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The Role of Impulsivity and Addiction in Gambling Behaviors: How Applied Neuroscience Research Can Help in the Monitoring and Management of Mental Health Issues

Yingzhen Jia[1*], Kimberly Rose Clark[2]

[1]College of Arts and Sciences, Boston University, Boston, MA, USA
[2]Department of Psychological and Brain Sciences, Dartmouth College, Hanover, NH, USA
Email: *yzjia@bu.edu, Kimberly.R.Clark@dartmouth.edu

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Abstract

One in five Americans experience symptoms associated with at least one mental health disorder every year. These include behavioral addictions, which have long been overlooked despite their similar neural bases with substance addictions. Gambling addiction, a type of behavioral addiction, deserves particular attention given the significant negative effects, this addiction has on financial and interpersonal health. The purpose of this paper is to review the available literature concerning the behavioral and neural processes involved in gambling addiction, including: the anticipation of reward, the role of dopamine, and the neural substrates of the decision-making processes involved in gambling addiction. Market research has also identified solutions that integrate applied neuroscience and self-tracking systems to monitor and manage mental health issues associated with gambling addiction. The authors then propose a gambling treatment-focused mobile app solution that addresses outstanding issues with a special design aimed at reversing plasticity in order to relieve the effects of gambling addiction.

Keywords

Applied Neuroscience, Gambling, Addiction, Mental Health Management

1. Introduction

The general goal of this paper is to provide an overview of addiction in order to consider a conceptual framework for a novel mental health assessment or treatment tool for gambling addiction. We begin by reviewing the definition and

prevalence of addiction, highlighting key features and characteristics associated with gambling addiction. We then review the neural basis of addiction with a focus on gambling behaviors and the brain and body measures associated with addictive tendencies. In addition, we also investigate the work of private companies providing services aimed at relieving mental health and addictive behaviors. Our aim is to offer a novel way to integrate the advantages of these tools with current neuroscience research on the topic. By synthesizing this information, the paper serves to enhance our understanding of gambling addiction and discuss how the application of current neuroscience information can help in the monitoring and management of mental health issues associated with gambling addiction.

1.1. General Statistics on Mental Health Issues

Mental health issues currently affect a significant portion of the population, with approximately 1 in 5 adults in the US experiencing symptoms associated with at least one mental health disorder each year. In 2021, only 47.2% of these individuals received treatment or intervention[1]. One of the most disruptive mental health issues is addiction. According to the Oxford Languages Dictionary, addiction is defined as "being addicted to a particular substance, entity, or activity"[2]. Addictive behavior should not be viewed as a singular condition but rather as a complex condition impacted by both intra- and interpersonal factors.

1.2. General Statistics Related to Gambling Addiction

For a majority of individuals who engage in forms of gambling, it is a healthy means of recreational entertainment. However, for some individuals, gambling moves beyond a healthy form of entertainment and becomes an addictive behavior. A recent report found that about 10 million people have reported a gambling addiction in the past year[3]. Approximately 85% of American adults have gambled at least once in their lives, and 60% in any given year, according to the National Council on Problem Gambling [1]. In addition, 86% of Americans consider gambling as an acceptable form of entertainment, as suggested by the American Gaming Association [2]. In the United States, gambling has gained significant popularity over the past few decades, especially in the form of online gambling, since the global pandemic of COVID-19. The estimated increase in online gambling is between 11% and 20%, excluding the highest and lowest estimates from 8 different studies in various countries [2].

Both the vast number of participants and the increasing trend in gambling call for additional research and methodology development for managing pathological gambling behavior. Given the remarkable amount of information available concerning drug addiction (compared to what we know about gambling addiction), a comparison between these two might provide important insights. As the *Diagnostic and Statistical Manual of Mental Disorders*, *Fifth Edition*, or DSM-V

[1]https://www.nami.org/mhstats.
[2]https://languages.oup.com/google-dictionary-en.
[3]https://skywoodrecovery.com/gambling-addiction/negative-effects-of-gambling-addiction/statistics/.

suggests, an individual can be accurately diagnosed as having an addiction if they meet two of the following 10 criteria: tolerance, withdrawal, hazardous use, social or interpersonal problems related to use, neglected major roles due to use, use of larger amounts over time, repeated attempts to quit or control use, increased time spent using, physical or psychological dependence problems related to use, and giving up other activities to use[4].

1.3. Defining General and Specific Types of Gambling

Gambling encompasses a range of activities, providing individuals with opportunities to participate in games of chance for entertainment or monetary rewards. The most prevalent forms include casino gambling, sports betting, lottery games, and online gambling; whereas social gambling, including bingo and raffles, is also popular. Each form of gambling also includes various types. In casino gambling, for example, betting includes games such as slot machines, roulette, blackjack, craps, baccarat, and poker, which can be played in brick-and-mortar locations or in online casinos.

1.4. Comparison between Addiction to Drugs and Gambling Behavior

Table 1 presents the ten DSM-V diagnostic criteria for drug addiction, their definition, and an example of how each relates to gambling addiction. Of note, is the compelling connection between gambling and drug addictions, suggesting a similar neural mechanism for both pathologies.

2. Understanding the Neural Basis of Addiction

Gambling addiction is thought to involve a combination of genetic and environmental factors. Research on the neural mechanisms of addiction has delineated a "reward system" in the brain that comprises several brain regions, including the ventral tegmental area (VTA), the nucleus accumbens (NAcc), and the prefrontal cortex (PFC). This reward system is involved in the anticipation, experience, and learning of rewards [3] [4].

2.1. Discussion of the Differences and Similarities between Drug and Behavioral Addictions

Despite the similar neural mechanisms involved in all types of addiction, there exist both similarities and differences between substance and behavioral addictions[5]. Perhaps in a different way, compared to drug addiction or alcoholism, behavioral addiction is an impulse control disorder described as being seized by the compulsion to take part in specific behavior or behaviors on a repeated basis, while neglecting potential physical, mental, or financial consequences. Gambling

[4]https://www.gatewayfoundation.org/addiction-blog/dsm-5-substance-use-disorder/#:~:text=DSM%2D5's%2011%20Criteria%20for%20Addiction&text=Using%20more%20of%20a%20substance,urges%20to%20use%20the%20substance.

[5]https://www.uk-rehab.com/behavioural-addictions/#:~:text=Although%20behavioural%20addiction%20is%20a,all%20substances%20are%20physically%20addictive.

Table 1. Chart of the 10 diagnostic criteria for addiction from the DSM-V (American Psychiatric Association, 2013) and the resemblance of gambling to drug addiction.

Criteria Identified by DSM-V	Definition of DSM-V	Resemblance to Gambling
Tolerance	Either a need for markedly increased amounts of the substance to achieve intoxication or the desired effect or a markedly diminished effect with continued use of the same amount of the substance.	Becoming so accustomed to gambling experience that significantly more monetary incentive is required to obtain the same levels of satisfaction.
Withdrawal	Either the characteristic withdrawal syndrome for the substance or that the substance is taken to relieve or avoid withdrawal symptoms.	Gamblers normally have a flashback of memories of their experiences and constantly remind themselves of the details of gambling.
Hazardous use	Recurrent substance use in situations in which it is physically hazardous.	Be willing to participate in gambling activities in places that are not commonly regarded as safe.
Social or interpersonal problems related to use	Continued use of a substance despite having persistent or recurrent social or interpersonal problems caused or exacerbated by the effects of the substance.	Significant issues arise both when gamblers neglect their roles in families or with friends and when are indebted after gambling losses.
Neglect major roles to use	Recurrent use of the substance leads to failing to fulfill a major part or responsibility to obligations at work, home, or school.	Spending time and money on gambling activities can lead to an inability to perform major roles at work, home, or school.
Use large amounts of longer	The substance is taken in larger quantities or even longer than intended.	More funds are put into gambling events; and more time is spent on related activities.
Repeated attempts to quit or control the use	There is a persistent desire or unsuccessful effort to cut down or control substance use.	Interventions from other people or institutions might not be sufficient to stop gambling activities despite gamblers themselves carrying the same intention.
Much time is spent using	A great deal of time is spent in activities necessary to obtain a substance, use the substance, or the ability to recover from its effects.	Gamblers spend their time intensively on obtaining funds for gambling and gambling activities.
Physical or psychological problems related to the behavior/use	Substance use is continued despite knowledge of persistent or recurrent physical or psychological issues that are likely to have been caused or exacerbated by the substance.	Despite previous negative outcomes related to gambling, the behavior continues.
Activities are given up to the behavior/use	Important social, occupational, or recreational activities are given up or reduced because of substance use.	It's common for gamblers to reduce their involvement in various social, occupational, or recreational activities as they need to spend time looking for funds and on gambling activities.

addiction falls into this category. Although a full diagnostic model has not yet been developed targeting this type of behavioral addiction, it is recognized that even some seemingly harmless activities can contribute to this phenomenon. In this way, it is theoretically possible for gamblers to become addicted without there being obvious physical evidence of addiction, as the changes occur from the dysfunction in the reward circuitry of the brain. On the other hand, substance addiction, in which an individual becomes physically dependent on ex-

ternal chemical substances, can cause more obvious physical symptoms that will require medical assistance. In short, though behavioral addiction and substance addiction share similar neural mechanisms, behavioral addictions receive much less attention as their effects are not as obvious in the short term. To better help gamblers with their specific type of behavioral addiction, a more thorough understanding of the neural origin of the reward system will be discussed.

2.2. Neural Origins of the Transformation from Reward-Seeking to Addiction: Understanding the VTA and NAcc Circuitry

The VTA is a small brain region within the brainstem that produces dopamine, a neurotransmitter associated with reward. When a rewarding experience or behavior occurs, dopamine projections from the VTA to the NAcc become active. Neurons in the VTA not only respond to the presence of rewards, but their response also depends upon whether the reward was expected [5]. To elaborate, Schultz and colleagues (1997) showed that dopamine neurons were most responsive to the delivery of a reward when that reward was unexpected, and they were least active when a reward that was expected was not delivered.

Thus, rather than simply being a reward detector, the function of the VTA is much more complex; being guided by the prediction value of environmental cues that precede the potential subsequent delivery of a reward (or lack thereof). Given these data showing that the VTA is most responsive to outcomes related to uncertain reward; and when compared to other data showing that the NAcc is responsive to reward per se; it has been suggested that VTA neurons may be involved in anticipation of rewards, while NAcc neurons may be involved in the experience of reward [6] [7].

To complicate matters, this increase in dopamine also produces the release of other neurotransmitters, such as glutamate and opioids, which are responsible for pleasurable feelings. Over time, the brain adapts to the increased levels of dopamine and becomes less sensitive to it [3] [4]. This means that people who engage in addictive behaviors, such as substance use or gambling will be a) highly sensitive to cues associated with the availability of reward via VTA activity, and b) will be highly activated by the delivery of reward requiring more and more to achieve the same level of pleasure via the NAcc.

2.3. Where the Regulation of Cravings Fails in Addiction: The PFC

The PFC is a region of the brain that is involved in decision-making and impulse control. The NAcc also sends projections to the PFC, alerting this part of the reward system about the presence of a reward, purportedly so the system can learn more about the environmental contingencies that led to this reward. It is thought that the PFC plays a role in avoiding addiction by helping people resist the temptation to use drugs or gamble (*i.e.* regulate their reaction to reward). However, in people who are addicted to drugs or gambling, the PFC is often less active, meaning they have trouble placing their knowledge about the negative

consequences of their addictive behavior (e.g. lost social relationships, criminal offenses) ahead of their desire for the drug or to gamble [3] [4]. Thus, behavioral addiction is thought to be related to dysfunction within the PFC leading to the observed impulse control disorder.

2.4. Neural Correlates of Gambling Addiction: fMRI-Based Research

Functional magnetic resonance imaging (fMRI) based research, which reveals the small hemodynamic changes that are associated with brain activity, can be used to examine which parts of the brain are carrying out critical functions during a given behavior [8].

These studies have identified neural circuits that support positive and negative emotions; specifically, the PFC and the amygdala are thought to play key roles. Emotions are important in guiding actions and organizing behaviors toward goals. The PFC supports affective working memory, whereas the amygdala plays a crucial role in the perception of emotional cues and production of emotional responses.

In a research study, eighteen individuals diagnosed with cocaine addiction and eighteen individuals diagnosed with gambling addiction were asked to perform a probabilistic reversal learning task during fMRI. Both cocaine users and pathological gamblers exhibited reduced ventrolateral PFC signal during the task, suggesting a neural marker associated with both gambling and cocaine addictions. These results also resonate with the suggested function of the PFC in affective working memory [9].

By understanding the neural mechanisms behind addictions, pathological gambling is quickly recognized to also be a "brain disorder"; one related to an underlying neurobiological abnormality [10] involving the neural circuitry that underpins gambling-related decision-making, including the ventral striatum, ventromedial PFC, VTA, and insula. The pathophysiology of gambling disorder manifests as a clinical disorder through the debilitating consequences of pathological gambling behavior. The behaviors follow known psychological features, including sensitivity to variable ratio schedules, near-misses, "losses disguised as wins", and the illusion of control. All of these features arise from the core decision-making circuitry that is perturbed in gambling disorder [10]. This information might help in the design of tools aimed at applying neuroscience to reverse such phenomena.

2.5. An Interaction between VTA/NAcc and the PFC Is at Work in Addiction

Interestingly, it has been noted that many individuals who have become addicted to drugs or other behaviors report that, though they no longer derive the pleasure they used to receive through addictive behaviors, they continue to maintain their addictive behavior. In response, Berridge (2007) [11] has proposed that drug addiction involves a disruption of the balance between "wanting" and "liking". Wanting is a motivational state that drives us to seek out rewards. It is as-

sociated with the anticipation of pleasure and the urge to act. Wanting is thought to be mediated by the VTA and NAcc. Liking is the subjective experience of pleasure that we feel when we consume a reward. It is associated with the release of dopamine in the brain. Liking is thought to be mediated by a system of PFC brain regions, that include the orbitofrontal cortex (OFC). In individuals addicted to drugs, the wanting system becomes hyperactive, while the liking system becomes hypoactive. This leads to a situation where these individuals are driven to seek out drugs (*i.e.* increased wanting), even though they no longer derive pleasure from them (*i.e.* decreased liking).

Together, these studies elucidate the involvement of three brain regions in the reward system that play a role in the production of dopamine and reward prediction (VTA), the processing of rewards (NAcc), and final decision-making (PFC). The overall loop is illustrated in Figure 1.

There exists little doubt that addictive drug use is related to the abnormal functional organization in the brain of the user, as shown by fMRI data. For example, compared with controls, chronic heroin users showed increased functional connectivity between the NAcc and ventral/rostral anterior cingulate cortex (ACC) in the PFC, between nucleus accumbens and OFC, and between the amygdala and OFC [12].

Several fMRI studies have localized specific brain regions related to various types of addiction. Neurosynth is an online platform for large-scale, automated synthesis of fMRI data. A search for studies related to various types of addiction produced, one hundred and thirty-five studies. The following is a summary of three that best relate to behavioral (*i.e.* non-substance) addiction and their associated brain regions.

Individuals with internet addiction disorder (IAD) are susceptible to a greater interference or "Stroop" effect and exhibit greater activation of the anterior and posterior cingulate cortices in the PFC during fMRI. This may underlie the diminished efficiency of response-inhibition processes in IAD [13]. Internet pornography addiction, one type of IAD, has also been found to be linked to increased ventral striatum activity (where the NAcc is located), especially when the

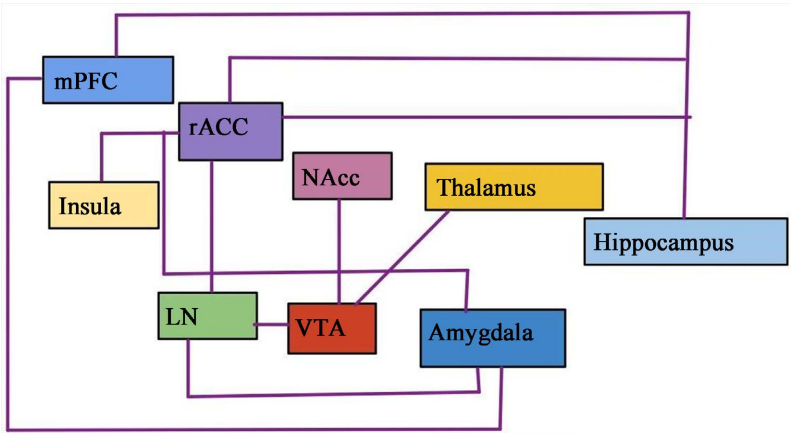

Figure 1. Brain regions and the reward system.

images shown to participants are closer to their preferences [14]. There is also an increase in the functional coupling between the ventral striatum and bilateral amygdala in gamblers with impulse control disorders (ICDs) compared to controls [15].

2.6. Corroborating Neural Evidence of Addiction through Trait-Based Inventories of Impulsivity and Addiction

Trait-based inventories assess relatively stable, or long-term personality or behavioral traits, reflecting individual differences in patterns of thoughts, feelings, and behaviors that are consistent and stable. Inventories exist that can address an individual's predisposition for engaging in addictive behaviors. For example, addiction susceptibility and the Big 5 Personality traits are correlated; specifically, neuroticism and openness are positively correlated with addiction susceptibility, whereas the traits of extraversion, agreeableness, and consciousness are negatively linked to addiction susceptibility [16].

2.7. Impulsivity and Trait-Based Assessments of Addiction Specifically Related to Gambling

In addition to trait-based assessments of addictive tendencies, there exists a body of inventories that specifically target assessments of gambling addiction. These include the Problem Gambling Severity Index, proposed by the Canadian Centre on Substance Abuse [17]. This index includes nine questions, each offering four choices classified according to severity. This inventory offers an opportunity for gamblers to realize the severity of their addiction and discover potential measures to be taken.

3. Background on Current Mental Health Apps

There exist an increasing number of "at-scale" apps, remotely administered measures, and assistance software dedicated to mental health. Many include measures of the body, such as emotional expression detection tools, eye tracking to monitor eye position information, cardiac measures (e.g. heart rate variability) to measure stress-related responses such as mental workload during specific tasks, and vocal fray analysis to measure stress. Sentiment analysis of positive and negative emotions is also included in some of these digital tools. Table 2 and Table 3 present a summary of such companies, what they offer respectively, what measures are used, and their mission to achieve.

From these tables, it is obvious that AI-led healthcare (20%) is becoming more prominent, and is often advertised as more accurate and precise. In addition, 30% of these companies provide platforms for integrated BPM as a solution for mental health monitoring. The majority (60%) of companies still aim to solely build connections between therapists and patients.

However, it is still surprising to see that the other 40% of companies integrate applied neuroscience within their products, despite only 20% of them using a

Table 2. Chart of 20 mental health companies, their merchandise, and missions.

Company	Offering Summary	Mission/Goal
Biobeat Medical	Uses health AI and ML on big data to provide actionable insights on patient care.	To improve mental well-being and reduce feelings of anxiety and stress.
CompanionMX	Combines a mobile app with an AI-based platform to help clinicians help people with mood disorders.	To help clinicians make smarter decisions for their mood disorder patients.
Amaha	Offers various self-help tools and therapy-based techniques for managing mental health.	To create a mental health ecosystem that provides treatment and care plans for a range of mental health conditions.
Mindyra	Uses mobile apps to track the mental health conditions of employees.	To explore the limitations of traditional employee assistance programs (EAPs) in addressing mental health challenges in the workplace.
Moodpath	Moodpath is an app that tracks an individual's mood and provides insights into their mental health.	To help users improve their emotional well-being, become more mindful, and address common mental health issues.
Shimmer Research	Supply customized sensor development services, volume manufacturing, and complete wearable sensor solutions for medical, neuroscientific, and clinical research.	To provide new data, new solutions, new insight, and new meaning.
Wysa	Uses AI-powered mental health app to provide personalized support.	To provide mental health support for everyone.
Meditopia	Uses mobile apps to improve emotional health with a designed meditation program.	To facilitate transformation and to help individuals learn how to look at their thoughts from a more objective perspective.
Lyra Health	Provides several comprehensive and effective mental health care options.	To transform access to life-changing mental health care.
Kingtsugi	Uses voice technology to help clinicians understand why their patients don't speak up.	To fill the gaps in mental healthcare.
Meru Health	Uses a holistic mind-body approach combining to provide flexible mental healthcare.	To build a new standard of mental health care.
Talkspace	Provides online therapy with therapists who are 24/7 available.	To eliminate the stigma associated with mental health and make therapy available to all.
AiBerry	Uses AI solutions to enhance the provider-patient relationship and screen for multiple health conditions with a short conversation.	To provide mental-health screening solutions to improve efficiency and save time for healthcare providers.
Solera Health	Builds online platforms to create a community that matches consumers and organizations.	To Change lives with choices.
Cognoa	Uses AI approaches to enable early diagnosis of behavioral health conditions.	To improve the ASD diagnosis and treatment pathway for children, caregivers, and the healthcare community.
I Am Sober	Uses the mobile app to track sobriety with an online community.	To maintain sobriety one day at a time.
Virgin Pulse	Uses a cloud-based employee wellbeing solution for businesses to promote mental healthcare.	To change lives for good.

Continued

Realeyez	Uses AI technology and collected data to measure human attention and emotion in response to advertising to drive optimal creative performance and media efficiency.	To make technology more human, and to bring a trillion more smiles to our planet every single year.
Affectiva	Uses human perception AI for market research that applies emotion recognition AI to determining user emotional engagement.	To bring emotional intelligence to the digital world with our emotion recognition technology that senses and analyzes facial expressions and emotions.
Tobii	Provide integrated products for both business and research using eye tracking.	To build technology that understands human attention and intent—what we call attention computing.

Table 3. Chart of 20 companies with their respective measures.

Company	Measures Used
Biobeat Medical	Health AI
CompanionMX	LVA, sentiment analysis
Amaha	Personalized platform and arranged psychiatry sessions
Mindyra	The screening tool, mobile tracking
Moodpath	BPM, voice analysis, GPS
Shimmer Research	GSR, BPM, HRV
Wysa	AI chat conversations
Meditopia	BPM, meditation
Lyra Health	Cognitive-based therapy
Kingtsugi	Voice analysis
Meru Health	BPM
Talkspace	Personalized BPM
AiBerry	Voice analysis, AI word analysis
Solera Health	BPM, a personalized platform
Cognoa	AI diagnosis
I Am Sober	Mobile tracking
Virgin Pulse	Integrated mental health assessment
Realeyez	Eye tracking
Affectiva	Emotion recognition
Tobii	Eye tracking

direct neurological approach.

4. Potential Novel Solution in Measuring Gambling Addiction Remotely

Limitations of current monitoring-only apps

Based on the information provided in Table 2 and Table 3, there are limita-

tions worth mentioning. The most noticeable limitation is the lack of the application of neuroscience, particularly in understanding the neural circuits and the root causes of addiction. These apps or websites primarily treat the external manifestation of addiction as the indicator for successful treatments, overlooking the long-lasting and recurrent neural effects associated with addiction. Incorporating information about addiction as a "brain disorder" might release patients from some of the guilt they may have concerning their symptoms and behaviors. Moreover, there exist no or very few available training solutions specifically focused on gambling addiction symptom reduction. Rather, most of the existing training solutions focus on the psychological side and not necessarily the behavioral aspects of the addiction. Further, existing mental health applications focus on descriptives and measurement but do not integrate a gamified aspect to their solutions. It has been shown that gamification of a desired goal increases goal attainment [18].

As only psychological solutions are available, there is a lack of quantitative indicators for the successful treatment of addiction. This issue is exacerbated by the unique nature of addiction, as it can be temporarily subdued through specific triggers without individuals realizing this is occurring. This, in turn, results in the recurring display of gambling behavior. It is only through quantitative indicators that the real condition can be supervised. By solely focusing on external manifestations, these platforms may provide short-term relief or temporary behavior modification but may fail to tackle the root complexities of addiction.

Another significant limitation of the mental health companies and mobile apps mentioned above is the restricted access they offer to the general public. This limitation arises from a combination of factors, including inadequate online publicity and the limited availability of apps specifically tailored to individuals struggling with certain types of addictions.

5. Capabilities of Novel Concept App

We have developed a new app concept to address the limitations of existing apps by adopting both psychological solutions and applied neuroscience, aimed at both public health outcomes and research potential. The design also considers the specific circumstances many gamblers face; the effects of gambling on persuasion and behavioral reinforcement. To this end, the overall design uses both comforting elements and colors while providing attention-grabbing language and visual cues. **Figure 2** presents example screenshots of the concept app.

By tracking certain behavioral responses within the app and collecting health data including heart rate, breathing rate, and body weight, we realized these data can provide important information both for the users and for research. If cooperation between the equipment companies can be established, we can work on collecting data and providing a monetary reward to users for participating in addiction research, which also helps them to alleviate the burden of quitting gambling while maintaining basic living standards. Researchers can also collect

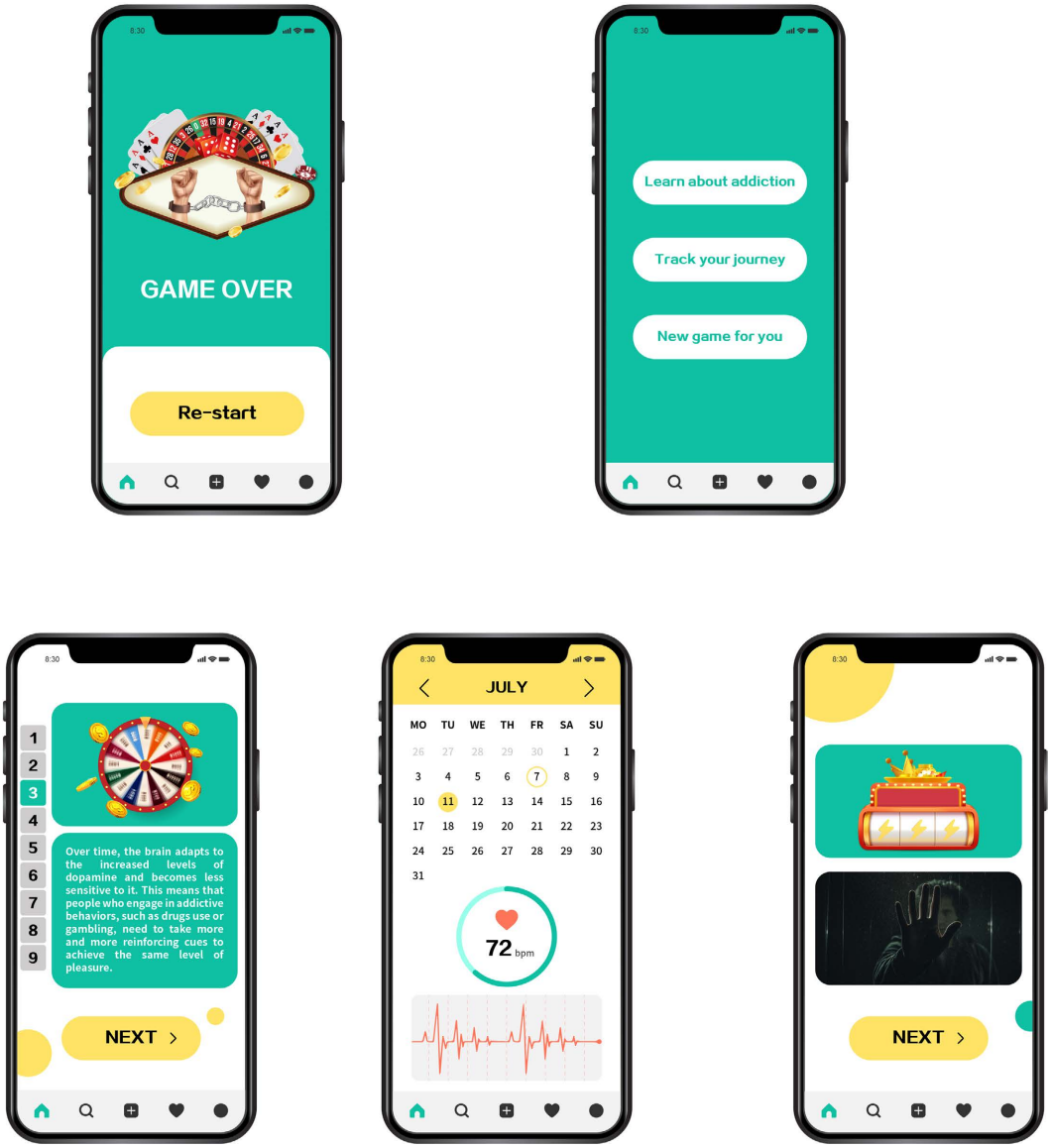

Figure 2. A presentation of the concept app's screenshots and form flow.

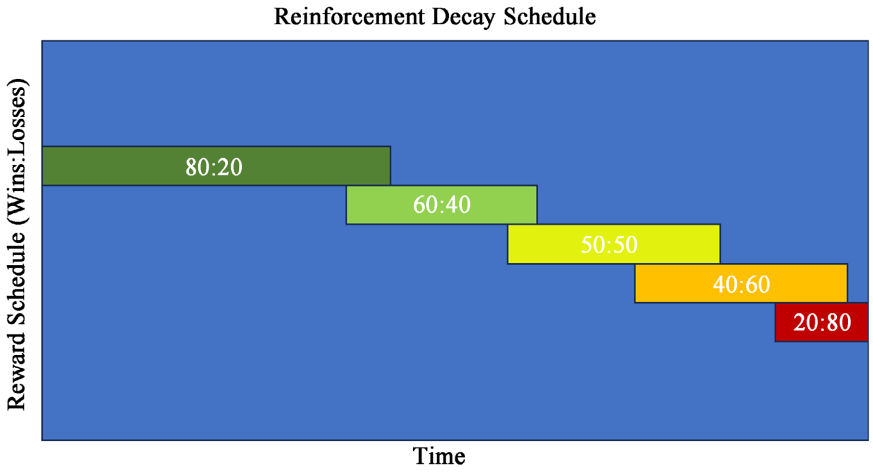

Figure 3. Reinforcement decay schedule.

metabolic data from individuals with pathological addiction to better understand this mechanism as it relates to gambling behavior.

6. Future Directions

As pathological gamblers often ignore feelings and responses from friends and family, it might be helpful to integrate such aspects into the app as well. For example, app users could choose a family picture to show on the opening page as a constant reminder of other reinforcements in their lives. Similarly, the use of several sensory modalities could also be more effective if individualized. Users could record voices from their relatives as reinforcement, being a positive or negative cue according to the contents of the sentence.

It is also possible to relate a reinforcement schedule with metabolic data. Heart rate and breathing rate can be a reference of excitement level, which could be used to monitor whether gamblers' responses to gambling have changed. Skin conductance is a more subtle and direct way of measuring excitement or attention that has the potential beyond attitude testing and can be monitored throughout the reinforcement training, testing the efficiency of the schedule.

Also, the app has the potential to integrate neural feedback therapy. This type of therapy is often used as a treatment for attention-deficit/hyperactivity disorder (ADHD) but can assist in other dimensions [19]. Neurofeedback therapy works to modulate the way the brain responds to certain cues. It has also been used to treat epilepsy, anxiety, depression, and insomnia, among other mental health disorders. This type of therapy has the potential to be integrated into assisting with gambling disorders.

Another possible direction for relieving the desire to gamble can be to decrease the satisfaction linked to winning itself. For example, optimal reinforcement schedules of winning and losing outcomes could be tested and implemented into future iterations of the concept app (see **Figure 3**).

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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