

**Testimony for Commerce Finance and Policy Committee,  
the Minnesota House of Representatives and the Minnesota State Senate**

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Dear Chairperson Stephenson and Honorable Members of the Committee:

Thank you for your leadership in advancing this important public debate on online safety and the very real dangers of tech addiction, especially of children and transitional age youth (18-25).

I am a Professor of Psychiatry and Addiction Medicine at Stanford University School of Medicine, where I teach, do research, and see patients struggling with a range of mental health conditions including tech addiction: Addiction to digital devices and digital media. I am also the author of [\*Dopamine Nation: Finding Balance in the Age of Indulgence\*](#) (Dutton 2021), which explores the new scientific discoveries that explain compulsive overconsumption.

In over two decades of medical practice, I have seen growing numbers of youth present with tech addiction and their downstream effects, including but not limited to anxiety, depression, suicidal

ideation, insomnia, inattention, eating disorders, body dysmorphia, and the physical sequelae of physical inactivity and sleep deprivation.

What is addiction? Addiction is a chronic, relapsing and remitting disease with a behavioral component, characterized by neuroadaptive brain changes resulting from exposure to addictive drugs. Every human being has the potential to become addicted. Some are more vulnerable than others. Risks for becoming addicted include genetic, developmental, and environmental factors (nature, nurture, and neighborhood). One of the biggest risk factors for addiction is simple access to addictive drugs. When supply of an addictive drug is increased, more people become addicted to and suffer the harms of that drug.

- a. The Diagnostic and Statistical Manual of Mental Disorders (DSM-5) uses the term “substance use disorder” to denote addiction. Although tech addiction is not yet included in the DSM-5, Gaming Disorder (addiction to online games) has been acknowledged by the World Health Organization and I believe the next edition of the DSM will encode tech addiction in some form.
- b. DSM-5 denotes 11 different criteria to diagnose opioid use disorder (OUD).<sup>1</sup> A short-hand way to remember these criteria is the “four C’s”: Control, Compulsion, Craving, and continued use despite Consequences.

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<sup>1</sup> *Diagnostic and Statistical Manual of Mental Disorders*. (DSM-5) Washington, DC: American Psychiatric Association; 2013 at p. 541.

- i. Control refers to out-of-control use, for example using more than intended, or an inability to cut back use when necessary.
  - ii. Compulsion refers to mental preoccupation with using against a conscious desire to abstain, and a level of automaticity that is outside conscious awareness.
  - iii. Craving refers to physiologic and/or mental states of wanting.
  - iv. Consequences refers to the social, legal, economic, interpersonal, and other problems that arise as a result of use, yet which still do not deter use.
- c. The DSM-5 also recognizes that addiction is a spectrum disorder, divided into mild, moderate, and severe, based on the number of criteria met.<sup>2</sup>
- d. From a neuroscience perspective, addiction is a disorder of the brain's reward circuitry.<sup>3</sup>
- i. Digital drugs stimulate the release of the pleasure neurotransmitter dopamine in the brain's reward pathway. In order to accommodate the high amount of dopamine released, the brain adapts by downregulating its own endogenous dopamine and its own endogenous dopamine receptors. This process is called neuroadaptation, and the result is a dopamine deficit state, wherein

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<sup>2</sup> *Id.* at pp. 541-542.

<sup>3</sup> Koob GF, Volkow ND. Neurocircuitry of addiction. *Neuropsychopharmacology*. 2010;35:217-238. doi:10.1038/npp.2010.4.

the threshold for experiencing pleasure goes up, and the threshold for experiencing pain goes down. Addicted individuals then need the substance not to feel good, but to escape the pain of withdrawal.

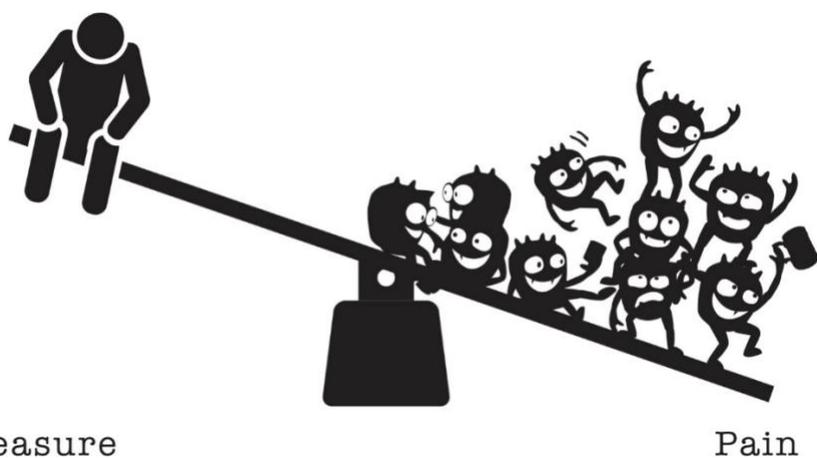
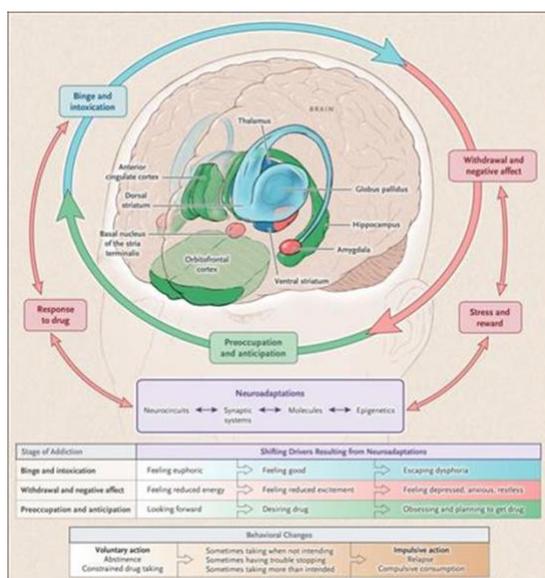
- ii. In severe forms of addiction, individuals commit all available resources to obtaining more of the substance, even forgoing natural rewards like food, finding a mate, or raising children.<sup>4</sup> By hijacking the brain's reward and motivational centers, addiction leads to compulsive, self-destructive consumption that overcomes the limits of voluntary choice. The cycle of neuroadaptation is illustrated below<sup>5</sup>:

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<sup>4</sup> Schultz W. Potential vulnerabilities of neuronal reward, risk, and decision mechanisms to addictive drugs. *Neuron*. 2011;69(4):603-617. doi:10.1016/j.neuron.2011.02.014.

<sup>5</sup> Volkow, ND., *et al.*, Neurobiologic Advances from the Brain Disease Model of Addiction. *N Engl J Med*. 2016; 374:363-371, Figure 1.

## Cycle of Neuroadaptation<sup>6</sup>



The image above<sup>7</sup> is intended as a representation of the longterm effect of intoxicants, including digital drugs, on the neurocircuitry of the brain. Pleasure and pain are co-located in the brain and work like opposite sides of a balance. One of the overarching rules governing that balance is that it wants to remain level. Drugs, including digital drugs, disrupt the balance by inducing an abnormally large influx of dopamine. This results in an initial feeling of intense pleasure,

<sup>6</sup> *Id.*

<sup>7</sup> Lembke, Anna. *Dopamine Nation: Finding Balance in the Age of Indulgence*, 2021, Dutton Penguin Random House.

followed by pain in the form of withdrawal. This is represented by the “gremlins” on the right side of the image. The addicted individual then seeks another dose of their digital drug, not to get high, but rather to avoid the pain and other negative sensations that accompany withdrawal. The universal symptoms of withdrawal from any substance or behavior are anxiety, irritability, insomnia, dysphoria, and craving. Because addiction affects the same neural pathways evolved over millions of years to encourage humans to seek out pleasure and avoid pain, everyone is vulnerable to the disease of addiction.

Children are especially vulnerable to neuroadaptation because their developing brains prune away the neurons and neural circuits they are using least and myelinate (make more efficient) the neural circuits they are using most. This pruning period lasts until approximately age 25, at which point the individual is left with the neural scaffolding they will use throughout their adult life.

Digital products are addictive by design. They can be analogized to cigarettes, except unlike cigarettes, digital media comes in an infinite supply available 24/7 and entirely for free. Social media is distinct from other forms of media, and distinctly more addictive, in the following ways:

- a. Social media is infinite. Quantity and frequency matter. The more of a drug a person uses, and the more often they use it, the more likely they will get addicted to it. Social media never runs out and pervades almost every aspect of our lives. Most school-age children are now required to have a laptop or other device to access class schedules, grades, and lessons.

- b. Social media relies on hyper-individualized targeting. Artificial intelligence (AI) algorithms gather user-data and then use this information to suggest future digital options through targeted advertising, alerts, and push notifications. Ads, alerts, and notifications become cue-induced triggers which release dopamine in the brain's reward pathway, leading to the craving which drives continued engagement.
- c. Social media (and other platforms) use ranking, enumerations, and streaks to maintain consumer engagement. Quantification makes these digital drugs more addictive, especially when quantification becomes a way to compare self to others using the same platforms. Teenagers are more sensitive to social comparisons than adults. For example, number of likes for a posted image, rankings in games, and desire to maintain 'streaks', are all ways these platforms collect and communicate numerical data to encourage compulsive overconsumption. Self-comparisons which register for the user as 'not measuring up' can lead to depression, anxiety, despair, and self-harm.
- d. Social media relies on gamblification of the platform to encourage overconsumption. Unpredictable rewards are more rewarding to the human brain than consistent rewards. The interactive nature of social media means that people are not just consuming media, they're creating and responding to it. When engagement leads to the desired and expected outcome, dopamine levels surge. When engagement leads to an undesired outcome, dopamine levels plummet. The uncertainty of the outcome is a potent elicitor of

addictive behaviors, as the uncertainty of the game itself becomes the source of addiction.

- e. Social media platforms do not make it easy to de-subscribe. Parental monitoring is labor intensive and requires a level of IT sophistication that is beyond most parents. Children are good at finding ways to circumvent existing guardrails.
- f. Social media is mostly free, making it more likely for consumers, especially children, to access it. The costs are largely hidden and have to do with opportunity costs (other ways children could be spending their time) and mental and physical health costs, as mentioned above.

Online digital products and devices bring with them clear societal and economic opportunities but can also lead to harms. Tech ecosystem stakeholders, including regulators, corporations, government, schools, and consumers together have a responsibility to address tech addiction and overuse, especially among youth.

Sincerely,

Anna Lembke, MD