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Leveraging the Numerosity Effect to Influence Perceived Expensiveness of Virtual Items

Yunhui Huang,[a] Kai H. Lim,[b] Zhijie Lin[c,*]

[a] Department of Marketing and Electronic Business, School of Business, Nanjing University, 210093 Nanjing, China; [b] Department of Information Systems, College of Business, City University of Hong Kong, Hong Kong SAR, China; [c] Department of Management Science and Engineering, School of Economics and Management, Tsinghua University, 100084 Beijing, China

*Corresponding author

Contact: yunhuihuang@nju.edu.cn, https://orcid.org/0000-0002-2619-7740 (YH); iskl@cityu.edu.hk (KHL); dr.zhijie.lin@gmail.com (ZL)

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Abstract. Selling virtual items (e.g., clothing, weapons, or virtual furniture) serves as one of the major revenue sources for online game operators. Therefore, exploring what specific factors and design attributes may affect the sales of virtual items has become an important issue. This research draws upon prior studies on currency numerosity, contextualizing them to online game contexts to develop several theory-based predictions about how online game currency numerosity affects players' perceived expensiveness and consequently their purchase intention of virtual items. To test these predictions, we conducted six experiments that investigate numerosity effects in massive multiplayer online games (MMOs) where players can exchange real money for game currency based on an exchange rate in order to purchase virtual items. Results indicate the following: (1) when the game currency exchange rate is not salient (e.g., game currency exchange rate is not mentioned or players have sufficient game currency in their account), players consider a virtual item as more expensive if the price is high (versus low) in numerosity; but (2) when the game currency exchange rate is salient (e.g., game currency exchange rate is mentioned and no additional information indicates that it is irrelevant), players consider a virtual item as cheaper if the price is high (versus low) in numerosity; in addition, (3) in the latter case, numerosity increases players' purchase intention of nonsocial, but not social, virtual items through the mediating effect of perceived expensiveness. Our notable findings contribute to the existing literature on numerosity and provide guidance for the design of virtual currency systems in MMOs.

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Keywords: currency numerosity • virtual items • massive multiplayer online games • exchange rate salience • perceived expensiveness • virtual currency systems

1. Introduction

The category of Massive Multiplayer Online game (MMO) encompasses a wide range of game genres, including role-playing (e.g., MapleStory and Dungeon Fighter Online), shootings (e.g., CrossFire and World of Tanks), and multiple player online battle arena games (e.g., Legends and Dota2). Most MMOs earn revenue from selling virtual goods to players. Virtual goods refers mainly to objects such as virtual items (e.g., clothing, weapons, or virtual furniture); virtual characters; and game currencies in MMOs, which are frequently bought and sold like conventional consumer commodities (Lehdonvirta 2009). It is estimated that MMOs earned more than $19.8 billion in 2016, roughly 60% of all digital PC game revenue (MMOs.com 2016). By the end of 2021, they are projected to reach a value of $43 billion (Statista 2019). As selling virtual goods serves as a major revenue source for MMO operators, exploring what specific factors and design attributes may affect the sales of virtual goods has become an important issue for the success of MMOs (e.g., Lehdonvirta 2009, Hamari and Lehdonvirta 2010, Roquilly 2011, Kim et al. 2013, Liao et al. 2015).

One particular stream of research (e.g., Hamari and Lehdonvirta 2010, Bombace 2013) has emphasized the importance of the design of game currency systems. Unfortunately, this stream of research has not provided theory-based guidelines for the design of game currency systems or empirically tested the influence of game currency systems on players' purchase intention of virtual goods. The literature on currency systems and numerosity in nongame contexts might shed light on the operationalization of a currency system in game contexts. At the first glance,

MMOs have many differences from our nongame daily lives, including the visual environments, rules of the world, important resources and how to obtain them, etc. The former also needs game platforms and has structured goals, objectives, and challenges that are artificially determined and are sometimes played from a third-person perspective, whereas the latter does not. However, research has suggested that people's behavior tendency holds across game and nongame contexts and thus principles found in one context could usually apply to the other context. On the one hand, game elements and game design techniques, which are called gamifications, have been used in nongame contexts, such as marketing (Hofacker et al. 2016), management (Robson et al. 2016), and education (Dicheva et al. 2015). On the other hand, online games could adopt similar strategies, such as segmentation and differentiation, found in traditional marketing (Hamari and Lehdonvirta 2010) to achieve nongame purposes (Kurihara 2015). Therefore, it is reasonable to draw inference from findings in nongame contexts to inform our understanding in game contexts.

Besides the online game industry, understanding of virtual currency systems also contributes to the fast-growing virtual currency (e.g., Bitcoin) business (Briere et al. 2015). Until 2016, the cumulative market capitalization of cryptocurrencies was below $18 billion. But this value has reached $237.1 billion by 2019 (Statista 2020). Virtual currencies have caught more and more attention from both practitioners and academics because of their high average return (Corbet et al. 2019) as well as their flexibility and effectiveness (Alghamdi and Beloff 2015). Considering the commonality between game and nongame contexts, examining the design of game currency systems could also shed light on the design of other virtual currency systems.

The first objective of the present research is to draw upon research on currency numerosity in nongame contexts (e.g., Harvey et al. 2013) to empirically examine how online game currency numerosity affects players' perceived expensiveness of virtual items and consequently their purchase intention. Here, numerosity refers to "a property of a stimulus that is defined by the number of discriminable elements it contains" (Brannon and Terrace 1998, p. 746) or "the number of units into which a stimulus is divided" (Pelham et al. 1994, p. 104). For example, the number 1,000 is higher in numerosity than the number 10. Currency numerosity refers to the number of currency units by which a certain value could be represented. For example, the Hong Kong dollar (HK$) is higher in numerosity than the U.S. dollar, as the price of the same product would be higher in numerosity displayed in Hong Kong dollars rather than in U.S. dollars (U.S.$1 ≈ HK$7.8). See Table 1 for a summary of the definitions of our key concepts.

Prior research conducted on numerosity effects has shown that numerosity influences people's magnitude perceptions (e.g., Harvey et al. 2013). However, careful scrutiny of the literature reveals that there are two streams of research that may lead to opposing conclusions on how currency numerosity may affect price perception. On the one hand, prior studies have demonstrated that an item is considered to be more expensive when the item is priced in a high (versus low) numerosity currency (e.g., Hong Kong dollar as compared with U.S. dollar) because people use *numerosity of a focal number* (i.e., *numerosity of label price* when referring to price perception) as a judgmental cue to infer quantity while ignoring other information (e.g., Raghubir and Srivastava 2002, Wertenbroch et al. 2007). On the other hand, Bagchi and Li (2011) assert that rewards of a loyalty program are perceived to be easier to obtain when spending per dollar earns more (versus fewer) face points (e.g., 10 points per dollar as compared with one point per dollar) despite the two loyalty programs being equivalent in terms of redemption value (i.e., 10 points in the first program are worth the same as one point in the second program for redemption purposes). Although not explicitly stated, it can be inferred from Bagchi and Li (2011) that an item would be considered as easier to get (i.e., cheaper) when the item is priced in a high (versus low) numerosity currency because people might rely on *numerosity of exchange rate* to make judgment.

We postulate that this contradiction may apply in online game contexts. Therefore, the second objective of the present research is to resolve this contradiction by investigating, in the context of an online game, the boundary condition under which people rely on the numerosity of label price versus the numerosity of exchange rate when evaluating item expensiveness. Through six experiments conducted among MMO players, we show that when the exchange rate between real money and game currency is not salient (i.e., not accessible because it is not mentioned or irrelevant because there is already enough game currency in a player's account for desired virtual items), players perceive virtual items as more expensive when they are priced in a high (versus low) numerosity currency. However, when the exchange rate is salient (i.e., exchange rate is mentioned and no additional information suggests that it is irrelevant), the above effect is reversed. As a result, when considering recharging their accounts with real money to purchase virtual items, players are more likely to do so in the high (versus low) numerosity condition. However, this downstream consequence of numerosity does not hold when a virtual item is used as a social symbol or a status signal (Lehdonvirta 2009).

Table 1. Definitions of Concepts in the Current Research

Concept	Definition	Note
Numerosity	A property of a stimulus that is defined by the number of discriminable elements it contains or the number of discriminable units into which it is divided	
Exchange rate	Amount of game currency one can buy with one unit of real money (i.e., how much game currency ¥1 can purchase in our experiments)	
Game currency numerosity	Number of game currency units by which a certain value could be represented	High game currency numerosity indicates high numerosity of label price and high numerosity of exchange rate.
Numerosity of label price	The number of focal currency units that a label price contains	A virtual item costing the same real money (e.g., $10) will have a label price higher in numerosity (e.g., 10,000 game currency as compared with 100 game currency) when it is in a game with higher numerosity of exchange rate (e.g., $1 = 1,000 game currency as compared with $1 = 10 game currency).
Numerosity of exchange rate	The number of game currency units that one unit of real money can exchange for	
Salience	To what extent some pieces of information are more attended to than others	
Maximum limit	The upper bound of a numerical range which could be used to calculate the distance between it and the focal number being evaluated	A budget could serve as a maximum limit to evaluate the amount of money that has been spent; the original price of a product could serve as a maximum limit to evaluate the sale price.
Actual cost in real money	An item's actual monetary value in real money (e.g., in dollars)	

The present research contributes to the literature in four important ways. First, by showing the moderating effect of exchange rate salience, it resolves the conflicting findings in the numerosity literature regarding how the numerosity of label price versus that of exchange rate affects price perception. Second, it is the first to extend the numerosity literature to game contexts, thus helping to dip into the similarities and differences in people's behaviors in nongame and game contexts. Third, by using game contexts to examine the features of virtual currency systems, it sheds light on the methodology to understand the fast-growing virtual currencies. Fourth, the empirical findings of the present research help to guide the design of game currency systems to boost players' purchase intention for virtual items for the benefit of game companies or to correct bias and prevent overspending for the benefit of players.

2. Theoretical Background and Literature Review

2.1. Classic Numerosity Effects: Numerosity of a Focal Number as a Judgmental Cue

The extant literature on classic numerosity effects indicates that people infer greater quantity from higher face value and ignore other relevant information (for a review, see Bagchi and Davis 2016). For example, $1 per day looks more affordable than $350 per year because 1 is smaller than 350 and the units (i.e., day versus year) are ignored (Gourville 1998). Pelham et al. (1994) suggest that this effect occurs because larger numbers are often associated with larger sizes, and the learned association between numerosity and size leads people to infer size from the largeness of a number (Josephs et al. 1994). However, other researchers suggest that numerosity is innate to human brains and individuals might subitize (perceive the number at a glance) rather than count numbers (Demeyere and Humphreys 2012). Functional magnetic resonance imaging also shows that human brains have topographic structures attuned to perceiving numerosity. During magnitude processing, a smaller space of the brain is dedicated to larger (versus smaller) numbers (Harvey et al. 2013). Below, we summarize the literature on different forms of classic numerosity effects found in nongame contexts.

2.1.1. Numerosity of a Focal Number as a Judgmental Cue in Currency Perception. Recent research on currency perception has repeatedly documented the classic numerosity effect. The *money illusion* (,Kahneman et al. 1986, Shafir et al. 1997, Fisher 2014) is a prototypical example. It shows that people overlook inflation rate information and base their judgment of a financial outcome on the numerical value of money

rather than its purchasing power (real value). For instance, a 10% salary increase with a 12% inflation rate is more satisfying than a 1% salary deduction with no inflation. Another example is the *face value effect* (Raghubir and Srivastava 2002, Wertenbroch et al. 2007), which suggests that spending is biased toward the numerical value when participants evaluate product prices in foreign currencies. Specifically, when spending in a currency high in numerosity (e.g., HK$7.8 = U.S.$1), consumers perceive the product to be more expensive; whereas when spending in a currency low in numerosity (e.g., £0.60 = U.S.$1), consumers perceive the product to be cheaper.

2.1.2. Numerosity of a Focal Number as a Judgmental Cue When Earning Bonus Points. The classic numerosity effect occurs not only in currency perception but also in response to intrinsically worthless bonus or reward points (e.g., bonus points from retailers, reward miles from airlines). Specifically, consumers tend to maximize bonus or reward points because they create an illusion of advantage (Hsee et al. 2003, Van Osselaer et al. 2004). In one study, Hsee et al. (2003) ask participants to choose between buying a certificate of deposit (CD) from a bank branch six minutes away to get $150 three years from now versus buying a CD from a branch five minutes away to get $100 now. Only 17% chose the first option. However, when the same payment was mediated by points, such that participants chose between buying a CD from a branch six minutes away to get 150 points that could be redeemed for $150 three years from now and buying a CD from a branch five minutes away to get 100 points that could be redeemed for $100 now, 44% preferred the first option. That is, the reward became more popular when it was mediated by more points. Similarly, Van Osselaer et al. (2004) have documented people's myopic maximization of intrinsically worthless points when choosing among loyalty programs.

2.1.3. Reversal of Classic Numerosity Effects: When a Maximum Limit Exists. The discussions above suggest that people judge a focal number that is higher in numerosity to be larger, while ignoring other background information, such as unit and type of currency. However, the classic numerosity effect could reverse when an upper bound of a numerical range (i.e., a maximum limit, such as a spending budget) exists. In this case, although consumers still pay attention to the numerosity of the focal number, they use it to calculate its distance from the maximum limit. Thus, higher numerosity that makes the distance from maximum limit appear larger would make a focal number (e.g., a product price) feel smaller (Gamble 2006, Wertenbroch et al. 2007, Bagchi and Li 2011). For example, Wertenbroch et al. (2007) find that when a spending budget is salient, high-numerosity (verus low-numerosity) currency leads to overspending because the difference between budget and price (i.e., the face value of money left) is perceived to be larger. Similarly, for high-price products, discounts are more attractive in high (versus low) numerosity currency because the difference between original and current prices looks larger (Lowe et al. 2012).

In short, the classic numerosity effect has been well documented in different areas, and people's tendency to use the numerosity of a focal number as a judgmental cue while ignoring other information, such as unit, suggests that numerical objects presented in higher (versus lower) numerosity are usually perceived to be larger in magnitude. Therefore, price presented in higher (versus lower) numerosity currency is often perceived to be higher (e.g., Raghubir and Srivastava 2002, Wertenbroch et al. 2007). However, the findings we have reviewed above tell only half of the story. Numerosity of a focal number (i.e., numerosity of label price when referring to price perception) is not the only cue that people could draw upon when making price judgments. As we will describe below, although largely ignored, prior studies indicate that people might use the numerosity of exchange rate as the judgmental cue, and their doing so might lead to different outcomes.

2.2. Numerosity of Exchange Rate as a Judgmental Cue

Bagchi and Li (2011) assert that when consumers know exactly how many points are earned per dollar (i.e., face step size, which could also be considered similar to the numerosity of exchange rate) in a loyalty program, a large face step size (e.g., 10 points per dollar spent) gives the impression that the reward ($6 off after accumulating 1,000 points) is easier to attain, whereas a small step size (e.g., 1 point per dollar spent) implies that progress is slow for the same reward ($6 off after accumulating 100 points). Note that Bagchi and Li's (2011) assertion has not been subject to empirical tests. However, if correct, it would suggest that when the exchange rate is clearly stated, consumers would feel it is easier to get the reward in the high (versus low) numerosity condition. Although no previous research has examined how such a tendency would affect people's price perceptions, it is reasonable to expect that when considering exchanging currency from one's own country (e.g., U.S. $) to a foreign currency (e.g., HK$ or £) to purchase a product, a consumer from the United States would perceive the product to be less expensive when spending in a currency high in numerosity (e.g., HK$) than low in numerosity (e.g., £). This presumed effect would occur because the person's attention would likely fixate on the ease of getting a large

numerical amount of foreign currency, and the U.S. dollar would seem to have higher purchasing power in the former case (i.e., U.S.$1 = HK$7.8) than in the latter case (i.e., U.S.$1 = £0.60).

2.3. Summary of the Effects of Currency Numerosity

The above review of previous findings points to the contradictory effects of currency numerosity on price perception. If people use *numerosity of a focal number* (i.e., numerosity of label price) as a judgmental cue, numerosity tends to increase perceived expensiveness; but if people use *numerosity of exchange rate* as a cue, numerosity tends to decrease perceived expensiveness. These observations regarding the previous research bring two unsolved questions. First, in online game contexts, do game players use the numerosity of a focal number, numerosity of exchange rate, both of them, or neither of them as the judgmental cue to evaluate prices? Second, if people's behaviors in games are parallel to those in nongame contexts, and both cues could be adopted, what is the boundary condition that determines which of the cues people rely on when evaluating item expensiveness?

2.4. Previous Findings About Virtual Item Purchase

Players' willingness to pay real money for virtual items is crucial for the revenue of game operators because many MMOs are "free-to-play." Free-to-play games allow users to enter the service for free but gain revenue from users who spend money on virtual items (Hamari and Lehdonvirta 2010, Hamari and Keronen 2016). This type of game dominates today's online game markets (MMOs.com 2016). Even "pay-to-play" games, which require users to pay a monthly or hourly based subscription fee, are increasingly converting their business models to this approach (Hamari and Keronen 2016). For this reason, previous research has focused on what drives the demand for virtual items (e.g., Lehdonvirta 2005; Animesh et al. 2011; Guo and Barnes 2011; Kim et al. 2011, 2012; Jung and Pawlowski 2014; Hinz et al. 2015; Hamari and Keronen 2016). Some of the factors identified include achievement and social and immersion motivations (Lehdonvirta 2005); enjoyment (Animesh et al. 2011); attaining social capital (Hinz et al. 2015); and maintaining a positive self-image (Hamari and Keronen 2016). This line of research provides insights on how to increase the demand for virtual items through better game design (e.g., Lehdonvirta 2009, Hamari and Lehdonvirta 2010, Liao et al. 2015). For example, Lehdonvirta (2009) suggest that attaching virtual items with functional attributes (i.e., attributes used as instruments toward fulfilling some higher objective, including potential performance boost and functionality); hedonic attributes (i.e., attributes that allow fulfilling a pleasure seeking goal, such as on-screen representations as well as any animations and sounds associated with them); or social attributes (i.e., attributes that express status, class, group membership, difference, or self-identity, such as rarity) could boost players' interest in purchasing them. This reasoning also points to the importance of considering virtual item heterogeneity (i.e., type of virtual item) in the design.

Nonetheless, this set of research comprises case studies only of popular MMOs, and the applicability of the general rules to other games is unknown. Moreover, although it has been suggested that game design should adopt game currency systems to increase players' incentives for purchases (Hamari and Lehdonvirta 2010), to our knowledge, the kinds of currency systems that could create the best virtual goods sales have never been discussed. The current research thus focuses on how game currency numerosity affects players' perceived expensiveness and purchase intention of different types of virtual items.

3. Research Hypotheses

3.1. The Effect of Game Currency Numerosity on Perceived Expensiveness

As cognitive misers (Fiske and Taylor 2013), consumers tend to make cost inferences from different available cues but not to actually calculate costs. According to the numerosity literature we reviewed above, game currency numerosity might affect players' price perception. However, previous findings do not indicate whether game currency numerosity increases or decreases perceived expensiveness. More specifically, high game currency numerosity usually indicates both high numerosity of label price and high numerosity of exchange rate. If players draw on numerosity of label price, as discussed in Section 2.1, they might consider an item as more expensive when game currency is high (versus low) in numerosity, because other information such as unit is ignored (Bagchi and Davis 2016). For example, for a virtual item that costs $60, being priced at 60,000 (versus 60) game currency looks more expensive, as the numerosity of 60,000 (versus 60) is higher. On the contrary, if players draw on the numerosity of exchange rate, as derived from Section 2.2, it would appear easier to get a large amount of game currency in the high (versus low) numerosity condition; thus, real money would seem to have higher purchasing power for game currency. Thus, a virtual item is perceived as less expensive in this condition. Using the same example, for the same virtual item that costs $60, being priced at 60,000 (versus 60) in game currency looks cheaper because players feel that $1 can buy a large amount of game currency when "$1 = 1,000 game currency," whereas $1 can buy only a small amount of game currency when "$1 = 1 game currency."

The contradiction between relying on the numerosity of label price versus relying on the numerosity of exchange rate has not been investigated in previous research because these two types of cues do not coexist simultaneously in the scenarios examined. For example, customers accumulate points in a loyalty program first and then redeem them for rewards later (Van Osselaer et al. 2004); travelers exchange their money for a foreign currency before traveling and spend the currency during their visit in the foreign country (Raghubir and Srivastava 2002). However, in MMOs, these two cues could be interdependent.[1] When considering purchasing a virtual item with real money, a player is considering whether to get game currency with real money to purchase the focal virtual item (Lehdonvirta 2009, Hamari and Lehdonvirta 2010). Therefore, both the label price and the exchange rate could take effect; how game currency numerosity affects perceived expensiveness of virtual items is unclear. To solve this problem, we next draw on the literature of psychological myopia.

Psychological myopia suggests that decision makers focus on information immediately related to their choice or judgment and ignore other (e.g., background) information (Keeney and Raiffa 1976, Fischer et al. 1987, Hsee et al. 2003). For instance, the order effect of package pricing shows "70 items for $29" is more favorable than "$29 for 70 items" because the first piece of information is salient and the item-price (versus price-item) makes items (versus price) salient, positively affecting evaluation (Bagchi and Davis 2012). As another example, *deliberational blindness* shows that the numerosity of product price in a foreign currency increases consumers' willingness to pay for the product because consumers fail to consider that they are unknowledgeable about the meaning of units. However, this effect diminishes when the units are made visually salient (i.e., enlarging the font size of the unit relative to the font size of the number) (Shen and Urminsky 2013) (also see Monga and Bagchi 2012 for similar focus on the relative salience between numerosity and unitosity).

Following this literature, we propose that whether the numerosity of label price or relying on the numerosity of exchange rate plays a dominant role depends on relative *salience*. Salience means to what extent some pieces of information are more attended to than others (Greifeneder et al. 2011). Previous research has suggested that cue salience is determined by the accessibility and relevance of the cue (Greifeneder et al. 2011, Schwarz 2012, Aronson et al. 2013). First, a cue is more likely to influence judgment when it is highly accessible. For example, moods, as cues to indicate people's social relationship satisfaction or product evaluation, are more likely to affect judgment when they are assessed in a manipulation check prior to measuring dependent variables because the manipulation check presumably increases the accessibility of people's affective experiences (Siemer and Reisenzein 1998, White and McFarland 2009). The accessibility of a cue could be due to inherent features (Taylor and Fiske 1978, Higgins 1996). In the case of encountering a virtual item in MMOs, the magnitude of the label price should be highly accessible by default. In contrast, a cue could also become accessible if people were recently exposed to it or used it, circumstances that are likely to override the impact of chronically accessible cues (Aronson et al. 2013). Therefore, although the exchange rate between game currency and real money might not be salient by default, it could be even more accessible than label price if players recently thought about it. This scenario is quite possible when players are considering purchasing game currency with real money.

Therefore, when the price of a virtual item is displayed *without* explicit reference to exchange rate between real money and game currency, players might use the most accessible information (i.e., numerosity of price) to judge the item's expensiveness. Thus, the virtual item would be judged as more expensive when the game currency is high (versus low) in numerosity. On the contrary, when the exchange rate between real money and game currency is temporarily made highly accessible and thus overrides the chronically accessible price numerosity (Aronson et al. 2013), such as by explicitly making players think about the exchange rate, players are likely to use it as a cue in making a judgment. Thus, the virtual item would be judged as less expensive when the game currency is high (versus low) in numerosity because players might feel that the purchasing power of real money is high (versus low) in this situation.

Second, even if accessible, a cue would not be adopted if the context strongly suggests it is irrelevant to the judgmental task. For example, people usually use their affect as a cue to indicate how they feel about the product, and thus positive affect leads to more favorable product evaluation. However, the effect of affect holds only for hedonic products and not for utilitarian products because, by nature, utilitarian products are judged based on whether they are able to meet people's functional needs rather than whether they bring positive feelings. Therefore, people's affect is not a relevant cue in this case (Adaval 2001). As another example, people consider a feature contained in an out-of-stock product more desirable than a feature contained in an alternative product in stock. However, the effect holds only when people are low in product category expertise. For experts, product knowledge enables them to evaluate the product features, and the behavioral track of other customers

(i.e., the stock-out cue) becomes an irrelevant cue for the judgment (Huang and Zhang 2016).

In the context of our study, we argue that when players already have enough game currency in their account to purchase the virtual item, even if the exchange rate is made highly accessible, it would just be a piece of irrelevant information. In this case, exchange rate is not directly associated with the focal judgment, as players do not need to use real money to trade for game currency before they purchase the virtual item. Therefore, we expect that players would use the numerosity of label price as the judgmental cue. However, if the judgmental context does not indicate that one cue is irrelevant, the informational value of the temporarily accessible cue would still hold. That is, if players are not told that they have enough game currency in their account, the highly accessible exchange rate should still be considered a relevant cue; we predict that players would draw on it to judge the expensiveness of a virtual item.

In sum, because the label price is by default accessible and relevant, the effect of game currency numerosity would depend on whether the players are in a judgmental context in which the exchange rate is made temporarily salient.

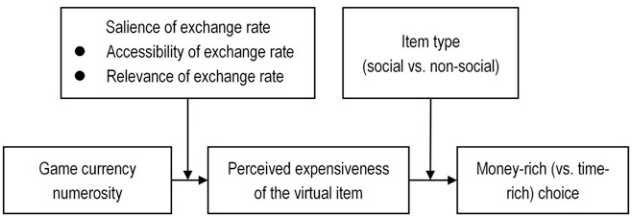
Hypothesis 1. *If the exchange rate is salient (e.g., made accessible through explicitly making players think about it, and there is no additional information suggesting that it is irrelevant), players consider a virtual item as cheaper when the game currency is high (versus low) in numerosity.*

Hypothesis 2. *If the exchange rate is not salient (e.g., without accessibility because players are not made to think about it or accessible but irrelevant because players have enough game currency in their account), players consider a virtual item as more expensive when the game currency is high (versus low) in numerosity.*

3.2. Overview of Studies

The overall research model is presented in Figure 1. Six experiments were conducted, using virtual items of different values, different experimental settings, and different sources of participants to increase the generalizability of the findings (Shadish et al. 2002). Studies 1–3 examined the effect of game currency numerosity on perceived expensiveness. Moreover, different experiments focused on different types of virtual items (i.e., a hedonic item in Study 1 and Study 2a, a functional item in Study 2b, and a social item in Study 3). As indicated above, the effect of numerosity on perceived expensiveness originates in people's natural responses to numerosity, which is independent of the type of virtual item. Therefore, virtual item heterogeneity should not alter the effects of game currency numerosity on perceived expensiveness. Below, we provide the detailed rationales for the design of each of the studies.

Figure 1. Research Model



Studies 1 and 2 were designed to test Hypothesis 1 and Hypothesis 2 by manipulating the salience of exchange rate through either accessibility (Study 1) or relevance (Study 2). Study 1 utilized a quasiexperiment design, which required participants to rely on their previous game-playing experience. The scenarios were realistic but at the same time induced some noise, including possible preexisting differences of players across conditions. Study 2 utilized a true experiment design using an artificial game setting. Here, we randomly assigned participants across conditions to equalize possible preexisting differences; but in our doing so, the realism of Study 2 is lower compared with Study 1. Together, Studies 1 and 2 complement and compensate for each other; consistency of findings across these two studies should provide confidence that the results obtained are robust and generalizable. Study 3 ruled out an alternative explanation of Hypothesis 1, which will be elaborated later.

Studies 4 and 5 focused on the contexts in which players were considering paying real money for virtual items (i.e., making the exchange rate salient) and examined the possible downstream consequences of numerosity, namely whether numerosity affects players' preference for getting enough game currency for an item through paying real money (i.e., the money-rich approach) over through spending time in accomplishing game tasks (i.e., the time-rich approach). We predict that game currency numerosity will increase players' likelihood of choosing a money-rich (versus time-rich) approach for nonsocial but not social items. These predictions are elaborated after Study 3.

4. Study 1

Study 1 employed a quasiexperiment to test Hypothesis 1 and Hypothesis 2. The salience of exchange rate was manipulated through altering its accessibility. To make the judgmental scenarios realistic and enable participants to make judgments based on their real experience, we asked MMO players to judge the expensiveness of a virtual item in the game they most frequently play. As the currency systems of games usually differ in numerosity, we expected that game

Table 2. Proportion of Participants for Each MMO

MMO	Approximate price range of virtual items sold by the official shopping system	Approximate exchange rate	n	Coding of numerosity
Age of Wulin (web game version)	RMB 15–300	1 RMB = 1	10	2
Ghost (mobile game version)	RMB 6–648	1 RMB = 10	5	3
Legend of the Swordman Online III (web game version)	RMB 15–300	1 RMB = 100	51	4
Ragnarok Online (mobile game version)	RMB 6–648	1 RMB = 10,000	40	6

Notes. The price ranges of the virtual items were obtained from an employee in the marketing department of a game company. The coding of numerosity is the same as the coding of the options of the exchange rate question. Please note that purchasing virtual items from official shopping systems is not the only way to get virtual items. Prices and items could vary when traded in unofficial ways.

players would perceive virtual items to be more expensive in a game that is high (versus low) in currency numerosity when exchange rate was not highlighted (i.e., Hypothesis 2). However, we expected this effect to be reversed when exchange rate was made salient by asking players to think about it (i.e., Hypothesis 1).

4.1. Method of Study 1

One hundred six MMO players were recruited from online discussion sites (i.e., Baidu post bars) for the four MMOs from Netease, a leading internet technology company in China, as described in Table 2. These discussion sites were established by Netease. They allow players of a specific game to share and discuss their experience in that game. The four particular MMOs were chosen because they were popular when we conducted the experiment (March 2017), and they differed in game currency numerosity. Demographic information of the participants is summarized in Table 3. Considering that most participants (86%) chose "The Legend of the Swordman Online III" (1 Renminbi (RMB) = 100 game currency) or "Ragnarok Online" (1 RMB = 10,000 game currency), we focused on these participants for the data analysis.[2] Thus, as shown in Table 4, Study 1 was a quasiexperiment with a 2 (game currency numerosity: high versus low) × 2 (salience of exchange rate: yes versus no) between-subjects design. Participants first indicated which MMO they played most frequently among the four MMOs. Then, for control variables, they answered questions about their game-playing behaviors (see Table 5 for details).

Next, according to the MMO they chose (see Table 2 for details), they were assigned to the numerosity condition consistent with the game they chose. In the salient exchange rate condition, participants were first asked about how much game currency equaled 1 RMB in the game they chose (1 = 1 RMB equals 0.1 game currency; 2 = 1 RMB equals 1 game currency; 3 = 1 RMB equals 10 game currency; 4 = 1 RMB equals 100 game currency; 5 = 1 RMB equals 1,000 game currency; 6 = 1 RMB equals 10,000 game currency).

Table 3. Summary of the Demographic Information of Participants

Demographics	Category	Study 1	Study 2a	Study 2b	Study 3	Study 4	Study5
Gender	Female	51.1%	46.8%	48.2%	52.8%	50.4%	49.7%
	Male	48.9%	53.2%	51.8%	47.2%	49.6%	50.3%
Age	18 or below	8.7%	1.6%	8.9%	0.40%	2.4%	2.3%
	19–24	64.1%	72.6%	64.3%	34.9%	85.0%	29.5%
	25–30	19.6%	23.2%	25.0%	36.7%	11.0%	37.6%
	31–36	5.4%	2.6%	1.8%	21.0%	1.6%	25.3%
	Above 36	2.2%	0.0%	0.0%	7.0%	0.0%	5.3%
Education	Middle school or below	2.2%	0.0%	2.7%	0.0%	0.8%	0.0%
	High school	10.9%	4.7%	17.9%	4.4%	7.9%	4.9%
	College or university	73.9%	64.2%	58.9%	89.5%	77.2%	88.6%
	Post university	13.0%	31.1%	20.5%	6.1%	14.2%	6.5%
Monthly expenditure	¥1,000 or below		12.1%	24.1%	4.4%	15.7%	5.1%
	¥1,001–3,000		58.9%	57.1%	36.7%	46.5%	36.0%
	¥3,001–5,000		16.8%	10.7%	36.2%	29.9%	38.1%
	¥5,001–7,000		7.9%	3.6%	13.1%	3.9%	14.2%
	¥7,001–9,000		2.6%	2.7%	4.8%	1.6%	3.7%
	Above ¥9,000		1.6%	1.8%	4.8%	2.4%	3.0%

Notes. The data are based on valid cases only. Study 1 allowed participants to skip the demographic questions. Thus, the above information is based on the data we collected. Percentages have been rounded and may not total to 100%.

Table 4. Treatment Conditions of Study 1

Treatment Conditions	Low numerosity: 1 RMB = 100 game currency	High numerosity: 1 RMB = 10,000 game currency
Exchange rate not salient: asking about exchange rate after evaluating expensiveness	Treatment 1 (n = 27)	Treatment 2 (n = 24)
Exchange rate salient: asking about exchange rate before evaluating expensiveness	Treatment 3 (n = 24)	Treatment 4 (n = 16)

By asking them the game currency exchange rate, we increased the accessibility and thus the salience of exchange rate. Next, they were asked to imagine that when they were playing the game they chose, they came across a virtual decoration (i.e., a hedonic virtual item) priced at 60/600/6,000/600,000 (i.e., 60 RMB).[3] For example, a player indicating that she or he played "The Legend of the Swordman Online III" (where 1 RMB = 100 game currency) most frequently would be presented with a virtual decoration priced at 6,000 game currency. Then, they reported the perceived expensiveness of the item (see Table 5 for details). In the condition that the exchange rate was not salient, participants were asked about the exchange rate of the game after, rather than before, judging the perceived expensiveness of the virtual item, a process that decreased the accessibility of exchange rate.

4.2. Results and Discussion of Study 1

4.2.1. Preliminary Analyses. Eighty-three percent of the participants chose the correct exchange rate, suggesting that participants were aware of the exchange rate of the game they chose.[4]

4.2.2. Perceived Expensiveness. A 2 (game currency numerosity: low versus high) × 2 (salience of exchange rate: yes versus no) between-subjects analysis of covariance with game-playing behaviors as control variables on perceived expensiveness yielded a significant interaction, $F(1, 85) = 8.91$, $p = 0.004$, partial $\eta^2 = 0.095$ (see Table 6 and Figure 2 for details).[5] Planned contrasts showed that when the exchange rate was not salient, participants considered the virtual item to be marginally more expensive in the high (versus low) numerosity condition (Mean in the high numerosity condition (M_{high}) = 5.50, standard deviation (SD) = 1.74 versus Mean in the low numerosity condition (M_{low}) = 4.33, $SD = 1.96$; $F(1, 85) = 3.08$, $p = 0.083$); however, when the exchange rate was made salient, participants considered the virtual item to be cheaper in the high (versus low) numerosity condition ($M_{high} = 2.88$, $SD = 1.75$ versus $M_{low} = 4.04$, $SD = 2.14$; $F(1, 85) = 4.77$, $p = 0.032$).

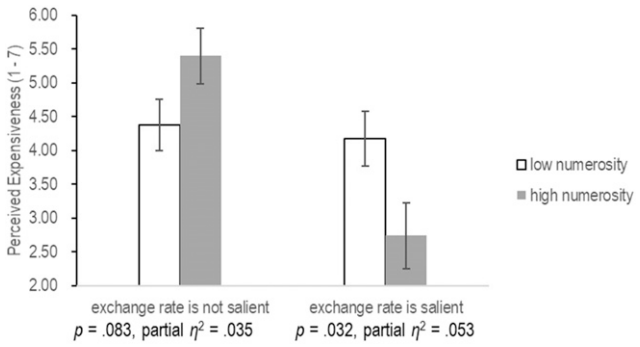
These results showed that people perceived a higher-numerosity product as more expensive when the exchange rate was not salient, and thus game players did not consider the exchange rate. However, the effect reversed when the exchange rate was salient. In this case, game players felt that the virtual item was cheaper when the game had a high (versus low) numerosity currency system. Study 1 provided preliminary support for both Hypothesis 1 and Hypothesis 2.

Notwithstanding, as mentioned, in using a quasiexperiment, we required participants to make judgments based on their previous experience about the game they chose. Although we focused on the differences of the game currency numerosity, different games could differ in many other ways, which could mean that participants' previous experiences differed in many ways. To overcome this problem, a true experiment showing convergent results with Study 1 was needed to provide better support for our hypotheses (Shadish et al. 2002).

5. Study 2

Study 2 utilized a true experiment to provide further evidence for the findings of Study 1. A fictional MMO was used to examine the effect of game currency numerosity on price perceptions. The ability to randomly assign experimental participants in true experiments allows researchers to control for any preexisting systematic differences among participants across different conditions (Shadish et al. 2002). Moreover, to show the generalizability of our findings, Study 2 recruited participants from a different source from that of Study 1, and two experiments with similar procedures were conducted. Study 2a used a hedonic item, and Study 2b used a functional item as the target.

Figure 2. Interaction Between Numerosity and Exchange Rate Salience in Study 1



Note. The above figure was based on estimated marginal means.

Table 5. Detailed Measurements in Each Study

Study	Construct	Items	Mean (Standard Deviation)	
Study 1	Expensiveness	How do you feel about this decoration? (1 = very cheap, 7 = very expensive)	4.23(2.06)	
	Control variables	How much do you like this game? (1 = not at all, 7 = very much)	5.34(1.32)	
		How many days have passed since the last time you played this game? (0 = zero days, 8 = eight days or more).	2.25(3.15)	
Study 2			Study 2a	Study 2b
	Expensiveness	How do you feel about this item? (1 = very cheap, 7 = very expensive)	4.73(1.46)	4.70(1.59)
	Item appeal (α = 0.91)	How do you feel about this item? 1) 1 = very unwilling to get, 7 = very willing to get 2) 1 = extremely dislike, 7 = extremely like 3) 1 = no need for, 7 = high need for	4.51(1.48)	4.12(1.65)
	Control variables	How often do you play similar MMO games? (1 = never, 5 = very often)	3.33(1.23)	3.37(1.42)
		How much do you like this type of MMO game? (1 = dislike very much, 7 = like very much)	4.88(1.37)	4.73(1.64)
Study 3	Expensiveness	How do you feel about this "Knife of Ghost"? (1 = very cheap, 7 = very expensive)	6.28(1.26)	
	Item appeal	How much do you need the "Knife of Ghost"? (1 = not at all, 7 = very much)	4.18(1.84)	
	Control variables	How often do you play similar MMO games? (1 = never, 7 = very often)	4.65(1.43)	
		How long have you been playing this type of game? (1 = never; 2 = less than one year; 3 = one–two years; 4 = two–three years; 5 = three–four years; 6 = five–six years; 7 = more than six years)	3.46(1.64)	
Study 4	Expensiveness	How do you feel about this book? (1 = very cheap, 7 = very expensive)	4.42(1.66)	
	Item appeal	How much do you need this book? (1 = not at all, 7 = very much)	4.94(1.35)	
	Check for option understanding	Based on your choice, how long do you think it will take for you to get enough silver bars? (1 = very short time, 7 = very long time)	4.24(2.15)	
	Control variables	How often do you play similar MMO games? (1 = never, 7 = very often)	5.13(1.74)	
		How much do you like this type of MMO game? (1 = dislike very much, 7 = like very much)	5.17(1.48)	
Study 5	Item appeal	How much do you need this item? (1 = not at all, 7 = very much)	4.08(1.46)	
	Check for option understanding	Based on your choice, how long do you think it will take for you to get enough silver bars? (1 = very short time, 7 = very long time)	4.55(2.10)	
	Perceived exchange rate	How much game currency do you think one RMB could exchange for? (1 = very little, 7 = quite a lot of)	3.28(1.55)	
	Perceived points earned per task	How much game currency do you think completing each task could earn? (1 = very little, 7 = quite a lot of)	2.98(1.37)	
	Manipulation check for item type	This product has functional features, such as allowing you to progress in the game faster. (1 = strongly disagree, 7 = strongly agree)	4.87(1.54)	
		This product enhances your sensory experience, making you feel happy. (1 = strongly disagree, 7 = strongly agree)	5.41(1.24)	
		This product helps to express to others the group, the status, and the class you belong to, your self-identity, and how you different from others. (1 = strongly disagree, 7 = strongly agree)	5.34(1.21)	
	Control variables	How often do you play similar MMO games? (1 = never, 7 = very often)	4.82(1.26)	
		How long have you been playing this type of game? (1 = never; 2 = less than one year; 3 = one–two years; 4 = two–three years, 5 = three–four years, 6 = five–six years, 7 = more than six years)	3.63(1.67)	
		Compared with other game players, how much have you spent in games? (1 = far below average, 7 = far above average)	3.56(1.46)	
		So far, how much have you spent in games? (in RMB)	4,235.03 (13,998.00)	
	Delayed gratification (1 = strongly disagree, 7 = strongly agree; * indicates reverse-coded item)	1. I would have a hard time sticking with a special, healthy diet.*	3.27(0.51)	
		2. I have always tried to eat healthy because it pays off in the long run.		
		3. I have given up physical pleasure or comfort to reach my goals.		
		4. When faced with a physically demanding chore, I always try to put off doing it.*		
		5. I try to consider how my actions will affect other people in the long term.		
		6. I do not consider how my behavior affects other people.*		
		7. I try to spend my money wisely.		
		8. I cannot be trusted with money.*		
		9. I cannot motivate myself to accomplish long-term goals.*		
		10. I have always felt like my hard work would pay off in the end.		

Table 6. Effect of Numerosity on Perceived Expensiveness

Study	Treatment condition	Low numerosity M	Low numerosity SD	Low numerosity N	High numerosity M	High numerosity SD	High numerosity N	F-statistic (planned contrast)	p
Study 1	Exchange rate not salient	4.33	1.96	27	5.50	1.74	24	3.08	0.083
	Exchange rate salient	4.04	2.14	24	2.88	1.75	16	4.77	0.032
Study 2a	Exchange rate not salient	4.20	1.29	49	4.76	1.43	46	2.96	0.087
	Exchange rate salient	5.25	1.27	52	4.65	1.70	43	4.22	0.041
Study 2b	Exchange rate not salient	4.04	1.37	26	5.07	1.44	28	7.26	0.008
	Exchange rate salient	5.30	1.47	30	4.29	1.76	28	7.38	0.008
Study 3	Exchange rate salient + without a reminder of actual cost	6.53	0.80	58	5.98	1.68	49	6.59	0.011
	Exchange rate salient + a reminder of actual cost	6.19	1.32	63	6.37	1.14	59	0.87	0.351
Study 4	Exchange rate salient	4.93	1.27	68	3.83	1.87	59	14.41	< 0.001

Note. SD, standard deviation.

All participants were introduced to a new MMO and its currency system. They were explicitly told about the exchange rate; thus, we had only the condition in which the exchange rate was accessible. Therefore, in Study 2, we manipulated salience of the exchange rate through its relevance rather than its accessibility. Specifically, in the salient condition, no additional information was provided to suggest that the exchange rate was irrelevant. Our theoretical framework suggests that, without any further information, players would be likely to use the highly accessible exchange rate as a cue to make a judgment and thus would perceive a virtual item as cheaper when 1 RMB could trade for more game currency (i.e., Hypothesis 1). By contrast, in the not-salient condition, participants were told that they had enough game currency in their account for the virtual item, thus making the exchange rate irrelevant for the purchase. In this case, the numerosity of the label price would more likely be operative, and players would consider a virtual item as more expensive when the game currency system was high (versus low) in numerosity (i.e., Hypothesis 2).

5.1 Study 2a

5.1.1. Method of Study 2a. One hundred ninety MMO players were recruited from online discussion groups in Wechat. Wechat is a Chinese instant messenger app developed and maintained by tech giant Tencent that allows users to form discussion groups as they like. We chose groups formed to discuss MMOs so as to recruit MMO players. Demographic information of participants is summarized in Table 3. A 2 (game currency numerosity: low versus high) × 2 (salience of exchange rate: yes versus no) between-subjects design was adopted. MMO players were invited to participate in a user study about a new MMO and were randomly assigned to one of the four experimental conditions (see Table 7).

Participants were told that a game developer was testing a new MMO game, and they were being recruited to test this game. In this game, players could choose to become a tank, a magician, a summoner, or a healer. Players could trade with other players and game nonplayer characters in different ways. They could gain game currency from the system by completing assigned tasks or could recharge game

Table 7. Treatment Conditions of Studies 2–5

Study	Treatment condition	Low numerosity: 1 RMB = 10 game currency	High numerosity: 1 RMB = 1,000 game currency
Studies 2a & 2b	Exchange rate not salient: having enough game currency in account	Treatment 1 (n_{2a} = 49; n_{2b} = 26)	Treatment 2 (n_{2a} = 46; n_{2b} = 28)
	Exchange rate salient: not mentioning players' account information	Treatment 3 (n_{2a} = 52; n_{2b} = 30)	Treatment 4 (n_{2a} = 43; n_{2b} = 28)
Study 3	Exchange rate salient + without a reminder of actual cost of the item	Treatment 1 (n = 58)	Treatment 2 (n = 49)
	Exchange rate salient + a reminder of actual cost of the item	Treatment 3 (n = 63)	Treatment 4 (n = 59)
Study 4	Exchange rate salient	Treatment 1 (n = 68)	Treatment 2 (n = 59)
Study 5	Exchange rate salient + a nonsocial item	Treatment 1 (n = 112)	Treatment 2 (n = 106)
	Exchange rate salient + a social item	Treatment 3 (n = 120)	Treatment 4 (n = 93)

Note. n2a refers to the number of participants in Study 2a and n2b refers to the number of participants in Study 2b.

currency using real money (10 RMB = 100 game currency in low-game-currency-numerosity conditions and 10 RMB = 10,000 game currency in high-game-currency-numerosity conditions).

Then, all participants were shown six scenarios that they might encounter in the game and answered questions about converting between real money and game currency before they proceeded (see Online Appendix A1.1 for details). For example, participants read that "Royal Ancient Times X has set up a shopping mall in which you can buy beautiful costumes for your game character. Different costumes will have different effects on your character. If you are currently using a summoner, you can choose the "Soul of the Forest" costume in the shopping mall, which will increase your spiritual power." Next, they were asked the following: "The price of the *Soul of the Forest* costume is 396 [39,600] gold ingots in the shopping mall. In order to recharge your account to buy this costume, how much money do you need (RMB 30, RMB 40, RMB 300, or RMB 400)?" These scenarios were displayed for two reasons. First, by illustrating game scenarios, we aimed to make the game more realistic, such that the participants would behave as if they were playing a real game. Second, we made sure that participants would be fully aware that the game currency system was high (or low) in numerosity as intended. That is, on the premise that the actual value in real money remained the same (e.g., RMB 39.6), the label price of an item changed (e.g., 396 gold ingots versus 39,600 gold ingots) in the question and the multiple choice options (e.g., RMB 30, RMB 40, RMB 300, or RMB 400) remained the same across different numerosity conditions. This approach allowed participants to infer the high versus low game currency numerosity even when they failed to choose the correct answer.

After that, participants were asked to imagine that they were playing the new game and encountered a virtual decoration that could make their virtual avatars better looking (i.e., a hedonic virtual item). The virtual item was priced at 688 (in low numerosity conditions) or 68,800 (in high numerosity conditions). While in the salient exchange rate conditions, participants were not told about their account information; in the not-salient exchange rate conditions, they were told that they had 2,000 (in low numerosity conditions) or 200,000 (in high numerosity conditions) game currency in their account. This manipulation made the exchange rate irrelevant for the judgmental task and thus reduced its salience.[6] Participants then rated the item's perceived expensiveness (i.e., the dependent variable) and its appeal (i.e., a control variable)[7] as well as their game-playing behaviors (i.e., control variables). See Table 5 for the detailed measurements.

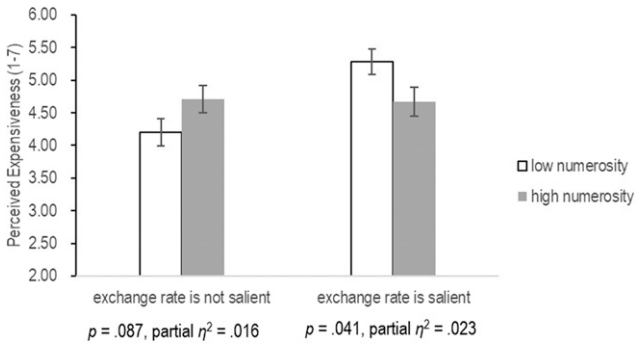
5.1.2. Results of Study 2a. A 2 (game currency numerosity: low versus high) × 2 (salience of exchange rate: yes versus no) between-subjects ANCOVA on perceived expensiveness with monthly expenditure, item appeal, and game-playing behaviors as control variables yielded a significant interaction, $F(1, 182) = 7.18$, $p = 0.008$, partial $\eta^2 = 0.038$ (see Table 6 and Figure 3 for details). Planned contrasts showed that when the exchange rate was not salient (i.e., when players had enough currency and thus the exchange rate was irrelevant), they considered the virtual item to be marginally more expensive in the high (versus low) numerosity condition ($M_{high} = 4.76$, $SD = 1.23$ versus $M_{low} = 4.20$, $SD = 1.29$; $F(1, 182) = 2.96$, $p = 0.087$); however, when exchange rate was salient (i.e., when no additional information indicated it was irrelevant), participants considered it to be cheaper in the high (versus low) numerosity condition ($M_{high} = 4.65$, $SD = 1.70$ versus $M_{low} = 5.25$, $SD = 1.27$; $F(1, 182) = 4.22$, $p = 0.041$).

5.2. Study 2b

5.2.1. Method of Study 2b. One hundred seventeen MMO players were recruited from MMO discussion groups in QQ. QQ is another Chinese instant messenger app developed and maintained by tech giant Tencent that allows users to form discussion groups as they like. The experimental procedure was similar to that of Study 2a, except that the target item was a piece of virtual equipment that could help to improve their game performance (i.e., a functional item). Five participants did not report their game-playing behaviors, leaving 112 valid cases (see Table 5 for the detailed measurements). Demographic information of participants is summarized in Table 3.

5.2.2. Results of Study 2b. A 2 (game currency numerosity: low versus high) × 2 (salience of exchange rate: yes versus no) between-subjects ANCOVA on perceived expensiveness with monthly expenditure,

Figure 3. Interaction Between Numerosity and Exchange Rate Salience in Study 2a



Note. The above figure was based on estimated marginal means.

item appeal, and game playing behaviors as control variables yielded a significant interaction, $F(1, 104) = 14.30$, $p < 0.001$, partial $\eta^2 = 0.121$ (see Table 6 and Figure 4 for details). Planned contrasts showed that when the exchange rate was not salient (i.e., when players had enough currency and thus the exchange rate was irrelevant), they considered the virtual item to be more expensive in the high (versus low) numerosity condition ($M_{high} = 5.07$, $SD = 1.44$ versus $M_{low} = 4.04$, $SD = 1.37$; $F(1, 104) = 7.26$, $p = 0.008$); however, when the exchange rate was salient (i.e., when no additional information indicated it was irrelevant), participants considered it to be cheaper in the high (versus low) numerosity condition ($M_{high} = 4.29$, $SD = 1.76$ versus $M_{low} = 5.30$, $SD = 1.47$; $F(1, 104) = 7.38$, $p = 0.008$).

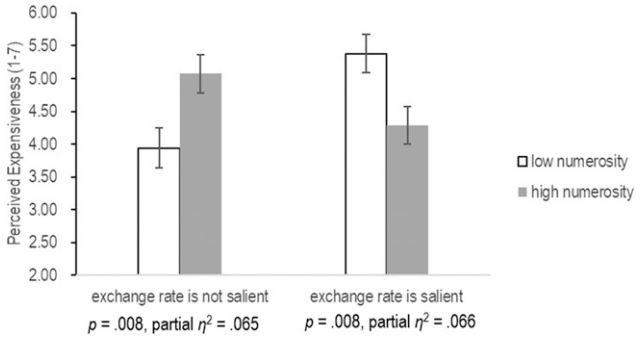
5.3. Discussion of Study 2

Consistent with the findings of Study 1, when the exchange rate was salient, players perceived the virtual items to be less expensive when the game currency was high (versus low) in numerosity; when the exchange rate was not salient (i.e., players had enough game currency in their account), the effect of game currency numerosity was reversed. Thus, Hypothesis 1 and Hypothesis 2 were verified using a laboratory experiment with better control for noise than in Study 1. Most importantly, the interaction effect between salience of exchange rate and numerosity on perceived expensiveness held, even when Study 2 used different sources to recruit players and a different way of manipulating the salience of the exchange rate, thus confirming the generalizability of the proposed effects.

6. Study 3

Studies 1 and 2 adopted different manipulations of exchange rate salience (accessibility and relevance) and consistently showed that it altered the effect of game currency numerosity. Although in-game stores usually would not mention the actual cost of virtual items, as in Studies 1 and 2, some third-party trading platforms usually highlight the actual cost. Thus, Study 3 focused on conditions in which players were considering purchasing an item using real money (i.e., exchange rate salient conditions) and examined the possible moderating effect of reminding of the actual cost. We proposed that as cognitive misers, players draw on the cue of exchange rate numerosity when the exchange rate is salient; thus, they would feel that real money has higher purchasing power in the high (versus low) numerosity condition (see the theorization of Hypothesis 1). This proposition implies that players would draw on the cue of exchange rate numerosity without considering the actual cost in real money of a virtual item (i.e., how many RMB the item actually costs). If so, reminding participants of the actual cost should diminish the effect of numerosity. In addition, Study 1 employed a hedonic virtual item, and Study 2 employed both hedonic and functional items. To ascertain that the theorized numerosity effect holds across item types and hence increases the generalizability of our theory and findings, Study 3 used a social virtual item as the target (Lehdonvirta 2009).

Figure 4. Interaction Between Numerosity and Exchange Rate Salience in Study 2b



Note. The above figure was based on estimated marginal means.

6.1. Method of Study 3

Participants were 244 MMO players. We used a different source, a Chinese paid online subject pool run by Sojump.com, to recruit participants in order to increase the external validity of our findings. Sojump.com provides a service for recruiting game players, but it does not differentiate between MMO and non-MMO game players. Therefore, we asked participants to report the games they played, and we coded whether they were MMO players. A 2 (game currency numerosity: low, 1 RMB = 10 game currency versus high, 1 RMB = 1,000 game currency) × 2 (a reminder of actual cost: with versus without) between-subjects design was adopted (see Table 7). The procedure is similar to that of Study 2. However, to further enhance the generalizability of our findings, Study 3 adopted an artificial game different from that of Study 2 (see Online Appendix A2.1 for details).

After familiarizing participants with the game currency system, we asked participants to imagine that when playing the game they found a social virtual item, a waist ornament called the "Knife of Ghost," priced at 50,000 (5,000,000) silver bars (Lehdonvirta 2009). We also told participants that "wearing the Knife of Ghost indicates that you have conquered the most difficult and secret areas, which shows other players that you are at the highest status of the game." Additionally, in conditions with a reminder of actual cost, we told participants the price in game currency (i.e., 50,000 or 5,000,000 silver bars); they also saw that this price equaled RMB 5,000 (see Online Appendix A2.2 for details). Participants then rated expensiveness,

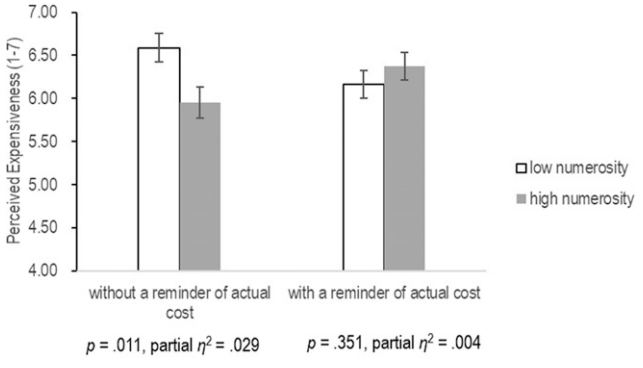
item appeal, and their game-playing behaviors.[8] A manipulation check after the main study showed 15 participants did not report the exchange rate correctly and were excluded from further data analysis, leaving 229 valid cases. Their demographic information is summarized in Table 3.

6.2. Results and Discussion of Study 3

A 2 (game currency numerosity: low versus high) × 2 (a reminder of actual cost: with versus without) between-subjects ANCOVA on perceived expensiveness with monthly expenditure, item appeal, and game-playing behavior as control variables yielded a significant interaction, $F(1, 221) = 6.34$, $p = 0.012$, partial $\eta^2 = 0.028$ (see Table 6 and Figure 5 for details). Planned contrasts showed that, without a reminder of actual cost, participants considered the virtual item to be more expensive in the low (versus high) numerosity condition ($M_{low} = 6.53$, $SD = 0.80$ versus $M_{high} = 5.98$, $SD = 1.68$; $F(1, 221) = 6.59$, $p = 0.011$); however, with a reminder of the actual cost, the effect of numerosity diminished ($M_{low} = 6.19$, $SD = 1.32$ versus $M_{high} = 6.37$, $SD = 1.14$; $F(1, 221) = 0.87$, $p = 0.351$). These results indicate that the findings of Studies 1 and 2 hold when using a social virtual item as the experimental stimulus and thus extend the generalizability of our theory across product types. Moreover, the results also suggest that the effects of numerosity would not exist when players are fully aware of the actual cost of the focal virtual item, thus uncovering an important boundary condition.

Moreover, these results ruled out an alternative explanation regarding the exchange rate salient conditions. Specifically, different exchange rates might cause players to use different numerical reference points (e.g., Wong and Kwong 2000) to evaluate the actual cost of a virtual item and thus shape participants' perceptions. For example, in Study 2, participants were first told how much game currency equaled 1 RMB before they evaluated the expensiveness of the item. In the high numerosity condition, they encountered a larger number (i.e., 1000 in "1,000 game currency"), which served as a reference point to make the actual cost in real money (i.e., 68.8 in "RMB 68.8") feel relatively smaller; in the low numerosity condition, they encountered a smaller number (i.e., 10 in "10 game currency"), making the actual cost in real money (e.g., 68.8 in "RMB 68.8") feel relatively larger. From this perspective, the difference in expensiveness perceptions would be caused by different reference points and has nothing to do with the perceived purchasing power of real money; a reminder of the actual cost in real money would not decrease the effect of numerosity. The moderating effect of reminder we found in Study 3 rules out this possible alternative explanation.

Figure 5. Interaction Between Numerosity and Reminding of Actual Cost in Study 3



Note. The above figure was based on estimated marginal means.

7. Discussion of Studies 1–3 and Possible Downstream Consequences

The results of Studies 1–3 provide convincing evidence supporting our theorization on numerosity effects. When the game currency exchange rate is not salient, players use *numerosity of label price* as the evaluation cue, and thus an item looks more expensive when its price is high (versus low) in numerosity; when the game currency exchange rate is salient, players use *numerosity of exchange rate* as the evaluation cue, and thus real money seems to have higher purchasing power in the high (versus low) numerosity condition, making an item appear less expensive. Most importantly, the findings of Studies 1–3 confirm that the effects of numerosity on perceived expensiveness hold across different types of virtual items, suggesting that these effects originate from people's natural responses to numerosity.

Previous research has suggested that perceived expensiveness plays an important role in influencing purchase intention (Kuksov and Lin 2017, Huang et al. 2019). Because whether players will spend real money in games is important for the financial success of MMOs, it is important to further examine if game currency numerosity affects players' virtual item purchase through perceived expensiveness. Virtual item purchase here means that players buy game currency with real money and then trade game currency for virtual items of interest, namely, the money-rich approach (Oh and Ryu 2007, Hamari and Lehdonvirta 2010, Bombace 2013). Many MMOs also allow players to earn game currency through accomplishing tasks in games and then trade that currency for virtual items, namely, the time-rich approach (Oh and Ryu 2007, Hamari and Lehdonvirta 2010, Bombace 2013). Therefore, in Studies 4 and 5, we examined how

game currency numerosity affected choice share of the money-rich (versus time-rich) approach as an indicator of players' purchase intention for virtual items.

Perceived expensiveness defines the subjective amount of economic outlay that must be sacrificed in order to engage in a given purchase transaction. A product becomes more attractive when it is perceived to be cheaper (Janiszewski and Lichtenstein 1999). When consumers consider a product, expensiveness tends to decrease purchase intention (Zielke 2010). Assuming most players would like to reach their game goal faster (Lehdonvirta 2009, Hamari and Lehdonvirta 2010) and the amount of economic outlay that must be sacrificed is the obstacle that prevents them from adopting the money-rich approach (Janiszewski and Lichtenstein 1999), players should have higher intention to spend real money for the virtual item when they consider it cheap. Players need to decide between the approaches of money-rich versus time-rich only when they do not have enough game currency in their account. Further, if they are considering the money-rich approach, they usually are also considering the exchange rate. In this case, players might consider the virtual item as cheaper in the high (versus low) currency numerosity condition and thus be more likely to adopt the money-rich (versus time-rich) approach. Study 4 examined this proposition.

We postulate that this prediction might not hold unconditionally. Whether an item is desired for its nonsocial versus social attributes might play an important role. Lehdonvirta (2009) theorizes that nonsocial attributes include both functional and hedonic ones. Functional attributes are used to increase players' chances of winning, including items providing a performance advantage. Hedonic attributes are desired because of their aesthetic attributes as well as visual and aural stimulation. Therefore, nonsocial attributes are desired for their inherent nature, and their value should not fade even if there are no other players in the same game. On the contrary, social attributes are not desired for inherent features as a commodity but for their ability to help players to distinguish themselves from other players. Note that although we distinguish among functional, hedonic, and social items, an item usually has multiple attributes. For example, a virtual item that makes players perform better may also make the game-playing experience more pleasant; a virtual decoration that makes players' avatar look more attractive may also aid self-expression and distinguish the self from other players; and, usually, items associated with social status or social markers also contribute to faster game progress or hedonic pleasure. Nonetheless, a virtual item always has a primary or most dominant attribute. Therefore, in this paper, item heterogeneity refers to differences in the primary attributes of items.

Players might want to gain items that help them to boost performance (i.e., functional items) or increase pleasant feelings (i.e., hedonic items), at minimal cost. As a result, game currency numerosity's leading an item to look cheaper should increase purchase intention. However, for social items, which are mainly for expressing status and distinctiveness, their economic worthiness according to their functional and hedonic attributes is not a consideration for players (Douglas and Isherwood 2002, Lehdonvirta 2009). In nongame contexts, consumers seek social products to distinguish themselves from social classes they do not value, such as lower classes (Veblen 2017). Based on costly signaling theory (Zahavi 1975, Grafen 1990), people try to gain status and impress others by indicating that they have enough money to purchase frivolous and wasteful goods (Griskevicius et al. 2007, Griskevicius et al. 2010). In such cases, high cost and difficulty to obtain become important product features, and expensiveness is used as a status symbol or social marker. In MMO games, social items should play a similar role, and whether game players would like to purchase such social items should depend on how they weight their social identity rather than the economic affordability of items. Therefore, we postulate that higher numerosity, which makes a social virtual item look cheaper, should not increase purchase intention. Study 5 examined this proposition.

8. Study 4

Study 4 aimed at showing the downstream effects of numerosity, as found in Studies 1–3, on purchase intention when players were considering recharging their accounts to purchase a virtual item (i.e., in the condition that exchange rate is salient). We expected that, in this case, numerosity would increase players' purchase intention for a virtual item (i.e., choosing the money-rich over the time-rich approach). As we discussed above, this effect should occur among nonsocial items. Thus, a functional item was adopted in this study. Study 4 also aimed to rule out the possibility that game players might not be aware of their game currency account information and hence would feel uncertain about the game currency in their account and that this uncertainty rather than exchange rate salience would result in numerosity's decreasing perceived expensiveness.

8.1. Method of Study 4

One hundred twenty-seven MMO players were recruited from online discussion groups similar to those in Study 2b. Participants' demographic information is summarized in Table 3. A single-factor (game currency numerosity: low versus high) between-subjects design was adopted. Game players were invited to participate in a user study about a new MMO and

were randomly assigned to one of two experimental conditions (see Table 7). The experimental materials and procedures were the same as those in the without-a-reminder-of-actual-cost conditions of Study 3, except that the target item was a functional virtual item (Lehdonvirta 2009). Participants were asked to imagine that when playing the game, they needed a virtual book on alchemy to upgrade.

The virtual item was priced at 800 (in low numerosity conditions) or 80,000 (in high numerosity conditions) game currency. Players needed to do 18–30 tasks to earn enough currency for the book; they could do one task each day, in which case at least 18–30 days were needed (see Online Appendix A2.3 for details). This approach was intended to parallel what players usually encounter in MMOs and was based on interviews with experienced MMO players. We did not restrict exactly how much time and effort the participants needed to expend to gain the item, because in real life, levels of performance vary among players. Then, participants chose between two options: "recharge the account with real money and get the book immediately" (i.e., money-rich approach) or "perform tasks until enough currency has been earned" (i.e., time-rich approach). This choice ensured that participants were fully aware and certain that they did not have enough game currency in their account. They also rated expensiveness, item appeal, a check of understanding the money-rich versus time-rich approach,[9] and game-playing behaviors (see Table 5 for details).

8.2. Results and Discussion of Study 4

8.2.1. Choice/Purchase Intention. We conducted a logistic regression on consumer choice (1 = money-rich, 2 = time-rich) with monthly expenditure, item appeal, and game-playing behaviors as control variables and numerosity (−1 = low, 1 = high) as the independent variable. Results showed a significant effect of numerosity (*Wald* $Z = 4.05$, $p = 0.044$). Specifically, 47.5% (27.9%) participants chose the money-rich approach in the high (versus low) game currency numerosity condition.

8.2.2. Perceived Expensiveness and Its Mediating Effect. As seen in Table 6, an ANCOVA showed that participants considered the virtual item to be cheaper in the high (versus low) numerosity condition ($M_{high} = 3.83$, $SD = 1.87$ versus $M_{low} = 4.93$, $SD = 1.27$; $F(1, 121) = 14.41$, $p < 0.001$, partial $\eta^2 = 0.106$). This is consistent with what we found in Studies 1–3 and thus confirmed that it was exchange rate salience rather than uncertainty about game currency in account that led numerosity to decrease perceived expensiveness.

Moreover, as shown in Figure 6, in order to test the mediating effect of perceived expensiveness, a bootstrapping analysis (Hayes 2018; model 4) using 5,000 samples with the same control variables was adopted. The bootstrapping strategy is recommended for mediation analysis when the total sample is not large (Preacher et al. 2007). The results confirmed that perceived expensiveness mediated the effect of numerosity on choice (95% confidence interval: −2.2570 to −0.4170). This finding showed that high (versus low) numerosity led consumers to be more likely to adopt a money-rich (versus time-rich) approach because high (versus low) numerosity made the virtual item appear cheaper.

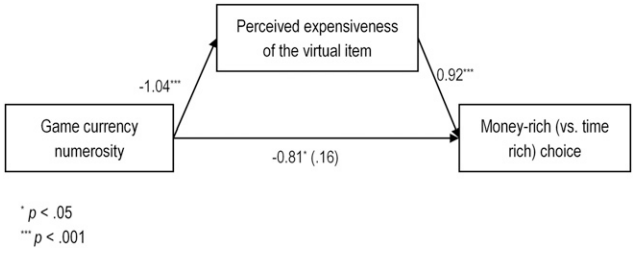
9. Study 5

Study 4 showed that when considering recharging one's account with real money to obtain a nonsocial item, game currency numerosity increased the possibility that players would use a money-rich approach because high (versus low) numerosity made the item appear cheaper. However, as we discussed in Section 7, the effect of numerosity on purchase intention should not hold when an item is desired for its social signaling effect, in which case its expensiveness is an embedded item feature rather than an undesirable cost. Study 5 aimed to show that game currency numerosity increased purchase intention only for nonsocial items, and not for social items.

9.1. Method

Participants were 470 MMO players recruited from a Chinese paid online subject pool run by Sojump.com. Similar to Study 3, because Sojump.com did not differentiate between MMO and non-MMO game players, we asked participants to report the games they played, and we coded whether they were MMO players. A 2 (game currency numerosity: low versus high) × 2 (item type: social versus nonsocial) between-subjects design was adopted. Participants were invited to participate in a user study about a new MMO and were randomly assigned to one of the four experimental conditions (see Table 7). The experimental materials and procedures were the same as those in

Figure 6. Mediating Effect of Perceived Expensiveness in Study 4



Study 4, except that the target item was either a social item or a hedonic item. The social item was a waist ornament called the "Knife of Ghost" priced at 1,200 (in low numerosity condition) or 120,000 (in high numerosity condition) silver bars. Participants read that "you can personalize your own identity tags after purchase, which would be visible to other players. This is the best way to express yourself to others." The hedonic (i.e., nonsocial) item was a virtual carriage called "Flower Blooming" also priced at 1,200 (in low numerosity condition) or 120,000 (in high numerosity condition) silver bars. Participants read that "flowers will bloom where it passes, which is very beautiful" (see online Appendix A2.4 for details).

After being exposed to the manipulations, participants were told they needed to do 30 super tasks to get 1,000/100,000 silver bars (1 task per day and two hours per task), and they chose between the money-rich and time-rich approaches (see Online Appendix A2.4 for details). They also rated item appeal, a check on understanding of the money-rich versus time-rich approach,[10] a manipulation check for item type,[11] their game-playing behaviors, and their past virtual item purchase behaviors.[12] Finally, because participants who chose the money-rich approach might be less patient and crave instant gratification, we controlled for possible individual differences by measuring participants' delayed gratification using a 10-item inventory from Hoerger et al. (2011) (see Table 5 for details). The manipulation check after the main study showed 39 participants did not report the exchange rate correctly and were excluded from further data analysis, leaving 431 valid cases. Demographic information is summarized in Table 3.

9.2. Results and Discussion of Study 5

We conducted a logistic regression on players' choice (1 = money-rich, 2 = time-rich) with monthly expenditure, item appeal, game-playing behaviors, past virtual item purchase behaviors,[13] and delayed gratification as control variables and numerosity (−1 = low, 1 = high), item type (−1 = nonsocial, 1 = social), and their interaction as independent variables. As shown in Table 8, the interaction between numerosity and item type was significant (*Wald* Z = 4.35, p = 0.037), confirming our prediction. Specifically, to get the nonsocial item, more participants chose the money-rich approach in the high (versus low) game currency numerosity condition (46.2% versus 35.7%; *Wald* Z = 4.05, p = 0.044). However, numerosity did not affect the way players chose to get the social item (34.4% versus 36.3%; *Wald* Z = 0.83, p = 0.362; see Table 8 and Figure 7 for details). These results showed that when players were considering recharging their account to purchase a nonsocial item, high (versus low) numerosity increased the purchase intention. However, game currency numerosity did not affect purchase intention for a social item.

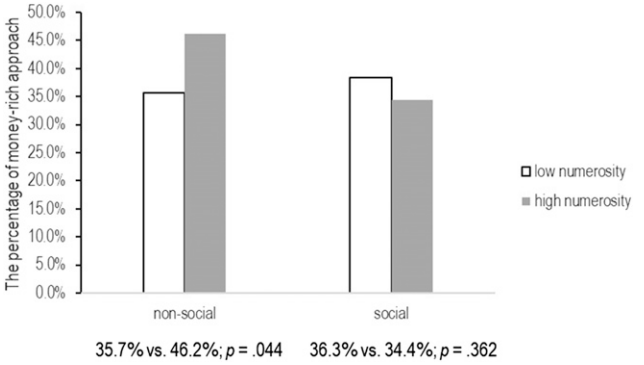
Table 8. Logistic Regression on Players' Choice

Predictor	Unstandardized Coefficient	Standard Error	Wald	p
Monthly expenditure	−0.525	0.145	13.118	0.000
Item appeal	−0.093	0.096	0.943	0.332
Frequency	0.191	0.135	2.005	0.157
Length of playing	0.120	0.096	1.562	0.211
Tendency to spend money	−0.522	0.136	14.660	0.000
Money spent (ln-transformed)	−0.514	0.112	20.978	0.000
Delayed gratification	−0.159	0.257	0.386	0.534
Numerosity	−0.099	0.127	0.609	0.435
Item type	0.031	0.130	0.058	0.810
Numerosity*item type	0.267	0.128	4.355	0.037
Constant	7.050	1.198	34.633	0.000

10. General Discussion

The present research shows that currency numerosity affects players' perceived expensiveness of virtual items. Specifically, when the exchange rate between real money and game currency is not salient, such as when the exchange rate is not explicitly mentioned (i.e., with low accessibility) or when players already have enough game currency for the focal virtual item (i.e., without relevance), the virtual item is perceived as more expensive when game currency is higher in numerosity. This finding is consistent with the classic numerosity effect found in nongame contexts (Bagchi and Davis 2016). On the contrary, when the exchange rate is salient, such as when the exchange rate is made accessible and no additional information suggests it is irrelevant, players use the numerosity of exchange rate as a cue to judge the purchasing power of real money. If one unit of real money (e.g., $1) can exchange for more units of game currency, players perceive that the cost to buy game currency is low; thus, they perceive the virtual item as cheaper. This result

Figure 7. Interaction Between Numerosity and Item Type in Study 5



is opposite of the classic numerosity effect found in previous research.

Furthermore, we have focused on a context that players usually encounter when playing games to examine the consequences of game currency numerosity. In particular, when they are considering purchasing a virtual item with real money (i.e., exchange rate is salient), players have higher purchase intention when numerosity is high (versus low), because virtual items are perceived as cheaper in this situation. However, this effect is more likely to occur when the virtual item is desired for its nonsocial attributes but could diminish when the virtual item is desired for its social attributes. These findings show the downstream consequences of game currency numerosity and the corresponding boundary condition.

10.1. Theoretical Contributions

Our work makes several major theoretical contributions. First, the moderating effect of exchange rate salience that we found helps to resolve the seemly contradictory findings of previous numerosity research. In particular, some research has shown that people use the numerosity of label price as the judgmental cue, which makes them consider an item as more expensive in a currency higher in numerosity (e.g., Raghubir and Srivastava 2002, Wertenbroch et al. 2007); however, other research has indicated that people might use the numerosity of exchange rate as the judgmental cue (Bagchi and Li 2011), which could result in people considering an item as less expensive in a currency high in numerosity. Our findings show that exchange rate salience determines which cue people use. When the exchange rate is not salient, people draw on the *numerosity of label price (*i.e., *numerosity of a focal number)*; when the exchange rate is salient, which means it is accessible and relevant, people draw on the *numerosity of exchange rate*. The latter phenomenon has been underexamined in previous research. Therefore, by identifying a moderator in this relationship, we resolve the contradicting findings in this stream of research.

Second, this research provides theoretical accounts and empirical examinations of how certain features of game currency systems could affect players' judgment and decision making. Although prior literature about virtual goods/worlds has come to agree that game currency system design is important for virtual goods sales and the revenue of game operators (e.g., Hamari and Lehdonvirta 2010, Bombace 2013), to our knowledge, few studies actually discuss features of game currency systems that could make a difference. This research focuses on game currency numerosity, which is a requisite feature that designers must determine in the process of game design, and shows that simply altering the numerosity of game currency could affect players' perceived expensiveness of virtual items. In addition, the effect on perceived expensiveness is not affected by the types of virtual items, suggesting that it is not due to environmental factors (e.g., social aspects) of specific games, as previous research about virtual goods purchase has emphasized (e.g., Animesh et al. 2011, Hamari 2015) but rather originates in people's natural responses to numerosity. Our research indicates that besides the game environment-dependent factors (e.g., game enjoyment and game sociability) of MMOs, game environment-free factors (e.g., how people cognitively process and evaluate a stimulus) should also be taken into consideration when examining players' behaviors. From this perspective, our research contributes to the literature by opening a new direction of inquiry.

Third, this research deepens our understanding of consumers' behaviors in game contexts by showing that currency numerosity could have different effects in game and nongame contexts. On the one hand, we find a seemingly reversed numerosity effect. That is, previous findings show that, in nongame contexts, people tend to underspend in a high (versus low) currency numerosity condition (e.g., Raghubir and Srivastava 2002). On the contrary, our research shows that when players are considering purchasing a virtual item with real money, they actually perceive the item to be cheaper in the high (versus low) currency numerosity condition. This discrepancy may occur because in nongame contexts, or at least in the scenarios that have been examined (e.g., Raghubir and Srivastava 2002, Wertenbroch et al. 2007), the currency exchange stage and the purchase stage are usually separated and thus people draw on the numerosity of label price without thinking about the numerosity of exchange rate when making a purchase. However, in game contexts, without enough game currency in their account, players would consider the exchange and the purchase stages simultaneously. In this case, numerosity of exchange rate is used as a judgmental cue, overriding the effect of numerosity of label price.

On the other hand, when players have enough currency in their account, they also use numerosity differently than in nongame contexts. In nongame contexts, when a budget, which is similar to game currency balance in an account in our research context, is provided, people use the numerical distance between the budget and the price as a cue in making a judgment (Wertenbroch et al. 2007). Thus, people perceive a product as cheaper in the high (versus low) currency numerosity condition. However, our results suggest that in MMOs, when players have enough game currency in their account, they use the numerosity of label price as a cue to evaluate the expensiveness of the virtual item and perceive a product as more expensive in the high (versus low) currency

numerosity condition. That is, players do not use the currency in their account to estimate how much game currency would be left after the purchase is made. One reason might be that in MMOs, currency in an account can change constantly and thus is less likely to be considered a maximum limit. These seemingly opposite findings thus indicate that people's mental representations of money in their wallet in nongame contexts and game currency in their account in MMOs could be very different. Therefore, although budgets are commonly used in nongame contexts (Larson and Hamilton 2012), they might not seem so important in game contexts. These findings also suggest that game contexts may not necessarily be parallel to nongame contexts, and thus marketing techniques to create demand for virtual goods might be different from those for physical goods.

Fourth, our findings suggest that when players are considering recharging their account with real money to purchase a virtual item, game currency numerosity decreases perceived expensiveness regardless of item type. However, whether the decreased expensiveness consequently increases purchase intention depends on item type. Although numerosity increases purchase intention through making nonsocial items appear cheaper, it does not affect players' purchase intention for social items. These results confirm that in virtual worlds, similar to in the real world, for social items, the expensiveness of an item should be considered a product feature that signals status rather than an undesirable cost. This finding explains the phenomenon that in virtual worlds, players might pay the equivalent of hundreds of U.S. dollars for a rare item despite its very modest appearance and complete lack of performance or functionality (Lehdonvirta 2009). It also indicates the importance of considering item heterogeneity when deciding market strategies in games.

10.2. Practical Implications

Practically, our findings provide several guidelines for MMO developers in game design. As Hamari and Lehdonvirta (2010) have suggested, game design should be part of business planning. First, our findings suggest to MMO developers that to encourage players to purchase game currency and thus virtual items with real money, designers might increase the numerosity of the currency system, because a currency system with high (versus low) numerosity leads consumers to perceive game currency and virtual items as cheaper, and thus they are more willing to choose to pay real money for nonsocial items. Second, our findings provide implications for the promotion strategies of MMOs already in the market. For MMOs with low numerosity currency systems, exclusive promotions might be given to encourage players to exchange real money for game currency before they have a specific virtual item to purchase. This approach would lead players to be more willing to obtain a nonsocial item because they would already have enough game currency in their account to purchase the item. For MMOs with high numerosity currency systems, exclusive promotions might be given when players encounter a specific virtual item that they would like to purchase but do not have enough game currency in their account.

Moreover, our research confirms that perceived expensiveness is easily biased by numerosity when players do not calculate the actual costs, which has strong implications on the consumer side. It is reasonable to expect that judgmental bias would be strengthened when people do not have the need or ability to calculate the actual cost. For example, previous research has suggested that people spend more when they pay by credit cards (versus cash) because counting out cash is painful (Yeung 2014). This suggests that the biasing effects of numerosity should be stronger in online games than in offline contexts as the need to count is minimized online. Following the same logic, children and teenagers would be more vulnerable to the biasing effect of numerosity because they are relatively weak in the ability to calculate. These inferences help to partially explain why children and teenagers are likely to suffer from the negative impact of online games. Therefore, from a consumer welfare perspective, it is important for governments to implement proper policies to guide the setting of financial systems of online games, especially when the players are children and teenagers. Most existing game currencies are higher in numerosity than real money, leading players to overspend. One policy that could be adopted is require that the game currency numerosity cannot be higher than the numerosity of real money in the country. Another policy could be that game designers must provide the actual cost of virtual items so that players' judgment would not be biased. Furthermore, as previous research suggests that people might have difficulty evaluating the magnitude of numbers (Hsee 1996) and thus the actual costs of virtual items, providing information about offline equivalents of virtual items should help to make sure that players know the actual value of virtual items and thus prevent overspending.

10.3. Limitations and Future Research

The present research has several limitations that provide avenues for future research. First, we used a combination of quasiexperiments and true experiments but did not conduct field experiments. As with any experimental research, to identify the effects of the constructs of interest, we simplified our experiments

and ignored some important factors that might also affect price perception and purchase intention for virtual items in real game-playing contexts. Future research could consider working with MMO operators by launching currency systems with different numerosity in field experiments to test how currency numerosity may affect game players' real purchase behavior for virtual items (Yang et al. 2012).

Second, the current research focused on the effect of game currency numerosity and randomly assigned participants to different conditions in Studies 2–5. The random assignment neutralized systematic preexisting differences across conditions. However, it also ignored the individual attributes that are important for marketing segmentation (Hamari and Lehdonvirta 2010). For example, it is possible that players' delayed gratification might interact with game currency numerosity to affect the preference for the money-rich versus time-rich approach. Specifically, players high in delayed gratification might be more inclined to choose the time-rich approach regardless of numerosity. Future research could test the possible moderating effect of individual differences in players' reactions to different game currency systems.

Third, although we have empirically tested how currency numerosity affects virtual item purchase intention, other features of currency systems remain unexplored. For instance, some MMOs allow players to purchase game currency with real money, but the real money cannot be cashed out (partial system), whereas other MMOs allow players to cash into and out of game currency (open system) (Bombace 2013). In our research, we used the open system. Future research could examine whether different systems have different effects on virtual item purchase.

Finally, in the contribution section, we suggested practitioners design a currency system as well as an appropriate display strategy to encourage players to purchase virtual items with real money. Although this approach seems to be an effective way to improve the game's financial performance in the short term, its long-term effect is undetermined. More specifically, on the one hand, players who choose to obtain virtual items through a money-rich (versus time-rich) approach might get bored easily because of the lower game engagement and thus quit the game sooner. On the other hand, it is also possible that the money-rich approach might increase game enjoyment or players' economic cost, leading to more game-playing behaviors. Although previous research has shown that selling or not selling virtual goods could affect gameplay and social welfare (Guo et al. 2019), how numerosity affects players' enjoyment and lifetime value requires further examination.

11. Conclusions

The design of game currency systems is important for the revenue of MMOs (Hamari and Lehdonvirta 2010, Bombace 2013); but few prior studies have explored, theoretically and empirically, how certain features of game currency systems could affect players' judgment and decision making. We contribute to the literature on game currency design by developing a set of theory-based predictions on how certain features of game currency systems could affect players' judgment and decision making and empirically testing these predictions. Through six experiments, we provide the first effort to examine how game currency numerosity affects players' perceived expensiveness of a virtual item and subsequent purchase intentions. Our findings also shed light on how to increase the revenue from the perspective of game operators or how to reduce players' overspending driven by the biasing effect of numerosity from the perspective of consumers.

Endnotes

[1] Note that although less likely, the simultaneous consideration of price and exchange rate may also happen in nongame contexts. For example, certain customers might constantly consider exchange rate when they are shopping using foreign currency; travelers might need to exchange their money for foreign currency in a foreign country and potentially make purchase decisions at the same time if they are running out of foreign currency.

[2] Regression analysis with all data showed consistent findings (see Online Appendices B1.1 and B1.2).

[3] The actual costs of virtual items in all studies were selected based on pretest interviews with experienced MMO players to best emulate what players would encounter in actual MMOs. Participants saw the label price but not the actual cost in real money (i.e., 60 RMB).

[4] The analysis with only these 83% of participants yielded similar findings (see Online Appendices B1.3 and B1.4 for a more detailed analysis using regressions).

[5] These results are based on the data of all participants who chose the two games. ANCOVA analysis with the data of the 74 participants who chose the two games and correctly answered the exchange rate question showed a similar interaction effect ($F(1, 68) = 4.55$, $p = .037$, partial $\eta^2 = .063$).

[6] A manipulation check confirmed that having enough game currency in their account decreased the extent to which players considered the exchange rate between RMB and game currency. However, it did not make them feel that they had higher purchasing power because they already had enough game currency, which excluded an alternative explanation. See Online Appendix B2 for details.

[7] In Studies 2–5, item appeal was measured to rule out the possibility of the interaction between numerosity and salience affecting perceived expensiveness by changing the item appeal. The nonsignificant interaction effects between numerosity and salience on item appeal assured that the effects on perceived expensiveness were independent of item appeal (see Online Appendices B2 to B5 for details).

[8] Participants actually chose between money-rich versus time-rich approaches before they evaluated the perceived expensiveness and reported their delayed gratification at the end. However, we found

that numerosity did not affect participants' choices either with or without reminding of actual cost, even after controlling for possible influence of delayed gratification. This is consistent with what we found in Study 5. For brevity, we do not report the results in the main text.

[9] Analysis of the check for the money-rich versus time-rich approach showed that participants choosing the time-rich approach indicated that they would need more time to get enough game currency than those choosing the money-rich approach ($M_{time\text{-}rich} = 5.39$, $SD = 1.27$ versus $M_{money\text{-}rich} = 2.30$, $SD = 1.93$; $F(1, 125) = 118.22$, $p < .001$, partial $\eta^2 = .486$), confirming that participants understood the difference between these approaches.

[10] Analysis of the check on understanding of the money-rich versus time-rich approach showed that participants choosing the time-rich approach indicated that they would need more time to get enough game currency than those choosing the money-rich approach ($M_{time\text{-}rich} = 5.63$, $SD = 1.06$ versus $M_{money\text{-}rich} = 2.86$, $SD = 2.21$; $F(1, 429) = 304.95$, $p < .001$, partial $\eta^2 = .415$), confirming that participants understood the difference between the time-rich and money-rich approaches.

[11] Analyses of the manipulation checks for the item type showed that participants scored the hedonic item higher on hedonic attribute ($M = 5.71$, $SD = 1.02$, repeated-measures ANOVA: $F(2, 434) = 22.42$, $p < .001$, partial $\eta^2 = .094$) than on functional attribute ($M = 4.98$, $SD = 1.53$, Bonferroni pairwise comparisons: $p < .001$) or on social attribute ($M = 5.32$, $SD = 1.26$, Bonferroni pairwise comparisons: $p < .001$), confirming that the hedonic attribute is the most dominant attribute of this item. Participants scored the social item higher on social attribute ($M = 5.36$, $SD = 1.16$, repeated-measures ANOVA: $F(2, 424) = 12.56$, $p < .001$, partial $\eta^2 = .056$) than on functional attribute ($M = 4.75$, $SD = 1.54$, Bonferroni pairwise comparisons: $p < .001$) or on hedonic attribute ($M = 5.10$, $SD = 1.36$, Bonferroni pairwise comparisons: $p = .073$), confirming that the social attribute is the most dominant attribute of this item.

[12] We also measured players' perception of the subjective amount of game currency that every unit of real money could exchange for and the subjective amount of game currency that completing each task could earn. Results showed that numerosity affected the former ($M_{low} = 2.96$, $SD = 1.49$ versus $M_{high} = 3.66$, $SD = 1.54$; $F(1, 420) = 25.79$, $p < .001$, partial $\eta^2 = .058$) but not the latter ($M_{low} = 2.90$, $SD = 1.35$ versus $M_{high} = 3.07$, $SD = 1.39$; $F(1, 420) = 1.93$, $p = .166$, partial $\eta^2 = .005$). These results support our theorization that numerosity took effect because it affected players' perceptions of the process to get game currency through real money but not to get game currency through completing tasks. See Online Appendices A2.4 and B5 for details.

[13] Because the money that participants spent was positively skewed, it was first ln-transformed (i.e., Ln_money_spent = ln(money_spent+1), considering that some participants indicated they had not spent any money).

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