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The effect of doll blind box uncertainty on consumers' irrational consumption behavior: the role of instant gratification, Gambler's fallacy, and perceived scarcity

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Abstract

Background The uncertainty associated with doll blind boxes has sparked a consumer frenzy in China. However, it remains unclear how the allure of uncertain rewards influences the irrational consumption behavior of blind box consumers. This study aimed to elucidate the internal mechanisms underlying this process. Specifically, this study investigated the relationships among perceived uncertainty, gambler's fallacy, instant gratification, perceived scarcity, and irrational consumption behavior.

Methods 434 Online questionnaires were distributed to Chinese doll blind box consumers. This study examines the impact of perceived uncertainty on consumers' irrational consumption behavior by employing the Stimulus-Organism-Response theory and constructing a mechanism model. The analysis was conducted using PLS-SEM in SmartPLS 4.0.

Results Perceived uncertainty positively affected instant gratification and gambler's fallacies. Gambler's fallacy and instant gratification significantly mediate between perceived uncertainty and irrational consumption behavior. Moreover, perceived scarcity positively moderated the relationship between gambler's fallacy and irrational consumption behavior. As perceived scarcity increased among blind box consumers, cognitive bias resulting from gambler's fallacy more significantly influenced the consumers to engage in irrational consumption behavior.

Conclusions This study clarified the psychological mechanisms underlying irrational consumption behavior among blind box consumers. Moreover, it provides specific suggestions for blind box consumer, product stakeholders and policymakers to better advocate rational consumption behavior.

Keywords Blind box, Perceived uncertainty, Instant gratification, Gambler's fallacy, Irrational consumption behavior

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Introduction

The blind box concept originated in Japan [1] and is a sales method inspired by "lucky bags" and "gacha eggs." The blind boxes were opaque and contained exquisite dolls of different styles designed by various designers. Consumers randomly drew dolls from these boxes (See Fig. 1). China's trendy doll blind box market is projected to reach 29.4 billion yuan by 2024.

Past research has shown that uncertain rewards stimulate consumer intentions and behavior more than certain rewards [1, 2]. Blind box products have emerged from reward-based uncertainty marketing strategies. For instance, several researchers explored the mechanisms through which blind box uncertainty affects purchases from the perspectives of consumer experience and consumption motivation [3–5]. Zhang et al. [3] found that the uncertainty of a blind box triggers consumer curiosity, which motivates consumers to purchase. Other researchers found that the uncertain rewards of blind boxes increase consumers' emotional value, which affects their purchase intentions [4, 5]. While these scholars have examined the enhancement of marketing performance attributed to blind box uncertainty through the lens of positive emotional experiences and optimistic outlooks, others have claimed that marketing products with uncertain characteristics (e.g., lotteries and freebies) may lead to abnormal consumer purchasing behaviors, such as impulse buying and addictive consumption [6, 7]. Hence, it is reasonable to believe that marketing products such as blind boxes, which offer uncertain outcomes partially or entirely determined by chance, can also lead to abnormal consumer behavior, such as irrational consumption behavior (ICB) [8–10].

ICB occurs frequently when consumers prioritize factors other than maximizing utility during purchases, disregard income constraints during consumption, or lack knowledge about consumer products. Behavioral economics research has established that consumption decisions in environments characterized by risk, uncertainty, and limited information frequently display irrational tendencies [11]. Blind boxes containing physical collectibles that can be sold in real-world currencies may exhibit a potential correlation with gambling psychology [12]. While existing research has established a link between gambling psychology and irrational decision-making [13, 14], the specific psychological mechanisms through which perceived uncertainty (PU) influences irrational consumption among blind box consumers have yet to be thoroughly investigated. Thus, a comprehensive and integrative framework is needed to articulate such psychological and behavioral mechanisms.

Previous psychological research has demonstrated that instant gratification (IG) and gambler's fallacy (GF) are significant factors contributing to irrational behavior [15, 16]. GF is the false belief in a negative correlation between independent trials of a random process, which may lead to misperceptions of "randomness" [15]; IG refers to a psychological tendency to desire immediate

Fig. 1 Doll blind boxes

fulfillment or reward [16], and an over-reliance on IG can lead to impulsive behavior and failure of long-term goals. Although previous research has confirmed that IG and GF may exacerbate the negative consequences of decision-making in the context of gambling psychology and behavioral economics [17], this psychological mechanism has not been effectively examined in uncertain reward consumption. Given the potential impact of uncertain rewards on consumer decision-making [17, 18], it is essential to enhance the understanding of consumer cognitive processes and psychological needs regarding doll blind boxes.

Furthermore, previous research has demonstrated that perceived scarcity (PS), as a significant marketing strategy, can influence consumer perceptions of product offerings [19, 20]. Scarcity marketing not only enhances the attractiveness of products but also impacts consumers' perceptions and evaluations of uncertain marketing cues. Hence, exploring the moderating role of PS will provide a more comprehensive insight into the consumer psychology of doll blind box consumers.

The research objectives of this study were twofold: (1) To examine the relationship between PU, IG, GF, and ICB. and (2) to examine the moderating effects of PS.

This study makes two major contributions to existing literature. From a theoretical perspective, this study advances research on the psychological and behavioral mechanisms of blind box consumers within the Stimulus-Organism–Response (SOR) theoretical framework. From a managerial perspective, this study offers valuable insights for both blind box consumers and organizations, including companies and governments, to promote rational purchasing decisions.

Literature review

Stimulus- organism- response theory

The SOR theory, proposed by Mehrabian and Russell, consists of stimulus (S), organism (O), and behavioral response (R) components and is widely used in psychology and consumer behavior research [21–23]. The stimulus component refers to the external environmental factors influencing customers in a shopping environment. The organism component represents customers' emotions and cognitions, and the response component encompasses individual cognition- and emotion-based behaviors such as recommendations, purchases, and adoptions [24, 25]. The key concept of the SOR theory is that external environmental stimulation does not directly influence customer behavior. Rather, external environmental stimulation influences customer behavior by mediating emotions and cognition [23]. The SOR theoretical framework has been used in shopping environments (electronic [e]commerce, physical stores, mobile shopping applications) to identify environment-specific stimulus factors (e.g., store ambiance, website quality, website security) [24–26].

Past consumer behavior research has shown that stimulus factors are not only external environmental factors but are also related to consumers' perceptions, such as perceived information quality [27], perceived interactivity [28], and PU [5, 25]. Zhang et al. [5] examined the impact of PU as an external stimulus on consumers' impulse purchase intentions in the context of blind boxes. Tang et al. [25] confirmed that PU is a crucial driver of users' switching intentions on e-commerce platforms. Consequently, PU can be regarded as a critical stimulus in understanding the behavior of blind box consumers.

Researchers have confirmed that organisms in the SOR model can be regarded as having individual cognitive (e.g., trust) and emotional (e.g., pleasure) [29, 30]. Following the concepts of GF and IG in the existing literature, this study identifies GF as a cognitive factor [15], while IG is categorized as an emotional factor [16]; both are measured as organisms (O). Within the SOR theoretical framework, R typically encompasses response and avoidance behaviors, with previous research considering consumption intention as a response factor [24]. Consequently, this study measured ICB as a response factor (R). Overall, this study examined how stimulus factors (PU) affect subsequent behavioral responses (ICB) through organisms (GF and IG) based on the SOR theoretical model.

Perceived uncertainty

Marketing research indicates that uncertainty creates a complex environment that prevents consumers from determining whether a product meets their needs [31–33]. Becke and Knudsen [33] defined PU as an individual's lack of understanding stemming from unknown or unreliable information. Quintal et al. [34] characterized PU as subjectively determined and ambiguous expectations regarding potential losses. Previous studies have investigated the negative effects of uncertainty on consumer purchases [24, 35]. A higher level of uncertainty makes it more challenging for consumers to accurately predict future transaction outcomes [25, 36].

However, recent studies have shown that uncertainty is not always negative [7, 37, 38]. New perspectives may emerge when uncertainty is linked to reward. Researchers have found that when uncertainty is associated with positive events, consumers may be more inclined to choose uncertain products and services [37, 38]. Numerous consumer behavior studies have confirmed the influence of positive uncertainty on consumer emotions and experiences [39–43]. Lee and Qiu [38] discovered that consumers tend to fantasize about favorable outcomes when confronted with positively uncertain events, such as lottery draws, leading to longer-lasting and more

intense positive feelings. Additionally, Laran and Tsiros [39] indicated that when businesses offer uncertain free gifts, consumers experience surprise and delight. Shen et al. [40] found that consumers experience positive emotions such as excitement while pursuing uncertain rewards, positively influencing their motivation. Ruan et al. [41] demonstrated that incorporating the processes of creating and resolving uncertainty in advertisements can evoke consumer curiosity, thereby fostering the potential for positive experiences. Furthermore, neuroscientific research has demonstrated that uncertainty can lead to heightened physiological arousal, increased interest, and enhanced information processing. Specifically, ambiguous information activates robust neural signals in the brain that are then utilized to evaluate reward uncertainty and guide appropriate behavioral decisions when confronted with partially known alternatives [44, 45].

Instant gratification

IG refers to the temptation and resulting tendency to choose a less rewarding but more immediate benefit [46]. IG is one of the most fundamental drivers inherent in humans: the tendency to seek pleasure and avoid pain, a concept known as the pleasure principle [47]. Tobin and Graziano [48] argued that individuals consistently strive to achieve the most satisfying outcomes in a short time in pursuit of happiness, excitement, ecstasy, and comfort. Those who seek IG tend to focus exclusively on the present, prioritizing immediate rewards and neglecting future consequences. Hence, IG is a pervasive phenomenon in an individual's daily life that significantly influences both individual behavioral norms and societal dynamics [48].

The effects of IG on cognition, psychology, and behavior have been thoroughly discussed in different research disciplines. Previous psychological research has shown that IG and individual characteristics are related. Individuals with pronounced impulsive traits tend to discount future rewards [16, 49–51]. These findings suggest that impulsive individuals prioritize immediate rewards, even if the rewards are of lower value or may lead to future losses. Similarly, O'Malley et al. [50] indicated that people who exhibit obvious impatience tend to favor immediate rewards and seek immediate satisfaction with their desires. Furthermore, recent research on consumer behavior indicates that IG significantly reinforces consumer demand for prompt responses and immediate services. Hsu et al. [52] demonstrated that contemporary online shopping websites must attract users promptly to deliver IG, thereby maintaining user trust and loyalty. Shim et al. [53] found that IG is a crucial factor that drives online community members to binge-watch content on online video platforms. Rani [54] found that in the digital age, IG promotes the need for personalized interaction and changes the consumption preferences of contemporary consumers.

Gambler's fallacy

GF refers to a person's tendency to conditionally estimate the probability of an event, even if all sequential events are independent and equally distributed [55]. Lien and Yuan [56] described GF as the belief that a sequence of independent outcomes over time should exhibit a short-run reversal. GF can be illustrated using routine examples such as coin tossing. For example, a person might assume a higher probability of a coin landing on the tails of the next toss if it landed on the heads of the previous nine tosses [15]. This fallacy is rooted in a cognitive bias termed the representativeness bias or the law of small numbers [56]. Representativeness bias frequently manifests in various life scenarios, including lottery games and horse racing [55, 57]. Clotfelter and Cook [58] investigated the "Pick 3" game in Maryland and discovered that following the appearance of a specific number on a winning ticket, the amount wagered on that number significantly decreases. Similarly, Kong et al. [55] observed the GF in their study of the Chinese lottery game "Daily 3": gamblers tend to avoid selecting numbers drawn in previous days until those numbers reappear after approximately 60 draws.

The root of GF lies in individuals' misunderstanding of "randomness," as they mistakenly equate the frequency of random events with their probability while disregarding the irregular and unpredictable nature of independent random events [56]. Some neuroscientific studies suggest that GF is closely related to the use of heuristics [57, 59]. Heuristics are rules of thumb that enable individuals to make decisions based on limited information [60]. Limited information may lead individuals to connect past results with future outcomes, thereby increasing their cognitive bias. Consequently, reliance on heuristics that leads to judgment or decision errors reflects a form of limited rational behavior [55].

Perceived scarcity

PS arises when individuals feel they possess less than they require [61]. Psychological researchers define PS as an individual's subjective experience of a lack of tangible or intangible resources such as time or money [61]. In the marketing literature, scholars assert that PS primarily pertains to the perception of product scarcity [20, 62]. Gupta and Gentry [20] proposed that PS reflects consumer perceptions of product shortages induced by retailers, particularly concerning specific styles or sizes. Aggarwal et al. [62] argued that the perception of scarcity associated with limited products can be evaluated from two perspectives: limited quantity scarcity and limited time scarcity. The concept of scarcity suggests a

reduction in free choice, which can significantly influence consumer desire for limited products [20].

Previous marketing literature indicates that PS is a significant marketing strategy that influences consumer perceptions of product offerings [63, 64]. In the context of fast fashion, researchers have found that marketers deliberately create product scarcity to evoke a sense of scarcity among consumers [65]. Retailers achieve this by limiting the number of styles available or frequently updating their product lines, thereby creating a perception of scarcity among consumers. This scarcity manipulation stimulates consumers' desire to purchase, ultimately influencing their buying decisions [65]. Furthermore, in the realm of luxury accessories, PS enhances consumers' perception and valuation of luxury brands [66, 67]. Consumers also demonstrate their social status and power by owning scarce luxury items. According to Chen and Sun [68], PS fosters a sense of exclusivity and enhances consumer perceptions, which in turn elicits positive emotions and increases both attractiveness and purchase intention. In the context of collectible markets, Phan et al. [69] find that scarcity cues can exacerbate consumers' social comparisons and drive their willingness to pay. Based on existing literature, scarcity has demonstrated a significant role and status in product marketing, prompting scholars to invest considerable effort in examining the impact of PS on consumers in different marketing contexts [65, 70–72]. Therefore, substantial opportunities remain to further explore PS within the context of blind boxes. This exploration could enrich our understanding of the cognition, psychology, and consumption decisions of blind box consumers.

Irrational consumption behavior

ICB refers to the excessive consumption or unreasonable hoarding of specific goods that deviate from rational cognitive evaluation [73, 74]. From the behavioral economics perspective [10], ICB encompasses consumer actions influenced by various factors, resulting in unreasonable consumption decisions. This behavior manifests in several ways: consumers often fail to pursue utility maximization, disregard income constraints when making purchases, overlook the law of diminishing marginal utility or possess an inadequate understanding of consumer products [75]. Lee et al. [76] suggested that ICB encompass conspicuous, impulsive, addictive, and habitual consumption. Researchers have indicated that a disordered consumption environment resulting from ICB poses a significant challenge for consumers, retailers, policymakers, and society at large. To mitigate this issue and promote greater social and economic stability, it is essential to conduct research on ICB [76, 77].

In reviewing the existing literature, we found that ICB has been extensively examined across various research contexts, including public safety incidents (e.g., COVID-19) [74], luxury fashion consumption [78], live broadcast marketing [79], and gambling [14]. These studies conclude that the causes of irrational consumer behavior are multifaceted [74, 77], encompassing psychological characteristics (e.g., anxiety), emotions (e.g., fear), social factors (e.g., social environment, resource shortages), and economic influences (e.g., financial pressure). Marketing and consumer behavior research places significant emphasis on irrational consumer behavior. Chen and Duan [10] concluded in their meta-analysis on irrational consumption that consumers' attitudes and intentions, marketing strategies, product signaling, and emotional guidance significantly influenced ICB. In the context of advertising marketing, Vrtana and Krizanova [80] found that emotionally appealing advertisements create a connection with a brand and promote irrational consumer behavior. Furthermore, researchers have shown that product characteristics play a crucial role in shaping consumer preferences and behaviors. Specifically, when products possess hedonic attributes [81] (e.g., lottery), consumers are more prone to impulse buying, contributing to ICB.

Although existing research has confirmed that numerous psychological and social factors serve as antecedents of ICB, these studies indicate a pressing need for further empirical investigation to elucidate the interrelationships among these antecedents. Additionally, it is essential to explore the various factors that may mediate or moderate the relationships between predictor variables and irrational consumer consumption behavior [77].

Hypothesis development and conceptual model

Perceived uncertainty and instant gratification

Previous research has demonstrated that the uncertainty associated with dollar blind boxes constitutes a positive form of uncertainty, reflecting unknown rewards [3, 5]. Lee and Qiu [38] proposed that consumers anticipating uncertain rewards may cultivate positive and lasting emotional attitudes. The pleasure derived from resolving uncertainty can be significant for consumers [40]. Wilson et al. [82] noted that uncertainty surrounding positive events can extend happiness, leading individuals to experience long-lasting positive emotions in uncertain situations.

Rewards can elicit positive emotions regardless of their certainty [6]. The fundamental nature of IG is associated with positive feelings, such as ecstasy, excitement, and happiness [48]. Tobin and Graziano [48] found that individuals often become vulnerable to the allure of rewards and pursue IG to maximize their current happiness. Park [67] noted that uncertain future outcomes lead individuals to prioritize short-term gains (i.e., obtaining rewards) and yield IG. Therefore, PU serves as a positive stimulus

that influences an individual's emotional state, eliciting feelings of curiosity and surprise [5, 24]. Based on the aforementioned literature, the following hypothesis is proposed.

H1 PU positively affects IG.

Perceived uncertainty and Gambler's fallacy

GF primarily stems from a misunderstanding of random events, which people infer from their behavior in tasks involving the generation of random sequences. Kong et al. [55] stated that when people encounter probabilistic products, such as lottery tickets, they believe that buying more tickets would increase their chances of winning the next round despite the randomness of the winning probability. This erroneous belief in the law of small numbers results in people placing more trust in typical events and disregarding basic probabilities in uncertain situations [59]. Armstrong et al. [13] stated that gamblers tend to justify their actions and reasoning using analytical thinking even if they do not reflect on their mistakes. Some researchers have demonstrated that although the outer packaging of blind box products indicates the probability of obtaining different styles, such products still possess a gambling nature [12, 83]. Consequently, the uncertainty associated with blind boxes exacerbates individuals' misconceptions about probability, leading consumers to mistakenly believe their chances of acquiring a desired product increase with each unsuccessful attempt. Based on the aforementioned studies, the following hypothesis is proposed:

H2 PU positively affects GF.

Instant gratification and irrational consumption behavior

IG strongly appeals to individuals and influences their future behavior. Luo and Pattanakul [84] suggested that the desire for immediate rewards stems from infancy, indicating that people make irrational choices from birth. Schultz et al. [43] stated that happiness derived from objects, events, situations, or activities positively reinforces consumption behavior.

Consumer psychology research indicates that IG is a key determinant of impulsive consumption behavior [52, 85]. Individuals who pursue IG tend to focus on the present rather than temporarily delay future consumption. To obtain what they desire, they are often unwilling to wait, opting instead for impulsive actions to achieve satisfaction. Liu et al. [86] found that pleasure and excitement increase the likelihood of irrational purchases because this sense of satisfaction provides spiritual fulfillment. Yin et al. [87] argued that IG represents a desire. When individuals become addicted to satisfying these desires, they anticipate continuous stimulation, disregard other realistic factors, and engage in irrational behavior.

Based on the aforementioned literature, the following hypothesis was proposed:

H3 IG positively affects ICB.

Gambler's fallacy and irrational consumption behavior

Previous research demonstrated that GF is a cognitive bias often resulting in irrational behavior among individuals [60]. In the context of gambling, this fallacy suggests that when gamblers experience a "losing streak," they are inclined to continue gambling under the erroneous belief that a win is imminent. This leads to illogical or distorted interpretations of gambling experiences, which, in turn, encourages increased risk-taking behavior [13]. Similar findings have been reported in behavioral economics studies. Chowdhury et al. [88] found that investors in financial markets may make irrational investment decisions in anticipation of a stock rebound due to its continuous decline. In the context of probabilistic products, Duan et al. [12] proposed that consumers mistakenly believe that the probability of winning the next draw increases after a series of unsuccessful attempts to obtain their desired item. These cognitive biases in investment probabilities may prompt consumers to engage in persistent consumption [83, 89]. Furthermore, Liu et al. [83] asserted that blind box marketing fundamentally undermines the assumption of rational shopping, arguing that consumers' repeated blind box purchasing behaviors can be attributed to their risk preferences, which favor small probabilities and exhibit an aversion to deterministic risks [90, 91]. This cognitive bias ultimately leads to ICB.

Based on the aforementioned results, the following hypothesis was proposed:

H4 GF positively affects ICB.

The moderating effects of perceived scarcity

Kluger et al. [92] argued that humans possess an inherent instinct to fulfill their own needs. When individuals recognize that their fundamental needs cannot be satisfied due to scarcity, they are likely to seek additional resources to compensate for this perceived lack. Numerous studies on consumer behavior have demonstrated that PS significantly influences personal emotions, cognition, and behavior. Park et al. [67]. noted that perceived product scarcity enhances the relationship between consumer attitudes and behaviors towards luxury goods. Chen and Zhang [35] confirmed the positive moderating effect of scarcity on the relationship between consumer value assessments and purchase intentions in a live commerce context. Shi et al. [66] found that a scarcity-driven marketing environment induces a sense of urgency

among consumers, thereby impacting their purchase decisions. Therefore, exploring the moderating effects of PS on emotion, cognition, and behavior regarding blind boxes may yield insights into the psychology of blind box consumers.

Previous research has explored the relationship between PS, IG, and behavior, both directly and indirectly. Laran and Salerno [39] demonstrated that individuals who perceive resources to be scarce are more likely to opt for IG. Jang et al. [93] found that owning a scarce product can evoke positive emotions in consumers, such as pride and satisfaction, thereby enhancing their purchase intentions. Furthermore, Yu et al. [77] discovered that, when faced with issues related to scarcity, individuals often struggle to resist the temptation of immediate rewards, leading to impulsive behaviors driven by PS. A higher degree of PS is associated with an increased likelihood of impulsive and instinctive behaviors, as individuals find it difficult to resist IG. One marketing strategy for a doll blind box is to create a scarcity of secret products [74, 83]. When consumers' desired secret doll blind boxes cannot be obtained, their desires will not be satisfied, and they will invest considerable time and money in repeat purchases. Therefore, we believe that PS positively moderates the relationship between emotions and consumption behaviors.

Moreover, researchers have demonstrated that scarcity can heighten individuals' expectations and beliefs regarding specific outcomes, thereby increasing their susceptibility to gambling fallacy [14, 15]. Scarcity may alter people's perceptions of risk, rendering them more inclined to take risks in pursuit of limited resources. Consequently, when confronted with scarce resources, individuals may overlook risks and probabilities, leading to irrational decision-making [19]. Indeed, whether a resource shortage is genuine or deliberately engineered through marketing strategies can induce cognitive biases in consumers [52]. These cognitive biases can disrupt individual reasoning and judgment, ultimately influencing decision-making processes. Hence, we propose that PS exacerbates the cognitive bias associated with blind box consumers (i.e., GF), fostering the illusion that purchasing more guarantees acquiring the desired items. This phenomenon is particularly evident in the context of commodities, such as secret blind boxes, ultimately resulting in blind consumption and impulsive buying behavior.

Thus, the following hypotheses and conceptual model (Fig. 2) were proposed:

H5 PS positively moderates the relationship between IG and ICB.

H6 PS PS positively moderates the relationship between GF and ICB.

Methodology

Measurements

The questionnaire was divided into two parts. The first part consisted of the respondents' demographic information, including sex, age, education level, frequency of blind box purchases, and occupation status. The second

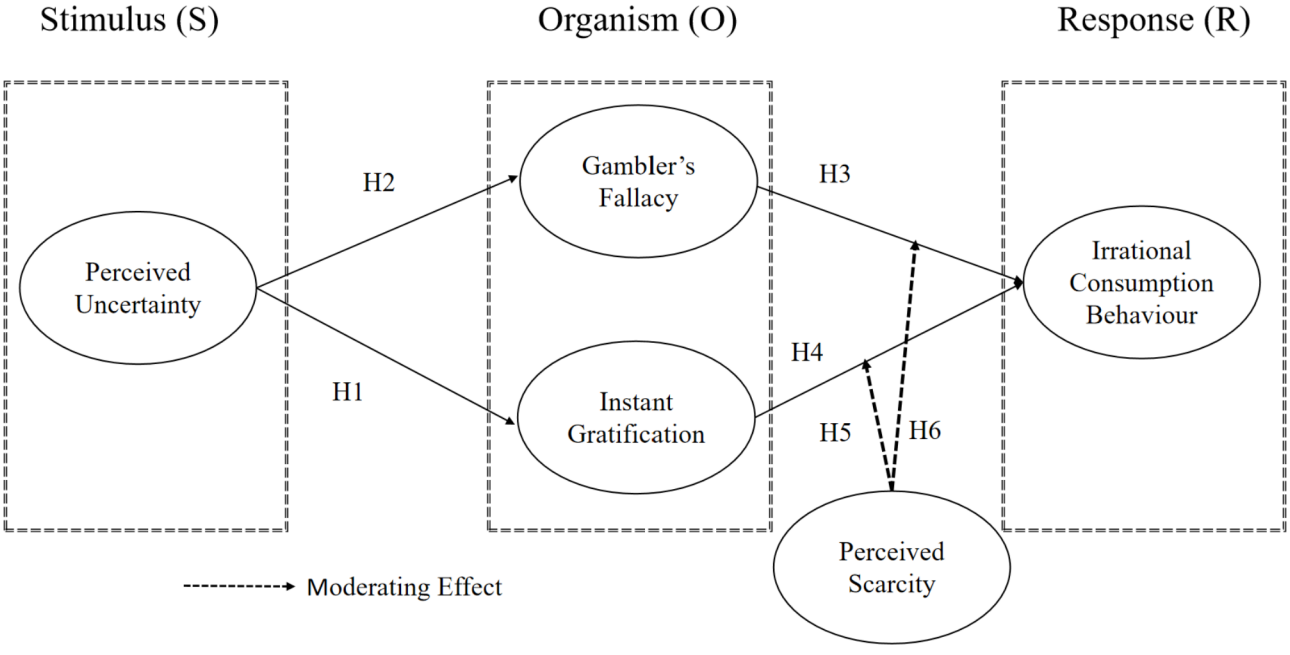

Fig. 2 Conceptual model

part was the main body of the questionnaire, including the measurement of the following variables: PU, IG, GF, PS, and ICB. All variables were measured using established scales to ensure data validity and reliability. All scales used a five-point Likert scale, with scores of 1 and 5 indicating strong disagreement and strong agreement, respectively. PU was measured using a three-item scale developed by Zhang et al. [1]. IG was assessed using a three-item scale developed by Liu et al. [86]. The concept of GF was adapted from Josson et al. [94] and consisted of three items. PS was measured using a five-item scale developed by Chen and Sun [95]. ICB was assessed using a four-item scale developed by Yue-qian et al. [74].

All research model variables were reflective indicators with a first-order structure. Back-translation was used, given that the questionnaires in this study were from the English literature, and the target respondents were Chinese blind box consumers. We translated the English questionnaires into Chinese and then back-translated the resulting Chinese-English versions to identify potential translation bias [96].

Table 1 Descriptive statistics

Characteristic	Category	*N*	Percentage (%)
Gender	Male	210	48.4
	Female	224	51.6
Age (years)	18–20	36	8.3
	21–30	251	51.8
	31–40	137	31.6
	41–50	10	2.3
	51–60	0	0
	≥61	0	0
Education level	Senior high school and lower	23	5.3
	College	52	12.0
	Bachelor's degree	180	41.5
	Postgraduate degree	141	32.5
	Doctorate	38	8.8
Frequency of blind box purchases	Daily	103	23.7
	Weekly	171	39.4
	Monthly	91	21
	Yearly	69	15.9
Occupation status	Student	177	40.8
	Government employee	53	12.2
	Corporate employee	144	33.2
	Freelance	52	12.0
	Unemployed	5	0.6
	Retired	2	1.2
	Other	0	0

Data collection

An online questionnaire was designed using the 'Wenjuanxing' Chinese questionnaire platform. Before conducting the formal online questionnaire survey, we conducted a pilot study in which 50 valid questionnaires were collected. Cronbach's alpha coefficients were used to determine internal consistency. The results of the pilot study showed good internal consistency for the total instrument (Cronbach's $\alpha = 0.943 > 0.7$) [97]. Therefore, a formal survey was conducted. The formal mass distribution is conducted via two Chinese social meida platforms: Xiaohongshu and Weibo. These platforms host active doll blind box communities, with each platform's posts on doll blind boxes exceeding 200 million views [3, 98]. Hence, we invited doll blind box online community members to fill out the questionnaire through purposive sampling, ensuring targeted and effective data collection. The questionnaire was examined and approved by the Research Ethics Committee of the Faculty of Hospitality and Tourism Management at Macau University of Science and Technology. Prior to answering the questions, all respondents were required to read the informed consent form, which included the purpose of the study, procedures involved, any potential risks or benefits, and the voluntary nature of participation. Only those who provided informed consent completed the online questionnaire. Furthermore, respondents qualified for participation based on one screening question: Have you ever spent over 500 min on blind boxes in a single month? Only respondents who answered 'yes' were eligible to participate [9]. In total, 455 formal questionnaires were returned. A total of 434 valid questionnaires were obtained after excluding 21 invalid answers (due to duplicate responses or a filling time of < 60 s), which yielded an effective response rate of 95.38%. Hair et al. [97] stated that the recommended minimum sample size for partial least squares structural equation modelling (PLS-SEM) was between 200 and 500. This approach is commonly used to determine the sample sizes in psychological and marketing studies [35, 99]. Therefore, the sample size used in this study was considered sufficient.

Results

Descriptive statistics

The respondents were predominantly female ($N = 224$, 51.6%). The respondents' ages ranged from 18 to 50 years, and most (51.8%) were in the 21–30-year-old age group. Most respondents (41.5%) held a bachelor's degree and purchased blind boxes weekly (39.4%). The two largest occupations were students (40.8%) and corporate employees (33.2%)(see Table 1).

Common method bias

This study uses a cross-sectional survey of Chinese respondents. The possibility of common method bias was examined by conducting Harman's single-factor test using SPSS 26. The test obtained a 36.48% variance for the first common factor, which is below the threshold of 50% [97]. The results indicated no significant common method bias. A covariance test was conducted using the variance inflation factor (VIF). The results demonstrated that all inner and outer VIFs were 1.237–1.789, which is below the recommended threshold of 3.3 [100]. Therefore, this study did not consider serious common method bias.

Measurement model assessment

The associations between the indicator variables and their respective constructs were evaluated using measurement models. The primary measurement model assessment indicators are composite reliability (CR), average variance extraction (AVE), and discriminant validity [97]. All variables in this study revealed a Cronbach's alpha coefficient of >0.7 and a CR of 0.757–0.853, which indicated good reliability. Additionally, all the AVE values were >0.5, indicating that each variable demonstrated convergent validity [101] (see Table 2). Heterotrait-monotrait (HTMT) ratios were used as the main criterion in the PLS-SEM studies. Sufficient discriminant validity was achieved when all the constructed HTMT values were below the conservative critical value of 0.85 (see Table 3).

Table 2 Measurement model assessment

Measurement construct	Factor loading	Cronbach's alpha	CR	AVE
PU (Perceived Uncertainty)		0.752	0.757	0.668
PU1	0.818			
PU2	0.808			
PU3	0.826			
IG (Instant Gratification)		0.811	0.813	0.725
IG1	0.833			
IG2	0.865			
IG3	0.857			
GF (Gambler's Fallacy)		0.799	0.799	0.713
IG1	0.838			
IG2	0.859			
IG3	0.837			
PS (Perceived Scarcity)		0.846	0.853	0.620
PS1	0.750			
PS2	0.801			
PS3	0.823			
PS4	0.753			
PS5	0.806			
ICB (Irrational Consumption Behavior)		0.810	0.830	0.638
ICB1	0.854			
ICB2	0.821			
ICB3	0.854			
ICB4	0.647			

Table 3 Discriminant validity (HTMT ratios)

	GF	IG	ICB	PS	PU
GF					
IG	0.365				
ICB	0.602	0.772			
PS	0.487	0.506	0.572		
PU	0.739	0.326	0.297	0.559	

Note: HTMT: Heterotrait-monotrait

Structural model assessment

Prior to examining the structural equation model, the explained variance of each endogenous variable was evaluated using R^2 and Q^2 values. These values should be at least 0.1 or greater than 0 [101, 102]. The data analysis results indicate that the ranges of R^2 and Q^2 are 0.162 to 0.376 and 0.101 to 0.262, respectively. Therefore, this structural model demonstrated good predictive relevance. The structural equation model was evaluated using 5000-sample bootstrapping (one-tailed, 0.05) in SmartPLS 4.0, and the results are presented in Table 4. PU positively affected both IG and GF. Therefore, H1 and H2 are supported. IG and GF positively affected the ICB. Therefore, H3 and H4 are supported. PS × IG and PS × GF represent the moderating effect of PS, and the results indicate that PS only positively moderates the relationship between GF and ICB. Therefore, H6 was supported, whereas H5 was not.

Moreover, to further elucidate the effect of PU on ICB, the product coefficient approach was adopted to yield bias-corrected bootstrap 95% confidence intervals (CIs)

Table 4 Hypothesis results

Hypothesis		β	T-value	*P*-value	CILL	CIUL	Result
H1	PU → IG	0.256	5.011	0.000	0.153	0.355	Supported
H2	PU → GF	0.577	14.541	0.000	0.497	0.653	Supported
H3	IG → ICB	0.516	13.086	0.000	0.438	0.594	Supported
H4	GF → ICB	0.271	6.147	0.000	0.182	0.357	Supported
H5	PS × IG →ICB	-0.047	0.037	0.202	-0.123	0.024	Not supported
H6	PS × GF → ICB	0.102	2.800	0.005	0.028	0.172	Supported

Note: CILL: confidence interval lower limit; CIUL: confidence interval upper limit

Table 5 Mediating effect results

Path	β	Stand deviation	T-value	*P*-value	CILL	CIUL
PU→IG→ ICB	0.145	0.133	5.037	0.000	0.081	0.184
PU→GF→ ICB	0.103	0.156	6.038	0.000	0.105	0.207

Note: CILL: confidence interval lower limit; CIUL: confidence interval upper limit

[102–104]. A bootstrapping approach was used to test specific indirect effects. In the bootstrapping analysis, the mediation effect was considered significant if the confidence interval for the indirect effect did not contain zero. The findings presented in Table 5 indicate that IG emerged as a significant mediator between PU and ICB (β = 0.132, T = 5.037, p<0.001). Moreover, GF played an important mediating role between PU and ICB (β = 0.158, T = 6.038, p<0.001).

Furthermore, to identify potential significant differences in the hypothetical relationships between male and female consumers, this study conducted a nonparametric partial least squares multigroup analysis (PLS-MGA) test using SmartPLS 4.0. The results (see Supplementary Material) indicate that the impact of PU on IG (H1) significantly differs between male and female participants, with a greater effect observed in females. H5 exhibited a substantial impact on males, while H6 had an even greater impact on females. No significant differences were observed in the remaining paths between the male and female groups.

Discussion and conclusion

Blind box consumption is becoming a new consumer force in the retail sector [83, 91]. Doll-blind boxes leverage an uncertain marketing strategy to stimulate consumer desire, and this characteristic of uncertainty may influence consumer purchasing behavior [3]. This study employed quantitative research methods within the SOR theoretical framework to explore the psychological mechanisms by which PU influences the ICB of blind box consumers, considering the effects of IG, GF, and PS in the context of doll blind boxes.

First, our empirical data demonstrate that PU positively influences IG and GF. PU as a stimulus positively influences consumer emotions and cognition, consistent with previous research findings grounded in the SOR framework [23, 24, 26]. Based on the results of the path coefficients, this study elucidates that uncertain rewards not only activate consumers' positive emotions but also exert a more significant influence on cognitive biases related to reward cues and positive outcomes. Oliveria et al. [105] and Ariyabuddhiphongs et al. [81] present further evidence indicating that individuals tend to rely on their intuition when faced with reward-driven uncertainty cues, which can lead them to misjudge the probability that a repeated outcome of a random event will occur. Therefore, during unpacking blind boxes, the uncertainty surrounding rewards amplifies consumers' expected biases regarding the outcomes of these random events, leading them to erroneously believe that they can control or identify the probability of obtaining their preferred blind box.

Second, our study confirms the direct and indirect effects of IG and GF on the relationship between PU and ICB. This result indicates that IG and the GF represent internal intervening processes (organisms) within SOR theory. Specifically, when purchasing doll-blind boxes, consumers derive satisfaction and pleasure from the unpacking experience but simultaneously lack accurate judgment regarding these probabilistic products [106]. These two factors (IG and GF) convert the stimulus of PU into irrational consumer behavior (response). Consumers invest more resources (cognitive and emotional) in pursuing uncertain rewards; this phenomenon parallels the psychobehavioral mechanisms observed in previous studies on lotteries and gambling [7, 79]. Furthermore, demographic analysis reveals that the primary consumer demographics for blind doll boxes comprise young individuals aged 21–30, aligning with findings from several prior studies on blind box consumption [3, 5, 17]. Young consumers are characterized by impulsivity, curiosity, and competitiveness [83], and their risk preferences drive them to make irrational purchasing decisions. The findings of this study support this perspective and further enrich the understanding of consumption behavior among blind box consumers by examining cognitive and emotional factors.

Third, this study confirmed the positive and significant moderating effect of PS on the relationship between GF and ICB. This finding is supported by previous consumer behavior research [93, 95] concluding that PS induces ICB by strengthening cognitive biases (e.g., value distortion and fear of missing out). Additionally, scarcity theory indicates that scarcity reinforces the consumer's delusions about limited resources, leading to a decrease in the individual's cognitive and executive control abilities [66, 68]. Therefore, we conclude that the scarcity of secret items in blind boxes is a marketing strategy intentionally employed by merchants to amplify GF in situations of scarcity, resulting in blind box consumer cognitive biases that significantly influence the ability to make rational decisions. Notably, this study indicates that PS does not moderate the relationship between IG and ICB. This outcome may be attributed to the nature of the blind doll box as a hedonic products [83, 98, 107]. Blind

box consumers are more focused on the emotional experiences and immediate rewards of opening a blind box [98], and this experience does not rely on scarcity. Even if they do not realize the scarcity of secret items in a blind box, consumers are still willing to sacrifice their monetary resources for something that triggers their emotions [91].

Fourth, according to the results of the multiple group analysis, significant differences exist between genders concerning the three hypothesized paths (H1, H5, and H6). These results represent novel insights that have not been documented in previous studies on blind boxes [3, 5, 17]. Specifically, female consumers exhibit a greater focus on the emotional experience associated with purchasing blind boxes than male consumers [83], and tend to make more irrational consumption decisions than their male counterparts because of the scarcity of secret items in blind boxes.

Theoretical implications

This study makes several theoretical contributions to the existing literature. First, although previous blind box studies have examined the psychological mechanisms (e.g., perceived value, luck, and curiosity) of PU on consumers' purchasing intention [3, 5], the mechanisms by which PU influences ICB remain inadequately explored. Therefore, based on the SOR theoretical framework, this study enables a deeper understanding of stimulus-elicited responses by revealing the psychological mechanisms underlying GF and IG. Moreover, this study addresses the call from other researchers for more outcomes to evaluate blind box consumption behavior [12, 108], thereby addressing the gap in the current literature on blind boxes.

Second, previous studies have predominantly explored the effect of consumers' motivations on their behavior for blind box consumption from an behavioral economic perspective (e.g.,utility, risk preference) [83]. Although these studies have provided valuable insights into consumer behavior in blind box market, they have neglected the role of cognitive factors in consumers' blind box purchase decisions. When faced with random events, individuals have cognitive expectations that affect their decision-making, but this cognitive process has not been fully explored in blind box research. This present study endeavors to bridge this significant gap. This study reveals the cognitive mechanisms that drive the behavior of blind box consumers by analyzing their cognitive biases (e.g., GF) in probabilistic judgments and decision-making processes. This work enriching the empirical application of cognitive psychology to specific consumption contexts, promote the development of the broader field of cognitive psychology.

Third, although previous studies have recognized that the scarcity of secret items in blind boxes is a marketing strategy intentionally created by blind box merchants to increase the attraction of blind box products [83, 98], these studies have neglected to explore the potential impact of PS on blind box consumption behavior. By conducting empirical research, this study verifies the positive moderating role of PS. This study enriches the empirical application of the scarcity concept by revealing the mechanisms of perceived scarcity acts on the cognition and behavior of blind box consumers. This study advances scarcity theory development and bridges the research gap of PS in the context of uncertainty marketing.

Practical implications

This study provides key practical advice for blind box consumers, product stakeholders, and policy implementers. First, the demographic characteristic results indicate that the primary consumer group for doll blind boxes consists largely of young individuals. Young consumers tend to be more sensitive to stimuli and may overlook the psychological and economic drawbacks associated with purchasing large quantities of blind boxes. This oversight can be attributed to a limited understanding of probabilistic products and their propensity for hedonic consumption. Consequently, we suggest blind box consumers carefully evaluate their financial circumstances and consumer needs when purchasing. For example, consumers can limit the proportion of their monthly disposable income spent on blind boxes to no more than 20% [12]. Once the budget is reached, consumers must stop purchasing blind box.

Second, although blind box marketing is popular among consumers because of its uncertain rewards, it does not imply that blind box merchants are permitted to mislead consumers by withholding essential information or employing other deceptive practices to generate marketing revenue. We suggest that blind box enterprises disclose key information more prominently. Examples include product type, style, extraction rules, and the probability of obtaining secret items. Such transparency assists consumers in comprehending the inherent risks associated with purchasing these products.

Third, policy implementers and regulatory agencies play crucial roles in guiding blind box consumers toward rational consumption. We propose that the government introduce appropriate market supervision policies. For example, the prohibition on the sale of blind boxes to children under the age of 8 years [108] and strategies to encourage consumers to report violations by merchants who do not disclose the probability of blind box extraction. We believe that, through the above series of measures, policy implementers can effectively monitor the disclosure of blind box probability and protect

consumer rights. Furthermore, it is necessary to establish an appropriate consumption attitude toward blind boxes. For example, the risks and precautions of blind box consumption should be effectively communicated to consumers through the media, community activities, school education, and other channels.

Limitations and future research

This study has several limitations. First, it was conducted exclusively in China, which limits the generalizability of the findings. Future research can apply this research model to other regions (e.g., North America and Japan) and contexts similar to blind boxes (e.g., gacha games and luck bags) [91] to test the generalizability of the research model.

Second, this study examines the psychological mechanisms underlying blind box consumption, specifically focusing on GF and IG. Given the distinctive marketing strategies associated with blind boxes, future research could investigate the influence of additional psychological mechanisms (e.g., addiction and perceived utility) on ICB.

Third, the results show that the moderating effect of PS on the relationship between IG and ICB among blind box consumers is not significant. Future research should explore other potential moderating factors (e.g., perceived luck, fate, and self-control ability) to better capture the essence of the ICB of blind box consumers [109, 110].

Fourth, this study relied on self-reported cross-sectional data, which may have limited the generalizability of the research findings. Therefore, to minimize the errors in parameter estimation associated with self-reported data, future research could employ a more rigorous longitudinal design, incorporating longer time lags and collecting data from multiple sources.

Finally, this study investigated the factors influencing blind box consumption from the perspective of consumer psychology. Future research could incorporate interdisciplinary perspectives and concepts beyond psychology, including behavioral economics concepts (e.g., anchoring effect and loss aversion) and neuroscience measurement methods (e.g., functional magnetic resonance imaging and eye tracking). By designing corresponding experiments, researchers can further elucidate the neural mechanisms and decision-making processes underlying blind box consumption behavior.

Abbreviations

SOR	Stimulus-organism-response
PU	Perceived uncertainty
IG	Instant gratification
GF	Gambler's fallacy
PS	Perceived scarcity
ICB	Irrational consumption behavior
PLS-SEM	Partial Least Squares Structural Equation Modeling
CMB	Common Method Bias
MGA	Multigroup analysis
HTMT	Heterotrait-monotrait
CILL	Confidence interval lower limit
CIUL	Confidence interval upper limit

Supplementary Information

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Supplementary Material 1

Author contributions

Conceptualization, F.X. and Y.X.; Methodology, F.X, H.Z and Y.X.; Software, H.Z. and X.Y.; Validation, F.X and X.Y.; Formal analysis, F.X. and H.Z.; Investigation, F.X. and X.Y.; Data curation, F.X. and X.Y.; Writing—original draft preparation, F.X. and H.Z.; Writing—review and editing, F.X. and Y.X.; Project administration, Y.X.

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Data availability

Data from this study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and Informed consent

This research did not collect any traceable data from respondents, and respondents' personal identity cannot be identified. Ethics approval for this study was received from Ethics Committee of Macau University of Science and Technology. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all participants included in the present study.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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