How your smartphone was engineered to outsmart you.


How many times a day do you think you use your smartphone? 100? 1000? According to one study, the average smartphone user swipes 2,617 times a day, while the top 10% of smartphone users clock in at an eye-popping 5,427 times per day. That’s an average of once every 33 seconds (and once every 16 seconds for those top 10%).

Could this possible be true? If it is any indication, pedestrian traffic deaths have skyrocketed over the past few years to the point where New York City began painting “LOOK UP” at street crosswalks. Never before in history have humans had access to so many addictive substances; the isolation, purification, and synthesis of substances such as heroin (and synthetic opioids), cocaine and even “food” is accelerating in sophistication every day. Now add to the list the ready availability and potency of online gaming and pornography thanks to the internet, and the addictive potential of delivery vehicles themselves (i.e. smartphones).

I remember the first time I got a cellphone. It was exciting to have a phone in my pocket, and certainly convenient to be able to make a call on-the-go, yet I didn’t sleep with it next to my bed. If given a choice, I wouldn’t prefer bodily harm to myself over it (yes, this was an actual study). I didn’t caress it 2,500 times a day. Yet, today the smartphone is so much more than a phone. And it is so much smarter. It didn’t spontaneously develop artificial intelligence; this type of technology has been increasingly designed to hook us more and more, to the point where internet addiction, for the first time is being considered for inclusion in the Diagnostic and Statistics Manual (the “Bible” of psychologists and psychiatrists).

Enter Irresistible: The Rise of Addictive Technology and the Business of Keeping Us Hooked. In this book, Adam Alter walks us through the history of behavioral addiction (part 1), how an addictive experience is engineered (part 2), and looks at what the future has in store for us, including some early-stage attempts at addressing the problem (part 3). This is a thoroughly entertaining and easy to read book, filled with the fascinating stories behind “milestones” in the evolution of behavioral addictions.

By definition, the field of study and the business behind internet and smartphone addictions is in its infancy –the iPhone recently celebrated its 10th birthday. Yet, behavioral addictions run deep, and have a history that can be traced back to the basic biology underlying reward-based learning, a discovery that earned Eric Kandel a noble prize in 2001 when he showed that the sea slug, which has only 20,000 neurons total, learns via positive and negative reinforcement (i.e. operant conditioning). This is the same basic mechanism that humans use for survival, as we learn to remember where to find calorie-laden food, and how to avoid danger.

After highlighting some of the startling statistics that suggest that behavioral addictions are an issue (I imagine few of us today would disagree with this - looking around us on the subway provides plenty of data), Alter spends a bit of time unpacking more “classical” addictions, such as cocaine, and how it made it into the first formulation of Coca Cola. He also describes some fascinating “lessons learned”
from what was feared to become an opioid epidemic but never happened, at the end of the Vietnam war. One of the key points relates back to the fundamental aspects of reward-based learning: context. Another way that this been described is for the formation of “context-dependent memory:” our survival mechanisms are set up to help us remember where food is so we can go back for more, and where danger, so we can avoid it. In a nutshell, soldiers in Vietnam formed context-dependent addictions to heroin. When then returned to the US after the war, the context was different, and the heroin epidemic never materialized (beyond a much smaller number of veterans who remained active users). To wit, the current opioid epidemic, which is alive and well (and killing more people than the HIV epidemic at its peak), is also dependent upon context, as the likely primary precipitant was the over-prescription of opioid pain medications right here in the US (of note: this is a complicated story, including being traced back to a significant degree to false marketing and miseducation of healthcare providers by specific companies; as an addiction psychiatrist working in one of the epicenters of the epidemic, I do not wish to oversimplify it).

Alter also takes a solid stab at describing some of the underlying neurobiology of addiction. In a very engaging story about the scientists and laboratories that were behind the famous discovery of the brain’s “pleasure centers” as they became to be known in the 1950’s and 60’s, he highlights how Milner and Olds came together to perform the experiments that showed that rats would prefer to stimulate a certain part of their brain to food –to the point of exhaustion and death.

We now know a lot more about the underlying biology of addiction, including the differentiation between “liking” and “wanting.” This work is touched upon in the book (e.g. Kent Berridge’s seminal work over the past few decades), yet at times some of the important distinctions may benefit from further differentiation. As a neuroscientist, I point this out not to nitpick about nuance that may not make a difference in the long run, but as an important caveat to the many related fields of psychology, marketing, cognitive neuroscience and the like, so that we can move forward as a whole to help conquer addiction. With differentiations such as liking something vs. wanting it, the long-held notion that dopamine is “the pleasure” molecule is now coming into question as it likely functions more in the realm of the latter than former. This is critical for the understanding of how reward-based learning works, how this can be “engineered” to get us addicted to technology, and in formulating mechanistically-based solutions.

Alter highlights the three main components of reward-based learning in his book: Trigger, Behavior, and Reward. From the standpoint of reward-based learning, what might not be so obvious to a behavior-focused society, is that this process is driven more by the reward than the behavior. In other words, it matters more what the reward for the behavior is than the behavior itself. For example, if we were to get an A+ on an exam or paper, the letter A and the symbol + by themselves are meaningless. They only matter in the context of what comes as a result –and these can come in many forms, from extrinsic or externally-based rewards of praise, admission to the college of our choice, etc. to the intrinsic or internally-based ones of the feeling of accomplishment we might feel ourselves. Yet not all rewards are created equally.

In humans, the drive of dopamine that is linked to wanting has also been shown to be linked to brain regions implicated in self-referential processing, such as the posterior cingulate cortex. Self-referential processing refers to times when we are thinking about ourselves or processing events related or relevant to us. Alter points to some interesting studies of romantic love (work by Arthur
Aron, Helen Fisher and others, e.g. (Aron, Fisher et al. 2005, Acevedo, Aron et al. 2012)) that, similar to drugs of abuse, activate the brain’s dopaminergic reward system. Looking carefully at these studies, it is interesting that individuals that have a more “obsessive” (arguably addicted) type of romantic love can be differentiated not by their dopaminergic activity, but by how active their posterior cingulate cortex is. This brain region is also activated when people who are addicted to various substances and behaviors such as cocaine, smoking and gambling are shown cues representing their substance/behavior of choice. And it is activated when adolescents get a bunch of likes in their Instagram feeds. In contrast, my lab has found that this same brain region gets deactivated with behaviors that are in the opposite spectrum of being caught up in addiction, yet are pleasurable in themselves, such as during meditation (and even a type of meditation that involves selfless/altruistic love). This may suggest that the drive behind wanting is even more separable from liking than previously conceived, and has important implications for addictive game and gadget design.

There are a number of very compelling stories of individuals with behavioral addictions threaded throughout Irresistible. In these depictions, the reader gets a very clear sense that the behavior quickly moves from pleasurable to driven – the same type of progression I have heard time and time again from my clinic patients who start using cocaine to feel the rush of getting high, but come to me for help when they are “chasing” which often is described in terms of simply trying to get back to baseline.

In the second part of the book, Alter expertly describes the “juice” which “refers to the layer of surface feedback that sits above [a video] game’s rules (p. 137).” This entire section is where the book really shines – admittedly, I couldn’t put it down. In a fascinating expose, Alter pulls back the curtain, expertly exposing and explaining the surprisingly basic rules that gamers use to engage and eventually hook players (e.g. points, badges, leaderboards). Very relatable stories of Super Mario Bros. and the games that will make it into the proverbial video game hall of fame are so vividly told that weeks after my first read of the book, I can still recall them (who knew that the guy who designed Tetris became so addicted to it that someone else had to finish the coding of it?). He also brings in more nuanced psychological theories that are layered in to drive behavior even more. For example, he explains Vygotsky’s “zone of proximal development” in which there is an intrinsic reward that comes with learning, especially when continually challenged with problems that are just beyond one’s reach, but not too far out of that zone. Another example comes from the “cliffhanger” scenario in which research has shown that we get ants-in-our-pants when a television show ends without proper resolution, and are motivated to quickly watch the next episode. Now we all know where the term “binge-watching Netflix” comes from.

In the final part of his book, Alter helps us take a sobering look at what could be our, and perhaps more importantly, our children’s futures, if we are not careful. He also provides a description of a number of different treatments that are being developed or adapted for behavioral addictions, such as Cognitive Behavioral Therapy. This may be a bit heroic in its telling, as the majority of treatments that have been developed for addictions have not met the level of accomplishment that society would deem wildly successful (e.g. relapse rates range up to 80 to 95%). On top of this, as Alter aptly points out, we don’t need to smoke cigarettes or shoot heroin to survive. Yet I can’t imagine driving into Boston and making it out alive without my smartphone’s GPS. We can’t just flush our computers and smartphones down the toilet. Might there be a solution? He goes on to set up straw man
arguments for replacing one addictive behavior with something else, as well as for distraction. Good luck trying to find behavior that is as addictive or as ubiquitous as your smartphone, which is also our go-to to distract us when we are nervous, bored, or procrastinating! As he puts it, “The goal, in the long run, is to be free of bad habits altogether—not to replace one bad habit with another (p. 273).”

Alter postulates, “The answer is not to medicalize these moderate forms of addiction, but to alter the structure of how we live, both at a societal level and more narrowly, as we construct our day-to-day lives (p. 258).” He then details behavioral architecture, an interesting idea that aims at designing temptation-free environments while blunting unavoidable temptations. For example, instead of avoiding Netflix altogether, the idea would be to understand the “binge-viewing trap” and based on this enlightened understanding, avoid this type of behavior by “turning off the show before the cliffhanger arrives (p. 288).” He admits that this is a tall order, as it goes against the Zeigarnik effect (i.e. we remember uncompleted tasks more than completed ones) -and I’m trying to imagine a single one of my patients, or myself for that matter, that has this level of self-control.

Perhaps there are other ways out? Following Self Determination Theory (key elements: autonomy, relatedness, competence), Alter goes on to detail a bit of the difference between extrinsic and intrinsic rewards that I mentioned earlier. For example, in one study, students enjoyed completing a series of puzzles until researchers began paying them. They had moved (or been artificially nudged) from the internal reward stemming from joy of the play to the clear external reward of monetary gain.

This may be a critical link. Bringing together what is known about reward-based learning, gamification, and the quality of extrinsic vs. intrinsic rewards, we might be able to tap into the very reward-based learning process that has gone from helping us get enough calories to survive to a society of obese video-game junkies. As Self Determination Theory hints at, we might be able to start by more clearly separating intrinsic from extrinsic rewards – for example, the joy that comes from discovery vs. the excitement that comes from getting a badge or a monetary reward. On a pragmatic level, helping individuals clearly see the value of the reward, not intellectually, but experientially, helps rewire the reward-value that is stored neutrally (e.g. orbitofrontal cortex plays a role here). Remember, reward-based learning is based on the reward/result, not on the behavior itself.

For example, in a study of mindfulness training, where we taught smokers to pay attention to what cigarettes actually taste like, they began reporting that they couldn’t believe how bad they tasted, and were incredulous that they hadn’t noticed this before. One of my favorite quotes from one of our participants: “Smells like stinky cheese and tastes like chemicals, YUCK!” With mindfulness training individuals were 5 times more likely to quit than with gold standard cognitive behavioral training. With technology addiction, we can do the same: help individuals clearly see the results of swiping their phones 5,000 times, or staying up all night to finish binge-viewing a television series.

Knowing another aspect of how the brain works with regard to reward-based learning may also help: rewards are relative. A simple example of this is being offered $1 vs $100. Which one do we prefer? We can do this simple experiment ourselves by putting the two bills next to each other and looking at our reaction etc. Cigarettes may not taste good, but they taste even worse when compared to something delicious. The same may be true if we can carefully compare extrinsic vs. intrinsic rewards in our own experience (and certain types of mindfulness training do just this). For example, in a
program that we created to help people break the habitual cycle of emotional or binge eating, especially in the setting of obesity (which is delivered digitally in an app-based platform named Eat Right Now –yes ironically, we use smartphones), we focused on helping people clearly see what the results of simply paying careful attention as they ate (intrinsic) vs. focusing on outcomes such as weight loss (extrinsic). Here’s an example from a participant:

The act of observing and identifying various elements of the experience, using all my senses, was so engrossing I was completely focused and invested in what I was doing and consequently found the act of consciously eating rewarding in and of itself; I got through 3/4 of the slice and had to stop. I just didn’t want to eat any more and offered the last 1/4 to my partner to finish. I knew that if I tried to eat the whole thing, on my own, I would feel sick; what had been an enjoyable experience would have been diminished and this choice made me feel really good. Lastly, and this was unexpected, when I finished the exercise I felt this unfamiliar level of clarity.

Importantly, she is describing (1) the intrinsic joy of eating, (2) the relative lack of reward that would result if she kept eating (“I would feel sick”), and (3) the natural change in behavior that did not require self-control. In a study of overweight and obese women (led by Ashley Mason, PhD), this “hacking” of the system led to a 40% reduction in craving-related eating (Mason, Jhaveri et al. 2017). It may be able to be applied to behaviors that may be vulnerable to dysfunctional reward-based learning such as anxiety, and more broadly to behavioral addictions that have been explicitly and systematically cultivated.

Adam Alter’s book is in itself irresistible for anyone who wants to learn how technology is being designed to get and keep us hooked. Knowing how the system works is the first step in changing it.

Judson Brewer MD PhD
Chief, Division of Mindfulness
Director of Research, Center for Mindfulness
Associate Professor, Medicine and Psychiatry
University of Massachusetts Medical School
Research Affiliate, Department of Brain and Cognitive Sciences, MIT

References: