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Variable-Ratio Reinforcement and the Spectrum of Addictive Behaviour: A Comparative Analysis of TCG Consumption and Pathological Gambling

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Abstract. With the explosive growth of the trading card (TCG) market, the variable ratio reinforcement behind its card-drawing mechanism has raised concerns about behavioural addiction among teenagers, and it is highly likely that they will develop bad habits prematurely. This study adopts a double-case comparison method to compare KAYOU Heavy consumers of TCG and patients with pathological gambling, who were found to share similar neurobiological bases. Both use probability opacity and recency effects to induce dopamine secretion, leading to irrational consumption. Although TCG rewards physical collectibles and social labels are legal, their addiction risk is often underestimated, and there is regulatory arbitrage and information asymmetry. These structural vulnerabilities —probabilistic opacity, near-miss neuro-addiction, and legitimisation bias—enable regulatory arbitrage and information asymmetry, leaving adolescent consumers exposed to addiction risk without risk perception. Based on this, this paper proposes strategies such as mandatory probability disclosure, limiting reinforcement intensity, and reconstructing risk assessment criteria. This study reveals TCG as an entry behaviour for problem gambling. The potential risks involved provide a theoretical basis for formulating regulatory policies on gambling consumer goods and are of great value for protecting the mental health of teenagers and regulating the development of the industry.

Keywords: Variable-Ratio Reinforcement, Near-Miss Effect, Behavioural Addiction, Problem Gambling, Trading-Card Game (TCG)

1. Introduction

1.1. Research background

In recent years, the booming unpacking culture of Trading-Card Games (TCGs) has grown in popularity around the world, especially among children and students. It forces more people to pay more attention to the variable-ratio reinforcement, a core behavioural-psychological mechanism. In 2024, the market size of the Chinese TCG industry reached 26.3 billion RMB, according to Kayou's prospectus.

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The customer base of domestic collectible card games (in a broad sense, the main category of card games) is mainly composed of teenagers, which is significantly different from that of overseas football star cards, which are mainly targeted at adults. The majority of the buyers are in offline stationery. Meanwhile, the World Health Organisation has classified gambling disorder as a recognised mental health condition. Behaviour-addiction research demonstrates that TCG pack-opening mechanics share isomorphic reinforcement structures with slot-machine gambling: rewards (rare physical cards or monetary prizes) are delivered with fixed statistical probability but occur at random times, which sustains persistent dopamine release and amplifies repetitive engagement [1]. According to consumer complaint statistics, 33% of TCG-related public complaints involve accusations of inducing excessive consumption among minors. Scholars warn that TCG consumption may potentially serve as a gateway behaviour for subsequent problem-gambling engagement among adolescents [2]. Accordingly, systematically comparing psychological mechanisms behind TCG unpacking and problem gambling carries substantial commercial-regulatory, children's mental education and public-health value. Such analysis helps identify early warning signals for behavioural addiction, optimise marketing ethics within the collectible-card industry, and prevent youth gambling-related harms.

1.2. Literature review

The theoretical background to understanding variable-ratio reinforcement and addictive behaviours is provided by existing studies, which provide a solid foundation. Dixon et al. demonstrated that the neural circuits involved in near miss outcomes are the same neural circuits that are recruited by winning rewards among gambling participants, which shows that near miss outcomes can bias individual risk perception [3]. As to the uncertain consumption, Zendle posited that the uncertain reward delivery provokes human tendencies to explore and collect, and therefore leads to repeat purchase of collectible commodities [4]. Cosenza et al. also have further demonstrated that loss aversion and sunk-cost fallacy effects are significantly greater in variable-ratio feedback than in quasi-gambling consumption and gambling situations, and that loss aversion and sunk-cost fallacy are strong determinants of compulsive behaviour in both cases [5]. Griffiths also described the common cognitive-distortion characteristics found in problem-gambling populations, such as illusion of control, gambler's fallacy and delay of gratification deficits [6]. While these previous studies discuss the addictive behaviours of individual behaviours, there is little academic research that systematically compares the consumption of TCG with pathological gambling.

Existing literature mainly addresses variable-ratio reinforcement effects in the context of isolated behaviours. There is still a lack of appropriate comparative research examining the similarities and differences in psychological mechanisms related to TCG unpacking and problem gambling. Previous studies often dismiss TCG pack-opening as "mild gambling" and neglect the consideration of three salient aspects of divergence. First, the rewards are quite unique: TCGs provide physical collectible cards with symbolic collection value, while traditional gambling provides monetary rewards with universal liquidity, potentially affecting overall addictiveness. Second, there are also divergent social labelling, with TCG consumption socially accepted as a recreational activity and gambling as a socially stigmatised activity, therefore influencing the willingness to seek psychological help when harms become apparent [7]. Third, the motivations to play differ: TCG players are motivated by collection-completion, with problem gamblers being more motivated by expectations of monetary loss-recoupment [8].

Existing studies mostly examine the effects of variable-ratio reinforcement and fail to compare variable-ratio reinforcement with pathological gambling. Research studies frequently characterise

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TCGs as "mild gambling" but fail to account for key differences: rewards of TCGs versus other games (symbolic vs. liquid), social disapproval associated with TCGs compared with other games (legitimised vs. stigmatised), and motivations for engaging in TCGs versus other games (collection completion vs. loss recoupment). In addition, there has been a lack of research regarding de-reinforcement interventions. This emphasis on analogy makes it difficult to have regulatory precision based on evidence.

1.3. Research framework

This paper compares heavy consumers of Ultraman TCG and pathological gamblers from the perspective of a model that conceptualises the relationship between variable-ratio reinforcement, cognitive distortion, behavioural addiction and consumption alienation. It is an analysis of functional utilities and pathologies – including probabilistic opacity and near-miss neuro-addiction – and it proposes solutions, including mandatory disclosure of probabilities, to protect adolescent mental health.

2. Case profile: dual manifestations of variable-ratio reinforcement

This research is a dual-case comparison study to investigate variable-ratio reinforcement mechanisms. Case A examines KAYOU TCG, a homegrown market leader, which, in 2024, had over 18 million registered users and RMB 10.57 billion in sales, and featured tiered booster packs for child-oriented IPs like Marvel and Ultraman [9]. By contrast, Case B is a 23-year-old man with a history of family members with a problem with gambling and novelty-seeking personality traits. His first INR 15 in online Rummy grew into INR 5000 per game in two months, leading to a debt of INR 1.5 million, depression and suicidal tendencies. Both of these cases have variable-ratio reinforcement, loss chasing, and sunk-cost escalation, but they are fundamentally different in nature and consequence. Table 1 outlines these differences: a regulated commercial consumption phenomenon has been contrasted to a clinical form of gambling disorder in which there is psychiatric deterioration and financial ruin.

Table 1. Comparative analysis of TCG consumption vs. pathological gambling

Dimension	Case A: KAYOU TCG Consumers	Case B: Pathological Gambling Patient
Nature	Regulated card-based IP collectible commercial consumption	Clinical gambling disorder (psychiatric condition)
Demographics	Primarily minors; >18M registered users	23-year-old adult male (single case)
Primary Harms	Unreasonable consumption; lack of transparency in the probability of winning	Severe depression, suicidal ideation, and financial ruin
Financial Trajectory	Tiered pricing; controlled discretionary spending	Rapid escalation (INR 15–5,000/game); debt spiral via credit/lending

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3. Dual-path analysis: functional utility and structural vulnerabilities

3.1. Functional utility: affective and socio-cognitive benefits

3.1.1. Dopaminergic activation and the lure of uncertainty

The variable ratio reinforcement is a way to continuously activate the human brain reward circuit by playing with the timing of the reward and maximising the amplitude of dopamine secretion, which results in subjective pleasure for TCG unpackers as well as for those who participate in gambling [10]. Neurobiological mechanisms underlying the sense of surprise during card pack opening and excitement associated with winning at gambling games are similar, leading to substantial nucleus accumbens activation and to strong instant gratification [11]. Such emotional stimulation is especially appealing to students facing academic pressures and provides an outlet to relieve everyday anxieties.

According to the survey result, the experience of suspense in unpacking about 65% of the TCG consumers finds more pleasure when compared to owning the card in the collection. In turn, becomes its own psychological reward. In addition, the anticipation of receiving a reward prior to its actual receipt can create flow state psychological experiences, provide a subjective sense of control for teens for a brief period of time and give them a mental break from their daily stresses.

3.1.2. Subcultural integration and identity formation

The TCG culture and the gambling community jointly constructed a unique subculture ecosystem, providing participants with a sense of belonging and identity resources [12]. In the TCG social circle, card collection transactions, offline battles, and online rare card displays formed a symbolic interaction system, where the rarity of the cards became the core trading resource. Adolescents obtaining high value, rare cards gain peer admiration and enhance self efficacy and group status through social presentation. Such social connections produce psychological compensation effects, especially for teenagers experiencing weak parent child communication or insufficient peer group support. Similarly, gambling community networks built through shared winning loss narratives and skill sharing also provide comparable group belonging experiences for gambling participants.

3.2. Structural vulnerabilities: cognitive exploitation and regulatory arbitrage

3.2.1. Probabilistic opacity and cognitive manipulation

TCG merchants often fail to print explicit rarity probability statements on physical product packaging or online sales pages, placing consumers in severe information asymmetry conditions when making purchase decisions [13]. One 2024 Chinese consumer rights survey suggests that merely 15% of TCG buyers can accurately state real world rare card draw odds. Probabilistic ambiguity converts variable ratio reinforcement into a cognitive manipulation instrument. Once consumers have opened several ordinary packs, they will easily be fooled by the "near miss" illusion and have expectations that "the next pack must contain rare cards," which encourages them to purchase the product repeatedly [3].

In commercial gambling situations, the casino resorts to near-miss visual presentation effects, and hides the player-to-player return rates. In both cases, information asymmetry is detrimental to conditions for rational individual decision making and contravenes basic principles of consumer information disclosure.

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3.2.2. Neuro-addictive pathways: the slippery slope of the near-miss effect

The near-miss (NM) effect is a common underlying risk factor in TCG unpacking and the development of problem gamblers [6]. But when TCG players repeatedly extract the same ordinary cards, these outcomes are perceived by human neuropsychological mechanisms as "close to success" signals that send micro-doses of dopamine, similar to actual acquisition of rewards, to players, which in turn increases the amount of money and time that they spend [11]. Near miss experiences activate brain regions, such as the anterior cingulate cortex and dorsal striatum, associated with loops of error monitoring and reinforcement learning, all of which have been proven by neuroimaging research. People think that "almost winning" means that they have a greater chance of winning and lose the behavioural ability to stop.

This neurobiological pathway leads to behaviour to shift from casual entertainment to compulsive repetition. Heavy use TCG consumers and 94% of clinical problem gamblers report clear signs of withdrawal – irritability, anxiety and intrusive compulsive thoughts – that affect their daily lives, negatively impacting their social and academic functioning.

3.2.3. Legitimisation bias and regulatory arbitrage

TCG products are considered legitimate forms of entertainment consumption, while unlicensed gambling is strongly rejected by society. Such divergence enables TCG products adopting variable ratio reinforcement mechanics analogous to slot machines to avoid equivalent gambling regulation scrutiny [7]. Merchants package quasi gambling mechanics as puzzle oriented youth entertainment and bypass gambling related legal constraints.

Influenced by divergent social labels, consumers underestimate TCG related addiction hazards: merely 8% of TCG consumers acknowledge potential addictive risks arising from card pack purchasing. In contrast, 100% of recognised problem gambling participants understand gambling addiction risks [14]. Such social cognitive bias creates regulatory blind spots. Although TCG driven financial loss and family conflict cases resemble harms caused by mild gambling disorders, the corresponding early intervention measures and policy support are still insufficient. The corresponding early intervention measures and policy support are still insufficient.

4. Managerial and regulatory implications: three gates on the pathway to harm

4.1. Mandatory probability disclosure and just-in-time cognitive correction

The near-miss illusion is an effect of information asymmetry. In the case of regulators, there should be a duty rather than just a recommendation to disclose. Manufacturers of trading cards (TCG) should be required by law to clearly and transparently identify the chances of obtaining any particular rarity level card in a prominent place on the physical package and e-commerce page, and refrain from confusing the public by altering concepts or creating their own. This move aims to break the information asymmetry and help consumers make decisions based on rational expectations. At the same time, "cognitive correction" educational tools should be introduced. For instance, pop-up prompts should be set up on the purchase interface to inform consumers that "each draw is an independent event and there is no guarantee", in order to counter the gambler's fallacy. In addition, this study can draw on the responsible marketing standards of the gambling industry and prohibit the use of misleading language such as "guaranteed profits" and "one hit, and you'll be captivated" in promotions targeting minors. This will reduce the irrational consumption impulse

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caused by the recency effect from the source and encourage children to avoid activities related to gambling as much as possible.

4.2. De-intensifying variable-ratio reinforcement: a product-safety duty

In response to the neuroaddiction pathways caused by recency effects, it is recommended to carry out technical de-enhancement and transformation of the gamification mechanism of TCG products. Firstly, the purchase frequency and draw frequency of a single time should be restricted to break the continuous investment - intermittent rewards in a variable ratio enhancement. Secondly, in product design, the nearly successful visual and auditory feedback should be weakened. For instance, when players draw repetitive or ordinary cards, the system should avoid special effects or sound effects like "next time certain" to reduce the abnormal secretion of dopamine and prevent players from making irrational behaviours. Finally, it is suggested to introduce a Cooling-off Period mechanism. When the system detects an abnormal increase in the user's consumption amount or duration, it will automatically lock the account for a period of time and provide links to mental health resources, thereby blocking the slope from entertainment consumption to pathological addiction.

4.3. Risk-based reclassification and inter-agency arbitrage control

The unified behaviour risk assessment standard for social label differences and regulatory arbitrage suggests reassessing TCG as social cognition of "legal entertainment", and establishing the interagency coordination regulatory framework. Although TCG differs from traditional gambling in form, its underlying psychological mechanism is isomorphic. Regulatory authorities should not exempt it from the review of gaming-like products just because of its "toy" attribute. It is suggested that TCG consumption be incorporated into the monitoring system for teenagers' behavioural addiction, and that manufacturers assume social responsibilities similar to those of game companies and establish an anti-addiction system for minors. At the same time, through public publicity and education, eliminate the social cognitive bias of the "no harm to card smoking" theory, and popularise to parents and children the harm of variant ratio reinforcement, so that the risk awareness of TCG addiction is as deeply rooted in people's hearts as smoking is harmful to health. By unifying the risk assessment standards, this study can fill the regulatory blind spots and prevent enterprises from taking advantage of the legitimacy of social labels to engage in regulatory arbitrage regardless of their potential harm.

5. Conclusion

5.1. Main findings

This study compared heavy consumers of KAYOU trading cards (TCG) with pathological gamblers, revealing the common decision distortion mechanism under variable ratio reinforcement: Although both belong to leisure and entertainment and mental illness respectively, their psychological mechanisms are highly isomorphic - both activate the brain's reward circuit through random rewards, induce dopamine secretion through the "recitation effect", and lead to the cognitive illusion of "almost winning", resulting in repetitive behaviors. The core difference lies in that TCG rewards physical collectibles and legalises them in society, with the motivation stemming from satisfying the desire to collect. Gambling is rewarded with currency and stigmatised by society. The motivation stems from recovering losses and reaping high profits. The "legalisation" facade of TCG has turned

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it into a regulatory blind spot, exposing teenagers to the risk of addiction without a sense of risk. In this regard, this paper proposes intervention strategies such as mandatory probability disclosure, limiting the intensity of reinforcement, and reconstructing social labels.

5.2. Research significance

The theoretical significance of this study lies in filling the gap in the comparative research between "gambling-like" consumption and pathological gambling, clarifying the risks of TCG as an "entry behaviour" for problem gambling, and expanding the theory of behavioural addiction. At the practical level, the research provides guidance for the TCG industry to optimise marketing ethics and embed anti-addiction mechanisms. It also offers a basis for regulatory authorities to formulate probability disclosure regulations for the "unboxing mechanism", which is conducive to better work by families and educators, protecting the mental health of teenagers, and reducing the occurrence of gambling at its root.

5.3. Research limitations and future prospects

This study mainly relies on secondary data for case analysis, lacking detailed primary data support. Moreover, Case B is a single clinical case, and there is no guarantee of rigour in statistical inference. Future research can adopt a hybrid method, obtaining actual data through large-sample questionnaires and interviews, and using field experiments to test the real effects of intervention strategies, providing a precise basis for governments to make policies.

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