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Social Facilitation Among Gamblers: A Large-Scale Study Using Account-Based Data

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Abstract

Previous research suggests that the presence of other gamblers in a gambling venue intensifies individual gambling behavior. To study such potential social facilitation among gamblers, we conduct a large-scale analysis of more than one million gambling sessions using player tracking data of the Norwegian gambling operator *Norsk Tipping*. In particular, we empirically assess the existence and strength of this facilitation, and how it manifests in differently utilized gambling venues. In our study, we control for (i) each individual's co-gamblers (frequent vs. occasional co-gamblers) and for (ii) the magnitude of individual's social participation (social seeking vs. social avoiding gamblers). We find that gamblers stake more money and play longer sessions the more crowded the venues get and that social avoiding gamblers gamble more when they play with their most-frequent co-gambler. Interestingly, our results strongly indicate that social avoiding gamblers are more susceptible to social facilitation than gamblers who are familiar with crowded gambling venues. Overall, our research is the first large-scale study of social facilitation among gamblers introducing a novel framework to empirically measure this effect. We believe that our work will have important practical implications for both gambling behavior researchers as well as the gambling industry in designing and evaluating responsible gambling tools.

Introduction

Gambling is a wide spread form of recreation and a possibility to socialize with other people (McNeilly and Burke 2001; Bernhard, Dickens, and Shapiro 2007). The way gamblers socialize varies from the sheer presence of other gamblers (i.e., sharing the same physical environment) to their interaction with friends. In the past, social psychological research has shown that the presence of others can influence human performance (Zajonc 1965; Rajecki et al. 1977; Guerin 1986). This effect is known as *social facilitation*.

To date, relatively little is known about social facilitation in gambling. In particular, there are few initial controlled laboratory studies examining social facilitation among gamblers. These studies suggest that individuals who play in the presence of others engage in more risky gambling behavior (Rockloff and Dyer 2007; Rockloff, Greer, and Fay 2011; Cole, Barrett, and Griffiths 2011; Molde et al. 2017). Currently, due to the lack of a systematic approach to measure social facilitation using player tracking data there are no empirical studies of this social effect. However, we believe that quantifying how gamblers influence each other in real-world settings represents an important stepping stone towards better understanding of potentially harmful and addictive gambling behavior. In turn, improved understanding of problematic gambling behavior will support the development of tools for responsible gambling (e.g., personalized messaging, mandatory play breaks, loss-limits, or loss-limit reminders), potentially curbing harmful gambling behavior.

Consequently, to address this problem, we aim to answer the following research questions (RQs) in this paper:
RQ1 (*Operationalization*): How can we operationalize social facilitation and what is its effect on gambling behavior?
RQ2 (*Utilization*): How does the strength of social facilitation depend on the utilization of the gambling venue?
RQ3 (*Co-Gambling Network*): How do frequent co-gamblers influence individual gambling behavior?
RQ4 (*Social Participation*): How does the strength of social facilitation depend on individual gambler's experience in playing with others?

We answer these research questions with a large-scale analysis of player account-based gambling data provided by Norway's national gambling operator *Norsk Tipping*. Within the scope set by our research questions, we operationalize social facilitation as the utilization of the gambling venue. Subsequently, we empirically analyze gambling behavior of social seeking gamblers (familiar at gambling in crowded gambling venues) and social avoiding gamblers (typically playing in absence of others) at different degrees of utilization and co-gambling frequencies.

We find a significant increase in gambling behavior for both social seeking and social avoiding gamblers due to social facilitation. This effect grows with an increasing utilization of the venue. Furthermore, we find that social avoiding gamblers are more susceptible to social facilitation and therefore to an increase in gambling behavior, especially when gambling with their most-frequent co-gamblers.

With our work we make three important contributions. First, we introduce a novel framework to empirically measure social facilitation among gamblers. Second, with our large-scale empirical study of social facilitation utilizing *Norsk Tipping* player tracking data, we go beyond the few

published studies, which mainly comprise small-scale controlled laboratory studies. Third, we derive suggestions for researchers and the gambling industry on how to improve the design and evaluation of responsible gambling tools.

Privacy, Ethics and Disclosure Ethical approval for the study was given by the research team's university ethics committee. This paper uses data of Norways national gambling operator *Norsk Tipping*. The dataset was accessed via secured databases, and the data was de-identified and no personally identifiable information was used. While we acknowledge the benefits, we also recognize the potential abuses, risks and ethical consequences of this type of research and expand on these aspects in the Discussion section.

Further Related Work

Social Facilitation in Gambling In the past, a few controlled studies evaluated whether social facilitation among gamblers exists (Rockloff and Dyer 2007; Rockloff, Greer, and Fay 2011; Cole, Barrett, and Griffiths 2011; Molde et al. 2017). These studies showed that individuals who play in the presence of others place more bets, lose more money, and make more risky bets. However, one of the main drawbacks of these studies is the limited number of participants ($N = 116$, $N = 135$, $N = 38$, and $N = 136$, respectively). We extend this line of research with a large-scale analysis of gamblers in Norway utilizing player account-based gambling data provided by *Norsk Tipping*.

An analysis of the effects of the size of gambling venues on individual gambling behavior (Sagoe et al. 2018) showed that individuals place more bets, spend more time and money per session in venues with two or more terminals. The authors note that one limitation of their study is the assumption that the number of terminals in a venue is a good proxy for the number of gamblers in the venue. We address this limitation in the present study by introducing a measure that captures the presence of other gamblers in the venue.

Research also suggests that the presence of a lively atmosphere may affect individual gambling behavior (Griffiths and Parke 2003). The authors mention that the presence of gambling friends may lead to increased risk-taking, skill level, and play time. In this study, we attempt to validate these observations by using the co-gambling frequency as a measure to approximate friendship between individuals.

Blurring Line between Offline and Online Gambling While our analysis involves individuals who share the same physical environment, there is also evidence that social facilitation occurs when the presence of other individuals is virtual (Rafaeli and Noy 2002). A pilot study with 38 participants aimed to bridge the gap between online and offline gambling and found that online roulette players who gambled in the physical presence of others placed the highest number of chips per bet and made the riskiest bets (Cole, Barrett, and Griffiths 2011). In addition, a study with 810 participants showed that offline gambling in combination with online gambling significantly increased the negative impacts (e.g., mental/physical health, finances or quality of life) both in terms of the number and intensity of the impacts (Papineau et al. 2018). In our study we have a similar setup where gamblers can play a variety of games (e.g. Roulette or Black Jack) on an electronic gaming machine (EGM) in the physical presence of other players in an online-like manner (i.e., these games are not physically played with other gamblers but on an EGM). Therefore, we contribute to this research with a large-scale analysis of real-world gamblers using player tracking data to enhance our understanding of potentially problematic gambling behavior.

The Role of Communities in Gambling Previous literature suggests that social factors contribute to the initiation and maintenance of gambling (Hope and Havir 2002; Neighbors et al. 2002; Reith and Dobbie 2011). In particular, a social network analysis of 40 frequent gamblers found that especially pathological gamblers tend to be closer with other gamblers (i.e., homophily), which may reinforce addictive behaviors (Meisel et al. 2013). A more recent study interviewed 784 gamblers and found that both gambling behavior and gambling-related harm normalizes through social connections (Russell, Langham, and Hing 2018).

Such social connections also exist online, for example, in the form of discussion forums where gamblers talk about gambling strategies or gambling problems. Although participation in online forums that discuss gambling problems can help individuals to cope with their problems (Rodda et al. 2018; Sirola et al. 2020), studies using survey data showed that participation in more generic gambling forums (e.g., sharing gambling experiences or gambling tips) correlates with problem gambling (Sirola, Kaakinen, and Oksanen 2018; Howe et al. 2019).

Gambling elements are also increasingly used in the gaming industry (King et al. 2015; Zendle and Cairns 2018), as well as in social networks (i.e., in the form of social network games) (Jacques et al. 2016). Researchers analysed the key motivations to play such games and found that social influence is the most important determinant of continuous intention to use such games (Xu 2014).

We contribute to this stream of research, which mainly consists of surveys, with a large-scale analysis of gambling behavior in different social settings (i.e., frequent co-gamblers and degree of social participation).

Methodology

Dataset Description

In this study, we analyze data of Norway's national gambling operator (*Norsk Tipping*). *Norsk Tipping* is the state-owned gambling company and offers lottery games, online casino games, sports-betting and land-based EGMs. The game outcomes on EGMs are not computed on the machines themselves, but on a centralized server. One prominent type of EGM *Norsk Tipping* operates is *Multix*, located in kiosks, gas stations, pubs, bars, and cafes across the country. These EGMs offer casino games, card games and skill games. The gambling venues include a varying number of EGMs ranging from one to eleven per location. *Norsk Tipping* requires each gambler to have a player account and gamblers can only play on EGMs after identifying with a player card. The

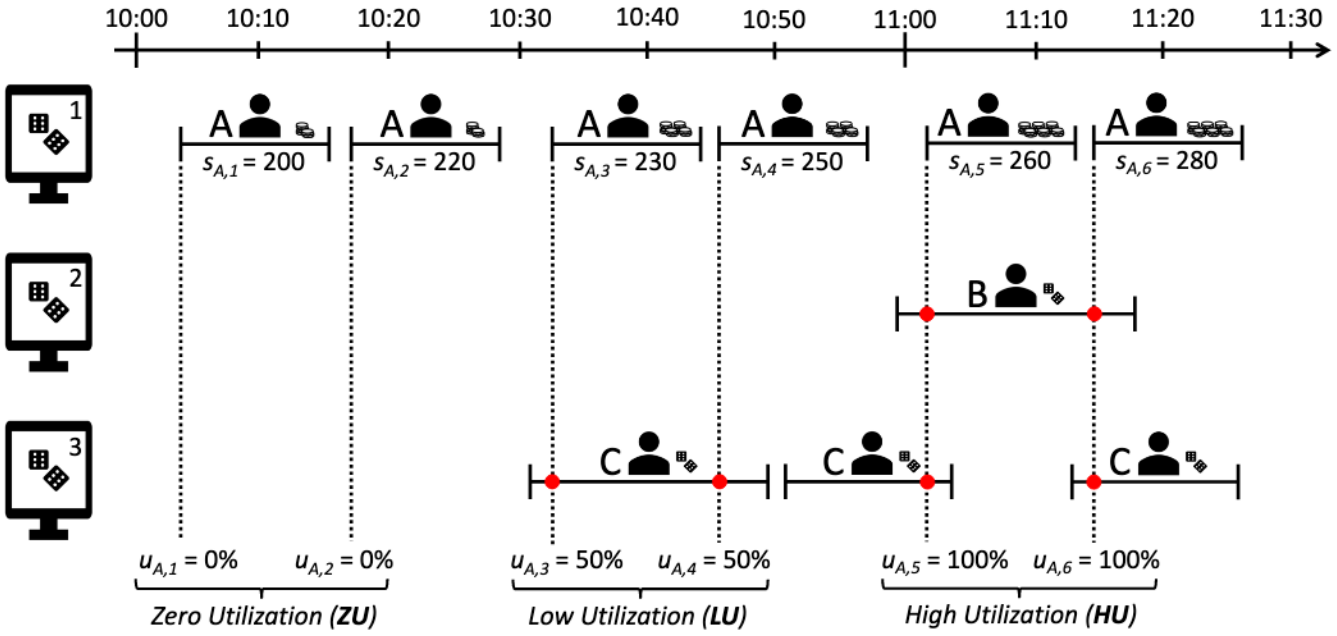


Figure 1: A framework to operationalize our measurements of social facilitation among gamblers. In this example, we consider a gambling venue with three electronic gaming machines (EGMs). We analyze the gambling behavior of `Gambler A`, who plays in total $k = 6$ sessions with the stakes $s_{A,k}$. To calculate the utilization $u_{A,k}$, we count the number of gamblers who play on the remaining two EGMs when `Gambler A` starts to gamble (dotted line). For example, `Gambler A` begins to play sessions 3 and 4 in the presence of `Gambler C`, therefore $u_{A,3} = u_{A,4} = 1/2 = 50\%$. We discretize u into three degrees of utilization, namely zero utilization (*ZU*, i.e. $u_{A,k} = 0\%$), low utilization (*LU*, i.e. $0\% < u_{A,k} \leq 50\%$), high utilization (*HU*, i.e. $u_{A,k} > 50\%$) and assign the stakes $s_{A,k}$ to the corresponding degrees of utilization using the vectors $\boldsymbol{s}_A(u)$ — i.e. $\boldsymbol{s}_A(ZU) = (200, 220)$, $\boldsymbol{s}_A(LU) = (230, 250)$ and $\boldsymbol{s}_A(HU) = (260, 280)$.

identification allows to keep track of each individual's gambling behavior.

Our dataset comprises all active *Multix* players which placed at least one bet between February and May 2018. In total, it contains 2 898 320 gambling sessions from 61 134 gamblers. A gambling session starts when a player inserts their player card and ends when the player card is extracted. The data contains information about each individual's in-session gambling behavior including stake, win, and time spent gambling during each session.

Preprocessing To compare gamblers who were registered during the whole observation period, we remove all gamblers who registered after February 2018. Next, to reduce noise (e.g., sporadic gamblers) we only analyze gamblers with at least 25 sessions during the whole period. Finally, as we focus on the analysis of social facilitation we remove all locations with a single EGM from the dataset and keep only gamblers who gambled at least two times alone and two times together with other gamblers. After these steps, we are left with 7 608 (12.3%) gamblers who played 1 178 096 (39.8%) sessions in the observation period. We also experimented with slightly differing thresholds. The results suggest that minor changes to the proposed thresholds yield statistically but not practically relevant differences.

Preliminaries

In this work, we propose a framework to assess social facilitation among gamblers. We operationalize social facilitation by measuring the utilization of the EGMs in the venue while individuals gamble. In Figure 1 we show an illustrative example highlighting the design of our framework.

Motivation vs. Facilitation (RQ1) One simple way to calculate the utilization while an individual gambler plays is to count the number of other individuals who gamble at the same time (henceforth, we will refer to gamblers playing at the same time as *co-gamblers*). However, this measure is potentially prone to confounders. Namely, the longer individuals gamble, the higher the probability that they gamble in the presence of others in at least one point in time. For example, gamblers who play very long sessions may likely cross paths with a large number of other players. This issue is a typical instance of survival bias or selection effects. Previous research has shown that survival bias can influence causal inference (Brown et al. 1992; Barbosa et al. 2016). Consequently, such metrics make it difficult to distinguish between intrinsic gambling motivation and social facilitation among gamblers.

To control for the survival bias, we thus propose an alternative measure. Instead of counting the number of co-gamblers during the whole gambling session, we only count the number of co-gamblers who are present at the start of an

individual's gambling session. Since the session start is an instantaneous event, our measure does not suffer from the survival bias. In Figure 1, we show an example of counting the co-gamblers for `Gambler A` at a session k. Therefore, this measure approximates the utilization of the venue during gambling and forms the basis for relating individual differences among gamblers with the social facilitation.

Utilization (RQ2) Another factor to consider is the number of EGMs in the different locations. For example, an individual who gambles with another gambler in a small location with only two EGMs might experience stronger social facilitation then when they gamble in a location with ten EGMs. Therefore, we define the *relative utilization* of the remaining gambling terminals as the final measure to operationalize social facilitation. In Figure 1, we show how to calculate the relative utilization $u_{A,k}$ for `Gambler A` in a venue with three EGMs. Each EGM represents one row in the figure and the columns represent time. `Gambler A` plays on EGM 1 and has six sessions between 10:00 and 11:30. For example, at the start of `Gambler A`'s sessions 5 and 6, `Gambler B` and `C` gamble on the remaining two EGMs leading to a fully utilized venue ($u_{A,5} = u_{A,6} = 2/2 = 100\%$).

Next, we discretize utilization in a finite number of *utilization degrees*. A naive consideration of co-gambling as the measure of utilization degree (i.e., marking all sessions as a high degree of utilization whenever $u_{A,k} > 0\%$ and as zero utilization otherwise), has a potential to introduce artifacts in differently-sized venues. Therefore, in the absence of an empirical basis on how to categorize the utilization without introducing such artifacts, we use a pragmatic approach and set the cut-off value for the categorization of the utilization at 50%. Therefore, we introduce three utilization degrees and analyze the gambling behavior for zero utilization, utilization smaller or equal to 50%, and for utilization larger than 50%. In other words, we analyze the difference in gambling behavior when gambler i gambles alone ($u_{i,k} = 0\%$), when gambler i gambles with a few other gamblers ($0\% < u_{i,k} \leq 50\%$) and when gambler i gambles with many other gamblers in crowded venues ($u_{i,k} > 50\%$). We label these three degrees as zero utilization (*ZU*), low utilization (*LU*) and high utilization (*HU*). Finally, we simplify the notation and refer to the three discretized degrees of utilization as u across gamblers and sessions.

Co-Gambling Network (RQ3) To investigate how frequent co-gamblers influence individual gambling behavior we construct and analyze a co-gambling network. In this network, each player represents a node and two nodes are connected if they co-gambled at least once. We utilize co-gambling frequency to determine the edge weight. Using this network, we introduce two *co-gambling degrees* f. First, when individuals gamble in the presence of their most-frequent co-gambler (*MF*), and second when they gamble in the presence of all other co-gamblers, which we call occasional co-gamblers (*OC*). Note that we experimented with a slightly differing threshold (i.e., two most-frequent co-gamblers vs. all other co-gamblers). Our results suggest that minor changes to the proposed threshold yield statistically but not practically relevant differences. We hypothesize that most-frequent co-gamblers induce stronger social facilitation on individuals.

Social Participation (RQ4) We further analyze whether social facilitation has different effects on players depending on the degree of their social participation. For that reason, for each gambler we operationalize social participation by calculating the fraction of sessions in which the gambler co-gambled. For example, `Gambler A` in Figure 1 gambled 4 out of 6 sessions (66.6%) with others. We subsequently categorize gamblers in two groups according to the median of this measure across all players. We term individuals above the median as *social seeking (SS)* gamblers, and individuals below the median as *social avoiding (SA)* gamblers. We hypothesize that individuals spending more time gambling with others are more likely to experience social facilitation.

In Table 1, we report the cut-off values for the two social participation groups and the median values of the median in-session gambling behavior. Social avoiding gamblers (*SA*) played less than 60% of their sessions with others with a median stake of 380 NOK in 6 minutes. In contrast, social seeking gamblers (*SS*) played more than 60% of their sessions with others with a median stake of 428 NOK in 6.6 minutes. Thus, social avoiding gamblers (*SA*) play significantly shorter sessions (statistically significant with U-test: $p < 0.001$) and stake significantly less per session (statistically significant with U-test: $p < 0.001$) compared to social seeking gamblers (*SS*). However, there is no significant difference between the two social participation groups in terms of gambling velocity (i.e., stake per minute).

In this study, we conduct all our experiments related to RQ1, RQ2, and RQ3 separately for these two social participation groups of gamblers, which renders our RQ4 orthogonal to the other three research questions. Therefore, we integrate the results and discussion of RQ4 directly into the sections dealing with RQ1, RQ2, and RQ3.

Social Facilitation

Detecting Social Facilitation For each individual i in the two social participation groups (*SA* and *SS*), we build a vector $\boldsymbol{s}_i(u)$ that contains all the stakes gambled in a given degree u of utilization. For example, `Gambler A` in Figure 1 plays two sessions in each degree of utilization. We assign the stakes of the sessions to the corresponding degrees of utilization using the vectors $\boldsymbol{s}_A(u)$ — more specifically, $\boldsymbol{s}_A(ZU) = (200, 220), \boldsymbol{s}_A(LU) = (230, 250)$ and $\boldsymbol{s}_A(HU) = (260, 280)$.

Analogous to the definition of position (i.e., gambling stake), time and velocity in physics, we introduce two further quantities and the corresponding vectors to capture gambling time and gambling velocity. We name those two vectors $\boldsymbol{t}_i(u)$ and $\boldsymbol{v}_i(u)$, where the gambling velocity ($\boldsymbol{v}_i$) is the element-wise division of the two vectors containing the stakes ($\boldsymbol{s}_i$) and gambling time ($\boldsymbol{t}_i$). Out of simplicity, we refer to these three vectors as gambling behavior $\boldsymbol{g}_i \in \{\boldsymbol{s}_i, \boldsymbol{t}_i, \boldsymbol{v}_i\}$. Using these vectors, we calculate an indicator variable $X_i(LZ)$, which indicates whether gambler i gambles more when playing with a few others (*LU*) as com-

Social Participation Group	*SA*	*SS*
Gamblers	3 799	3 809
Total # of sessions	605 502	520 636
Median # of sessions	114	100
Median stake (NOK)	380	428
Median time (minutes)	6	6.6
Median stake per minute	69.2	67.7
Min. % sessions co-gambled	8%	60%
Median % sessions co-gambled	46%	73%
Max. % sessions co-gambled	60%	98%

Table 1: Descriptive statistics of gamblers categorized into two groups according to the median of the fraction of sessions they gambled with others. We report median values of the median in-session gambling behavior for both groups. Overall, social avoiding individuals (*SA*) play significantly shorter sessions (U-test: $p < 0.001$) and stake significantly less per session (U-test: $p < 0.001$) compared to social seeking individuals (*SS*). In terms of gambling velocity (stake per minute), there is no significant difference between the two social participation groups.

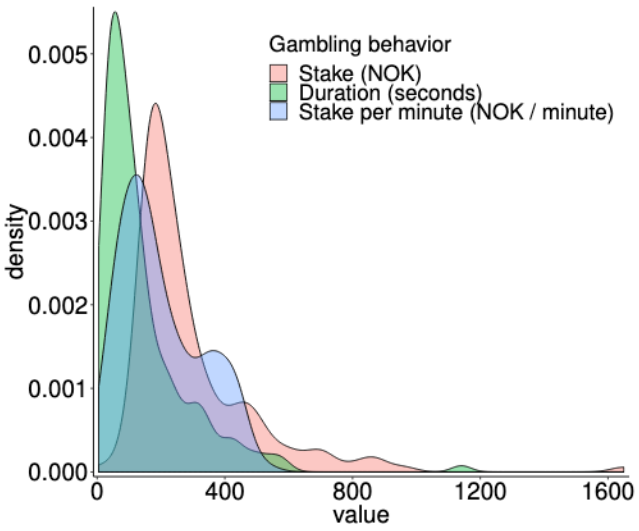


Figure 2: Gambling behavior distribution of a randomly selected gambler. It shows the right-skewed distribution of in-session stake, time and velocity (stake per minute).

pared to gambling alone (*ZU*). We formalize this as follows:

$$X_i(LZ) = \mathbb{1}_{median(\boldsymbol{g}_i(LU)) > median(\boldsymbol{g}_i(ZU))}, \quad (1)$$

where $\mathbb{1}$ is an indicator function, which evaluates to 1 if individual i gambles more in *LU* compared to *ZU*, and to 0 otherwise. *LZ* denotes the two degrees of utilization that we compare (i.e. $\boldsymbol{LU} > \boldsymbol{ZU}$).

Similar to this variable, we introduce two further indicator variables $X_i(HZ)$ and $X_i(HL)$, comparing whether individuals increase their gambling behavior when gambling with many others (*HU*) as compared to gambling alone (*ZU*), and whether they gamble more when playing with many others (*HU*) as compared to gambling with a few others (*LU*) respectively. We use the median for comparison due to the right-skewed distribution (cf. Figure 2) of the in-session stake ($\boldsymbol{s}_i$), time ($\boldsymbol{t}_i$) and gambling velocity ($\boldsymbol{v}_i$). For all three variables, a value of one indicates an increase, and a value of zero a decrease (or no change) in gambling behavior when playing in higher degrees of utilization. The null model states that there is no observable effect caused by the utilization of the venue, which means that when an individual plays at higher degrees of utilization, an increase in gambling behavior is just as likely as a decrease. This is equivalent to flipping a fair coin for each individual and metric of gambling behavior. To capture these binary indicators, we propose using $Bernoulli$ random variables, as their sums also have closed-form solutions (i.e., $Binomial$ random variables), which in turn allow exact statistical tests and fast inference. Therefore, the null model for all three indicator variables follows the following $Bernoulli$ distribution:

$$X_i(LZ), X_i(HZ), X_i(HL) \sim Bernoulli(p = 0.5) \quad (2)$$

For each group of social participation P (i.e., *SS* and *SA*), we summarize the outcome of each indicator variable as:

$$E(P, c) = \sum_{i \in P} X_i(c) \sim Binomial(n, p = 0.5), \quad (3)$$

where n is the number of gamblers in each social participation group, and c one of the three comparisons (*LZ*, *HZ*, *HL*). We then estimate p with the sample proportion ($\hat{p} = E/n$) and test whether we can reject the null hypothesis ($p = 0.5$) by performing exact binomial test for each social participation group. Finally, we perform Z-tests to evaluate if the observed proportions between gamblers in the two groups of social participation are different. We use the Bonferroni correction to compensate for the $m = 9$ tests (see Table 2).

Measuring Social Facilitation To measure the overall strength of social facilitation, we compute the relative change in gambling behavior as follows:

$$r_G(u) = \frac{median(G(u))}{median(G(ZU))} \quad (4)$$

In the above formula, $G(u)$ represents a vector which contains the gambling behavior $\boldsymbol{g}_i$ of all individuals played in the degree u of utilization. Note that G characterizes gambling behavior in terms of in-session stake, time, and velocity. We calculate $r_G(LU)$ and $r_G(HU)$ to measure the relative change in gambling behavior when gambling in the two degrees *LU* and *HU* compared to gambling alone (*ZU*).

Finally, within the two degrees *LU* and *HU* we calculate two further ratios to measure the influence of most-frequent co-gamblers (*MF*) and occasional (*OC*) co-gamblers:

$$r_G(u, f) = \frac{median(G(u, f))}{median(G(ZU))}, \quad (5)$$

where $G(u, f)$ contains the gambling behavior of all individuals gambled in the utilization degree u and co-gambling degree f. Using this definition, we compare gambling behavior for four different combinations of utilization and co-gambling degrees relative to the behavior when individuals gamble alone ($G(ZU)$). The first two

combinations include individuals co-gambling with their most-frequent co-gambler in a low or high utilized venue ($G(LU, MF), G(HU, MF)$), and the remaining two combinations include gamblers who play together with occasional co-gamblers in a low or high utilized venue ($G(LU, OC), G(HU, OC)$).

To measure variability in the strength of the influence, we bootstrap, with 10 000 repetitions, all gamblers and their sessions within each group of social participation. For each repetition, we calculate the ratio of the median in-session behavior as described in Equations 4 and 5. From the resulting bootstrap distribution, we compute 95% confidence intervals for the median value of each random sample of sessions.

Results

Existence of Social Facilitation

The first two sub-tables in Table 2 show the fraction of gamblers within each social participation group who gamble more during co-gambling compared to gambling alone. In both social participation groups there are a significant number of players who experience social facilitation and therefore play longer sessions and spend more money per session. Although individuals decrease their gambling velocity during co-gambling, we observe that the highest proportion of individuals who play longer sessions ($\hat{p}_t = 62.3\%$) and place higher stakes ($\hat{p}_s = 59.5\%$) in total are social avoiding gamblers at the highest degree of utilization (cf. $\hat{p}$ for $c = \boldsymbol{HZ}$). Regarding RQ1, these findings indicate a strong effect of social facilitation among gamblers, and in particular among social avoiding gamblers.

Except for social seeking gamblers (*SS*) in the *HU* degree, more gamblers experience social facilitation by playing longer sessions than staking more money (Z-test for both groups in $c = LZ : p < 0.001$ and Group *SA* in $c = HZ : p < 0.01$). Column $SA > SS$ in Table 2 shows that social avoiding gamblers (*SA*) are more susceptible to gamble longer sessions, which leads to a decrease in gambling velocity compared to social seeking gamblers (*SS*)[1]. This finding is contrary to our initial expectations in RQ4 that individuals who typically frequently gamble with others (i.e., *SS* gamblers) are more prone to social facilitation. Summarizing, a significant amount of gamblers experience social facilitation and therefore play longer, stake more money in total, but decrease their gambling velocity.

Strength of Social Facilitation

Impact of Utilization We further analyze the strength of the social facilitation and its dependence on the degrees of utilization (RQ2) and start with a short inspection of the third sub-table of Table 2, which compares the gambling behavior between the high and low degree of utilization. We observe here that for a significant number of gamblers social facilitation grows with an increasing degree of utilization.

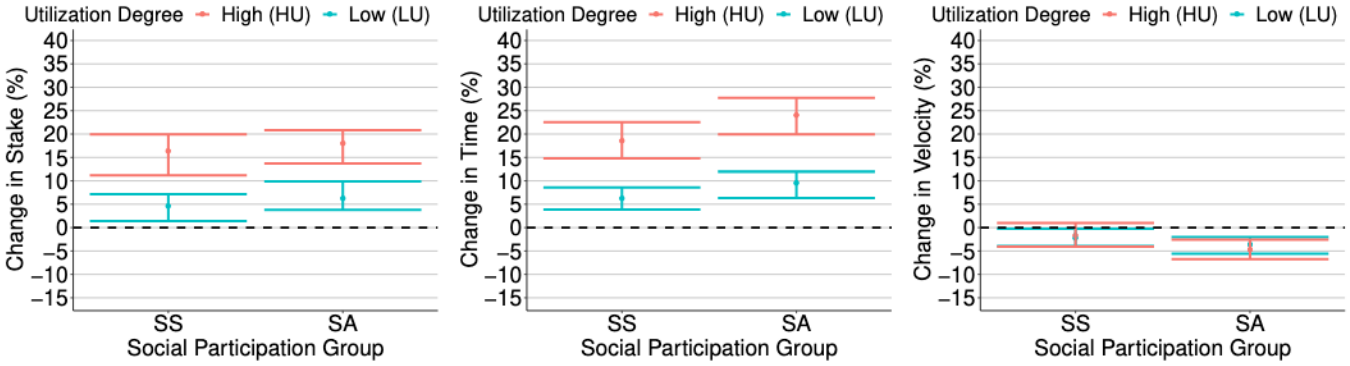
Continuing our analysis we illustrate in Figure 3 the bootstrapped distribution of the relative change between the median in-session behavior when gambling with others compared to gambling alone. It shows the median change of 10 000 random samples with the 95% bootstrap confidence interval (CI). Except for the gambling velocity of social seeking individuals in the *HU* degree (cf. – for *SS* in Figure 3c), the CIs for both social participation groups and degrees of utilization do not intersect with the horizontal line at zero. This indicates that there is a strong social facilitation leading to a significant increase in gambling behavior.

In line with the results from Table 2, both the increase in stakes and gambling time are significantly larger for the high degree of utilization than for the low degree (cf. – *HU* and – *LU* in Figure 3a and 3b). In particular, social avoiding gamblers (*SA*) experience the strongest effects of social facilitation and increase their stakes by 18.1% [13.7%, 20.8%] and their gambling time by 24% [19.9%, 27.7%]. While there is no significant difference between the two social participation groups (RQ4), we observe a trend that social avoiding individuals (*SA*) gamble more due to social facilitation than social seekers (*SS*). Due to the overlap of the CIs in Figure 3c, there is no significant difference in the gambling veloc-

Group	*SA*	*SS*	$SA > SS$
$\hat{\boldsymbol{p}}$ for $c = \boldsymbol{LZ}$:			
$\hat{p}_s$	55.8%***	52.8%**	-
$\hat{p}_t$	60.2%***	56.5%***	**
$\hat{p}_v$	43.2%***	46.3%***	-
$\hat{\boldsymbol{p}}$ for $c = \boldsymbol{HZ}$:			
$\hat{p}_s$	59.5%***	56.8%***	-
$\hat{p}_t$	62.3%***	58.6%***	**
$\hat{p}_v$	41.0%***	45.4%***	***
$\hat{\boldsymbol{p}}$ for $c = \boldsymbol{HL}$:			
$\hat{p}_s$	55.2%***	55.1%***	-
$\hat{p}_t$	55.6%***	55.7%***	-
$\hat{p}_v$	45.6%***	48.5%	-

Table 2: Estimated proportion ($\hat{\boldsymbol{p}}$) of social avoiding (*SA*) and social seeking (*SS*) gamblers who gamble more due to social facilitation. The first two sub-tables divided by a horizontal rule show the proportion of gamblers who increase their in-session stake (s), time (t), and velocity (v) while gambling in the low (*LU*) and high (*HU*) degree of utilization as compared to gambling alone (*ZU*). We abbreviate these two comparisons c with ***LZ*** (i.e., $\boldsymbol{LU} > \boldsymbol{ZU}$) and ***HZ*** (i.e., $\boldsymbol{HU} > \boldsymbol{ZU}$). The last sub-table shows the proportion of gamblers who gamble more in the high degree of utilization as compared to the low degree (i.e., $\boldsymbol{HU} > \boldsymbol{LU}$). Column $SA > SS$ indicates that *SA* gamblers are more susceptible to gamble longer sessions due to social facilitation, which leads to a decrease in gambling velocity compared to *SS* gamblers[1]. Overall, we observe that at higher degrees of utilization and thus under stronger social facilitation, individuals overall stake more money over a longer period of time, even if they reduce their gambling velocity. We report significance at * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ after Bonferroni correction.

[1]Note that, as the magnitude of $\hat{p}_t$ is greater than that of $\hat{p}_s$, we check for the statistical significance of $SA < SS$ in the $\hat{p}_v$ measure.



(a) Relative Change in Stake (b) Relative Change in Gambling Time (c) Relative Change in Gambling Velocity

Figure 3: Relative change in gambling behavior for social seeking (*SS*) and social avoiding (*SA*) gamblers due to social facilitation. The plots show the bootstrapped change in gambling behavior when playing in high (*HU*) and low (*LU*) utilized venues as defined in Equation 4. Here and in subsequent plots, error bars show 95% bootstrap confidence intervals. Overall, we observe individuals in higher degrees of utilization gamble significantly higher stakes over a longer duration.

ity between the two degrees of utilization. In summary, we observe that social facilitation among gamblers exists and significantly increases with higher degrees of utilization.

Impact of Frequent Co-Gamblers Figure 4 shows the bootstrapped distribution of the change between the median in-session behavior when gambling with the most-frequent and occasional co-gamblers within the degrees of utilization compared to gambling alone. Similar to Figure 3, it shows the median change of 10 000 random samples with the 95% bootstrap CI. In line with the results in Figure 3a and 3b, within a degree of co-gambling, the increase in stakes and gambling time are significantly larger for the high degree of utilization than for the low degree.

Regarding RQ3, we observe that social avoiding gamblers (*SA*) stake significantly more when they gamble with their most-frequent co-gambler compared to gambling with occasional co-gamblers (cf. – *HU-MF* and – *HU-OC*, as well as – *LU-MF* and – *LU-OC* in Figure 4a). More specifically, social avoiding gamblers (*SA*) stake 31.9% [25.9%, 38.1%] more and gamble 30.5% [24.4%, 35.6%] longer when playing with their most-frequent co-gambler in crowded venues (cf. – *HU-MF* in Figure 4a and 4b). Furthermore, social avoiding gamblers (*SA*) stake significantly more than social seekers (*SS*), when they play with their most-frequent co-gambler (cf. – *HU-MF* and – *LU-MF* between *SS* and *SA* in Figure 4a). This finding indicates that social avoiding gamblers are more likely to gamble more due to social facilitation compared to social seeking gamblers (RQ4). In summary, most-frequent co-gamblers exert significantly stronger social facilitation on social avoiding gamblers.

Discussion

In this study, we investigate the effects of social facilitation among gamblers by analyzing player account-based data at different degrees of utilization and co-gambling frequencies. Our results consist of three main findings. First, social facilitation among gamblers exists and grows with an increasing utilization of the venue, resulting in higher stakes and longer sessions, although the gambling velocity reduces. Second, most-frequent co-gamblers exhibit stronger social facilitation upon social avoiding gamblers than occasional co-gamblers do. Third, while we find that both groups exhibit susceptibility to social facilitation, social avoiding gamblers appear to be more susceptible to such facilitation than gamblers who are more familiar with crowded gambling venues.

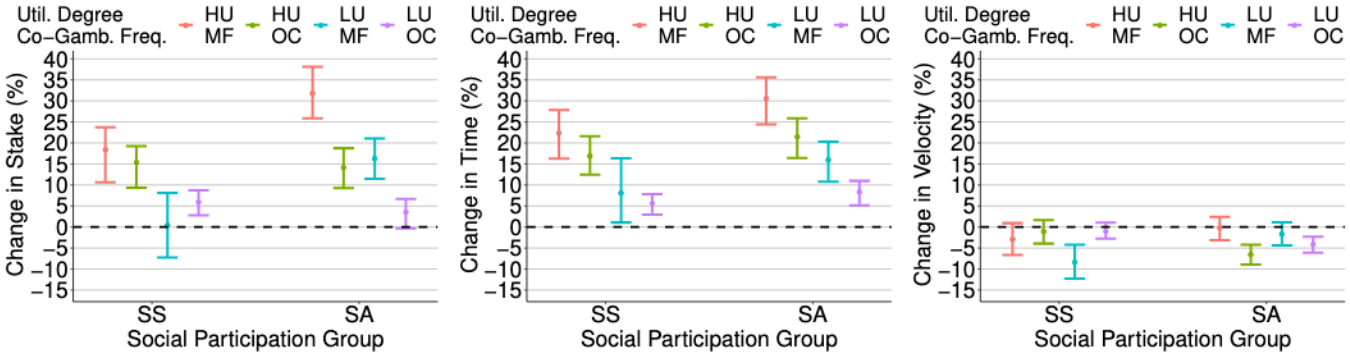
Utilization and Social Facilitation

We found that a significant number of individuals play longer sessions and increase their stakes when they gamble with others. This effect becomes stronger in higher degrees of utilization. Therefore, we empirically validated the findings of laboratory studies which reported that gamblers place more bets, lose more money, and make riskier bets in the presence of others (Rockloff and Dyer 2007; Rockloff, Greer, and Fay 2011; Cole, Barrett, and Griffiths 2011). Furthermore, we found that a significant number of individuals decrease their gambling velocity when they gamble with others. This result is in line with a controlled study that showed that participants who play alone place their bets on average faster than participants who play with others (Molde et al. 2017).

Responsible gambling tools could leverage these findings and adapt the duration of the mandatory play breaks depending on the current utilization of the venue. We suggest incorporating venue utilization as a potential confounder in ongoing analyses (Auer, Hopfgartner, and Griffiths 2019a) of the effect of mandatory play breaks in gambling behavior.

Frequent Co-Gamblers and Social Facilitation

Our findings indicate that most-frequent co-gamblers exhibit stronger social facilitation on social avoiding gamblers, leading to an increase in both stakes and play time. Assuming that co-gambling frequency correlates with potential friendships between gamblers, this finding is in line with the



(a) Relative Change in Stake (b) Relative Change in Gambling Time (c) Relative Change in Gambling Velocity

Figure 4: Relative change in gambling behavior for social seeking (*SS*) and social avoiding (*SA*) gamblers due to social facilitation of frequent co-gamblers. The plots show the bootstrapped change in gambling behavior when playing in four different combinations of utilization and co-gambling degrees (*HU-MF*, *HU-OC*, *LU-MF*, *LU-OC*) as defined in Equation 5. *SA* gamblers stake significantly more when playing with the most-frequent co-gambler compared to gambling with occasional co-gamblers (cf. *HU-MF* and *HU-OC*, as well as *LU-MF* and *LU-OC*). Further, *SA* gamblers stake significantly more than *SS* gamblers when gambling with their most-frequent co-gamblers (cf. *HU-MF* and *LU-MF*). These findings indicate that most-frequent co-gamblers exhibit significantly stronger social facilitation on social avoiding gamblers.

observations of a study suggesting that the presence of gambling friends may influence gambling behavior and lead to increased risk-taking, skill level, and play time (Griffiths and Parke 2003). A recent study examining the importance of friends and family in gambling also showed that the proportion of friends and family gambling regularly was the second strongest discriminator of at-risk gambling after gambling related variables (Mazar et al. 2018). Furthermore, a survey of Australian gamblers showed that influences from people within an individual's social network can shape their gambling behavior through normalization, and for those in higher risk networks, also normalize gambling-related harm (Russell, Langham, and Hing 2018).

Regarding responsible gambling tools, future work should analyze the spread of tool features (e.g. loss-limit setting behavior) across the co-gambling network. We believe that usage of such tools also normalizes within such networks. Such network information could be used to customize personalized messaging (i.e., feedback concerning individual gambling behavior in the form of text messages) by including normative feedback from the co-gambling network.

Social Participation and Social Facilitation

Our findings indicate, that gamblers from the social seeker group develop a stronger resilience to social facilitation due to their increased experience of gambling with many others, while social avoiding gamblers do not. This finding contradicts our initial expectations that social avoiders gamble less due to social facilitation, because the psychological literature suggests that social avoiders (i.e., individuals with a negative orientation towards social presence) experience performance impairment under social presence (Uziel 2007) and avoid taking risks due to fear of social embarrassment (Taylor, Laposa, and Alden 2004; Association et al. 2013).

Further, our results corroborate the findings of a study which found that gamblers playing on EGMs are less likely to play alone as opposed to traditional gamblers (i.e., gamblers who play table poker, card games, roulette or similar games in a casino) (Bernhard, Dickens, and Shapiro 2007). In particular, we find that in our data the median value of the fraction of gambling sessions that individuals play with others is 60%. In other words, 50% of the gamblers in our dataset play at least 60% of their sessions in the presence of others indicating a strong tendency of playing in company of other gamblers. Moreover, we observe that the gambling velocity decreases while the gambling time increases when individuals gamble in the presence of others. One potential explanation for this could be that individuals socialize while gambling.

We suggest to take into account whether the gambler is a social seeker or a social avoider while evaluating the existing responsible gambling tools, as well as to incorporate this information in future interventions to avoid harmful gambling and to improve the well-being of gamblers.

Ethical Implications

Despite the potential to improve existing responsible gambling tools as highlighted above, there are important ethical implications associated with the implementation of such quantitative analyses in practice. Therefore, we discuss now possible (unintended) negative consequences of our work. In particular, while understanding how different social settings influence the gambling behavior may contribute to the development of better tools helping gamblers to understand their own behavior, it can also be (mis)used to make venues more addictive. However, both qualitative and quantitative research suggests that corporate social responsibility, in particular a commitment to responsible gambling programs is closely related to customer satisfaction (Kim et al. 2017; Abarbanel, Cain, and Philander 2018; Auer, Reiestad, and

Griffiths 2020) and that the usage of such tools increases players' loyalty to the gambling operator (Auer, Hopfgartner, and Griffiths 2019b). For that reason, it may be not only more ethical, but also more sustainable to use the findings from our paper responsibly. Nevertheless, we suggest further research to identify and mitigate such possible unintended implications of the work.

Limitations

We assumed that the number of co-gamblers present at the start of a session is a good proxy for the utilization of the venue. However, this measure does not capture the cases where shortly after the start of a session another person stops or starts to gamble on another EGM. We investigated the number of sessions where another person starts or stops gambling within one minute after the start of the session and found that they are almost equal. Therefore, we conclude that the effect induced by other players who immediately start or stop gambling after the start of the session exists in both directions and affects nearly the same number of sessions. Alternatively, we could define a time window around the start of the session where we count the number of gamblers present. However, following the *Occam's razor*, we opt for a simpler measure as we cannot assess whether gamblers leave the gambling venue immediately after finishing their gambling session nor we can evaluate whether they start to gamble instantly when they enter the gambling venue.

Moreover, our categorization for the degree of utilization of the remaining gambling terminals was pragmatic due to the absence of a recommendation in current literature. However, changing our 50% threshold to 40% or 60% thresholds does not qualitatively alter our results and interpretations.

The unavailability of the demographic data, in particular gender and age is another limitation of our study. Previous literature indicates that men take more risks (Byrnes, Miller, and Schafer 1999), are more socially anxious than women, and that such attributes are related to more problems with gambling (Wong et al. 2013). Without data on gender, we could not evaluate whether gambling reflects such previous findings and whether a higher proportion of men gamble alone and are therefore potentially more susceptible to social facilitation.

Further, although our dataset combines sessions with various game types (i.e., casino games, card games and skill games), information about the specific game type was absent from our data. Previous literature suggests that there are inherent differences between game types with respect to the risk factors for problem gambling (Welte et al. 2007; LaPlante et al. 2011; Scalese et al. 2016). Information about the different games played would enable us to assess the degree to which the range of gambling involvement in these games influences the gambling behavior. For example, we could assess whether individuals who play a broader range of games also play longer sessions and therefore more frequently in the presence of others. We see the inclusion of gender, age, game types and the range of involvement in these games as a promising avenue of future work.

Finally, Norway's legal regulations on loss and play time limits could have influenced our findings. Such limits imply less extreme gambling behavior, and, as such, our estimations may be conservative. Future work could take into account the effects of these play and loss limits as well as other responsible gambling tools.

Conclusion

In this work, we introduced a novel framework for measuring social facilitation among gamblers and presented the first large-scale study of this effect across Norwegian gamblers. We found significant differences in gambling behavior due to social facilitation. In particular, gamblers stake more money and play longer sessions the more crowded the venues get. Moreover, social avoiding gamblers wager more when they play with their most-frequent co-gambler. Finally, we found that social avoiding gamblers are more susceptible to social facilitation than gamblers who are familiar with crowded venues.

In our study, we highlighted the challenge of distinguishing between intrinsic gambling motivation vs. social facilitation and how to overcome this challenge. Knowing how the utilization of a venue and frequent co-gamblers influence gamblers facilitates the improvement of the design and evaluation of responsible gambling tools. We believe incorporating information about the current utilization of a venue and a gambler's co-gambling network into responsible gambling tools may potentially help individuals to better control and understand their own gambling behavior.

In future studies, we plan to analyze how the usage of responsible tools (e.g., loss-limit setting behavior) spreads across the co-gambling network. Also, assessing whether there are influential gamblers who motivate other individuals to gamble more represents an interesting direction for subsequent studies. We also believe that investigating different mandatory play break duration depending on the current utilization of the venue is an important avenue for the future research. Finally, analyzing data from gambling operators from other countries would shed more light on how our results here generalize across various gambling populations.

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