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Loot box gambling and economic preferences: A survey analysis of Japanese children and adolescents

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Abstract

This study reports the results of a survey on how much elementary, middle, high school, and university students (1210 respondents) in Japan spend on "Gacha," or loot box gambling in social-network games. About 34% of the respondents in the survey had bought "Gacha." Loss-averse or risk-averse respondents had less experience paying for "Gacha," and their highest billing amount charged per month was lower. Furthermore, future-oriented respondents had less payment experience than those who were present oriented, and the highest billing amount charged per month among the former respondents was also lower.

JEL codes D12, D91
Keywords: Gacha (loot box gambling), social-netowrk games, adolescents, risk preference, loss avoidance and time preference

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1 Introduction

Game addiction has become a worldwide problem because of the widespread use of social-network games. In May 2019, the World Health Organization's diagnostic criteria, the International Classification of Diseases, Revised Edition (ICD-11), classified "gaming disorder" as a disorder due to addictive behavior. This disease classification will come into effect in 2022. In Japan, the Cabinet Office (2018) reports that youth smartphone users spend an average of 148 minutes a day on the Internet and reports a case study of children paying too much for social-network games. The Cabinet Office (2018) points out that more than 70% of smartphone users in elementary, middle, and high schools play games with their smartphones. Male users are significantly more likely to play games in middle and high school than female users are.

There are three types of prior studies on game addiction. First, some prior studies have focused on the relationship between psychological factors and game addiction (Kim et al., 2008; Kuss and Griffiths, 2012).[1] Second, there are studies on how to move away from game dependence(Acland and Chow, 2018).[2] Third, there is a case study of preventive education wherein children and adolescents are not addicted to playing games (Toyoda, 2019).[3]

In this study, we investigate the effect of economic preferences about billing in social-network games, which is a new form of payment behavior made possible by the development of information and communication technology and is one of the first steps involved in game addiction. For this reason, we focus on billing behavior. In Japan, where there is widespread use of smartphones, some social-network game users pay for "Gacha,"[4] a type of loot box gambling for obtaining items and characters with a certain probability, to enjoy collecting them, and/or to accelerate the progress of the game for a small charge.

"Gacha" is essentially a gamble, and the decision to purchase it or not would be closely related to risk preference. It is known from research based on behavioral economics[5] that people make

[1]Kim et al. (2008) examined the interrelationship of social-network gaming addiction, aggression, autonomy, and narcissism. A questionnaire was administered online to 1,471 game users (about 80% male users). Kim et al. (2008) found that aggression and narcissism were positively correlated with social-network game addiction, and autonomy was negatively correlated with this addiction. Kuss and Griffiths (2012) organized the results of 58 empirical studies and found that addiction to the Internet games is influenced by risk factors, such as personal characteristics, and enjoyment of the game. They also found that addiction produces a variety of negative consequences.

[2]To avoid game addiction, it is vital to reduce the amount of time spent playing games. Acland and Chow (2018) examined whether players' own voluntary commitment was effective to reduce the amount of time spent playing social-network games. About 25% of players used voluntary commitment. When this commitment was made, the number of hours per play and the number of times the game was played decreased, but the number of weeks spent playing the game increased. These results suggest that involuntary commitments, such as financial incentives, are required.

[3]Toyoda (2019) introduces a case study of an elementary school in W Prefecture. In this case, (1) pledges were made based on family circumstances; (2) teachers told their pupils how to use smartphones properly in class; and (3) they let their pupils consider the disadvantages of smartphone dependence.

[4]According to Koyama (2016, p.324), loot box gambling refers to a system of purchasing characters and virtual items by drawing lots in social-network games on smartphones and mobile phones. The type of character or virtual item the user gets depends on probability. In Japan, loot box gambling is called "Gacha." This name comes from the term "Gacha" or "Gacha-Gacha," which refers to "Gashapon" coin-operated toy vending machines that release a toy in a plastic capsule. Because social-network games often have effects that imitate the rotation of the "Gacha-Gacha," players call the loot box "Gacha-Gacha." In Japan, playing a single "Gacha" costs from JPY 100 to 500, and the cost of playing "Gacha" 10 times is usually enough to draw 11 raffles.

[5]See Kahneman (2011).

various biased choices when faced with risky situations, such as those found in buying "Gacha." In addition, although rare characters and items can be obtained by taking time, purchasing a "Gacha" can save time. Therefore, it is thought that the purchase of "Gacha" is also closely related to time preference.

Despite the importance of investigating the relationship between economic preferences and purchasing "Gacha," only a few studies have analyzed the experience of purchasing "Gacha" by adolescents for social-network games. For example, Arai (2013) conducted a survey of adults and Morimoto (2018) did so of college and university students.

This may be due to the peculiarity of billing behavior for social-network games in Japan.[6] Therefore, we need to be very cautious about applying foreign billing behavior studies to the investigation of the billing behavior of the Japanese youth.

We conducted a questionnaire survey of 1,210 respondents in Japan. They were elementary, middle, and high school students and undergraduates. The survey results indicate that respondents who were more likely to be risk averse and loss averse had significantly less experience of purchasing "Gacha," and their maximum monthly amount of purchasing "Gacha" was also significantly lower. Concerning time preference, those who were future oriented and those with future bias among those who were time inconsistent had significantly less billing experience and significantly lower maximum billing amount per month compared to present-oriented respondents.

Our study makes two contributions to the literature. First, we provide new insights into the preventive education of game addiction. Before starting education, teachers can check the economic preferences of their students. This would help teachers to offer more precise advice to their students.

Second, our study contributes to recent behavioral economic research that investigates preferences measured in experiments, and questionnaires are correlated with actual behavior (Barsky et al., 1997; Dohmen et al., 2011; Liu, 2013). Although most of these studies focus on adults and university students, some focus on adolescents,[7] such as Castillo et al. (2011), Castillo et al. (2018), Golsteyn et al. (2014), and Sutter et al. (2013).[8]

The remainder of this article is structured as follows. In Section 2, we explain how we conducted the questionnaire surveys for the elementary, junior, and high school students and undergraduates.

[6]In a survey article on billing behavior (Hamari et al., 2017), 19 reasons were mentioned for billing behavior in social network games. However, none of the reasons included "collecting characters" (getting a specific character), which is a popular way to play in Japan. According to a report (Annie, 2017), while there is a commonality among hit titles in the smartphone gaming market between the United States and European countries, those in the Japanese smartphone gaming market are very different from both former markets. There are very few games in the Western smartphone gaming market in which "Gacha" for getting a character exists. However, in the Japanese market, Pokémon Go is the only game that does not have a "Gacha" for getting a character.

[7]Sutter et al. (2019) provides an excellent survey on experimental studies for youth.

[8]Castillo et al. (2011) estimated the time preference of youth aged 13 and 14 years in Georgia and found that the number of discipline referrals was larger for those with a high time discount rate than for others. Castillo et al. (forthcoming), a follow-up study of Castillo et al. (2011), showed that adolescents with higher time discount rates had lower high school graduation rates. Castillo et al. (2018) showed that students with lower risk aversion at the ages of 13–14 years had more disciplinary referrals and lower high school graduation rates. Golsteyn et al. (2014) showed that time preference at the age of 13 years predicts long-term outcomes, such as school performance, lifetime earnings, and unemployment. Sutter et al. (2013) measured time preference, risk preference, and ambiguity preference for 10–18-year-olds in Austria and examined their correlation with various behaviors. Their results showed that youth with higher time discount rates were more likely to smoke and drink, have a higher body mass index (BMI), save less, and behave poorly in school.

In Section 3, we submit the research hypotheses. In Section 4, we introduce the survey results. Section 5 discusses the results and concludes.

2 Questionnaire Survey

Table 1: Profile of the schools

School	A (high)	B (junior high)	C (primary and junior high)	D (high)	E (univ.)	F (univ.)	G (junior high and high)
Area	Kansai	Kansai	Kansai	Kansai	Kansai	Kanto	Kansai
Establishment by	public	public	public	private	private	private	private
Grade of the respondents	1st	3rd	6th to 8th	2nd year	1st to 4th	1st to 4th	3rd junior high to 2nd high
Num. of obs.	256	121	116	82	162	88	385
% of female	54	49	57	46	52	17	57
Who conducted survey	teacher	author	author	author	author	author	teacher

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From December 2018 to December 2019, we conducted surveys on financial knowledge, preferences, billing behavior for social-network games, and financial behavior at six schools located in the Kansai region and one school located in the Kanto region. The profile of each school is shown in Table 1.

There are five schools in the Kansai region. School A is a public high school, and all respondents are in grade 10. School B is a public junior high school, and all respondents are in grade 9. School C is a public integrated primary and junior high school, and the respondents are in grades 6 to 8.[9] School D is a private high school, and the respondents are in grade 11. School E is a private university in the Kansai region. School F is a private university in the Kanto region. School G is a private integrated junior and senior high school, and the respondents are in grades 9, 10, and 11.

Table 2: The distribution of the maximum amount per month for purchasing "Gacha"

	School A	B	C	D	E	F	G	Total
0. Have not purchased "Gacha"	78.52 %	73.55	73.28	67.07	64.81	32.95	59.74	65.62
1. JPY 1−−500	5.86	1.65	4.31	10.98	6.17	7.95	4.93	5.54
2. JPY 501 −− 1,000	5.08	5.79	5.17	3.66	6.79	7.95	4.16	5.21
3. JPY 1,001−− 3,000	5.86	8.26	10.34	9.76	7.41	10.23	9.61	8.51
4. JPY 3,001−−5,000	1.95	4.96	3.45	3.66	4.94	7.95	3.38	3.80
5. JPY 5,001−−10,000	1.56	3.31	0.86	1.22	6.17	13.64	7.01	4.88
6. JPY 10,001−−30,000	1.17	2.48	0.86	2.44	3.70	15.91	5.97	4.30
7. JPY 30,001−−50,000	0.00	0.00	1.72	1.22	0.00	1.14	1.30	0.074
8. Higher than JPY 50,000	0.00	0.00	0.00	0.00	0.00	2.27	3.90	1.40
Num. of respondents (female)	256 (140)	121 (60)	116 (66)	82 (38)	162 (85)	88 (15)	385 (220)	1210 (624)

In School A, we did not conduct classes; instead, a high school teacher distributed a questionnaire to the students and asked them to answer it. In School B, Ogawa conducted a questionnaire and a class on financial knowledge; in School C, Motonishi conducted a questionnaire and a class on financial knowledge. Since the survey was conducted before the class began, the content of the class did not affect the responses. However, before conducting the questionnaire for sixth-grade

[9]The brief results of Schools A, B, and C are reported in Ogawa et al. (2019).

students in School C, we gave them a brief 3-minute explanation of the concept of "investment." In Schools B and C, each class consisted of 30–40 students and lasted 45–50 minutes. We visited three to four classes to conduct the questionnaire. Schools A and C have a higher proportion of girls, while School B has a gender ratio of almost 1:1.

Table 3: Gender difference in billing behavior (highest amount of billing for social-network games in a month). Values in parentheses are the number of respondents)

School	A		B		C		D		E		F		G	
	Female	Male	F	M	F	M	F	M	F	M	F	M	F	M
0. Have not purchased "Gacha"	116	85	56	33	56	29	28	27	59	46	6	23	170	60
1. JPY 1−−500	9	6	0	2	2	3	4	5	5	5	2	5	9	10
2. JPY 501 −− 1,000	6	7	2	5	2	4	1	2	3	8	2	5	10	6
3. JPY 1,001−− 3,000	5	10	2	8	6	6	4	4	7	5	3	6	14	23
4. JPY 3,001−−5,000	1	4	0	6	0	4	1	2	4	4	1	6	1	12
5. JPY 5,001−−10,000	1	3	0	4	0	1	0	1	3	7	0	12	8	19
6. JPY 10,001−−30,000	2	1	0	3	0	1	0	2	4	2	1	13	3	20
7. JPY 30,001−−50,000	0	0	0	0	0	2	0	1	0	0	0	1	0	5
8. Higher than JPY 50,000	0	0	0	0	0	0	0	0	0	0	0	2	5	10
Total	140	116	60	61	66	50	38	44	85	77	15	73	220	165

At School D, Ogawa gave a lecture on introductory economics and then conducted a questionnaire. At School E, Motonishi, Kawamura, and Ogawa conducted the questionnaire at the end of the economic experiment or of the lecture. At School F, Koyama and Kawamura conducted the questionnaire at the end of the lecture. At School G, the questionnaire was conducted by the teachers of this school.

The questionnaire asks students about their experience of purchasing "Gacha" in social-network games (highest amount of money spent in a month), time preference, risk preference, age and sex.[10] Taking into account the length of class time, differences in understanding, and the amount of money respondents would have and spend in their lives, in Schools B and C, we decreased the number of questions and lowered the amount of money offered for questions to elicit risk preference and time preference. In Schools B and C, we asked those who had paid for the game for the reasons they paid.

In the area where School A is located, students who wish to attend a public high school can choose from a number of schools within the school district. Within a school district, there are differences between high schools based on academic performance. By contrast, students in Schools B and C attended public schools within their respective school districts. This might result in sample bias in School A, because of the impact of which public school students enroll at the school. School D is a private, medium-ranked high school in Osaka Prefecture; School E is a private university in the upper-middle range in the Kansai region; and School F is also a private university in the upper-middle range in the Kanto region. School G is a private, upper-middle-class high school in Osaka Prefecture.

For all schools, there may be bias in the data from localities and the choices of the respondents about which type of school to go to. For universities, there may be bias in the choice of

[10]We also collected a quiz on interest rates, a quiz on inflation, and a quiz on mortgages, which we do not use in this study.

lecture courses. However, there is very little bias arising from the response rate, as the number of respondents who did not answer the questions was low.

3 Hypothesis development

Purchasing "Gacha" in social-network games enables users to obtain some kinds of items and characters by probability. In addition, paying the bill does not necessarily guarantee that a user will get the items and characters that he or she wants. Thus, we assumed that purchasing "Gacha" in social-network games is associated with risk attitudes.

The user may feel purchasing "Gacha" is the loss of his or her money.[11] Thus, we assumed that purchasing "Gacha" in social-network games is associated with loss aversion.

In addition, items obtained through "Gacha" can speed up the progress of the social-network game through growing a particular character. "Gacha" gives a person a quick advantage over others in the game. Thus, there is a trade-off between time and money. For this reason, payment for "Gacha" is also related to time preference.

In our questionnaire, we asked the respondents' risk, loss, and time preferences.[12] The preference questions are simple, and we did not implement more elaborate questions, such as those of Holt and Laury (2002). There are two reasons for this. First, we thought it would be difficult to get elementary and middle school students to answer many questions about their preferences. Second, there was a time constraint, because the implementation took up part of the class time. Booth and Nolen (2012), Moreira et al. (2010), and Golsteyn et al. (2014) analyzed the economic preferences of youth with a small number of questions. Booth and Nolen (2012) introduced one simple question with binary choice to ask about risk preference.[13] While Booth and Nolen (2012) used this question to calculate performance payment, we did not use any monetary reward.[14]

Moreira et al. (2010) asked children aged 4 to 6 years to answer one question about risk preference.[15] Golsteyn et al. (2014) asked respondents to answer a hypothetical question on time preference.

First, we constructed a hypothesis about risk preference. In the questionnaire, respondents chose one of the options, "get JPY 1,000 for sure" or "get JPY 2,000 with a probability of 50%," or "get JPY 500 with a probability of 50%." The answer to this question enables us to judge whether a respondent is risk averse.

[11] Some users may think of the loss as a situation wherein he or she cannot complete a series of items or characters and considers there to be a further opportunity in trying to obtain more "Gacha." Those who think this way are likely to be immersed in the social-network game and are charged more. The number of respondents with high billing amounts is small in this survey. Therefore, we did not consider this possibility.

[12] Designing the questionnaire, we refer to the questions on economic preferences in Ida et al. (2009), Kahneman (2011), and Ogawa et al. (2012).

[13] In Booth and Nolen (2012), the question for risk preference is "Fiver Lottery." In this lottery, "Each student chooses Option 1 or Option 2. Option 1 is to get £5 for certain. Option 2 is to flip a coin and get £11 if the coin comes up heads or get £2 if the coin comes up tails."

[14] Camerer and Hogarth (1999) pointed out that whether a participant is given monetary incentive does not affect the mean performance in risky choices. In Holt and Laury (2002), there is no significant difference between hypothetical and real choices.

[15] In Moreira et al. (2010), participants aged 4 to 6 years were offered the choice between a visible quantity of 150 ml of strawberry juice and a random receipt of 0 or 300 ml of juice. Depending on the outcome of their choice, they could get juice (0, 150, or 300 ml). The experimental results showed that the children were risk seeking.

Because "Gacha" is loot box gambling in a social-network game, which is a kind of "lottery," we examine the following hypotheses.

H1 Risk-averse respondents have less experience of purchasing "Gacha" in social-network games than other respondents have.

H2 The highest monthly amount spent on purchasing "Gacha" in social-network games by risk-averse respondents is smaller than that of other respondents.

Buying "Gacha" is the same as paying to play a lottery. If users do not get the item they are looking for, they will lose the money paid. Therefore, people who want to avoid losing money may be hesitant to spend money on "Gacha." The question about loss avoidance is whether users would choose to "receive 3,000 yen with a 50% chance and pay 1,000 yen with a 50% chance" or "do nothing." This question corresponds to Q22 in the B and is made by reference to Q5 in Kahneman (2011, Chap.26). We classified the respondents who chose the latter into those with loss avoidance.

Thus, we propose the following hypotheses.

H3 Loss-averse respondents have less experience of purchasing "Gacha" in social-network games than other respondents have.

H4 The highest monthly amount spent on purchasing "Gacha" in social-network games of loss-averse respondents is smaller than that of other respondents.

Finally, we propose a hypothesis about time preference and billing behavior. We have two questions about time preference. One is to choose "get 7,000 yen now" or "get 10,000 yen a year later" (Q19 in B). The other question is to choose "get 7,000 yen a month later" or "get 10,000 yen 13 months later" (Q20 in B).

To develop our hypothesis, we categorized the respondents into two groups. The first group is the "time-consistent" group. In this group, those who answered "1 year later" in Q19 and "1 year and 1 month later" in Q20 were defined as future oriented, and those who answered "right now" in Q19 and "1 year and 1 month later" in Q20 were defined as present oriented. The second group is "time inconsistent, " corresponding to the participants who answered Q19 and Q20 differently.

The following hypothesis holds for respondents with time-consistent preferences. A trade-off between time and money arises because monetary payments for "Gacha" allow them to obtain a quicker advantage in the game. Therefore, we present the following hypotheses.

H5 Future-oriented respondents are less likely to have billing experience in social-network games than are present-oriented respondents.

H6 The highest billing for social-network games is lower for future-oriented respondents than for present-oriented respondents.

Time-inconsistent respondents can be divided into those with present bias and those with future bias. The former comprised those who responded "now" in Q19 and "1 year and 1 month from now" in Q20, while the latter were those who responded "1 year from now" in Q19 and "1 month from now" in Q20. In this study, a dummy variable was constructed for each econometric analysis.

Although time-inconsistent respondents can be divided into naive and sophisticated (O'Donoghue and Rabin, 1999), we did not ask questions for classifying two types. Therefore, it is difficult to submit hypotheses on time-inconsistent respondents. If the number of naive respondents is large, they might have more experience of purchasing "Gacha" and large highest amounts of money spent purchasing it in a month. However, a comparison with present-oriented respondents is difficult. Meanwhile, assume that the number of sophisticated respondents is high. One type of sophisticated respondent decides to purchase "Gacha" and actually purchases it. The other type of sophisticated respondent decides not to purchase it and does not in fact do so. Therefore, it is difficult to submit hypotheses on the differences among sophisticated respondents, present-oriented respondents, and future-oriented respondents.

4 Questionnaire results: Who purchases "Gacha" in social-network games?

Table 2 shows the distribution of the highest amount of purchasing "Gacha" in social-network games (per month). With the exception of School F (a private university), the majority of students in all other schools had never purchased it. Overall, 65.6% of the respondents had never purchased "Gacha" in social-network games.

The percentage of purchasing experience decreases as the monthly highest amount of purchasing "Gacha " increases. This is a common trend, with the exception of School F.

Table 3 shows the relationship between gender and billing behavior. In most schools, male students had more experience of billing in social-network games than female students had.

We now examine the relationship between the preference of the respondents and the highest billing amount ever charged for social-network games. Figure 1 shows the relationship between risk aversion and billing behavior. This figure shows that risk-averse respondents have less experience with billing and a smaller maximum billing amount per month than risk-loving respondents.

Figure 2 shows the relationship between loss avoidance and the maximum amount of billing for social-network games in a month. Most loss-averse respondents had never paid billing for social-network games before, and had a lower maximum billing amount ever charged in a month than other respondents.

Figure 3 shows the relationship between time preference and the highest billing for social-network games in a month. Present-oriented respondents had significantly more billing experience than future-oriented respondents. Present-biased respondents had significantly more billing experience than future-biased respondents. However, there was not a significant difference between present-oriented and present-biased respondents. The results were similar between future-oriented and future-biased respondents.

Table 4 shows the variables list for regression and Table 5 shows the results of logit regression. The dependent variable is billing experience. If a respondent has this experience, this variable is 1, and otherwise 0. The baseline respondents are present-oriented.

Let us examine the regression results. Male respondents are significantly more likely to have been charged. Risk aversion is not significant for male respondents (model 2), but is negative and significant in the other models. In other words, risk-averse respondents are significantly less likely to have experienced billing. Thus, Hypothesis 1 is supported.

likely to have experienced billing. Thus, Hypothesis 1 is supported.

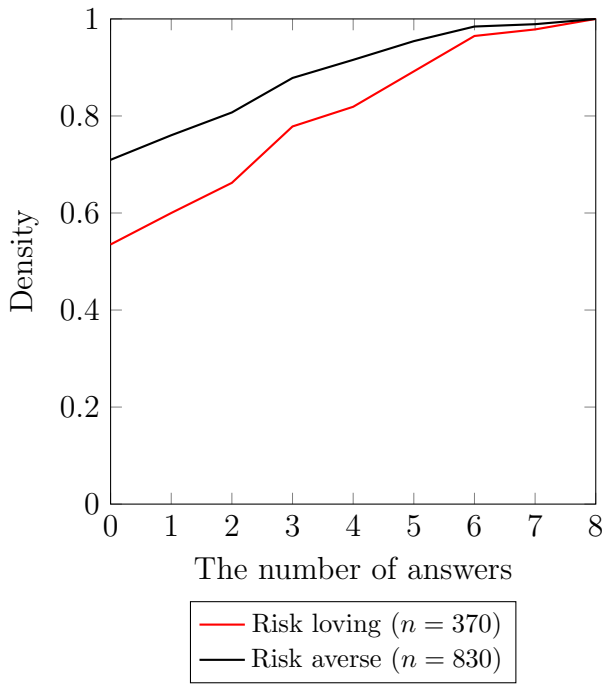

Figure 1: Risk aversion and the highest amount of billing for social-network games in a month (cumulative distribution, Kolmogorov–Smirnov test, $p < 0.001$). The number of answers is shown in Tables 2 and 3.

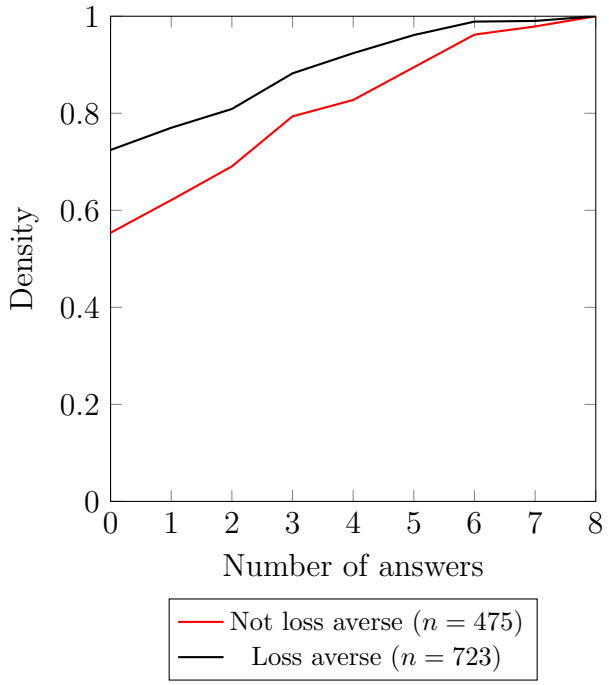

Figure 2: Loss aversion and the highest amount for purchasing "Gacha" in a month (cumulative distribution), Kolmogorov–Smirnov test, $p < 0.001$. The number of answers is shown in Tables 2 and 3.

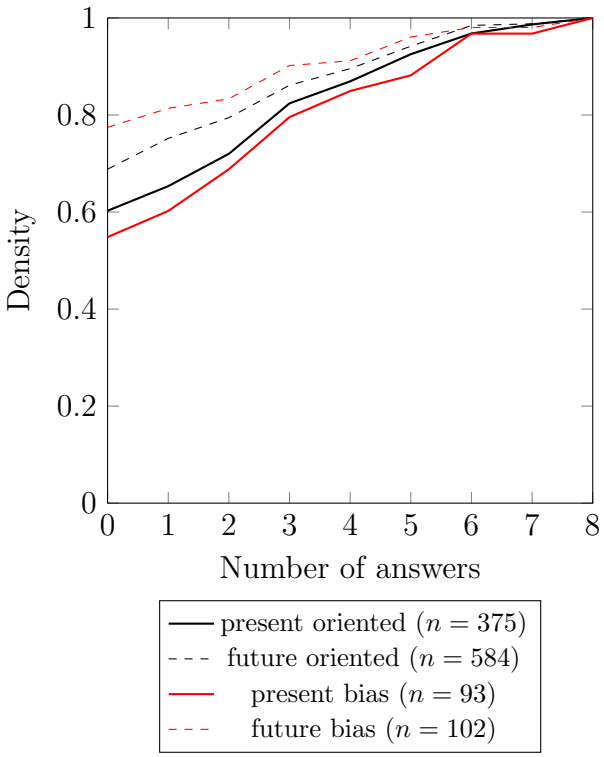

Figure 3: Time preference and the highest amount of billing for social-network games in a month (Cumulative distribution). A significant difference is observed between present oriented respondents and future-oriented respondents and between present-biased and future-biased respondents (Kolmogorov–Smirnov test, $p < 0.001$). A non-significant difference is observed between present-oriented and present-biased respondents and between future-oriented and future-biased respondents. For the number of answers, see Tables 2 and 3.

The result for loss aversion is similar to that for risk aversion. In all models, the coefficient of loss aversion is negative and significant in their experience of purchasing "Gacha." Thus, Hypothesis 3 is supported.

We examine the effect of time preference on the experience of purchasing "Gacha." From Table 5, future oriented (timcons_f) and future-bias (future_bias) respondents had significantly lower experience of purchasing "Gacha" than baseline respondents. In all the regression models, except for the model for male respondents, future-oriented respondents had significantly lower billing experience than present-oriented respondents. Thus, Hypothesis 5 is supported. Female respondents with a future bias were also significantly less likely to have experience of purchasing "Gacha."

Table 6 shows the results of the regression analysis with the highest billing amount in a month as the dependent variable. Male respondents had significantly higher maximum billing status. Risk aversion is negative and significant in all models, except for the regression analysis for male respondents only. In other words, those who were risk averse had significantly lower maximum bills. Thus, Hypothesis 2 is supported.

The coefficient of loss aversion is negative and significant in all models. Those who were loss averse had significantly smaller maximum billing amounts in a month. Thus, Hypothesis 4 is supported.

We now check the relationship between time preference and highest billing amount in a month. Compared to the baseline respondents, future-oriented and future-biased respondents (Models 1 and 2) had significantly smaller maximum billing amounts; Hypothesis 6 is supported.

variable	explanation
MAPGacha	Maximum amount of purchasing "Gacha" in social-network games in a month (Tables 2 and 3)
PEXGacha	Experience of purchasing "Gacha" (1=yes, 0=no)
male	dummy: male= 1, female= 0
eduyear	Years of education
X_dummy	X=A, B, C,...G. School dummy (School E is the baseline).
risk aversion	dummy for risk aversion. 1 is risk averse, otherwise 0.
loss aversion	dummy for loss avoidance. 1 is loss averse, otherwise 0.
timcons_f	Time preference dummy (future-oriented). 1 is future oriented.
timcons_n	Time preference dummy(present-oriented). 1 is present oriented.
present_bias	Time-inconsistent dummy (present-bias). 1 is present bias.
future_bias	Time-inconsistent dummy (future-bias). 1 is future bias.

Table 4: List of variables

	(1) All	(2) Male	(3) Female
male	1.028***		
	(0.141)		
eduyear	-0.040	-0.036	0.070
	(0.097)	(0.130)	(0.162)
A_dummy	-0.785	-0.646	-0.395
	(0.517)	(0.709)	(0.809)
B_dummy	-0.719	0.060	-1.561
	(0.613)	(0.835)	(1.062)
C_dummy	-0.607	-0.130	-0.422
	(0.796)	(1.078)	(1.283)
D_dummy	-0.297	-0.160	0.052
	(0.479)	(0.642)	(0.729)
F_dummy	0.945***	1.179***	1.250**
	(0.319)	(0.371)	(0.589)
G_dummy	0.172	0.864	-0.113
	(0.497)	(0.704)	(0.758)
risk aversion	-0.290*	-0.083	-0.790***
	(0.149)	(0.185)	(0.251)
loss aversion	-0.464***	-0.313*	-0.698***
	(0.139)	(0.182)	(0.215)
timcons_f	-0.338**	-0.074	-0.610***
	(0.146)	(0.193)	(0.236)
future_bias	-0.676**	-0.784*	-0.631*
	(0.278)	(0.402)	(0.373)
present_bias	0.163	0.181	0.153
	(0.263)	(0.344)	(0.387)
_cons	0.057	0.333	-0.429
	(1.441)	(1.952)	(2.365)
N	1198	582	616
pseudo R^2	0.121	0.078	0.102

Robust standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 5: The result of Logit regression. The coefficient is the odds ratio. The dependent variable is PEXGacha.

MAPGacha	(1) All observations	(2) Male	(3) Female
male	0.241***		
	(0.116)		
eduyear	-0.118	-0.120	0.018
	(0.092)	(0.148)	(0.107)
A_dummy	-0.198**	-0.167	-0.147
	(0.459)	(0.770)	(0.516)
B_dummy	-0.135*	-0.047	-0.162
	(0.554)	(0.926)	(0.618)
C_dummy	-0.154	-0.085	-0.121
	(0.729)	(1.205)	(0.826)
D_dummy	-0.087*	-0.060	-0.066
	(0.410)	(0.687)	(0.453)
F_dummy	0.137***	0.223***	0.063
	(0.313)	(0.406)	(0.496)
G_dummy	0.020	0.195	-0.063
	(0.454)	(0.789)	(0.504)
risk aversion	-0.056*	-0.018	-0.122**
	(0.136)	(0.192)	(0.183)
loss aversion	-0.090***	-0.107***	-0.084**
	(0.118)	(0.184)	(0.135)
timcons_f	-0.064**	-0.051	-0.084*
	(0.121)	(0.201)	(0.130)
future_bias	-0.051*	-0.072*	-0.036
	(0.206)	(0.377)	(0.231)
present_bias	0.020	0.045	0.005
	(0.241)	(0.370)	(0.263)
N	1198	582	616
R^2	0.182	0.162	0.077

Standardized beta coefficients; Robust Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 6: The results of regressions

Table 7: The reason for purchasing "Gacha" (Schools B and C) : multiple choice. This is the same as Table 3 in Ogawa et al. (2019). P value is the result of the Wilcoxon rank-sum test (two-sided) to examine the gender difference. The number of male and female respondents who purchased "Gacha" is 50 and 18, respectively.

Reason	Number of male respondents who check "yes"	Number of female respondents wh
(1) Because of great deal	19	5
(2) To beat the other players.	7	0
(3) To have fun playing with other players.	19	3
(4) To speed up the progress of the game	7	2
(5) To play games comfortably	15	3
(6) To complete the limited-time event	7	4
(7) To get a certain character	20	6
(8) To make sure that the game does not go away	6	1

5 Discussion and Conclusion

As mentioned in Section 1, the decision-making of adolescents in the real world is related to their preferences. In this study, we investigated the effects of risk preference, loss avoidance, and time preference on the behavior of adolescents purchasing "Gacha" (loot box gambling) in social-network games.

Our investigation of 1,210 respondents in Japan shows the following results. (1) Risk-averse respondents have less experience purchasing "Gacha" in social-network games than other respondents and their monthly highest amount of purchasing "Gacha" is smaller than that of other respondents (H1 and H2 are supported). (2) Respondents with loss avoidance have less experience of billing for social-network games than other respondents, and the highest amount of billing for social-network games of respondents with loss avoidance is smaller than that of other respondents (H3 and H4 are supported). (3) For time preference, future-oriented respondents have less experience buying "Gacha" than present-oriented respondents, and their highest amount of money for "Gacha" in a month is smaller than that of present-oriented respondents (H5 and H6 are supported).

We briefly compare our results with those of previous studies, considering the differences in sample characteristics and collection methods. Morimoto (2018) investigated the billing behavior in social-network games of undergraduate students (100 respondents) and the relationship between economic preferences and this behavior. The number of respondents who had an experience of billing in social-network games was 20 (27.8%). Our respondents consisted of a range of elementary school students to university students, with a different respondent profile to only university students in Morimoto (2018). We found that the experience of purchasing "Gacha" increases with schooling years. Focusing on the student sample only, the experience of buying "Gacha" of our respondents is higher than that in the existing study. Differences in data collection may be the reason for the difference.

Based on the result of a questionnaire, Arai (2013) reported that 173 (34.6 %) of non-student respondents had experience purchasing "Gacha." Although the number of years of schooling of respondents in our study is different from that of Arai (2013), the rate of experience of buying "Gacha" is almost the same. In our results, the percentage of university students is 66% (School F) and 41% (School G). These percentages are larger than those in Arai (2013).

Our questionnaire did not consider how many elementary and junior high school students had smartphones. Based on the results of the Cabinet Office (2018), some do not have smartphones. Therefore, we might not understand their purchasing behavior in social-network games well. When conducting this type of questionnaire, we should focus on respondents with smartphones.

The gender differences in the purchasing behavior showed that male respondents purchased "Gacha" more and had a higher amount of billing for social-network games than female respondents. While there is room for further analysis of the reasons for this finding, we examine some of the reasons based on the results of this survey.

We asked respondents who had purchased "Gacha" in Schools B and C to provide the reason for purchasing it (Table 7). The major reason was not that they wanted to beat players (competitive spirit) but that they wanted to have a specific item or character and that a mark-down sale had been held.

However, reason (3) in Table 7 shows a significant (but mild) gender difference regarding competitive spirit (Fisher test, $p < 0.10$); male respondents seemed to purchase "Gacha" based on the competitive spirit. Niederle and Vesterlund (2007) explored the gender differences of competitive spirit in a more general context. Their experimental results reported that men prefer to participate in competitions and to attain higher rewards, whereas women prefer not to participate in competitions but to attain rewards according to their quality of work. The trend of our male respondents who purchased "Gacha" may be in line with Niederle and Vesterlund (2007).

We now turn to future research. Although our respondents provided answers on the highest amount they spent purchasing "Gacha" in a month, another way to conduct this study would be to determine the average amount spent purchasing ''Gacha" in the last 6 months. It would be interesting to ask this question in a future questionnaire. It would also be worthwhile to use a more informative explanatory variable. By employing a quantitative measure for risk attitude and time preference, it might be possible to explain the gender difference in billing behavior in a social network game. Determining and controlling for the motivation for the billing behaviors of the respondents would enhance the investigation of the relationship between billing behaviors and behavioral parameters. The motivation for billing may differ by gender, but the relationship between billing behaviors and behavioral parameters of the respondents who have similar motivations does not differ by gender.

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A Additional analyses

Here, we introduce the new variable "RA2." This is defined as follows:

RA2=risk aversion+loss aversion.

Thus, this variable is 0, 1, or 2.

The regression results for which we introduce this variable are presented in Tables A1 and A2. In these tables, the baseline participants are present-oriented time preference. These tables indicate that RA2 has a negative and significant effect on billing experience and the highest amount of billing for social-network games.

	(1) All observations	(2) Male	(3) Female
male	1.021***		
	(0.141)		
eduyear	-0.040	-0.036	0.069
	(0.097)	(0.130)	(0.161)
A_dummy	-0.780	-0.649	-0.404
	(0.515)	(0.706)	(0.805)
B_dummy	-0.717	0.054	-1.567
	(0.611)	(0.831)	(1.060)
C_dummy	-0.616	-0.141	-0.417
	(0.795)	(1.074)	(1.285)
D_dummy	-0.292	-0.155	0.047
	(0.478)	(0.640)	(0.727)
F_dummy	0.933***	1.158***	1.251**
	(0.318)	(0.368)	(0.589)
G_dummy	0.173	0.860	-0.117
	(0.495)	(0.700)	(0.757)
RA2	-0.381***	-0.198*	-0.739***
	(0.091)	(0.115)	(0.152)
timcons_f	-0.348**	-0.082	-0.602**
	(0.146)	(0.194)	(0.234)
future_bias	-0.671**	-0.756*	-0.626*
	(0.276)	(0.399)	(0.376)
present_bias	0.147	0.143	0.153
	(0.264)	(0.342)	(0.387)
_cons	0.073	0.351	-0.431
	(1.439)	(1.945)	(2.366)
N	1198	582	616
pseudo R^2	0.121	0.077	0.102

Robust Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A1: The results of Logit regression: the dependent variable is PEXGacha

	(1) All observations	(2) Male	(3) Female
male	0.240***		
	(0.115)		
eduyear	-0.117	-0.120	0.015
	(0.092)	(0.147)	(0.107)
A_dummy	-0.197**	-0.168	-0.152
	(0.458)	(0.765)	(0.514)
B_dummy	-0.134*	-0.048	-0.165
	(0.554)	(0.921)	(0.616)
C_dummy	-0.155	-0.087	-0.121
	(0.728)	(1.199)	(0.824)
D_dummy	-0.086*	-0.059	-0.068
	(0.410)	(0.684)	(0.451)
F_dummy	0.136***	0.219***	0.063
	(0.312)	(0.401)	(0.493)
G_dummy	0.021	0.194	-0.066
	(0.453)	(0.785)	(0.502)
RA2	-0.116***	-0.098**	-0.155***
	(0.083)	(0.122)	(0.103)
timcons_f	-0.066**	-0.054	-0.080*
	(0.121)	(0.201)	(0.132)
future_bias	-0.051*	-0.067*	-0.034
	(0.205)	(0.370)	(0.232)
present_bias	0.018	0.037	0.004
	(0.241)	(0.370)	(0.261)
N	1198	582	616
R^2	0.181	0.159	0.076

Standardized beta coefficients; standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A2: The results of regression: the dependent variable is MAPGacha

B Questionnaire for high school students and university students.

This questionnaire was administered to high school students and university students.[16]

Please read the following questions and choose one that you think is correct and tick the boxes.

Q1. You have 100 JPY in a savings account with an interest rate of 2% per year. If you leave your deposit intact, what will your balance be after 5 years?

☐ (1) more than 102 JPY

☐ (2) just 102 JPY

☐ (3) less than 102 JPY

☐ (4) I do not know

Q2. You owe 20,000 JPY at an interest rate of 15% per year. If you leave the debt as is, what will be your balance after 1 year?

☐ (1) more than 23,000 JPY

☐ (2) just 23,000 JPY

☐ (3) less than 23,000 JPY

☐ (4) I do not know

Q3. Suppose your savings account has an interest rate of 1% per year and the rate of inflation (rate of price growth) is 2% per year; how much can you buy with the money in this account in the next year?

☐ (1) More than in this year

☐ (2) Unchanged

☐ (3) Less than in this year

☐ (4) I do not know

Q4. What usually happens to the price of bonds when the interest rate increases?

☐ (1) increase

☐ (2) unchanged

☐ (3) decrease

[16] We used this questionnaire in School G.

☐ (4) There is no relationship between bond prices and interest rates.

☐ (5) I don't know

Q5. A 15-year loan has a higher monthly payment than a 30-year loan, but the total interest payment over the repayment period is less than a 30-year loan. Is this statement correct or incorrect?

☐ (1) correct

☐ (2) wrong

☐ (3) I don't know

Q6. It is safer to invest assets in multiple companies for a safer return than to invest them all in a particular company?

☐ (1) correct

☐ (2) wrong

☐ (3) I do not know

Q7. What happens to the JPY-denominated value of financial assets held in foreign currencies when the JPY appreciates?

☐ (1) increase

☐ (2) unchanged

☐ (3) decrease

☐ (4) I do not know

Q8. When you try to sell a financial asset in a hurry, the price of the asset tends to fall. Which of these drops is greater, real estate or government bonds?

☐ (1) The price of real estate falls by more than that of government bonds.

☐ (2) The price decline is the same for real estate and government bonds.

☐ (3) The price of the real estate falls by more than that of government bonds.

☐ (4) I do not know

Q9. You do not have to buy insurance for a very unlikely event to occur. Is this statement correct or incorrect?

☐ (1) correct

☐ (2) wrong

☐ (3) I do not know

Q10. Investments with a high return potential are often at great risk. Is this statement correct or incorrect?

☐ (1) correct

☐ (2) wrong

☐ (3) I do not know

Q11. How many questions about financial knowledge did you think you could answer correctly in Q1 through Q10?
( ) questions.

Q12. What is your faculty and department?
Faculty : ( )
Department : ( )

Please read the following questions and choose the one that applies to you.

Q13. What is your grade? (university students only)

☐ (1) 1st year

☐ (2) 2nd year

☐ (3) 3rd year

☐ (4) 4th year

☐ (5) higher than 4th year

Q14. What is your gender?

☐ (1) male

☐ (2) female

☐ (3) no answer

Q15. Do you want to invest your money in stocks and other investments when you become a member of society?

☐ (1) I'd love to invest.

☐ (2) I'd like to invest.

☐ (3) I'm not really looking to invest.

☐ (4) I don't want to invest at all.

Q16. Are you willing to pay for information on how to reliably make money from your investments?

☐ (1) yes

☐ (2) no

Q17. Do you find it appealing to have property insurance that covers even small losses?

☐ (1) yes

☐ (2) no

Q18. What is the maximum amount per month you have purchased "Gacha" in social-network games with smartphones, game consoles, and computers?

☐ (1) I have not ever been billed for social-network games.

☐ (2) JPY 1 to JPY 500

☐ (3) JPY 501 to JPY 1,000

☐ (4) JPY 1,001 to JPY 3,000

☐ (5) JPY 3,001 to JPY 5,000

☐ (6) JPY 5,001 to JPY 10,000

☐ (7) JPY 10,001 to JPY 30,000

☐ (8) JPY 30,001 to JPY 50,000

☐ (9) More than JPY 50,000

Read the following questions, choose the answer that you think is correct, and mark the number on the mark sheet.

Q19. Which would you choose?[17]

☐ (1) get JPY 7,000 right now.

☐ (2) get JPY 10,000 1 year later.

Q20. Which would you choose?

☐ (1) get JPY 7,000 a month later.

☐ (2) get JPY 10,000 1 year and 1 month later.

[17]The monetary amount in Q19 and Q20 is different for the questionnaire for elementary/junior high school students and for high school/university students. (1) is JPY 1,600 and (2) is JPY 2,000.

Q21. Which would you choose?

☐ (1) get JPY 1,000 for sure.

☐ (2) get JPY 2,000 with a probability of 50% or get JPY 500 with a probability of 50%.

Q22. Which would you choose?

☐ (1) get JPY 3,000 with a probability of 50% or pay JPY 1,000 with a probability of 50%.

☐ (2) do nothing.