and perspective on technology and how it's impact on our brains and society.

I am a tech geek at heart and love any new technology. I am often the first to adapt any new technology. The Apple personal computer was introduced to in 4th grade. In junior high I became a frequent visitor of the computer lab. I would spend lunch and time after school programming. I participated in computer programming competitions in high school. And would repair/build computers for friends and their parents in high school. I remember talking to several friends parents who were physicians when I was in high school who all advised me to go into computers and not medicine. In college, though I enjoyed keeping up with the latest computer advancements, I focused the majority of my time and energy to biology and specifically neurobiology. The Brain and how it worked was what I desired to learn and understand. Some friends and I even began an undergraduate publication for those interested in Neuroscience called "The Harvard Brain," an undergraduate journal on musing of the mind. I was encouraged recently to learn that it still exists.

I took a break from my hobby of keeping up with the latest technology while in medical school and was stunned when the world wide web had exploded and I was completely unaware during my first 2 years of medical school. I saw computers as a tremendous tool when needing vast amounts of information available when practicing medicine. In medical school I had an HP 200lx, which was in fact a PC the size of my hand that I would use for various lists and as a pharmaceutical database in medical school. I then got a palm based phone as soon as it was available, the Treo 650. When the iPhone was introduced in 2007, everything changed. I still remember Steve Jobs introducing the iPhone as 3 devices, a "widescreen iPod with touch controls"; a "revolutionary mobile phone"; and a "breakthrough Internet communicator." What was different this time was how functional the touch screen was and the current state of the internet, which was now at your finger tips. This was a true game changer!

I tell you this because for all my love of technology and every new technology advancement that is introduced there are some down sides that even I, an apple evangelist, am starting to be concerned.

I would like to begin with the Opioid epidemic. As an ophthalmologist, I am fortunate that my surgeries produce almost no pain post-operatively. During surgery pain is mostly controlled with medications such as lidocaine, that make the need for systemic narcotics minimal. We do use fentanyl in IV sedation cases, but minimally. And I rarely prescribe narcotics. Let's begin with some basics. What is a narcotic? It is a class of drugs originally from the poppy that bind to opioid receptors and block the feeling of pain. They also can cause mood changes, sedation, and respiratory suppression. Drug abuse and overdoses leading to death have exploded in the last 15 years. Here is a table of overdose deaths per 100,000 people published in the New York Times August 10, 2017



At first I didn't believe how bad this problem was, but it is real. I graduated from medical school in 1998 and I still remember being drilled that if patient's have pain, and it is real, there is no reason not prescribe narcotics to alleviate their pain. I think the previous generation of physicians would not prescribe narcotics for pain when necessary out of fear for addiction. So there was a change in the education system, teaching this fear was unsubstantiated. And in my experience most prescribed narcotics for post-operative pain do not typically lead to addiction. Chronic pain is where there is more risk of addiction if it is not related to cancer and end of life pain as in hospice care.

According to CDC report, “The opioid epidemic in the U.S. is fundamentally tied to two primary issues. The first issue was the significant rise in opioid analgesic prescriptions that began in the mid-to-late 1990s. Not only did the volume of opioids prescribed increase, but well-intentioned healthcare providers began to prescribe opioids to treat pain in ways that we now know are high-risk and have been associated with opioid abuse, addiction, and overdose, such as prescribing at high doses and for longer durations. The second issue is a lack of health system and healthcare provider capacity to identify and engage individuals, and provide them with high-quality, evidence-based opioid addiction treatment, in particular the full spectrum of medication-assisted treatment.” But this approach to the problem in my mind does not address the actual cause.

Just because it is being given and is more available does not necessarily mean that this would lead to such an increase in overdose and abuse. So let’s look at some other issues, particularly where are these drugs coming from? During this same time period a friend of mine with a sleep disorder was suffering from addiction. In his course of treatment he went to a rehab facility for several weeks. It was here that he discovered the online world of drugs to order. He told me he could pretty much order anything he wanted from China if he so desired. This I believe is one of the largest problems with rising deaths, the easy availability of extremely strong narcotics. The drugs ordered are often pharmaceutical grade with much higher potent than street heroin. Fentanyl is 80 times more potent than morphine and is usually only used during surgical procedures. Now it could be ordered online and arrive in your mailbox, with little ability of law enforcement to prevent this. Availability and increased potency is a big problem. In addition the cost is often less than if you had a prescription filled at the pharmacy.

So we have two logical explanations for increased supply that being increased prescriptions given and online availability, but why is demand on the rise. What has changed in our society that may explain this and what is the real cause of addiction. I want to reference a TED talk by Johann Hari (a British journalist) which helped me understand this. Back in college I distinctly remember being presented with an animal model for addiction where a rat in a cage would choose morphine over water or food to the point of death. The assumption is that there is a chemical hook that once exposed to a drug leads to addiction. Recurrent use than leads to addiction, where withdrawal occurs without use. That led to the goal of avoiding drugs and the criminalization of any drug use. Hence the war on drugs in the US. There is one major problem with this idea. Rats don’t normally live in solitary confinement. There is a fundamental flaw in the design of this experiment. Canadian psychologist Bruce K. Alexander designed a new experiment. And instead of an isolated cage, rats would have an amazing park. In this new environment, the rats did not choose the morphine water over regular water. This suggests that though environment alone is not the cause the cause is much more complicated being exposed and hooked on drugs. Another example of this is the use of heroin addiction among Vietnam soldiers was 20 times higher in Vietnam and returned to pre-war rates when they returned. Environment does matter. The US history of treating addicts as criminal has not worked. And a study by the Brookings Institute in 2008 compared the rate of “hard core drug users” in the US to those in Europe with

more lenient policies and found the rate of addiction to hard core drugs in the US was 4 times higher. I do credit our response to the current opioid crisis, treating this not as a war but a health crisis.

Before I get to my theory about technology contribution to this problem, I would like share one other personal experience this past year. This summer we got together with some old friends from Chicago at our cottage. We were fairly close, when we lived in Chicago, but the distance and business in life meant that we had not kept in touch. We caught up quickly over the weekend. Their older daughter was born within months of our daughter. They shared some frustration with her in these teenage years with greater distancing and challenges with social media and her smartphone. You could tell there were some real struggles in the past year. The week after they returned to Chicago she committed suicide. It is one of the most painful things to see a family go through. My mind wants an answer, though in times of crisis where we can not find an answer it is sometimes best to just love and support. There is no good answer for such a painful situation. Though I was not close to her, after spending that weekend with them, this was very painful for my wife and I.

So let's examine suicide in our country. What is the incidence of suicide and is it increasing? In the tables below notice that there is an increase, but there is a significant increase in the last 7 years for those between the ages of 15 to 44.

A CDC study found that girls were particularly at risk: Their suicide rate rose by 65% from 2010 to 2015. The number of girls with severe depression rose by 58%. And in this

### 10 Leading Causes of Death by Age Group, United States – 2014

Rank	Age Groups										Total
	<1	1-4	5-9	10-14	15-24	25-34	35-44	45-54	55-64	65+	
1	Congenital Anomalies 4,746	Unintentional Injury 1,216	Unintentional Injury 730	Unintentional Injury 750	Unintentional Injury 11,836	Unintentional Injury 17,357	Unintentional Injury 16,048	Malignant Neoplasms 44,834	Malignant Neoplasms 115,282	Heart Disease 489,722	Heart Disease 614,348
2	Short Gestation 4,173	Congenital Anomalies 399	Malignant Neoplasms 436	Suicide 425	Suicide 5,079	Suicide 6,569	Malignant Neoplasms 11,267	Heart Disease 34,791	Heart Disease 74,473	Malignant Neoplasms 413,885	Malignant Neoplasms 591,699
3	Maternal Pregnancy Comp. 1,574	Homicide 364	Congenital Anomalies 192	Malignant Neoplasms 416	Homicide 4,144	Homicide 4,159	Heart Disease 10,368	Unintentional Injury 20,610	Unintentional Injury 18,030	Chronic Low. Respiratory Disease 124,693	Chronic Low. Respiratory Disease 147,101
4	SIDS 1,545	Malignant Neoplasms 321	Homicide 123	Congenital Anomalies 156	Malignant Neoplasms 1,569	Malignant Neoplasms 3,624	Suicide 6,706	Suicide 8,767	Chronic Low. Respiratory Disease 16,492	Cerebro-vascular 113,308	Unintentional Injury 136,053
5	Unintentional Injury 1,161	Heart Disease 149	Heart Disease 69	Homicide 156	Heart Disease 953	Heart Disease 3,341	Homicide 2,588	Liver Disease 8,627	Diabetes Mellitus 13,342	Alzheimer's Disease 92,604	Cerebro-vascular 133,103
6	Placenta Cord. Membranes 965	Influenza & Pneumonia 109	Chronic Low. Respiratory Disease 68	Heart Disease 122	Congenital Anomalies 377	Liver Disease 725	Liver Disease 2,582	Diabetes Mellitus 6,062	Liver Disease 12,792	Diabetes Mellitus 54,161	Alzheimer's Disease 93,541
7	Bacterial Sepsis 544	Chronic Low Respiratory Disease 53	Influenza & Pneumonia 57	Chronic Low Respiratory Disease 71	Influenza & Pneumonia 199	Diabetes Mellitus 709	Diabetes Mellitus 1,999	Cerebro-vascular 5,349	Cerebro-vascular 11,727	Unintentional Injury 48,295	Diabetes Mellitus 76,488
8	Respiratory Distress 460	Septicemia 53	Cerebro-vascular 45	Cerebro-vascular 43	Diabetes Mellitus 181	HIV 583	Cerebro-vascular 1,745	Chronic Low. Respiratory Disease 4,402	Suicide 7,527	Influenza & Pneumonia 44,836	Influenza & Pneumonia 55,227
9	Circulatory System Disease 444	Benign Neoplasms 38	Benign Neoplasms 36	Influenza & Pneumonia 41	Chronic Low Respiratory Disease 178	Cerebro-vascular 579	HIV 1,174	Influenza & Pneumonia 2,731	Septicemia 5,709	Nephritis 39,957	Nephritis 48,146
10	Neonatal Hemorrhage 441	Perinatal Period 38	Septicemia 33	Benign Neoplasms 38	Cerebro-vascular 177	Influenza & Pneumonia 549	Influenza & Pneumonia 1,125	Septicemia 2,514	Influenza & Pneumonia 5,390	Septicemia 29,124	Suicide 42,773

Data Source: National Vital Statistics System, National Center for Health Statistics, CDC.  
Produced by: National Center for Injury Prevention and Control, CDC using WISQARS™.



table below for those 10-34, it is the second most common cause of death Author Jean Twenge of the book “iGen: Why Today’s Super-Connected Kids Are Growing Up Less Rebellious, More Tolerant, Less Happy--and Completely Unprepared for Adulthood--and What That Means for the Rest of Us.” reported that “About 48% of those who spent five or more hours a day on their phones—a lot of time by any measure—had thought about suicide or made plans for it, vs. 28% of those who spent only one hour per day on their phones. No other variables—like household financial issues, homework, or school pressure—could account for the rise in mental health issues over that time. We can’t say the growing use of smartphones caused the increase in mental health issues, but that was by far the biggest change in teens lives from between 2010 and 2015. Other issues such as household financial issues, homework, or school pressure were not correlated with these findings. However, teens who more involved in sports, live social interactions, homework, and going to church had a lower risk for both depression and suicide.

Commentary by a CNN opinion report Kara S. Alaimo lists 7 reasons why the iPhone has made our lives worse.

1. They're bad for our brains.
2. While we're busy on our phones, we're ignoring the world around us.
3. We're also ignoring one other.
4. They're ruining our relationships.
5. They promote FOMO ("fear of missing out") syndrome.
6. We have come to need constant validation.
7. We're expected to be available for work 24-7.

Smartphones can be addictive not only on games, which were developed for the direct purpose of creating increased use and addiction. How does this create addiction? Games have a direct reward system which triggers the release of dopamine in the brain. This quick repeated activity leads to more cravings and even withdraws when games are not being played. This same type of pattern can be seen with social media apps as well or even checking the news for new information. You may ask what is the problem of smartphone/internet addiction?

A CDC report I found on CNN reported December 1, 2017 that 9 people die and 1000 people are injured each day from smartphone use while driving. Well for starters there is texting or using your phone while driving. "Millennials are the worst offenders, according to Pew. Fifty-nine percent of people between the ages of 18 and 33 reported texting while driving, compared with 50% of Gen Xers (age 34 to 45) and only 29% of baby boomers." At the annual meeting of the Radiological Society of North America in Chicago a study was presented that presents phone usage is changing our brains. "

Researchers from Korea University in Seoul used brain imaging to study the brains of 19 teenage boys who were diagnosed with internet or smartphone addiction. Compared with 19 teenagers who were not addicted, the brains of the addicted boys had significantly higher levels of GABA, a neurotransmitter in the cortex that inhibits neurons, than levels of glutamate-glutamine, a neurotransmitter that energizes brain signals. "GABA slows down the neurons," explained Yildirim, who was not involved in the Korean study. "That results in poorer attention and control, which you don't want to have, because you want to stay focused. So that means you are more vulnerable to distractions." "It's a very small study, so you have to take it with a grain of salt," said Stanford neuroradiologist Dr. Max Wintermark, an expert in neuroimaging who was also not connected with the research. "It's the first study that I read about internet addiction, but there are many studies that link alcohol, drug and other types of addiction to imbalances in various neurotransmitters in the brain."

What was once socially inappropriate, using your phone during a conversation is now the norm. I found several studies that compared social experiences with smartphones and without and they to no one's surprise showed that without phones the quality of conversation and overall experience was much more positive. I did find several that suggested that there could be some social benefit of using social media in increasing connections with friends, but the majority were negative.

The April, 2017 Harvard Business Review had the following article, “A New, More Rigorous Study Confirms: The More You Use Facebook, the Worse You Feel.” In this article they report that they “used three waves of data from 5,208 adults from a national longitudinal panel maintained by the Gallup organization, coupled with several different measures of Facebook usage, to see how well-being changed over time in association with Facebook use.” The concluded “Overall, our results showed that, while real-world social networks were positively associated with overall well-being, the use of Facebook was negatively associated with overall well-being. These results were particularly strong for mental health; most measures of Facebook use in one year predicted a decrease in mental health in a later year. We found consistently that both liking others’ content and clicking links significantly predicted a subsequent reduction in self-reported physical health, mental health, and life satisfaction.”

The WSJ on January 7, 2018 reported, “Jana Partners LLC and the California State Teachers’ Retirement System, or Calstrs, which control about \$2 billion of Apple shares, sent a letter to Apple on Saturday urging it to develop new software tools that would help parents control and limit phone use more easily and to study the impact of overuse on mental health. ... Apple hasn’t offered any public guidance to parents on how to manage children’s smartphone use or taken a position on at what age they should begin using iPhones.” In the past month former Facebook executive Chamath Palihapitiya has announced his guilt for developing, “tools that are ripping apart the social fabric of how society works.” He said, “The short-term, dopamine-driven feedback loops that we have created are destroying how society works. No civil discourse, no cooperation, misinformation, mistruth.” I think we can all agree this past election cycle saw this to be the case at times.

As someone interested in the neuroscience, I wanted to take a deeper look at the science behind what it means to be social. I was amazed by what I learned. Matthew D. Lieberman a neuroscientist with a PhD in Psychology from Harvard and currently professor at UCLA wrote a book, “Social: why our brains are wired to connect.” I found this book utterly fascinating giving anatomical understanding our social interactions and need for social interactions. What is it that makes us different than other animals. Is it our opposable thumbs. After reading this book, I have come to the conclusion that our brains are wired for social interaction that is different than other animals. To better understand this let me explain a little history about neurobiology. Up until the 1990s, the only way to truly study and understand how different parts of the brain contributed to our function was to wait until someone with specific trauma to isolated areas of the brain survived and then study their behavior. The classic psychology in everyone’s first psychology class is Phineus Gage who had an iron rod that wen completely through his frontal lobe. But the invention of the PET scan in which radioactive tracers could be used to identify areas of higher oxygen or metabolism, have been used to study brain activity during specific activities. The Pet scan has since been replaced with the functional MRI or fMRI. It takes advantage of the difference between deoxygenated hemoglobin from oxygenated hemoglobin in being able to asses areas of the brain that

are active. This has opened a tremendous area of research and many studies have been done to better understand neural networks present in the brain with specific activities.

This entire paper could be focused what I learned from this book, but in order to tie this all together, I will try to use several of his studies to help us understand social and brain function. The work of Dan Siegel and his explanation of interpersonal neurobiology was also very helpful.

I would like to first look at the default mode network(DMN). This is the pathway that is active when cognitive, visual, or motor tasks are completed. The time between tasks has been termed “social cognition” or the the process of thinking about yourself, others, or your relationship to others. Previously it was thought that social intelligence was no different than cognitive intelligence applied to social settings. But this suggests there is a completely different part of the brain that is assigned to this process. “A few provocative findings that suggest default network activity during rest, may reflect an evolved predisposition to think about the social world in our free time rather than its being merely a moment-by-moment personal choice.” This area of activity in the brain has been seen in newborns as early as 2 days old. An example where this area of the brain does not function normally is autism spectrum disorder where deficits in social communication and interaction may stem from a problem in the DMN.

How is screen activity that is social truly different than live interaction? The biggest difference is the interaction between two social people and this leads to differences in actual brain activity that does not occur with a screen. Now I want to reference the work of Andrew Meltzoff and Patricia Kuhl at the University of Washington and their research on early childhood development. He established that imitation and interaction in newborns occurs, likely in connection with the DMN. Dr. Meltzoff shows early newborns can imitate actions such as sticking out their tongues. Social interactions with newborns is critical part of their brain development. Screen activity has not shown to yield the same benefits as live interaction and if screen activity takes away from parental interaction it is detrimental. And social interaction is fundamentally necessary for our neurodevelopment.

A new model for the mind presented by Dan Siegel helps us understand our social dimension of who we are. He defines the mind as “an embodied and relational process that regulates the flow of energy and information. An emergency process that arises from energy and information flow within you and between you and others.” Mindfulness as an application of these principals is trying to improve and develop our social awareness of ourself and others. It can help with depression, anxiety, and bullying. It is being implemented in Holland Public Schools.

When we experience the death of a close friend or family member, it is a painful experience. Where is this pain? And how can we understand it better? in 1978, Jaak Panskeep hypothesized that social pain used the same pain system that physical pain did in the brain. He noticed that the attachment process of animals could be seen to

parallel the experience of addiction. To test his hypothesis, he took some puppies and isolated them from their mother. The puppies would cry out in distress. If he gave the puppies low doses of morphine, not enough to cause sedation, the cries would stop. This suggests that the same neurochemical cause of physical pain and distress may be present with social pain.

Lieberman set out to further study this hypothesis looking at fMRIs of a specific part of the brain the, dorsal anterior cingulate cortex and the anterior Insula. These parts of the brain are thought to be central to distress from pain. Not perception of pain, but distress beyond pain. The cingulate cortex is densely populated with opiate receptors. He designed an experiment where the subject was told they were studying brain activity while he played a video game. The video game consisted of throwing a ball with two other subjects. After several minutes the two other subjects would only throw the ball to each other and exclude the subject. In reality, there was only 1 person playing and a computer was doing the rest. What they saw on the fMRI scan was that the dorsal anterior cingulate cortex and anterior Insula would activate when the subject was excluded. A separate study looking at pain showed similar activity in this area. The next step was most interesting. When the study subjects were given Tylenol the activity in this area was blocked.

I don't have any easy solutions. The iPhone or smartphone does have many benefits. It has brought the internet to many that previously did not have it. It allowed my daughters to watch live their grandmother's funeral in Myanmar and connect with their family. But, too much of many good things come consequences and side effects that may be very serious. We are wired to connect socially, and decreasing this whether it be our changing culture, addiction to the internet, or pseudo social interactions has consequences. I am most concerned for the next generation if their neurodevelopment is somehow hampered by the tech society with live in. We need to set boundaries and limits. Technology is here to stay and though it has many benefits. However, we have limited time each day and when so much is spent on a screen it has potential consequences to our brain and more importantly brain development. We have a basket at home and require our children to put their phones away to be present. It has been a struggle to accomplish this. Ironically while typing this paper the other night, Isaac and Sophia were on their phones and Nathaniel was playing Minecraft all while the TV was on. Smartphones are here to stay, now we have to learn how to balance the benefits and limit potential negative effects they may be having on us.

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