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The Effects of the Presence of Others on Risky Betting in a Laboratory Gambling Task Among High-Risk Gamblers: A Cross-over Randomized Controlled Trial

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Abstract
We explored the effects of the presence of and cooperation with others on risky betting in a laboratory-based gambling task among high-risk gamblers. Specifically, we compared risky betting under solo, parallel, and cooperation conditions using a stratified randomized, cross-over design. Stratification was conducted according to participant age and gender. The participants were 40 Japanese adults (20 women, 20 men; mean age = 46, SD = 12.80). In the experiment, each participant conducted the Game of Dice Task (GDT) individually (solo condition), in parallel with another participant (parallel condition), and working together with another participant (cooperation condition). Linear mixed modeling results showed that when we controlled for previously specified covariates, there were no significant differences among the solo, parallel, and cooperation conditions regarding risky betting (parallel: estimates = 0.10, SE = 0.79, $p = .900$; cooperation: estimates = 0.95, SE = 0.79, $p = .232$). However, post-hoc analysis showed a significant difference between the solo and cooperation conditions regarding the number of times participants chose the riskiest bet (parallel: estimates = 0.18, SE = 0.52, $p = .739$; cooperation: estimates = 1.13, SE = 0.53, $p = .035$). Thus, we found that neither the presence of nor cooperation with others decreased risky betting in the GDT among high-risk gamblers. However, we did observe that participants displayed the riskiest betting behavior (i.e., selecting the single choice) in the GDT during the cooperation condition, compared with the solo condition.

Keywords Problem gambling · Harm reduction · The other presence · Cooperation with others

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Background

Problem gambling can have a considerable negative impact on people's lives (Langham et al., 2016). Reportedly, the global lifetime prevalence of problem gambling is between 0.7 and 6.5% (Colado & Grifitthes, 2016). Including those at risk of transitioning to problem gambling and their families, it is estimated that a significant number of people face harm due to excessive gambling. A previous review (Langham et al., 2016, p. 4) defined gambling-related harm as any initial or exacerbated adverse consequence due to an engagement with gambling that leads to decrement to the health or well-being of an individual, family unit, community or population. This review further reported that harms could occur either sequentially or simultaneously. Types of harm can include financial, interpersonal, emotional or psychological, health-related, professional, educational, and criminal harms. To reduce these harms, international guidelines recommend implementing evidence-based and best-practice policies to minimize gambling, including specific requirements for policies on gambling (Gainsbury et al., 2014). Such guidelines include a minimum legal age of 18 years for gambling participation, licensing gambling venues and activities that ensure responsible gambling, and mandated consumer protection strategies. Other guidelines clarify safe gambling practices most strongly associated with reduced gambling-related harm (Hing et al., 2019).

In addition, as evidence-based and best-practice methods, several harm-minimization strategies have been made available for those who are susceptible to or face gambling-related harm that were devised to prevent pathological gambling behaviors and facilitate self-control with respect to gambling (Harris & Griffiths, 2017). These strategies include supply-reduction (reducing opportunities for gambling and providing low-investment gambling machines), demand-reduction (education to raise awareness about the potential harms of serious gambling), and harm-reduction interventions (approaches to reducing gambling-related harm, such as personalized normative feedback; McMahon et al., 2019; Tanner et al., 2017). Currently, psychotherapy (e.g., cognitive-behavioral therapy) is the most effective treatment for directly reducing gambling behavior (Petry et al., 2017). Furthermore, for gambling disorder, psychotherapy combined with psychopharmacology may provide better patient retention rates in comparison to psychopharmacology alone (Kraus et al., 2020). Psychotherapy aims to develop skills to avoid and cope with urges to gamble as an integral part of treatment. However, even with treatment, it is still difficult to stop gambling completely, and approximately 30% of those who receive cognitive behavioral therapy relapse within one year (Aragay et al., 2015). Thus, it is beneficial to consider relapse/lapse when treating gambling disorder, and even if gambling behavior is resumed, the development of a harm-reduction approach is important to continue minimizing the negative effects, so the individual does not return to their before-treatment levels.

In line with its original aims, the continued use of a harm-reduction approach has been shown to decrease addictive behaviors and related negative effects over the long term (McMahon et al., 2019). However, the main treatment components of cognitive behavioral therapy currently shown to be most effective in reducing gambling behavior do not incorporate to establishing a harm-reduction gambling, although the main components are effective in reducing a variety of harms. In other words, the goal of existing cognitive behavioral therapy is to acquire skills to reduce gambling (Menchon et al., 2018). Therefore, harm-reduction is not sufficiently provided for problem gamblers through common forms of psychotherapy, such as cognitive behavioral therapy. In addition, the destructive power of the reward (stimulation and excitement) of addictive

behaviors, including gambling, is irreplaceable, and the learning history ingrained in gamblers' lives makes it difficult for them to stop gambling behaviors. Therefore, establishing a harm-reduction approach to allow individuals to continue to live their lives while controlling gambling behaviors is an appropriate intervention, because it not only reduces the negative effects of problem gambling but also is based on understanding the gambler's ecosystem.

To date, most harm-reduction approaches have been based on strategies to work with individuals and their environment to reduce gambling behavior and its negative effects (Hing et al., 2019; McMahon et al., 2019). In this study, we examine whether the presence of others leads to the suppression of gambling behavior as a new harm-reduction strategy. Previous studies have identified a "social shield effect," in which, compared to gambling around others, gambling while alone leads to excessive gambling behavior (Lemoine & Roland-Lévyet, 2017; Rockloff & Greer, 2011). In this study, we examine not only the social shield effect but also the effects of parallel and cooperative gambling with others. Parallel gambling refers to gambling while sitting next to another gambler, while cooperative gambling refers to two people gambling while talking (consulting) with each other so that their scores would be higher, which increases the possibility of making calm decisions, compared to gambling while alone.

Therefore, we aimed to explore the effects of the presence of and cooperation with others for risky betting in a laboratory-based gambling task among high-risk gamblers. Specifically, we compared risky betting under solo, parallel, and cooperation conditions in the gambling task. We hypothesized that participants would display less risky betting in the parallel and cooperation conditions, compared with the solo condition, based on the findings of previous studies showing that the presence of others, including an audience, inhibits problem gambling (Lemoine & Roland-Lévyet, 2017; Rockloff & Greer, 2011).

Despite the considerable negative impact of problem gambling (Langham et al., 2016), and the effectiveness of interventions for problem gambling including, cognitive behavioral therapy, identified in previous studies (Gooding & Tarrier, 2009), barriers such as shame, embarrassment, or stigma prevent many problem gamblers from seeking help (Suurvali et al., 2009). In other words, although there are effective treatment and prevention approaches, there are those who are unable to receive them. Furthermore, self-help groups are among the most important social resources in problem gambling treatment. Self-help groups exist worldwide and anyone can join them anonymously. Currently, several online self-help groups have been established in response to the COVID-19 pandemic. It is also important to propose a harm reduction approach that is effective and can be utilized by a larger number of gamblers, while fully utilizing existing social resources and medical care, such as self-help groups. If this study shows that the presence of others under parallel or cooperative conditions can inhibit risky betting, it may be possible for gamblers to cooperate with self-help group members, friends, or someone else who gambles to achieve harm-reduction without relying on medical and clinical psychological experts.

Method

Ethics

The study protocol was approved by the Ethics Committee at the School of Psychology, Tokai-Gakuen University (2021–10).

Trial Design

This study used a stratified randomized, cross-over design. Stratification was conducted according to participant age and gender. A researcher from the company that helped facilitate this study (Marketing Service Co., Ltd.) cooperated in recruiting participants and paying rewards for participation. The reasons for using a cross-over design are that the effects of the three methods of gambling (solo, parallel, and cooperative) can be compared, and the between-subject variability in the comparison of the three methods of gambling can be excluded. Furthermore, random assignment allows for similar background information on the participants between each group. However, the purely random assignment may also develop a bias. In particular, we wanted to eliminate extraneous variables in this experiment in order to have the participants engage in conversation. In other words, we stratified for gender and age because we thought that the combination of gender and age would have an impact on the conversation itself.

Study Setting and Procedure

The experiment in the present study was conducted from December 25–27, 2021. From December 3–6, 2021, participants were recruited from online survey panels operated by a survey company in Japan (Cross Marketing, Inc.). Potential participants read an explanation on the website regarding the purpose of the screening questionnaire, how the obtained data would be used, and how their personal information would be handled. The instructions stated that, by completing the screening questionnaire, panel members were considered to have consented to participate in the study, and those who consented completed the screening questionnaire. The last question on the screening questionnaire asked whether respondents wished to participate in a subsequent experiment on gambling behavior. Participants who expressed their interest in a subsequent experiment were again provided with a written explanation of the study (the experimental study's schedule, honoraria, and information about the research team and research funding) by the researcher from the research company.

The inclusion criteria were as follows: (a) aged 20–69 years, (b) a history of gambling within at least one year, and (c) moderate-to-problem gambling symptoms on the Problem Gambling Severity Index (PGSI; So et al., 2019) with scores ranging between 3 and 27.The research company staff divided participants who met the eligibility criteria into pairs, and each pair was composed of individuals who did not know each other and were of the same gender and generation. The mean difference in age between each pair was 4.05 years (SD = 3.87; range = 0–12).

Then, the first author produced a computer-generated list of random numbers to allocate each pair to one of six groups as follows: solo–parallel–cooperation, solo–cooperation–parallel, parallel–solo–cooperation, parallel–cooperation–solo, cooperation–solo–parallel, and cooperation–parallel–solo. We tested betting behaviors in a laboratory gambling task under three conditions through a cross-over design.

In the solo condition, participants completed the game of dice task (GDT) one at a time (while one participant was performing the task, the other was in the waiting room). In the parallel condition, two participants performed the GDT at the same time, but without any conversation allowed during the task. In the cooperative condition, two participants performed the GDT at the same time and were told to consult with each other so that their scores would be higher. In addition, they were told that their combined scores would be

totaled for the final score. Before the cooperation condition, participants were instructed to introduce themselves by name and share their gambling experience, including preferred type of gambling and how long they had been gambling.

Participants were asked to enter the waiting room one hour before the experiment started. To reduce the risk of response bias, the participants were not told prior to providing informed consent that the researcher aimed to explore the effects of the presence of and cooperation with others for risky betting in a laboratory gambling task. For this reason, the participants were only told that the research consisted of a gambling experiment, without the words "presence of others" or "cooperation with others" mentioned. Participants were informed of the duration of the experiment and that they could quit at any time if they wanted. Participants were also provided both verbal and written explanations of how their personal information would be protected. Then, participants' written consent was obtained and they completed a baseline assessment.

After the baseline assessment, participants were asked to engage in a 30-min, three-condition experiment. They were instructed to sit next to each other, approximately 30 cm apart, and face forward. To prevent COVID-19 infection, both the experimenter and participants wore face masks during the experiment, and acrylic panels were placed between the two participants and between the participants and experimenter. In addition, after each participant pair completed the experiment, all laboratory equipment used was cleaned using an alcohol-based disinfectant. Figure 1 shows the actual room where the experiment was conducted. After completing all three conditions, participants were administered a post-assessment questionnaire designed to measure whether they could

Fig. 1 A photograph of the laboratory

calculate probabilities and expected values in relation to the GDT during the experiment. The experiment concluded with a debriefing in which participants were informed that the purpose of this study was to examine how the presence of and cooperation with others affected risky betting in a laboratory-based gambling task.

Screening

Demographics

Participants were asked questions on gender, age, education level, annual income, money spent on entertainment and leisure (allowance), and marital status.

Gambling Behavior and Symptoms

Participants were asked to report the types of gambling they engaged in during the previous year. Participants were also asked to report the number of days they gambled and the total time spent gambling during the previous month.

Gambling symptoms were assessed using the Japanese version of the PGSI (PGSI-J; So et al., 2019). The PGSI (Ferris & Wynne, 2001) is a nine-item self-report scale designed to assess gambling severity during the past year. Total scores range between 0 and 27. Participants responded using a four-point Likert scale to indicate the extent to which they agreed with each item (0 = *never*, 1 = *sometimes*, 2 = *most of the time*, and 3 = *almost always*). Higher scores indicated more severe problem gambling symptoms and were interpreted as follows, based on the classification by Ferris and Wynne (2001): 0 = non-problematic, 1–2 = low risk, 3–7 = moderate risk, and 8 or more = problematic gambling.

Primary Outcome Measures

Game of Dice Task

The GDT (Brand et al., 2005) was used in this study to measure risky betting in a laboratory-based experiment. Before beginning the computerized task, participants were instructed to maximize their fictitious starting capital of 1,000 Japanese Yen (JPY) within 18 throws of a single virtual die. They were explicitly briefed on the game's rules and the amounts of money associated with each of the possible options. For each trial, before the die was thrown, participants were required to bet on the outcome of the throw by choosing a single number, or combinations of two, three, or four numbers. If they choose one of the six possible single-number options (from "1" to "6," winning probability = 0.17, expected value = − 666.67 JPY), they received a fictitious gain of 1,000 JPY when the chosen number was thrown, but a fictitious loss of 1,000 JPY when one of the five unchosen numbers was thrown (called "single choice"). Choosing one of three possible combinations of two numbers ("1 and 2," "3 and 4," "5 and 6," winning probability = 0.33, expected value = − 166.67 JPY) was linked to a gain of 500 JPY when one of the numbers included in the chosen combination was thrown, but a loss of 500 JPY when one of the numbers not included in the combinations was thrown (called "double choice"). Participants could also choose one of two possible combinations of three

numbers ("1, 2, and 3" or "4, 5, and 6," winning probability = 0.50, expected value = + 33.33 JPY) linked to a potential gain/loss of 200 JPY (called "triple choice"). Finally, participants could choose one of the three possible combinations of four numbers ("1, 2, 3, and 4;" "2, 3, 4, and 5;" or "3, 4, 5, and 6," winning probability = 0.67, expected value = 666.67 JPY) that would lead to a gain of 100 JPY if one of the four numbers chosen was thrown, but a loss of 100 JPY otherwise (called "quadruple choice").

In total, the participants could choose from 14 different alternatives (single choice: "1," "2," "3," "4," "5," and "6," double choice: "1 and 2," "3 and 4," "5 and 6," triple choice: "1, 2, and 3" or "4, 5, and 6," and quadruple choice: "1, 2, 3, and 4;" "2, 3, 4, and 5;" or "3, 4, 5, and 6") in each trial. Single choice was the riskiest option, whereas quadruple choice was the most conservative and advantageous option. A single or double choice was classified as risky betting, while a triple or quadruple choice was classified as non-risky betting. The winning probabilities and gain and loss amounts associated with each alternative remained stable throughout the task and across all three conditions. Before starting the experiment, participants were carefully instructed on the rules; however, they were not told which option was the most advantageous. After each throw, the monetary gain or loss was indicated on the screen accompanied by a distinct sound (the jingle of a cash machine for a gain; a dull tone for a loss). The current total capital and number of rounds remaining were also displayed on the screen. Selecting either the single or double choice in the GDT was used as the measure of risky betting in this study.

Japanese Version of the Gambling Symptom Assessment Scale

The Gambling Symptom Assessment Scale (GSAS; Kim et al., 2009) assesses the following gambling symptoms during the previous week: urges, thoughts, gambling behavior, excitement, distress, and personal trouble. The present study employed the Japanese version of the GSAS (GSAS-J; Yokomitsu & Kamimura, 2019), and as with the original, participants responded using a five-point Likert scale to indicate the extent to which they agreed with each item. Higher scores indicated severer gambling symptoms: 8–20, mild gambling symptoms; 21–30, moderate gambling symptoms; 31–40, severe gambling symptoms; 41 or more, extreme gambling symptoms (classification based on Kim et al., 2009). In this study, the total scale demonstrated high internal consistency ($\alpha = 0.93$).

Japanese Version of the Gambling Urge Scale

The Gambling Urge Scale (GUS; Raylu & Oei, 2004b) assesses an individual's gambling urges. The six-item Japanese version of the GUS (GUS-J; Tanaka et al., 2017) was used in the present study. As with the original GUS, participants responded using a seven-point Likert scale to indicate the extent to which they agreed with each item. Higher scores indicated stronger gambling urges. The GUS-J has good internal consistency ($\alpha = 0.88$) and good convergent validity (correlation coefficient with the SOGS-J: $r = 0.55$; Tanaka et al., 2017).

Japanese Version of the Gambling Related Cognitions Scale

The Gambling Related Cognitions Scale (GRCS; Raylu et al., 2004a, b) assesses gambling-related cognitions. The present study employed the 23-item Japanese version (GRCS-J; Yokomitsu et al., 2015). As with the original GRCS, participants responded using a seven-point Likert scale to indicate the extent to which they agreed with each item (1 = *does not apply at all* to 7 = *fairly applicable*). Higher scores indicated a higher number of cognitive

distortions. The total GRCS-J has good internal consistency (α = 0.94) and good convergent validity (correlation coefficient with SOGS-J: r = 0.61; Yokomitsu et al., 2015).

Japanese Version of the NEO Five Factor Inventory

The NEO Five Factor Inventory (NEO-FFI) measures personality characteristics based on the five-factor theory and comprises 60 items across five subscales: neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness. The reliability and validity of the Japanese-version NEO-FFI have been confirmed, with a previous study showing high reliability for the five subscales (α = 0.86 − 0.92; Shimonaka et al., 1999). Reliability was also good in the present study (neuroticism: α = 0.89, extraversion: α = 0.83, openness to experience: α = 0.70, agreeableness: α = 0.68, and conscientiousness: α = 0.83). This scale was used to control for personality trait variance.

Statistical Analysis

Analyses were conducted using IBM SPSS version 26 and up-to-date R software (R Foundation for Statistical Computing, Vienna, Austria). Descriptive statistics were presented as means and standard deviations (SD) for each variable. Linear mixed modeling (LMM) was used to examine the effects of the presence of and cooperation with others for risky betting in a laboratory-based gambling task among high-risk gamblers. In the analysis, the dependent variable was risky betting in the GDT. Independent variables were the conditions (solo, parallel, and cooperation) as fixed-effect variables; participants as a random-effects variable; and gender, age, number of gambling days, amount of money spent on gambling, and GSAS, GUS, GRCS (gambling expectancy, perceived inability to stop gambling, illusion of control, predictive control, and interpretative bias), and NEO-FFI scores. No missing values were included in the analyses. As a post-hoc analysis, the number of times each option was chosen (single, double, triple, and quadruple choice) was analyzed in the same way as the primary outcome. For all tests, significance (two-tailed) was inferred at $p < 0.05$. For all analyses, statistical significance was set at $p < 0.05$.

We also visually plotted the relationship between gambling severity during the past year for the pair who participated in the experiment together and participants' risky betting and examined the trends of these relationships.

Sample Size

In the design of this study, no prior sample size was determined prior to the experiment. Due to research funding constraints, the maximum number of participants was set at 40.

Results

Demographic Characteristics

Table 1 shows participants' demographic data and gambling behaviors. Of the 40 participants, 50% ($n = 20$) were men and 50% ($n = 20$) were women. Mean participant age was 46 years (SD = 12.80; range = 25–69).

Table 1 Participant demographics ($n = 40$)

	n (%)
Gender	
Men	20 (50.0)
Women	20 (50.0)
Age	
Means (SD)	46.00 (12.80)
20–29	5 (12.5)
30–39	8 (20.0)
40–49	11 (27.5)
50–59	8 (20.0)
60–69	8 (20.0)
Occupation	
Business owner	1 (2.5)
Managing post	4 (10.0)
Clerical work	10 (25.0)
Technical job	4 (10.0)
Sales staff	4 (10.0)
Service industry	3 (7.5)
Self-employed business	2 (5.0)
Commerce and industry self-employed	3 (7.5)
Full-time homemaker	5 (12.5)
Unemployment / age-limit retirement	4 (10.0)
Education	9 (22.5)
High school (equivalent test)	5 (12.5)
Two-year and career college	
Four-year college	25 (62.5)
Graduate school	1 (2.5)
Income (a month)	
< 100,000 JPY	7 (17.5)
100,000–199,999	5 (12.5)
200,000–299,999	3 (7.5)
300,000–399,999	4 (10.0)
400,000–499,999	4 (10.0)
500,000–599,999	9 (22.5)
600,000–699,999	3 (7.5)
700,000–799,999	3 (7.5)
900,000–999,999	1 (2.5)
1000,000–1500,000	1 (2.5)
Allowance (a month)	
10,000–19,999	1 (2.5)
20,000–29,999	7 (17.5)
30,000–39,999	2 (5.0)
40,000–49,999	5 (12.5)
50,000–59,999	6 (15.0)
60,000–69,999	1 (2.5)

Table 1 (continued)

	n (%)
70,000–79,999	3 (7.5)
80,000–89,999	4 (10.0)
90,000–99,999	5 (12.5)
100,000–150,000	4 (10.0)
150,000–	2 (5.0)
Marital status	
Married	14 (35.0)
Experience of divorce and/or bereavement	24 (60.0)
Single	2 (5.0)

Types of Gambling and Consulting Behaviors

Of the participants, 80% ($n=32$) played the lottery, 75% ($n=30$) bet on horse races, and 52.5% ($n=21$) were pachinko players. Only one participant had a history of treatment (Table 2).

Gambling-Related Variables

In the full sample, the mean PGSI score was 7.38 (SD = 5.44). The mean of the number of days participants had gambled and amount of money they had spent on gambling during the previous month were 5.80 (SD = 5.69) days and 32,210 (SD = 47,441.81) JPY, respectively. The mean scores of the GRCS, GUS, and GRCS were 13.03 (SD = 8.87), 13.65 (SD = 8.13), and 77.30 (SD = 25.26), respectively (Table 3).

Table 2 Participant's types of gambling and consulting behaviors ($n=40$)

	n (%)
Types of gambling	
Horse races	30 (75.0)
Keirin (bicycle races)	10 (25.0)
Motorboat races	9 (22.5)
Motorcycle race	8 (10.0)
Slot machines (not online)	16 (40.0)
Pachinko	21 (52.5)
Casino (not online)	3 (7.5)
Foreign eXchange	5 (12.5)
Lottery (loto, numbers, etc.)	32 (80.0)
Toto (sport betting)	16 (40.0)
History of treatment	
Self-help group	1 (2.5)
Doctor	1 (2.5)

Table 3 Descriptive statistics about gambling related variables and personality

	Mean (SD)	Zeroth quartile	First quartile	Median	Third quartile	Forth quartile
PGSI	7.38 (5.44)	3.00	4.00	5.50	9.00	27.00
Gambling day	5.80 (5.69)	0	2.00	4.50	8.00	25.00
Amount of money	32,210 (47,441.81)	0.00	3000.00	20,000.00	38,750.00	200,000.00
GSAS	13.03 (8.87)	0	7.25	11.00	17.75	41.00
GUS	13.65 (8.13)	6.00	8.00	10.50	16.75	36.00
GRCS						
Total	77.30 (25.26)	28.00	65.25	75.00	88.00	134.00
Gambling expectancy	14.93 (4.91)	4.00	12.00	15.00	18.00	24.00
Perceived inability to stop gambling	13.05 (7.75)	5.00	7.00	13.00	14.75	34.00
Illusion of control	12.45 (5.25)	4.00	8.00	12.50	15.75	24.00
Predictive control	22.18 (5.39)	11.00	18.25	22.00	25.75	34.00
Interpretative bias	14.70 (5.77)	4.00	10.25	15.00	18.00	26.00
NEO-FFI-						
Neuroticism	25.50 (8.45)	4.00	18.25	26.00	31.75	40.00
Extraversion	25.93 (5.47)	15.00	22.25	26.00	30.75	36.00
Openness	29.45 (5.09)	21.00	25.25	29.50	33.75	41.00
Agreeable	29.53 (6.55)	8.00	25.25	31.50	34.00	42.00
Conscientiousness	30.10 (5.88)	15.00	26.25	30.00	35.25	40.00

Differences in the Dependent Variable Among Conditions

Table 4 shows the means and SD for risky and non-risky behaviors during the GDT. As shown in Table 5, the LMM results indicated that when we controlled for previously specified covariates, there were no significant differences found among the solo, parallel, and cooperation conditions regarding risky betting (parallel condition: estimates = 0.10, SE = 0.79, p = 0.900; cooperation condition: estimates = 0.95, SE = 0.79, p = 0.232). Furthermore, for post-hoc analyses, the LMM results showed a significant

Table 4 Descriptive statistics of risky and non-risky behaviours on the game of dice task

	Sole condition Mean (SD median Skewness, Kurtosis	Pararell condition Mean (SD median Skewness, Kurtosis	Cooperation condition Mean (SD median Skewness, Kurtosis
Risky beting	3.00 (5.33)	3.10 (5.25)	3.95 (6.32)
	0.00	1.00	0.50
	1.94, 2.64	1.97, 2.87	1.55, 0.91
Safety betting	15.00 (5.33)	14.90 (5.25)	14.05 (6.32)
	18.00	17.00	17.50
	− 1.94, 2.64	− 1.97, 2.87	− 1.55, 0.91
Types of betting			
Single	0.20 (0.69)	0.38 (1.01)	1.33 (4.02)
	0.00	0.00	0.00
	4.72, 25.00	3.32, 12.02	3.84 14.46
Double	2.80 (5.19)	2.73 (4.78)	2.63 (4.66)
	0.00	1.00	0.00
	2.11, 3.47	2.21, 4.11	1.99, 2.97
Triple	5.83 (4.94)	4.95 (4.73)	4.47 (5.15)
	6.00	4.00	3.00
	0.56, − 0.36	0.58, − 1.10	1.31, 0.99
Quadruple	9.18 (6.54)	9.95 (6.09)	9.57 (7.19)
	10.00	9.00	12.00
	− 0.50, − 1.39	− 0.04, − 1.32	− 0.29, − 1.57
Wins	9.93 (2.17)	10.60 (2.52)	9.80 (2.98)
	10.00	11.00	10.00
	− 0.54, 0.54	− 0.01, − 0.69	− 1.03, 0.78
Lossess	8.07 (2.17)	7.40 (2.52)	8.20 (2.98)
	8.00	7.00	8.00
	0.54, 0.54	0.01, − 0.69	1.03, 0.78
Net_score	12.00 (10.66)	11.80 (10.50)	10.10 (12.65)
	18.00	16.00	17.00
	− 1.94, 2.64	− 1.19, 2.87	− 1.55, 0.91
Score	592.50 (1447.97)	957.50 (1270.55)	− 105.00 (3415.27)
	1000.00	1300.00	1100.00
	− 1.82, 3.14	− 1.19, 1.17	− 2.55, 6.58

Table 5 The results of linear mixed model

Measurements	Risky betting			Single choice			Double choice			Triple choice			Quadruple choice		
	estimate	SE	p	estimate	SE	p	estimate	SE	p	estimate	SE	p	estimate	SE	p
Fixed effect															
Intercept	−14.78	12.05	.234	−6.07	4.62	.203	−8.71	10.25	.406	−2.67	9.95	.791	35.45	13.62	.017*
Sex	−1.51	2.01	.461	−0.41	0.77	.596	−1.10	1.71	.528	−1.30	1.65	.441	2.81	2.26	.229
Age	0.02	0.08	.816	0.02	0.03	.595	0.00	0.06	.973	−0.08	0.06	.195	0.07	0.09	.450
PGSI	0.24	0.19	.237	0.03	0.07	.667	0.20	0.16	.230	0.09	0.19	.576	−0.33	0.22	.150
Gambling days	−0.02	0.20	.938	−0.02	0.08	.782	0.01	0.17	.974	−0.08	0.17	.620	0.01	0.23	.666
Amount of money	0.00	0.00	.791	0.00	0.00	.634	0.00	0.00	.922	−0.00	0.00	.332	0.00	0.00	.631
GSAS	−0.13	0.20	.512	0.08	0.08	.311	−0.21	0.17	.225	−0.16	0.16	.323	0.30	0.22	.198
GUS	−0.06	0.20	.779	−0.06	0.07	.427	0.01	0.17	.976	−0.04	0.16	.800	0.10	0.22	.665
GRCS-GE	0.32	0.34	.353	0.06	0.01	.637	0.26	0.29	.377	0.33	0.28	.246	−0.66	0.38	.102
GRCS-IS	0.09	0.26	.728	−0.01	0.10	.281	0.20	0.22	.372	0.19	0.22	.399	−0.28	0.29	.358
GRCS-IC	0.15	0.26	.578	−0.01	0.13	.950	0.16	0.22	.496	0.13	0.22	.573	−0.27	0.30	.369
GRCS-PC	0.50	0.36	.177	0.08	0.14	.566	0.42	0.31	.182	−0.30	0.30	.325	−0.20	0.41	.622
GRCS-IB	−0.30	0.28	.308	0.01	0.11	.929	−0.31	0.24	.218	0.20	0.23	.412	0.10	0.32	.756
Caluculation_probability	−1.08	2.40	.658	−0.12	0.09	.896	−0.96	2.04	.644	0.49	0.20	.806	0.58	0.27	.831
Caluculation_expectation	−0.35	1.85	.850	0.71	0.70	.326	−1.07	1.57	.505	−0.20	1.53	.892	0.56	0.21	.790
Neuroticism	−0.06	0.16	.716	0.01	0.06	.890	−0.07	0.13	.625	0.06	0.13	.658	−0.00	0.18	.998
Extraversion	−0.18	0.21	.407	0.05	0.08	.578	−0.23	0.18	.226	−0.06	0.18	.752	0.24	0.24	.337
Openness	0.31	0.21	.175	0.03	0.08	.733	0.28	0.19	.149	−0.01	0.18	.937	−0.29	0.25	.249
Agreeable	0.21	0.16	.214	0.04	0.08	.481	0.16	0.14	.250	0.14	0.13	.317	−0.35	0.18	.074
Conscientiousness	−0.11	0.22	.615	−0.02	0.08	.796	−0.09	0.18	.634	0.24	0.18	.201	−0.13	0.25	.612
Pararell condition	0.10	0.79	.900	0.18	0.52	.739	−0.08	0.60	.900	−0.88	0.84	.303	0.78	0.93	.406
Cooperation condition	0.95	0.79	.232	1.13	0.53	.035*	−0.18	0.60	.770	−1.35	0.84	.114	0.40	0.93	.668
Random effect	variance	*SD*		variance	*SD*		variance	*SD*		variance	*SD*		variance	*SD*	
Intercept	16.40	4.05		1.18	1.08		12.48	3.53		9.25	3.04		20.48	4.53	
Residual	12.46	3.53		5.50	2.35		7.15	2.67		14.24	3.77		17.20	4.15	

* $p < .05$

difference between the solo and cooperation conditions regarding the number of single choices (parallel condition: estimates = 0.18, SE = 0.52, p = 0.739; cooperation condition: estimates = 1.13, SE = 0.53, p = 0.035). However, the LMM results showed no significant differences among the three conditions regarding the number of double, triple, and quadruple choices.

Gambling Severity During the Previous Year and Risky Betting

Figure 2 plots the changes in risky betting during the parallel and cooperation conditions compared to the solo condition for each participant, classified according to the gambling severity of the pair. The left and right sides of Fig. 2 show increases or decreases in risky behavior in the parallel and cooperation conditions compared to the solo condition for each individual and classified by the severity of gambling for the experimental pairs, respectively.

Discussion

The present stratified cross-over randomized controlled trial found that the presence of or cooperation with others did not decrease risky betting in the GDT among high-risk gamblers. However, the post-hoc analysis demonstrated that more participants selected the single choice, which was the riskiest betting behavior in the GDT, in the cooperation condition, compared with the solo condition. Therefore, the findings of the present study did not support the hypotheses that risky betting in the parallel and cooperation conditions would be less than that in the solo condition.

The present study's unexpected findings suggest that the cooperation condition may promote riskier gambling behavior. The kurtosis of single choice was lower in the cooperation condition than in the solo condition, meaning that more participants were located at the peak of the distribution in the solo condition than in the cooperation condition. This indicates that the behavior of participants in the solo condition was more homogeneous than in the cooperation condition with respect to the single choice, and that, on average, participants tended to make fewer single choices in the solo condition.

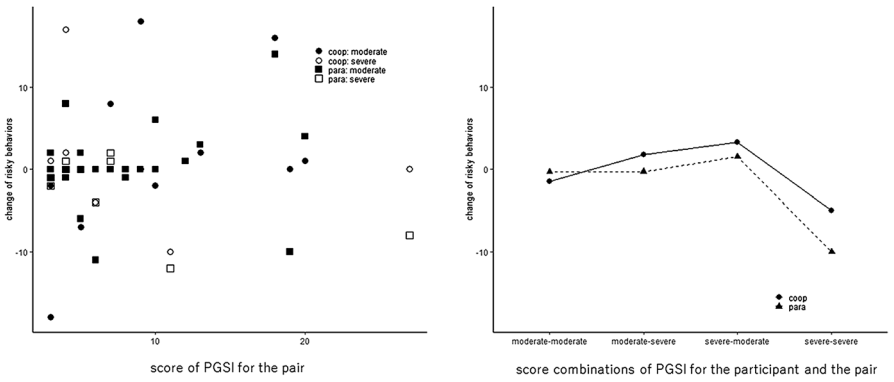

Fig. 2 The relationship between participants' risky behavior and gambling severity in each pair

Regarding in prior studies but promoted it in this study, the content of the comparison condition different between this study and previous studies. The previous study (Lemoine & Roland-Lévyet, 2017; Rockloff & Greer, 2011) examined the effects of gambling in situations where others were around but did not examine changes in gambling behavior when gambling together in the presence of others, as in this study. Lemoine and Roland-Lévy (2017) conducted an experiment to examine the effect of an audience's presence on risk-taking behavior while gambling. Participants were randomly allocated to one of our three conditions (they played alone which is similar to the solo condition in our study, while being observed by the experimenter, or while being observed by the experimenter and being videotaped). Participants in that study were observed by the experimenter under two observation conditions (Lemoine & Roland-Lévy, 2017). In addition, Rockloff and Greer (2011) also compared gambling behaviors (e.g., bet size and bet speed) under three conditions in which participants played while they were alone, observed by six people, or observed by 26 people, thereby varying the number of people observing the participant. Thus, prior studies seem to place importance on the "observation" variable. However, in our study, rather than using "observation" as a variable, we examined the influence of the "presence of others" in the parallel condition, where people were only next to others who were also gambling, and in the cooperation condition, where people were told to combine their final scores with others, in addition to consulting and conducting the experiment while having a conversation. It is possible that these procedural differences between this study and previous studies may have led to the discrepancy in findings. In an interview survey of gamblers (Flores-Pajot et al., 2021), it is suggested that the presence of others led them to spend more time or money gambling. On the other hand, this previous study showed that social influences have the potential to both promote and discourage gambling behavior. Therefore, whether others function as a risky facilitator of gambling behavior or a brake on it may vary from gambler to gambler. Therefore, in the future, it is necessary to consider the relationship between the presence of others and gambling not only through an experimental examination of gambling with others as in this study, but also through a quantitative survey on how gamblers think about the presence of others. Furthermore, a post-hoc visual-plotted analysis showed that risky betting was reduced in the parallel and cooperation conditions, compared with the solo condition, for pairs with higher severity of problem gambling symptoms. In the future, we would like to examine under what conditions gambling behavior would be reduced by conducting the experiment again with pairs with higher severity of problem gambling symptoms and higher scores for gambling-related variables.

In addition, regarding why the presence of others inhibited risky betting in prior studies but promoted it in this study, it is possible this may have been caused by the task used. While the present study used the GDT, previous studies have used tasks such as roulette (Lemoine & Roland-Lévy, 2017) and gambling machines (slots) shown on a computer screen (Rockloff & Greer, 2011). Social inhibition (i.e., reduced individual performance in the presence of others), has been studied in the context of social psychology. It has been suggested that a well-trained task (i.e., a familiar task) promotes social facilitation, whereas a complex task involving novel responses suppresses social facilitation. The fact that the task we used in this study was a novel task for participants may have led to different results from those obtained in the previous context of social inhibition. Therefore, it is important to examine this issue in the future using tasks similar to those in previous studies or that are familiar to gamblers (e.g., actual gambling machines).

Limitations

This study's first limitation is that the participants were gamblers recruited through an Internet survey, who were paid an honorarium to participate; thus, this study was not conducted in a real-world context. In addition, the fact that the rewards were predetermined amounts may have influenced participants' motivation with respect to scoring high on the GDT. In other words, the participants in this study was "high-risk gamblers interested in research methods." An gambling in a real gaming venue, in contrast, may tend to be more or less encouraging of risky or intense betting by the rewards resulting from betting or real-time behavior and consultation with others, and thus might produce different outcomes.

Furthermore, the experiment was conducted using the GDT rather than an actual gambling task. Donati et al. (2019) reported that the GDT showed no relationship with gambling severity or gambling frequency, suggesting that it may not identify problem gamblers. Therefore, it is important to examine the effects of the presence of and cooperation with others on gambling behaviors by using machines and locations used for gambling in the real world, such as pachinko parlors and racetracks.

Finally, this study was conducted without a pre-designed sample size due to budget constraints. It is important that the next study be conducted with a pre-designed sample size using the effect sizes obtained in this study.

Conclusion

Despite its limitations, this study asked participants about, and controlled for, variables that potentially influence gambling behavior, including cognitive distortion and gambling urges. To our knowledge, this experiment was the first to examine the effects of the presence of and cooperation with others while, and is therefore the first step in a series of studies on this topic. We found that neither the presence of nor cooperation with others decreased risky betting in the GDT among high-risk gamblers. However, from post-hoc analyses, we demonstrated that participants displayed the riskiest betting behavior (i.e., selecting the single choice) in the GDT during the cooperation condition, relative to the solo condition.

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Author Contributions KY made substantial contributions to the conception of the study. KY, MK, and TT designed the study, and KY and TT contributed to the acquisition of data. KY drafted the work and substantively revised it. All authors read and approved the final manuscript.

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Availability of Data and Materials The datasets generated by the survey research during and/or analyzed during the current study are available in the OSF repository, https://osf.io/4fwc6/."

Declarations

Conflict of interest KY had received an honorarium from a for-profit company promoting integrated resorts in Japan and abroad, and had advised them on their efforts to prevent gambling addiction from April, 2019 to March, 2020. KY has also received honoraria from domestic tobacco companies to advise on research on tobacco products and psychology from June, 2021. In addition, KY was employed by Cureapp Corporation to work on an application development project for the prevention of alcoholism from January, 2019 to June, 2021.

Consent for Publication Not applicable.

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