Responsible provision of online gambling

Effects, usability and gamblers’ experiences of protective measures implemented in online gambling environments

Ekaterina Ivanova
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Abstract

Problem gambling is considered a public health problem in many countries and is associated with serious financial and health-related harms for both problem gamblers and significant others. It is possible to create gambling environments that would promote sustainable gambling behaviors and prevent excessive gambling. However, research on the effectiveness of tools for responsible provision of gambling is scarce and the quality of the research is low. Also, there exists a conflict of interest between making a profit when providing gambling and protecting vulnerable customers. The general aim of the project was to study the effects, usability and gamblers’ experiences of tools for responsible provision of online gambling. Study I evaluated the effects of a prompt to set voluntary deposit-limit of optional size among 4,328 customers of an online gambling platform. During the data collection period, all customers from Finland registering an account on the gambling platform were randomized into being prompted to set a deposit-limit either 1) at-registration, 2) before their first deposit, 3) after their first deposit or 4) to an unprompted control group. Gambling intensity, measured with aggregated net loss, was tracked during 90 days after registration. No differences in gambling intensity between the intervention and control groups were found neither on the whole-group level (B (95% CI) = -0.080 (-0.229-0.069), p = .291), nor in the subgroup of the most involved gamblers (B (95% CI) = 0.042(-0.359-0.442), p = .838).

Study II aimed at predicting gaming freeze (as a proxy parameter for problem gambling) in online gamblers. For the sample of N=2,618 (N=1,309 freezers), a total of 105 predictors were created based on the data tracked by the gambling platform. The analysis was carried out using the machine learning method Random Forest. The predictive accuracy of the model applied to the dataset was 0.615, with a specificity of 0.686 and a sensitivity of 0.543. Study III aimed at investigating non-problem gamblers’ experiences of protective measures. A total of N=10,200 active customers of an online gambling platform were asked to rate their previous experiences of protective tools, their inclination to abandon a gambling service due to perceived overexposure to protective measures and answer questions on their symptoms of problem gambling. N=1,223 responded to the questionnaire, with the majority of the sample being moderate-risk gamblers (38.5%), followed by low-risk gamblers (26.8%), non-problem gamblers (18.9%) and problem gamblers (15.8%). In general, non-problem gamblers were not more disturbed by protective measures than other categories of gamblers. More problem gamblers have previously abandoned a gambling service due to perceived overexposure to protective measures compared to non-problem gamblers (OR(95% CI)= 7.17(3.61-14.23), p < .001). In conclusion, a prompt to set a voluntary deposit-limit of optional size did not appear to be effective in decreasing gambling intensity in online gamblers, indicating the need of evaluating alternative designs. Predicting gaming freezes in the current project resulted in a low accuracy, indicating that gaming freeze is not suitable as a proxy measurement for problem gambling and suggesting the need for collecting subjective data on symptoms of problem gambling. The results of Study III suggest that protective measures can be tested and implemented without the risk of disturbing recreational gamblers.

Keywords: Problem gambling, responsible gambling, responsible provision of gambling, deposit limit, prediction of gambling problems, experiences of responsible gambling tools, attitudes towards responsible gambling tools, online gambling.

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Department of Psychology

Stockholm University, 106 91 Stockholm
RESPONSIBLE PROVISION OF ONLINE GAMBLING
Ekaterina Ivanova
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To all the giants who let me stand on their shoulders
Abstract

Problem gambling is considered a public health problem in many countries and is associated with serious financial, psychological, health-related and other harms for both the person engaging in excessive gambling and significant others. Based on psychological theories of human behavior and experimental studies, it is possible to create gambling environments that would promote sustainable gambling behaviors and prevent excessive gambling to some extent. Data collected in online gambling environments can potentially be used to analyze objective gambling behaviors to identify at-risk gamblers and evaluate the effects of protective measures. However, research on the effectiveness of tools for responsible provision of online gambling is very scarce and the quality of existing research is low. One likely reason for that is that there exists a clear conflict of interest between making a profit when providing gambling services (applies to both governments and the gambling industry) and protecting vulnerable customers. The general aim of the current thesis was to study the effects, usability and gamblers’ experiences of tools for responsible provision of online gambling. Study I evaluated the effects of a common pre-commitment tool – a prompt to set voluntary deposit-limit of optional size – among 4,328 customers of an online gambling platform. During the data collection period, all customers from Finland registering an account on the gambling platform were randomized into being prompted to set a deposit-limit either 1) at-registration, 2) before their first deposit, 3) after their first deposit or 4) were placed in an unprompted control group. Gambling intensity, measured with aggregated net loss, was tracked during 90 days after registration. The results show that the customers in the prompted groups were more likely to set a deposit limit compared to the control group. Gambling intensities in the three intervention groups were considered equal (Bayes Factors of the alternative hypothesis over the null hypothesis under 0.33), and they were pooled together to be compared with the control group. No differences in gambling intensity were found neither on the whole-group level (B (95% CI) = -0.080 (-0.229-0.069), p=.291), nor in the subgroup of the most involved gamblers (B (95% CI) =0.042(-0.359-0.442), p=.838). Study II aimed at predicting gaming freeze (as a proxy parameter for problem gambling) in customers of an online gambling service one week before the freeze occurred based on one week of gambling data. For the sample of N=2,618
(N=1,309 freezers), a total of 105 predictors were created based on the data on gambling activity tracked by the gambling platform, including intensities, frequencies, trajectories and variations for parameters reflecting monetary and time-related gambling involvement, as well as preferred gambling categories. The predictive analysis was carried out using the machine learning method Random Forest. The predictive accuracy of the model applied to the dataset was 0.615, with a specificity of 0.686 and a sensitivity of 0.543. **Study III** aimed at investigating non-problem gamblers’ experiences of and attitudes towards tools for responsible provision of online gambling. A total of N=10,200 active customers of an online gambling platform were e-mailed a link to a questionnaire, where they were asked to rate their previous experiences of protective tools, reactions to pictures of protective measures, rate their inclination to abandon a gambling service due to perceived overexposure to protective measures and answer questions on their symptoms of problem gambling. N=1,223 responded to the questionnaire, with the majority of the sample being moderate-risk gamblers (38.5%), followed by low-risk gamblers (26.8%), non-problem gamblers (18.9%) and problem gamblers (15.8%). In general, non-problem gamblers were not more disturbed by protective measures than other categories of gamblers. Problem gamblers tended to have slightly more negative reactions to the pictures of protective measures than other categories of gamblers. Problem gamblers were also more likely to abandon a gambling service due to perceived overexposure to protective measures they considered unnecessary compared to non-problem gamblers (OR(95% CI) = 7.17(3.61-14.23), p<.001). In conclusion, a common pre-commitment design (a prompt to set a voluntary deposit-limit of optional size) did not appear to be effective in decreasing gambling intensity in online gamblers, indicating that this particular design cannot be classified as a protective measure and there is a need of evaluating alternative designs. Predicting gaming-freezes in the current project achieved a relatively low accuracy, indicating that gaming freeze is not suitable as a proxy measurement for problem gambling and suggesting the need for collecting subjective data on symptoms of problem gambling and combining them with data on gambling activity in the analyses. The results of Study III suggest that protective measures can be tested and implemented without the risk of disturbing recreational gamblers or channelling them away to gambling services that lack a customer care agenda.
Problemspelande, när det handlar om spel om pengar, klassificeras som ett folkhälsoproblem i många länder och kopplas till allvarliga ekonomiska, psikologiska och hälsorelaterade risker för både personer som ägnar sig åt ohållbart spelande och personer i deras omedelbara närhet. Det är möjligt att skapa spelmiljöer som främjar hållbart spelande och förebygger problemspelande. Dessutom är det möjligt att använda data som samlas i online spelplattformar för att identifiera spelare som ligger i riskzonen för spelproblem samt för att utvärdera effekterna av skyddsverktyg. Dessvärre finns det väldigt lite forskning om effekterna av skyddsverktyg och kvalitén av den befintliga forskningen är låg. En sannolik anledning till detta är en inbyggd intressekonflikt mellan de vinster som hasardspel genererar för den som tillhandahåller dem å ena sidan (oavsett om det handlar om offentliga eller privata aktörer) och behovet att skydda spelare som kan utveckla eller har utvecklat spelproblem å andra sidan. Det aktuella projektet syftade till att studera effekterna, användbarheten samt spelarnas erfarenheter av skyddsverktyg implementerade i online spelplattformar.

Studie I utvärderade effekter av ett vanligt förekommande skyddsverktyg – en uppmuntran att sätta en gräns för hur mycket pengar man kan deponera på sitt spelkonto – hos 4328 spelare av en online spelplattform. Alla spelare från Finland som registrerade ett konto i plattformen under datainsamlingsperioden blev slumpmässigt indelade i fyra grupper. Grupp 1 fick uppmuntran att sätta en deponeringsgräns under registreringsproceduren, grupp 2 fick samma uppmuntran precis innan de skulle sätta in sin första deponering, grupp 3 fick samma uppmuntran direkt efter att de satt in sin första deponering och grupp 4 var kontrollgruppen som inte fick någon uppmuntran. Det primära utfallsmåttet var spelintensiteten, som representerades av deltagarnas nettoförlust, aggregerad under 90 dagar från registreringsdagen och framåt. Deltagarna i interventionsgrupperna satte deponeringsgräns i större utsträckning än deltagarna i kontrollgruppen. Det fanns dock inga skillnader i spelintensitet mellan de tre interventionsgrupperna (grupp 1-3) och de slogs ihop för att jämföras med kontrollgruppen. Inga skillnader i spelintensitet hitta-
des mellan den sammanslagna interventionsgruppen och kontrollgruppen varen på helgruppsnivå (B (95% CI) = -0.080 (-0.229-0.069), p=.291) eller bland de mest aktiva spelarna (B (95% CI) = 0.042(-0.359-0.442), p=.838). Ett vanligt förekommande skyddsverktyg (en uppmanan att sätta en deponeringsgräns) hade ingen effekt på onlinespelarnas spelintensitet. Detta antyder att den specifika utformningen av verktyget inte kan klassas som en skyddsåtgärd samt att det finns behov av andra skyddsåtgärder.

Syftet med studie II var att predicera frivillig avstängning från en eller flera spelkategorier (som ett indirekt mått på spelproblem) hos spelarna i en online spelplattform en vecka innan avstängningen baserat på speldata samlad under en vecka. Studien analyserade 2618 spelare (varav 1309 använde sig av själavstängningen). Totalt skapades det 105 prediktorer baserad på spelaktiviteten, inklusive spelintensitet (till exempel hur mycket pengar deponerades totalt), frekvenser (t ex hur många deponeringar gjordes per speldag), spelutveckling (exempelvis ökning/minskning i deponeringssummor) och variationer (exempelvis hur mycket spelsummorna skiljer sig från varandra). Prediktionsanalysen genomfördes med hjälp av metoden Random Forest. Modellen kunde korrekt identifiera dem som använde sig respektive inte använde sig av avstängningsverktyget med 62% noggrannhet. Den låga precisionen i den prediktiva analysen antyder att spelavstängning inte är ett passande indirekt mått för spelproblem samt att information om symtom på spelproblem behöver samlas i spelplattformar för att kunna på ett tillförlitligt sätt identifiera spelare i riskzonen för spelproblem.

Syftet med studie III var att undersöka spelares erfarenheter av och attityder till skyddsåtgärder i spelplattformar. Totalt 10 200 aktiva användare av en online spelplattform fick en länk till ett frågeformulär skickad till sin e-post där de ombods att skatta sina tidigare erfarenheter av skyddsåtgärder och sina reaktioner på bilder av vanligt förekommande skyddsåtgärder. De ombods också skatta sin benägenhet att överge en spelplattform på grund av upplevd överexponering för skyddsåtgärder samt svara på frågor om symtom på spelproblem. Totalt 1223 spelare besvarade formuläret. Den största gruppen (38,5%) hade moderat risk för spelproblem, 26,8% hade låg risk för spelproblem, 18,9% var icke-problemspelare och 15,8% var problemspelare. Icke-problemspelare stördes inte av skyddsåtgärder i större utsträckning än andra kategorier av spelare. Problemspelerare hade en tendens att vara något mer negativa till bilder på skyddsåtgärder. Dessutom har problemspelare tidigare övergett en spelplattform på grund av upplevd överexponering för skyddsåtgärder i större utsträckning än icke-problemspelare (OR(95% CI)= 7.17(3.61-14.23), p<.001). Resultatet från studie III antyder att
skyddsverktyg kan testas och implementeras i spelplattformar utan risk för att störa nöjesspelare eller för att kanalisera dem till spelföretag utan skyddsagenda.
List of publications


Abbreviations

BF – Bayes Factor
LDW – losses disguised as wins
NL – net loss
OR – odds ratio
PGSI – Problem Gambling Severity Index
RG – responsible gambling
RPG – responsible provision of gambling
TPB – theory of planned behavior
TRA – theory of reasoned action
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Introduction

Gambling and problem gambling

Gambling is an activity in which an individual wagers something of value on an event with an uncertain outcome, with a chance of winning a value higher than the one originally invested. Human beings have been gambling since the rise of the first human societies, and there is proof that gambling exists throughout the vast majority of human cultures (Schwartz, 2006). Although gambling entails a risk that the individual will lose resources, the universality of gambling indicates that it is clearly attractive. In countries for which data on gambling engagement is available, past-year prevalence in the general population ranges from 30% to 82%, with an average of 63% (Gowing et al., 2015). The global gambling industry revenue is predicted to reach 525 billion U.S. dollars in 2023 (Smith, 2018). The value of the global gambling market is expected to double between 2017 and 2024 (Statista, 2019). Considerable research has been conducted to understand individuals’ reasons to gamble despite the fact that losing money is an inherent feature of gambling. Studies have revealed a variety of gamblers’ self-reported motivations, such as a desire to win, curiosity, socializing, emotional uplift, and escape from unpleasant feelings (Coman, Burrows, & Evans, 1997; Klingemann, 1995; Neighbors, Lostutter, Cronce, & Larimer, 2002; Raghunathan & Pham, 1999; Steel & Blaszczynski, 1998). These motives have been classified by scholars in different manners, but enhancement, socializing, and coping are recurrent themes (Flack & Stevens, 2019; Lee, Chae, Lee, & Kim, 2007; Luceri & Vergura, 2015). Several psychological mechanisms have been suggested to contribute to sustained gambling. Scholars in the field of learning theory have experimentally studied possible mechanisms that prevent gambling behaviors from extinction, a process that otherwise would be expected given the infrequency of positive consequences of engaging in gambling (Ramnerö, Molander, Lindner, & Carlbring, 2019). Current evidence suggests that gamblers tend to prefer faster and smaller rewards as the time to getting a large reward increases (delay discounting) and prefer taking higher risks with a chance of receiving higher rewards despite low probability of winning (probability discount). Also, studies have found that verbal contingencies (i.e. when a relationship between a behavior and reinforcers is postulated, but never experienced, e.
g. “blue means luck”) tend to compete with actual reinforcement contingencies. Moreover, events like near wins (e.g. a slot machine showing three out of four cherries in a row) and losses disguised as wins (LDW, winning, but less than what was wagered) both seem to reinforce continued gambling, although the individual continues to lose money (Ramnerö et al., 2019). The uncertainty, or randomness, of rewards seem to play an important role in sustaining gambling (Ramnerö et al., 2019), and it has been hypothesized that the tendency to persist with behaviors with uncertain outcomes developed in early mammals as it was necessary in order to gain any rewards at all (Anselme & Robinson, 2013). The organisms did not have any control over their environment, and refraining from searching for resources, like food, in sites where they only might appear randomly would mean not getting any resources at all (Anselme & Robinson, 2013). For regular gamblers, multiple neurochemical systems are believed to be associated with gambling activities, including the systems that are related to regulating processes, such as arousal, excitement, impulse control, reward/reinforcement, pleasure/urges, stress responsiveness, and cognitive functioning (Potenza, 2013).

Gambling in general has been of particular interest to society throughout history, and its common downsides are well-known. A person engaging in excessive gambling can experience a wide range of harms: financial, psychological, health-related, cultural, harms related to economic activities and studies, relationships and criminal acts (Langham et al., 2015). For these reasons, gambling activities are typically strictly regulated and sometimes formally prohibited (Littler, 2011; Ma & Gottlieb, 2016; Nikkinen, Egerer, & Marionneau, 2018; Tan, 2012). Problem gambling — a vaguely defined term describing the phenomenon when an individual suffers negative consequences due to gambling activities (Cowlishaw & Kessler, 2016) — is recognized in all parts of the world and considered to be a public health problem in many countries (Adams, Raeburn, & de Silva, 2009; Gainsbury et al., 2014; Marshall, 2009; Sundqvist & Rendonahl, 2019). Numerous studies have shown that gambling problems tend to be associated with higher levels of impulsivity, reward-seeking, presence of erroneous cognitions and deficiencies in decision making in risky situations (Chowdhury, Livesey, Blaszczynski, & Harris, 2017; Devos et al., 2020; Kovács, Richman, Janka, Maraz, & Andó, 2017; MacLaren, Fugelsang, Harrigan, & Dixon, 2012). Also, the population of problem gamblers seems to be heterogeneous. Blaszczynski and Nower (2002) suggested a pathways model of problem gambling and described three different pathways to gambling problems. The first pathway included behaviorally conditioned gamblers, who lack any clear pre-condition to develop gambling problems, and the problems arise due to a combination of contextual fac-
tors (e.g., increased accessibility to gambling), classical and operant conditioning and erroneous beliefs about gambling. The second pathway includes emotionally vulnerable problem gamblers, who show symptoms of anxiety and/or depression prior to developing gambling problems and who gamble to modulate emotional states or meet specific psychological needs. The third pathway included “antisocial impulsivist” problem gamblers, showing signs of impulsivity, antisocial personality disorder and attention deficit (Blaszczynski & Nower, 2002). Later studies were able to identify subgroups of gamblers corresponding to the three pathways of the pathways model (Milosevic & Ledgerwood, 2010; Valleur et al., 2016).

The past-year prevalence of problem gambling worldwide in studies conducted between 2000 and 2015 ranged between 0.1% and 5.8%, but at least a part of the variation can be attributed to the different ways to measure the phenomenon (Calado & Griffiths, 2016). A psychiatric diagnosis related to gambling problems was introduced in 1980, bearing the name pathological gambling and belonging under impulse control disorders up until 2013, when the 5th edition of the Diagnostic and Statistical Manual of Mental Disorders was released and the new diagnosis of gambling disorder was introduced as the first behavior addiction (American Psychiatric Association, 2013). Gambling disorder shares important behavioral, biological, and neurochemical traits with other addictive disorders, and the reclassification is important for research on and the implementation of strategies aiming to prevent and to combat gambling-related harms (Fauth-Bühler, Mann, & Potenza, 2017). Gambling disorder is characterized by excessive gambling and preoccupation with gambling activities, development of tolerance, withdrawal symptoms, failed attempts to quit gambling as well as social and economic consequences of excessive gambling (American Psychiatric Association, 2013). Problem gambling and gambling disorder potentially lead to high socio-economic costs (Walker, 2007), are associated with a wide range of health issues (Karlsson & Håkansson, 2018; Sundqvist & Rosendahl, 2019), are more common among economically vulnerable population groups (Dowling et al., 2017), and have a considerable negative impact on significant others (Salonen, Castrén, Alho, & Lahti, 2014; Svensson, Romild, & Shepherdson, 2013). Problem gambling is more common among men than women (Merkouris et al., 2016) and younger people are at greater risk of developing gambling problems (Abbott, Romild, & Volberg, 2017). Problem gambling is highly comorbid with substance abuse disorder, mood disorders and anxiety disorders (Lorains, Cowlishaw, & Thomas, 2011). Gambling problems tend to fluctuate over short periods of time (Abbott et al., 2017). The course of development of gambling disorder is characterized by the possibility to lose large sums of money in the very beginning of
Avoiding and reducing gambling-related harms

As described above, gambling is a dual phenomenon that has existed since the dawn of human societies. It can serve functions of emotional enhancement, intellectual stimulation, socializing, and coping on the one hand, and in many cases, it is associated with considerable negative impacts on individuals and societies. Gambling is a consumer commodity, but due to its dual nature, it is not an ordinary commodity (Hellman, 2019). Providing gambling services commercially inevitably leads to a conflict of interest in which efforts to maximize revenue will stand against efforts to minimize gambling-related harms (Yani-de-Soriano, Javed, & Yousafzai, 2012). The dual nature of gambling as a commodity often makes the government a stakeholder with two conflicting roles of both a regulator (to protect vulnerable individuals) and a beneficiary of gambling generated revenues, regardless of the government being the provider of gambling services or the collector of taxes from commercial gambling operators (Adams, Buetow, & Rossen, 2010; Orford, 2009).

Efforts to avoid or to reduce gambling-related harms are made in the vast majority of jurisdictions (Williams, West, & Simpson, 2012). However, the dual nature of the gambling phenomenon can potentially lead to what could be called dummy-prevention, or efforts that are made to satisfy stakeholders interested in prevention but that do not lead to an actual reduction in excessive gambling (Hancock & Smith, 2017). The key aspect of efforts that claim to aim at avoiding and reducing gambling-related harms is not that they can be ineffective - because ineffective strategies are not specific for the field of problem gambling. The key aspect here is that the true intention with the efforts can be to make them ineffective. Existing measures against excessive gambling have been called “symbolic” and “ineffective”, and the regulatory oversight has been described as “generally anemic and ineffectual” (Hancock & Smith, 2017). These concerns should be taken into consideration when attempting to define and to evaluate strategies aiming at avoiding and reducing gambling-related harms.
Efforts to avoid or limit gambling-related harms can be referred to differently depending on who is providing the efforts, who is targeted, and what the precise purpose is. For example, the term “consumer protection” implies a view of gamblers as consumers buying a service, and protection is not necessarily limited to the harms of excessive consumption of gambling products specifically (Harmon, 2018). Consumer protection is typically not self-regulated by the industry, but a domain of supervision of public regulators (Harmon, 2018). The term “prevention of problem gambling” is more focused on the health aspects of excessive gambling, and the terms “social responsibility” and “social corporate responsibility” refer to the industry’s self-regulation beyond the domain of mandatory consumer protection (Yani-de-Soriano et al., 2012). Although the different terms imply different aspects of protection, they are quite often used interchangeably (Ariyabuddhiphongs, 2013; Griffiths, Wood, & Parke, 2009; Marianneau & Järvinen-Tassopoulos, 2017; Tetrevo & Patak, 2019), which is natural given the overlap among them. For instance, describing true odds of winning in a game can be required as a part of a correct description of a consumer product, but it can also be seen as a brief educational intervention to prevent excessive gambling. However, the lack of consensus regarding how different efforts should be classified also implies a lack of consensus in what exact purpose the efforts have and who is responsible for implementing the efforts. The first type of the efforts to be described, consumer protection, is the only effort targeting gambling as a consumer commodity, not specifically focusing on the potential harms associated with gambling as an addictive commodity.

Consumer protection

Consumer protection laws aim to protect consumers when a product or a service does not work as promised, the consumer has been overcharged or wrongly charged for an item (Harmon, 2018). Although consumer protection is applicable to gambling services, the concepts of consumer protection were developed to target the ordinary consumer commodities—not specifically to target the features that make gambling “no ordinary commodity”. Littler (2012) argues for the need of a separate legislative domain for protection of vulnerable individuals from the public health perspective:

The possibility of relying upon a consumer protection approach would then prevail for non-problem gamblers and where gambling was truly a recreational activity. Indeed, Stuyck subsequently professed the view that the ‘protection of weak citizens and protection of the public at large against health and safety hazards should be appraised on their own merits, and are not an objective of
“consumer” policy’. Extrapolating such an approach to the gambling environment, this would mean that the protection of the ‘vulnerable’ in the parlance of British legislation would probably fall outside the scope any EU-wide gambling-consumer policy. (Littler, 2012, p. 230)

According to Littler (2012), social law would be the most suitable legislative domain for regulating the protection of gamblers from harms associated with gambling as an addictive commodity. In sum, the term consumer protection can be considered inappropriate when addressing efforts aiming at reducing the harms related to gambling as an addictive commodity.

Prevention of problem gambling

Prevention of problem gambling is a domain specifically targeting harms related to gambling as an addictive commodity (Grande-Gosende, López-Núñez, García-Fernández, Derevensky, & Fernández-Hermida, 2019; Statens Beredning för Medicinsk Utredning, 2019). Efforts applied on very different levels can be labeled as preventive, including the public policy level, regulation, education, interventions beyond education, and health promotion (Vera, 2012). Preventive efforts are typically differentiated partly based on whether they target the general population or specific groups based on certain risk factors, but also based on when they are applied timewise, such as prior to the occurrence of any symptoms, or when individuals already begin to show some symptoms (Dickson-Gillespie, Rugle, Rosenthal, & Fong, 2008; Vera, 2012). Preventive strategies in the field of problem gambling can be introduced at the policy level (e.g. age limits), take the form of educational programs implemented in schools and targeting adolescents, be applied to gambling venues (opening hours, prohibition of smoking, ban of ATMs close to the venue), and involve the design of gambling machines (ban of large note acceptors, mandatory use of player card) and games themselves (regulation of speed and bonuses, notifications about time and money spent gambling) (Williams et al., 2012). Currently, our knowledge of effective prevention of problem gambling is very limited (Ariyabuddhiphongs, 2013; Dickson-Gillespie et al., 2008; Grande-Gosende et al., 2019; Statens Beredning för Medicinsk Utredning, 2019; Williams et al., 2012). Current research suggests that personalized feedback and educational strategies for youth have potential to help avoid and reduce gambling-related harms (Grande-Gosende et al., 2019; Statens Beredning för Medicinsk Utredning, 2019). As of today, literature reviews show that research on prevention of problem gambling is very scarce and the quality of existing studies is low (Ariyabuddhiphongs, 2013; McMahon, Thomson, Kaner, & Bambra, 2019; Williams et al., 2012).
Responsible gambling

Responsible gambling (RG) is a commonly referred to concept when minimization of gambling-related harms is discussed. RG is defined by Blaszczynski, Ladouceur, and Shaffer (2004) as “policies and practices designed to prevent and reduce potential harms associated with gambling; these policies and practices often incorporate a diverse range of interventions designed to promote consumer protection, community/consumer awareness and education, and access to efficacious treatment” (p. 308). This definition describes RG as a broad phenomenon, covering the entire range of strategies, including those discussed in the previous section about prevention of problem gambling, and even access to treatment, which goes beyond prevention. It could be argued that this definition makes the term RG redundant, as it does not bring anything new to existing efforts. The term has also been criticized for not clarifying whose responsibility it is to ensure that gambling-related harms are avoided, thereby enabling responsibilization of the consumers (Alexius, 2017; Miller & Thomas, 2018; Miller, Thomas, Smith, & Robinson, 2016; Orford, 2017). Some studies have indeed interpreted the term in this manner (Hing, Russell, & Hronis, 2018; Wood, Wohl, Tabri, & Philander, 2017).

Social responsibility

Harm-minimization efforts made by gambling providers have sometimes been labelled “social corporate responsibility” (Griffiths et al., 2009; Tetrevoa & Patak, 2019; Wood & Griffiths, 2010). However, given the presumed lack of intention on the part of providers to make choices expected to result in economic losses, the term may not be appropriate in this context (S. May, Cheney, & Roper, 2007). This may be the reason for the popularity of using the term RG, which did not have the same connotation when it was introduced (Geiger & Cuzzocrea, 2017).

Responsible provision of online gambling

As described above, consumer protection, prevention, responsible gambling and social corporate responsibility are all terms used to describe efforts to avoid or reduce gambling-related harms. Each of them focuses on at somewhat different aspects of gambling related harm-minimization, but they are also used interchangeably. This creates the need for clear communication of precisely what phenomenon is being studied in research focused on efforts to reduce gambling-related harms. The current thesis focuses on RG tools in a narrow sense, studying effectiveness, patterns of use, and attitudes toward features:
1) Implemented in online gambling environments 
2) Described as facilitating the responsible provision of gambling by helping gamblers to gamble in a sustainable manner 

To be of interest for the current project, it is deemed sufficient if a feature is presented as a responsible gambling tool by the provider (the gambling company). This means that even if the features do not have a true intention to reduce gambling intensity and do not have a true effect on reducing gambling intensity, they are still of interest for the project. The latter means that the actual effectiveness of the feature to help gamblers to gamble in a more sustainable manner may be unexplored. The lack of the desired effect of the tool may also be well-known by gambling industries, as they have unlimited access to the relevant data, and by other stakeholders, such as researchers and policy makers. This definition is different from the definition of RG tools suggested by Blaszczynski et al. (2004) that includes all the strategies — both at gambling operator and policy levels — that can be used to decrease levels of gambling-related harms and prevent new cases of problem gambling. Another definition of RG suggested in Williams et al. (2012) clearly includes two aspects: one is the consumers’ responsible gambling and the second is the responsible provision of gambling by the industry. The first aspect – responsible gambling as a characteristic of an individual engaging in gambling - is not included in the definition used in the current project. When it is considered important to leave out the aspect of the individual responsibility in the current project, the term responsible provision of gambling (RPG) will be used.

Theoretical basis for RPG

There is evidence that certain features presented in gambling environments make gamblers gamble more intensively. Conversely, the absence of those features is associated with lower gambling involvement. The active components of these features correspond to a number of well-established theories of human behavior.

As it already has been mentioned, the concepts of learning theory explain a range of phenomena related to context dependent gambling intensity (Ramnerö et al., 2019). It has been established that the presence of so called losses disguised as wins (when the gambler wins less money than was wagered) is associated with maintained gambling behavior (Templeton, Dixon, Harrigan, & Fugelsang, 2015). LDW reinforce and prevent extinction of gambling behaviors despite the absence of an actual win (Templeton et al., 2015), suggesting that eliminating LDW can lead to faster
extinction of gambling behaviors when substantial amounts of money have been lost. Sounds and lights related to wins can also serve a reinforcing function even when they are presented in the absence of a win (M. J. Dixon, Collins, Harrigan, Graydon, & Fugelsang, 2015), and just as with LDW, reducing these effects can aid gamblers with stopping gambling. It has also been shown that negative sounds reduce the reinforcing effect of LDW (M. J. Dixon et al., 2015).

Verbal rules can dominate over contingency-shaped behaviors, meaning that a behavior that is not followed by reinforcement or even followed by a punishment can be maintained if a previously learned rule supports the continued use of the behavior in question (Hayes, Brownstein, Zettle, Rosenfarb, & Korn, 1986). The phenomenon has been observed in subjects performing gambling tasks, where verbal incorrect descriptions of payback percentage of a roulette game guided the subjects’ behaviors in the presence of the actual consequences of playing the game (M. R. Dixon, Hayes, & Aban, 2000). Providing accurate rules about the mechanism of gambling (e.g., accurate payback percentages or information about the independence of gambling events) can lead to reduced gambling in problem gamblers (Ramnerö et al., 2019). This suggests that providing correct information about gambling and about strategies for controlling one’s gambling (i.e., functional verbal rules to guide gambling behavior) can be an effective harm-minimization method. However, as providing information sometimes fails to create new verbal rules (Beresford & Blaszczynski, 2019), further study of methods to present information that can serve this function is required.

The role of delay discounting and probability discounting in gambling has already been mentioned (Petry, 2012). Gamblers, and problem gamblers specifically, tend to prefer faster rewards even if they are small (delay discounting) and take risks wagering for improbable, but high, rewards (probability discounting) (Ramnerö et al., 2019). With regard to discounting, it can be reasonable to suggest that the decision on how much money can be spent on gambling during a certain gambling period should be made prior to entering a gambling session, and there is evidence that such a decision can be effective in moderate-risk gamblers and problem gamblers even when the limits are self-imposed and there is no external mechanism in place to prevent gamblers from spending more than intended (Rodda, Bagot, Manning, & Lubman, 2019).

Cognitive theory suggests that erroneous cognitions – such as the belief that past outcomes of the game predict its future outcomes or the belief in one’s own ability to influence the outcome of the game – are associated with gambling problems (Sharpe & Tarrier, 1993). Some scholars have
focused on trying to modify erroneous cognitions in order to make an impact on gambling intentions and gambling behaviors, but the results were inconclusive (Maria Anna Donati et al., 2018; R. K. May, Whelan, Meyers, & Steenbergh, 2005; Steenbergh, Whelan, Meyers, May, & Floyd, 2004; Toneatto & Gunaratne, 2009).

Already several decades ago, literature on gambling described a dissociation-like state of disruption in the integration of mental activities, impaired awareness and narrowing of attention occurring in a gambling session (Jacobs, 1988; Kuley & Jacobs, 1988), and the state is often referred to as dissociation, flow or even dark flow (Lavoie & Main, 2019; Schluter & Hodgins, 2019; Wanner, Ladouceur, Auclair, & Vitaro, 2006). A recent qualitative study interviewed thirty-nine electronic gaming machine problem gamblers and the respondents reported impaired ability for critical thinking, self-observation, self-control and decision-making, for assessing the use of money and the consequences of continued gambling (Oakes, Pols, Lawn, & Battersby, 2018). The gamblers also had problems recalling their experiences from the time they were dissociating (Oakes et al., 2018). Several scholars have hypothesized that addressing the issue of dissociation could help gamblers have better control of their gambling (Schluter & Hodgins, 2019; Stewart & Wohl, 2013). One proposed way of doing this is to interrupt the dissociative state, for instance by interrupting the game and providing correct information on gambling behaviors (Stewart & Wohl, 2013). Setting a limit for how much time and money can be spent on gambling prior to beginning a gambling session can compensate for impaired ability to assess the spendings and to make decisions.

Theory of reasoned action (TRA) was proposed by Fishbein in the end of the 1970s and suggested that human behaviors were rational to their nature and that the individual chose the most optimal behavior in any situation based on the available information (Fishbein, 1979). The theory does not imply that the available information is objective or correct. According to the theory, the behaviors conducted by an individual are based on behavioral intentions which are determined by both attitude towards the behavior and subjective norms related to the behavior (Fishbein, 1979). Therefore, engaging in gambling would be driven by the intention to gamble derived from the individual’s attitude towards gambling (either positive or negative) and the belief of what others might think of gambling (Cummings & Corney, 1987). Numerous scholars applied TRA to explain gambling behaviors (Moore & Ohtsuka, 1999; Shin & Montalto, 2015; Thrasher, Andrew, & Mahony, 2011). In line with TRA, providing information to gamblers to adjust their attitudes towards gambling (for example, warning about the dangers of gambling) and to inform about
others’ negative attitudes towards excessive gambling, and providing information on normative gambling behaviors has been used to influence individuals’ gambling activity (Auer & Griffiths, 2015; Celio & Lisman, 2014; Neighbors et al., 2015). Also, Procter et al. (2019) found that attitudes and subjective norms towards RG tools positively correlated with intentions to use RG tools which also predicted the actual use of RG tools. To summarize, principles of TRA have been applied to both explain gambling behaviors and behaviors related to the use of protective measures.

Theory of planned behavior (TPB) is a modification of TRA and adds the aspect of perceived behavioral control to the parameters influencing the intention to gamble (Ajzen, 1985). This theoretical approach has been applied to gambling behaviors and both attitude towards the behavior, subjective norms and perceived behavioral control were related to gambling engagement (R. J. Martin et al., 2010). One study showed that perceived behavioral control had significant influence on the intention to gamble (J. Lee, Chen, Song, & Lee, 2014). According to TPB, one could hypothesize that modifying a gambler’s perceived behavioral control (for instance, through modifying their perception of whether they have enough time and money to gamble) could influence their intention to gamble.

High speed of the game has been associated with the game’s increased capacity to cause and maintain excessive gambling (Harris & Griffiths, 2018). The phenomenon can be explained using a variety of different theoretical approaches, including already mentioned dissociation state (which high speed is considered to contribute to), as well as higher frequency of losses and randomly distributed reinforcers. Both are able to hinder extinction of gambling behaviors according to the learning theory (Ramnerö et al., 2019).

Empirical studies on RPG

Recently, a number of reviews have been published summarizing the current state of evidence on the effectiveness of tools (and designs) described as promoting sustainable gambling behaviors (Drawson, Tanner, Mushquash, Mushquash, & Mazmanian, 2017; Ladouceur, Shaffer, Blaszczynski, & Shaffer, 2017; McMahon et al., 2019; Tanner, Drawson, Mushquash, Mushquash, & Mazmanian, 2017). In their umbrella review of preventive strategies for problem gambling, McMahon et al. (2019) created a classification of potential preventive measures that is also applicable to responsible provision of online gambling. The authors identified three strands of harm-minimization, including supply reduction, demand reduction, and harm reduction, and classified the identified specific
strategies according to these categories. Currently, the classification system is not well-established or researched in the field of prevention of problem gambling or RPG online. However, it can be considered useful for creating a comprehensive map of different strategies associated with RPG in contemporary online gambling platforms.

**Supply reduction**

McMahon et al. (2019) have not identified any strategies from the online gambling domain aiming at supply reduction. However, they did mention reduced opening hours for land-based gambling venues, and its equivalent in the online domain would be shutting down the possibility to wager at a gambling site during certain hours. For the current thesis, there is no information on gambling websites having opening hours, nor is there information on possible effects of such a design.

**Demand reduction**

The two types of interventions discussed in the demand reduction section—youth prevention interventions and smoking bans in land-based venues—are not easily translated to online gambling settings (McMahon et al., 2019). However, clear information on gambling websites about gambling harms and true odds of winning could be considered examples of demand reduction interventions that can create correct verbal rules (Ramnerö et al., 2019). Another such example would be designing online gambling environments to make it easier to leave, e.g. by adjusting light and sound effects and regulating LDW (Ramnerö et al., 2019). In land-based settings, warning messages, information on money spent on gambling and graphical messages (as opposed to only using text) can be considered potentially effective in helping gamblers to reduce their gambling intensity (Ladouceur et al., 2017).

**Harm reduction**

**Self-exclusion.** A possibility to irreversibly shut down one’s gambling account for a longer period of time is also well-described in gambling literature (Caillon et al., 2019; Hayer & Meyer, 2011; Hing, Russell, Tolchard, & Nuske, 2015; Tremblay, Boutin, & Ladouceur, 2008). In their review, Ladouceur et al. (2017) conclude that there is some evidence of effectiveness of self-exclusion both in land-based and online settings, but with lack of long-term evaluations and presence of methodological weaknesses in the reviewed studies, it is hard to draw firm conclusions. In another review, Drawson et al. (2017) conclude that gamblers tend to experience improvement in their problem gambling status, and although many individuals return to gambling after the end of the exclusion period, a decrease in gambling intensity could be sustained up to one year after exclusion.
Automatic and personalized feedback. Feedback messages in online gambling environments exist in a variety of forms, from messages created by the platform as an automatic reaction to the gamblers’ behaviors (session length, money spent, number of games played, etc.) to more sophisticated features asking gamblers about their insights into their own gambling patterns, their beliefs about gambling, and their symptoms of gambling problems (Auer & Griffiths, 2018; Gainsbury, Aabarabanel, Philander, & Butler, 2018; Wohl, Davis, & Hollingshead, 2017). Self-appraisal feedback has been specifically highlighted as a potentially effective harm-minimization strategy (Drawson et al., 2017; Tanner et al., 2017). Potential effectiveness of normative feedback has already been mentioned (Ajzen, 1985; R. J. Martin et al., 2010) and several studies showed its positive effects in reducing gambling intensity (Auer & Griffiths, 2015; Celio & Lisman, 2014; Neighbors et al., 2015). Providing feedback has also been highlighted as a preventive strategy with most evidence (Grande-Gosende et al., 2019; Statens Beredning för Medicinsk Utredning, 2019).

Maximum bets. This feature is related to pre-commitment/limit setting, but the limit is set by the gambling operator or determined by the gambling regulator rather than being set by the consumer. The potential effectiveness of maximum bets is highlighted in the literature (Drawson et al., 2017; Tanner et al., 2017).

Self-test – a questionnaire on symptoms of problem gambling – is not mentioned in (McMahon et al., 2019). However, self-test was highly recommended for implementation in online and offline gambling environments by researchers, clinicians and recovered problem gamblers (Wood, Shorter, & Griffiths, 2014). The tool is implemented in some gambling platforms and a study by Forsström, Hesser, & Carlbring (2016) showed that there existed a subgroup of gamblers who specifically preferred using the self-test tool and that self-testers were one of the subgroups with higher levels of gambling problems.

Pre-commitment/limit-setting. Pre-commitment tools can be designed in different manners, but the main idea is that prior to engaging in a gambling activity, users of gambling services can set a limit for how much they can gamble for in terms of how much money they can deposit, stake, lose, or win or how much time they can spend in the platform during a certain period of time. Pre-commitment is often mentioned in reports and peer-reviewed literature and seems to be relatively common in online gambling environments (Auer, Littler, & Griffiths, 2015; Bonello & Griffiths, 2017). Effectiveness of pre-commitment is one of the foci of the current thesis and will be discussed in more detail later.
The sources having reviewed available evidence on effectiveness of strategies for prevention of problem gambling and RPG highlight the lack of studies in this field and the low quality of the existing studies, prohibiting from drawing any firm conclusions (Grande-Gosende et al., 2019; Ladouceur et al., 2017; McMahon et al., 2019; Statens Beredning för Medicinsk Utredning, 2019). It is difficult to assess the implementation rate of different tools for RPG and the current evidence suggests that potentially most effective RG tools – pop-up windows, risk assessments and mandatory limits - are also the ones that are implemented least often (Marionneau & Järvinen-Tassopoulos, 2017).

**Pre-commitment in gambling**

One strategy for RPG that has the potential to help individuals gamble in a sustainable manner by setting pre-committed limits (Ladouceur, Blaszczynski, & Lalande, 2012) exists in a number of variations, such as the possibility of setting a limit for how much money can be spent in an online gambling platform during a certain period of time (Auer & Griffiths, 2013), a limit for how much money can be deposited into a personal account (Broda et al., 2008), a time limit (Kim, Wohl, Stewart, Sztainert, & Gainsbury, 2014), and even proposed in a form of a winning limit (Walker, Litvin, Sobel, & St-Pierre, 2015). A number of trials that have been conducted in land-based settings, such as those reviewed by Ladouceur et al. (2012), and mostly published as non-peer-reviewed reports, did not show clear evidence of the effectiveness of pre-commitment. An option of setting a monetary limit seem to be common among online gambling operators (Bonello & Griffiths, 2017; Cooney, Columb, Costa, Griffiths, & O’Gara, 2018). Online gamblers tend to have positive attitudes about voluntary spending limits, whereas mandatory limits are viewed as patronizing (Bernhard, Lucas, Jang, & Kim, 2006; Gainsbury, Parke, & Suhonen, 2013). However, Auer and Griffiths (2013) claimed that most problem gamblers are not susceptible to voluntary limits. Also, a very recent study conducted among users of gambling services provided by the Norwegian national gambling monopoly found that four out of five respondents had a positive attitude to the newly introduced global mandatory loss limit (Auer, Reiestad, & Griffiths, 2018). Griffiths et al. (2009) found that 70% of individuals in a sample of over 2,000 online gamblers considered limit setting to be a useful feature, and 56% of them had used the limits. Nelson et al. (2008) observed that only 1.2% of users of an online betting website (N = 567 out of N = 47,134) used the available deposit-limit feature. The self-limiters showed a higher gambling intensity than the rest of the sample, and the intensity was reduced slightly after setting the limit. Broda et al. (2008) monitored over 47,000 users of an
Internet sports betting operator over the course of two years. They found that only 0.3% of individuals tried to exceed their spending limit, and the majority of individuals never even got close to their limits (Broda et al., 2008). However, the results are questionable due to the considerable height of the limits and their potential ineffectiveness in preventing large economic damage (Wood & Griffiths, 2010). A study conducted by Auer & Griffiths (2013) concluded that a voluntary spending limit was the strategy that had the greatest effect on casino and lottery gamblers. However, the study did not use a randomized design. In the context of preventing problem gambling, setting spending limits is a potentially effective but unexplored field.

Currently, no clear and acknowledged theoretical framework exists to explain the potential effectiveness of pre-setting a limit in gambling. Ladouceur, Blaszczynski, and Lalande (2012) stressed the importance of making expenditure decisions in the absence of emotional arousal. This can be explained by the fact that problem gamblers have difficulties controlling their behavior in a gambling session due to increased levels of arousal (Wilkes, Gonsalvez, & Blaszczynski, 2010). Also, they have an inability to self-regulate specifically in the context of an attempted behavior change (Ricketts & Macaskill, 2003). In-session decision making can be impaired due to high levels of impulsivity among problem gamblers (Bagby et al., 2007), delay and probability discounting (Ramnerö et al., 2019) and the state of dissociation occurring in a gambling session (Schluter & Hodgins, 2019). These factors can make it more difficult to stop depositing/betting while actively gambling. From the point of view of behaviorism, making an expenditure decision prior to gambling would make sense due to the absence of established operations and reinforcers that otherwise occur during a gambling session and that distort decision making (James & Tunney, 2016; Weatherly & Flanery, 2008).

While the potential effectiveness of pre-commitment may seem logical based on the underlying theories, the results of existing trials are inconclusive (Ladouceur et al., 2012), with only one trial addressing the effectiveness of setting a deposit limit (Broda et al., 2008). Nevertheless, setting deposit limits does occur as official recommendations (Productivity commission, 2010) and requirements (Finansdepartementet OU, 2018) from authorities. It can be used to market gambling services as being responsible (Song, Lee, Norman, & Han, 2012).

Prediction of gambling problems
In online gambling platforms, gambling behavior data is being routinely collected and stored (Gainsbury, Russell, Wood, Hing, & Blaszczynski,
This data can potentially be used to protect vulnerable customers (Deng, Lesch, & Clark, 2019). Although the conflict of interest is likely to hinder the protective efforts for most of the gambling companies (Yani-de-Soriano et al., 2012), regulators can require such efforts given there is evidence for their effectiveness, and publicly run gambling operators with harm minimization as a primary goal can be interested in implementing strategies based on the automatic identification of at-risk individuals.

Behavioral data collected in online gambling platforms has been previously used to identify vulnerable customers and to predict events connected to problem gambling, and based on the current evidence, the goal can be considered feasible (Brosowski, Meyer, & Hayer, 2012; Chagas & Gomes, 2017; LaBrie, Kaplan, Laplante, Nelson, & Shaffer, 2008; Percy, França, Dragičevic, & d’Avila Garcez, 2016). One study clustered gamblers based on their gambling activity to identify gambler subgroups with distinct patterns of gambling behaviors (Braverman, LaBrie, & Shaffer, 2011). Data on problem gambling severity used as a target variable was available for some researchers (Excell et al., 2014), and others needed to find a proxy parameter to use as an indicator of gambling problems, such as the customer triggering the operator’s RG interventions (Gray, LaPlante, & Shaffer, 2012) or self-exclusion (Percy et al., 2016). Previously, parameters such as early signs (Haefeli, Lischer, & Schwarz, 2011), cross-game aspects (Braverman, LaPlante, Nelson, & Shaffer, 2013), and breadth and depth of gambling involvement (LaPlante, Nelson, & Gray, 2014) were used to predict gambling problems (Table 1). The predictive accuracies in previous studies having used machine learning methods to identify problem gamblers were 0.62-0.66 (Philander, 2014) and 0.87 (Percy et al., 2016).
Table 1

Variables Having Shown Strongest Association with Gambling Problems

<table>
<thead>
<tr>
<th>Publication</th>
<th>Predictors</th>
</tr>
</thead>
<tbody>
<tr>
<td>LaPlante et al. (2014)</td>
<td>Total number of active gambling days, total number of different games played, preferring live action gambling.</td>
</tr>
<tr>
<td>Gray et al. (2012)</td>
<td>Total number of active gambling days, number of days between the first and the last gambling day, total NL, total value of stakes, total number of bets.</td>
</tr>
<tr>
<td>LaBrie et al. (2008)</td>
<td>Age, frequency of gambling days, number of days between the first and the last gambling day, total NL, percent loss, total value of stakes, total number of bets, monetary value per bet.</td>
</tr>
<tr>
<td>Xuan and Shaffer (2009)</td>
<td>Monetary value per bet, odds per bet, NL per bet.</td>
</tr>
<tr>
<td>Braverman et al. (2011)</td>
<td>Total NL, average amount bet per gambling day, total number of bets, total amount wagered.</td>
</tr>
<tr>
<td>Braverman et al. (2013)</td>
<td>Age, total number of different games played, preferring live-betting and Internet casino, variance of player stake.</td>
</tr>
<tr>
<td>Borowski et al. (2012)</td>
<td>Total number of different games played, preferring poker and live betting.</td>
</tr>
<tr>
<td>Haeusler (2016)</td>
<td>Age, number of days between the first and the last gambling day, number of deposits, total value of deposits, variance of withdrawals, reversals of deposits, preferred payment methods: e-wallets, mobile billings, prepaid cards.</td>
</tr>
</tbody>
</table>

The majority of gambling platforms do not collect data on symptoms of problem gambling and finding a reliable marker for gambling problems in online activity data is crucial for conducting predictive analyses. Some
studies have used player self-exclusion as a target variable when attempting to predict gambling problems (Dragičević et al., 2015; Haeusler, 2016; Percy et al., 2016). However, this approach has been reasonably questioned (Griffiths & Auer, 2016). Only a small minority of gamblers use self-exclusion (Hayer & Meyer, 2011), and gambling problems are far from the sole reason for self-exclusion (Griffiths & Auer, 2016). It is possible that a considerable proportion of self-excluders do not have gambling problems and that a considerable proportion of non-excluders are problem gamblers (Griffiths & Auer, 2016; Motka et al., 2018). The majority of online gambling data is not available for research purposes, and when it is, it most certainly does not include information on symptoms of problem gambling. Until diagnostic data becomes available, it is still necessary to find a proxy parameter for gambling problems in gambling behavior datasets to use as a target variable in predictive analyses. Apart from the option to self-exclude, gamblers sometimes have the possibility to freeze one or several gambling categories for an optional period of time (Bonello & Griffiths, 2017; Cooney et al., 2018). The tool is less invasive than self-exclusion, which suggests that a larger proportion of individuals with gambling problems would choose to game-freeze as opposed to self-exclude (Caillon et al., 2019). This would justify an effort to conduct a predictive analysis with gaming freeze as a target variable and proxy for gambling problems.

Gamblers’ experiences of tools for responsible provision of gambling

Current evidence suggests that consumers generally tend to have positive attitudes toward RG tools (Auer et al., 2018; Engebø, Torsheim, Mentzoni, Molde, & Pallesen, 2019; Forsström et al., 2016; Gainsbury, Angus, Procter, & Blaszczynski, 2019). However, concerns have been raised regarding the possible disturbance that RG tools may cause to recreational gamblers who are not considered to be at risk of developing gambling problems. Williams et al. (2012) mentioned that it would be necessary to accept the disturbance of non-problem gamblers in order to protect those at-risk of developing gambling problems. The Productivity Commission in Australia, which is responsible for governmental inquiries in the field of gambling, consequently stressed in its latest report the importance of preserving to the greatest possible extent the positive aspects of gambling (such as entertainment and employment opportunities) while also protecting at-risk customers (Productivity commission, 2010). The report suggests that the expected benefits of customer protection strategies included in the inquiry must be balanced against their expected costs, such as a decrease in enjoyment among recreational gamblers and their
possible consequent abandoning of a regulated gambling operator in favour of an unregulated one (Productivity commission, 2010). A governmental inquiry investigating the de-monopolization of the Swedish gambling market suggested a model of required consumer protection with an explicit focus on not needing to intervene in the case of recreational gamblers (SOU 2017:30, 2017). In 2004, the first outline of a new framework—the so-called “Reno model”—was suggested for the design and implementation of RG tools (Blaszczynski et al., 2004). The authors warn about the potential harms that RG tools could cause to non-problem gamblers and encourage stakeholders to be aware of them (Blaszczynski et al., 2004). The importance of preserving the entertaining aspects of gambling by being cautious with RG tools was repeated in a subsequent paper (Ladouceur, Blaszczynski, Shaffer, & Fong, 2016). The need to limit disturbance of recreational gamblers has also been expressed by other researchers (Auer et al., 2015; Gainsbury, Aro, Ball, Tobar, & Russell, 2015; Monaghan, 2008, 2009).

No study to date has investigated whether recreational gamblers are being disturbed by RPG tools and consequently abandon gambling services with extensive protective measures. Generally, gamblers’ attitudes toward protective measures – that are most often referred to as RG tools in literature - seem to be positive (Gainsbury et al., 2019, 2013; Ladouceur et al., 2012; Nisbet, Jackson, & Christensen, 2016; SOU, 2008) and consumers have expressed that RG tools communicate the integrity of the service and decrease worry related to the chances of winning others’ money (Wood & Griffiths, 2008). A survey among 10,838 online gamblers showed that the implementation of RG tools might enhance consumers’ favourable attitudes towards an operator (Gainsbury et al., 2013), which does not support the idea of customers being channelled away by protective measures. Very few gamblers report being disturbed by protective measures (Gainsbury, Aro, et al., 2015; Monaghan, 2008; Monaghan & Blaszczynski, 2010), and the relationship between the level of gambling problems and attitudes toward RG tools is unknown. According to one study, some common reasons for frustration were the voluntary nature of the limits and the fact that RG tools allowed the user’s winnings to compensate for the wagered money, disturbing the picture of the total money wagered (Griffiths et al., 2009). These concerns indicate that there is a demand for stricter protective tools. Blaszczynski, Gainsbury, & Karlov (2014) found that protective measures had more negative effect on the enjoyment of gamblers with higher rates of gambling problems. Auer et al. (2018) studied gamblers’ attitudes towards a global mandatory loss limit introduced by the Norwegian national gambling monopoly and found that four out of five of the respondents had positive attitudes towards the tool and only a few respondents gambled outside the platform.
when the limit was reached. A longitudinal study from Sweden showed that unregulated online gambling operators had a higher proportion of problem gamblers among their customers when compared to regulated operators (Svensson & Romild, 2011), which suggests that recreational gamblers are not a high-risk subgroup when it comes to abandoning the regulated gambling market. Higher rates of gambling involvement are associated with more severe gambling problems (Binde, Romild, & Volberg, 2017), therefore non-problem gamblers are likely to be exposed to RG tools to a relatively low extent.

RG tools are not as widely implemented as modern technology allows, and the tools that are likely to be most effective—such as risk assessments, mandatory spending limits, and pop-up windows—seem to be implemented least often (Marionneau & Järvinen-Tassopoulos, 2017). This supposedly results in a lack of proper evaluation of such protective strategies and means that overexposure to unnecessary protective tools (with subsequent loss of recreational customers to the unregulated market) does not seem to be a pressing issue. The concerns raised by governments, researchers, and industries lack evidence and seem to be based on loose assumptions. At the same time, the concerns may create a substantial obstacle to developing effective online RPG tools.
Aims

To summarize, problem gambling is considered a public health problem in many countries. Gambling is not an ordinary consumer commodity due to its addictive properties and connection to a psychiatric diagnosis, making governments stakeholders with two competing interests: an interest to protect vulnerable individuals and an interest to benefit from gambling revenue. Representatives of the gambling industry need to balance between the need to maximize profit and the regulatory requirements to minimize excessive gambling. Different strategies are applied in order to avoid and decrease gambling-related harms. The strategies are referred to as consumer protection, prevention of problem gambling, RG and social corporate responsibility. There does not seem to exist a clear consensus on when different terms should be applied (e.g. in relationship to what groups are targeted by the strategies and which stakeholders are in charge), and the terms are often used interchangeably. The clear conflict of interest, together with the unclear terminology, creates challenges for developing and implementing effective strategies for avoiding and limiting gambling-related harms.

The current thesis focuses on responsible provision of online gambling – strategies that are implemented in online gambling platforms in order to help gamblers to use the services in a sustainable manner. There exists a substantial theoretical basis for development of effective RPG tools and designing gambling environments in a responsible manner. Despite the theoretical basis and promising results in experimental studies, the research on effectiveness of RPG is very scarce and the existing research is considered to be of low quality. It is challenging for the stakeholders interested in harm minimization to be guided by the current evidence. Different pre-commitment designs – a possibility to set a limit for how much time and money one can spend on gambling during a certain period of time – are relatively common in gambling environments. Although they are considered potentially effective, there has been no study investigating the effects of a pre-commitment in a randomized design. Online gambling platforms routinely collect behavioral data that can be used to identify individuals at-risk of developing gambling problems and promote development of effective RPG tools. Also, gamblers tend to have positive attitudes towards RPG tools, but different stakeholders have expressed that
it is important to beware of disturbing recreational gamblers, a concern that does not have any empirical evidence to lean against and needs to be addressed in research as it can be an obstacle in development and implementation of effective tools for responsible provision of online gambling.

The general aim of the current project was to study the effects, usability and gamblers’ experiences of tools for responsible provision of online gambling.

Study I aimed to investigate the effects of a voluntary prompt to set a deposit limit of optional size on gambling intensity for new customers of an online gambling service.

Study II aimed to explore predictors of freezing one or several gambling categories in a set of behavioral data tracked in an online gambling platform using the Random Forest machine learning method.

Study III aimed to investigate non-problem gamblers’ previous experiences of and attitudes towards protective measures in online gambling platforms.
Role of funding sources

The PhD position of the author of the current thesis was funded by a grant from Ålands Penningautomatförening (Paf) - a publicly governed gambling operator from the Åland Islands in Finland. Paf has provided the data for the current project. Paf had no involvement in analysing and interpreting the data, neither were they involved in the writing of the current thesis.
Method

All three studies conducted as a part of the current project used data collected by Ålands Penningautomatförening (Paf), a publicly run gambling operator from the Åland islands, a self-governed region in Finland. Only the customers using Paf’s online gambling service—paf.com—in Finland were analyzed. The service provides slot-games, bingo, betting, poker, and casino games. All study protocols were approved by the Regional Ethics Committee in Stockholm, Sweden (registration numbers 2016/1924-31, 2016/2497-31/5, 2017/1926-32). Participants in all three studies were playing on paf.com from Finland. All the participants were 18 years of age or older, as an individual must be at least 18 to register an account with the gambling service with a personal identification number required at registration. The analyses were conducted using the statistical software R version 3.5.0 (R Core Team, 2018) for Studies I and III and version 3.6.1 (R Core Team, 2019) for Study II.

Study I

Procedure

In 2016, all potential customers of paf.com that initiated account registration at the platform were randomized into one of four conditions of equal sizes: (1) a control condition with a standard customer journey without any extra communication, (2) a pre-registration group receiving a prompt to set a voluntary weekly deposit limit of optional size while registering the account, (3) a pre-deposit group receiving the same prompt when initiating their first deposit, and (4) a post-deposit group receiving a prompt right after having made the first deposit. The research group received data on the platform activity of 10,339 randomized customers over 90 days beginning at account registration. Of this initial sample, customers with online slots as the preferred gambling category were selected, which resulted in the final sample of 4,328 gamblers. The study’s hypotheses and the analysis plan were pre-registered at the Open Science Framework (https://osf.io/g67gu/) before the researchers received access to the data.
Participants
From the initial sample of N=10,339 customers, only slot players were selected, resulting in a final sample of N=4,328 individuals. A customer was considered a slot player if online slots were their preferred gambling category in more than 80% of active gambling days during the 90-day period of data collection. A gambling category was considered to be preferred during an active gambling day when the individual wagered more money on games in the category than on games in any other category. There was no lower limit for the amount of gambling activity. For instance, if an individual only played one game during the 90-day period of data collection and the game was an online slot, the individual was identified as a slot player.

Measures
The customers' aggregated net loss (NL), or aggregated sum of the customers' wagers and winnings, that occurred during the 90-day period of data collection was used as a primary outcome measure. Secondary outcome measures were the customers' inclination to set and to increase/remove a deposit limit, the sum of deposits, and the number of active gambling days, defined as days when at least one bet was placed without being subsequently removed. The data for calculating the primary and secondary outcome measures were collected automatically by the gambling platform, gender was provided by the customer at registration, and age was calculated by the platform based on the personal identification number required during the registration process.

Analyses
Player NL and deposits (in euros) were adjusted prior to conducting the analyses so that the medians of the whole sample would equal 100. The procedure was necessary due to financial confidentiality. A logistic regression was used to study between-group differences regarding proportions of individuals who set/increased/removed a deposit limit and the proportion of individuals with a positive aggregated NL (individuals having lost money during the period of data collection). A linear regression with log-transformed dependent variables was used to study between-group differences regarding the size of NL among individuals with positive NL, sum of deposits, and total number of active gambling days. The
analyses were conducted both at the whole-group level and for the sub-group of 10% of the most intensive players based on the total number of gambling days.

Bayes Factors of the alternative hypothesis over the null hypothesis ($BF_{10}$) – or ratios of the likelihood of the alternative hypothesis to the likelihood of the null hypothesis – were calculated for all the comparisons. Because no $BF_{10}$ exceeded 0.33 for the comparisons among the three intervention groups, the gambling intensities were considered equal (Dienes, 2014), and they were pooled together for the comparison with the control condition.

**Study II**

**Procedure**

The research group received access to the data on the platform activity of 15,000 randomly selected customers from Finland. For all included customers, the time frame for extracted gambling activity was between 01.01.2017 and 31.12.2017 (12 months). The data provided had been routinely collected by Paf and was not a part of any other research project. The data included information provided by the customer during registration (such as age and gender), gambling account data (such as deposits and withdrawals), and data on gambling activities (such as games played, number and value of stakes, NL, and winnings). The data on the use of a gaming freeze ($N=2,686$ of the original sample have used the tool) were also provided. No sensitive personal information was used in the study, and no intervention from the research group was in place. When registering an account on the gambling website, all prospective customers actively consented to the data being used for research purposes.

**Participants**

The original sample consisted of 15,000 randomly selected customers who had made at least one deposit to their gambling account within the 12 months prior to data extraction. Out of the original sample of $N=2,686$ freezers, only the ones with at least 14 days between the first available date of activity in the platform and the freeze were selected ($N=1,791$ freezers). For each non-freezer, a dummy-freeze was created by randomly selecting one day (with some activity in the platform) out of days having occurred at least 14 calendar days after the first available date.
For the main analysis, only individuals having had activity in the platform between days -14 through -8 before the freeze/dummy-freeze were selected. This reduced the sample of eligible freezers to N=1,309 and in order to achieve a balanced final sample N=1,309 non-freezers were randomly selected, resulting in the total sample size of N=2,618 for the main analysis. The data included in the dataset for the main predictive analysis was gambling activity having occurred during days -14 through -8 before the freeze/dummy-freeze. Two additional datasets were created for secondary analyses. The first one included the same N=2,618 individuals presented in the main dataset, but used the data having occurred days -14 through the date of the freeze/dummy freeze. The second secondary dataset included all the N=1791 freezers having had at least 14 calendar days between the first date available and the date of the freeze (total N=3,582 with N=1,791 randomly selected non-freezers), using the data collected during days -14 through the date of the freeze/dummy-freeze. See Table 2 for the overview of the three data sets.

Table 2

*Characteristics of the Data Sets in Study II*

<table>
<thead>
<tr>
<th>Data set</th>
<th>N</th>
<th>Restriction</th>
<th>Data included</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main data set</td>
<td>2,618</td>
<td>Any activity in the platform occurring days -14 through -8 before the freeze/dummy freeze</td>
<td>Data on the activity in the platform occurring days -14 through -8 before the freeze/dummy freeze</td>
</tr>
<tr>
<td>Data set for comparison 1</td>
<td>2,618</td>
<td>Any activity in the platform occurring days -14 through -8 before the freeze/dummy freeze</td>
<td>Data on the activity in the platform during the 2 weeks before the freeze</td>
</tr>
<tr>
<td>Data set for comparison 2</td>
<td>3,582</td>
<td>Any activity in the platform during the 2 weeks before the freeze</td>
<td>Data on the activity in the platform during the 2 weeks before the freeze</td>
</tr>
</tbody>
</table>

**Measures**

The research group received access to monetary variables (NL, deposits, withdrawals, winnings, stakes), time spent gambling (both duration of the sessions and timestamps for session starts and ends), and the types
of games played. The following parameters of the variables were used in the analysis: totals, frequencies, maximum values, variations, and time slopes. Apart from the created predictors displayed in Table 3, age, gender, as well as preferred gambling category and second preferred gambling category were used as predictors, resulting in the total number of predictors $k=105$. 


Table 3  

*Summary of Created Predictors*

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Frequency/Average</th>
<th>Highest occurring value</th>
<th>Variation</th>
<th>Slope</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of sessions</td>
<td>Per active gambling day</td>
<td>Per active gambling day</td>
<td>Per active gambling day</td>
<td>Per active gambling day</td>
</tr>
<tr>
<td>Length of sessions</td>
<td>Mean value</td>
<td>Absolute maximum</td>
<td>Variation of absolute values</td>
<td>Variation of absolute values</td>
</tr>
<tr>
<td>Gambling days</td>
<td>- *</td>
<td>- *</td>
<td>- *</td>
<td>- *</td>
</tr>
<tr>
<td>Number of deposits</td>
<td>Per active gambling day</td>
<td>Per active gambling day</td>
<td>Per active gambling day</td>
<td>Per active gambling day</td>
</tr>
<tr>
<td>Sum of deposits</td>
<td>Mean value</td>
<td>Absolute maximum</td>
<td>Variation of absolute values</td>
<td>Variation of absolute values</td>
</tr>
<tr>
<td>Number of withdrawals</td>
<td>Per active gambling day</td>
<td>Per active gambling day</td>
<td>Per active gambling day</td>
<td>Per active gambling day</td>
</tr>
<tr>
<td>Sum of withdrawals</td>
<td>Mean value</td>
<td>Absolute maximum</td>
<td>Variation of absolute values</td>
<td>Variation of absolute values</td>
</tr>
<tr>
<td>Number of stakes</td>
<td>Per session</td>
<td>Per session</td>
<td>Per session</td>
<td>Per session</td>
</tr>
<tr>
<td>Sum of stakes</td>
<td>Per session</td>
<td>Per session</td>
<td>Per session</td>
<td>Per session</td>
</tr>
<tr>
<td>NL</td>
<td>Per session</td>
<td>Per session</td>
<td>Per session</td>
<td>Per session</td>
</tr>
<tr>
<td>Wins</td>
<td>Per session</td>
<td>Per session</td>
<td>Per session</td>
<td>Per session</td>
</tr>
<tr>
<td>Number of night sessions</td>
<td>- *</td>
<td>- *</td>
<td>- *</td>
<td>- *</td>
</tr>
</tbody>
</table>
Table 3 (continued)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Frequency/ Average</th>
<th>Highest occurring value</th>
<th>Variation</th>
<th>Slope</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration of night sessions</td>
<td></td>
<td>Absolute maximum</td>
<td>Variation of absolute values</td>
<td>Variation of absolute values</td>
</tr>
<tr>
<td>Number of work time sessions</td>
<td>Per active gambling day</td>
<td>Per active gambling day</td>
<td>Per active gambling day</td>
<td>Per active gambling day</td>
</tr>
<tr>
<td>Duration of work time sessions</td>
<td>Mean value</td>
<td>Absolute maximum</td>
<td>Variation of absolute values</td>
<td>Variation of absolute values</td>
</tr>
<tr>
<td>Number of weekend sessions</td>
<td>Per active gambling day</td>
<td>Per active gambling day</td>
<td>Per active gambling day</td>
<td>Per active gambling day</td>
</tr>
<tr>
<td>Duration of weekend sessions</td>
<td>Mean value</td>
<td>Absolute maximum</td>
<td>Variation of absolute values</td>
<td>Variation of absolute values</td>
</tr>
<tr>
<td>Number of different gambling categories</td>
<td>Per active gambling day</td>
<td>Per active gambling day</td>
<td>Per active gambling day</td>
<td>Per active gambling day</td>
</tr>
<tr>
<td>Number of different games</td>
<td>Per active gambling day</td>
<td>Per active gambling day</td>
<td>Per active gambling day</td>
<td>Per active gambling day</td>
</tr>
</tbody>
</table>

For each parameter, a total value (sum over the whole period) was calculated.

*These parameters could not be calculated as the time unit to calculate the frequency and highest value among others would be a week, and the current study only handled data during one week of gambling.

A night session is defined as a session starting between 11 PM and 7 AM.
Weekend sessions were sessions that started on a Saturday or a Sunday.
NL-net loss.
Analyses

The predictive analysis was carried out using the method Random Forest as implemented in the package Caret for the statistical software R (3.6.1) (Kuhn, 2016). The main dataset of N=2,618 was randomly split into a training dataset (70% of the subjects, N=1,834) and a testing dataset (30% of the subjects, N=784). To train the model, repeated cross validation was used, meaning that the training set was split into 10 subsets with each combination of N=9 subsets used for training purposes and being tested on the 10th subset. The procedure was repeated three times with each combination of 9/1 subsets. The number of decision trees grown each time was set to ntry=500. The number of variables randomly selected as predictor candidates was constant mtry = 10 (square root of the total number of predictor variables). The predictive performance of the trained model was then applied to the testing dataset. Partial dependencies for the N=20 most important variables were calculated and plotted. The two comparison datasets were subjected to the same splitting-training-testing procedure.

Study III

Procedure

The data for Study III was collected by distributing a survey on the individuals' experiences of RPG tools among active Finnish-speaking customers at paf.com. After the pilot testing conducted on 200 customers, the finalized survey was emailed to 10,000 customers on the 20th of February 2018. On the 26th of February 2018, one reminder was sent to 8,826 customers who had not responded to the survey, and the data collection was closed on the 1st of March 2018. In the email, the potential respondents received information about the purpose of the survey, about the collaboration between Paf and Stockholm University, and about the possibility to cease participation at any time and to win a gift card from verkokauppa.com, which could not be exchanged for money or used to pay for gambling services. Per each group of 100 customers, one 50-Euro gift card was raffled. The questionnaire included more detailed information about the study, the ethical approval, the handling of the data, and contact information both for customer support at Paf and the project team at Stockholm University. In the end of the questionnaire, prior to submitting the answers, the respondents could agree to participate (their answers were saved) or not (the answers were deleted). The gift card winners were chosen randomly and informed by email.
Participants
The study's participants were randomly selected among active Finnish-speaking customers at paf.com and included N=200 for the pilot testing (conducted among Swedish-speaking customers) and N=10,000 for final send out. Customers were not included if they had self-excluded or had frozen at least one gambling category at paf.com. Customers who had chosen not to receive any outbound communication from Paf were excluded as well as those who had their gambling account shut down due to having violated the terms of use or legislative conditions (e.g., legislation against money laundering). Also, the customers that were identified by the operator as showing behaviors potentially associated with problem gambling were not included. If a respondent scored between 3 and 7 on the Problem Gambling Severity Index (PGSI) (Wynne, 2003), they received an email from Paf's customer support informing them about the level of gambling problems indicated by their responses to encourage them to stop gambling (for instance, by shutting down their gambling account) and to seek help. Respondents scoring 8 or more on the PGSI received an email about their indicated level of gambling problems, about their account being shut down, and about where one could seek help.

Measures
The questionnaire distributed to potential respondents included four modules: 1) questions about the users' previous experiences of protective measures and other content common for gambling platforms not related to customer protection, 2) questions about the users' reactions to pictures of protective measures and pictures of content not related to customer protection, 3) level of gambling problems measured with PGSI, and 4) the customers' inclination to abandon a gambling service due to the perceived overexposure to protective measures. In the first module, the customers were presented with three verbal descriptions of protective measures: setting a time or monetary limit, possibility to conduct a self-test on signs of problem gambling, and possibility to freeze the access to a number of gambling categories or the whole account. In the second module, the pictures of protective measures showed an overview of protective measures of the platform, a balance of the user's spending and winnings, and a prompt to conduct a self-test. For each question in the first module and each picture in the second module, the respondents answered the same series of questions about their reactions to/experiences with protective measures. First, the participants had to rate their overall reaction to the previous experience/presented picture using a 5-point Likert scale (Very Negative to Very Positive). Second, they had to rate how
much they liked the experience/picture and how good, pleasant, informative, important, and helpful it was on a 7-point Likert scale. The single items were based on the Attitude Toward the Ad Scale (Rossiter & Bergkvist, 2009) and the Perceived Relevance of the Ad Scale (Morris, Choi, & Ju, 2016). The respondents also rated how disturbing, forced, intrusive, irritating, stupid, or terrible the experience/picture was on a 7-point Likert scale. The single items were based on the Perceived Intrusiveness of the Ad Scale (Li, Edwards, & Lee, 2002) and a survey of how irritating a commercial can be perceived (Wells, Leavitt, & McConville, 1971).

**Analyses**

The respondents’ answers about their previous experiences with and reactions to pictures constituted four dimensions: overall reaction, attitude dimension, perceived intrusiveness, and how irritating the respondents considered the content. The differences regarding scores for these four dimensions between non-problem gamblers (PGSI = 0), low-risk gamblers (PGSI of 1 or 2), moderate-risk gamblers (PGSI between 3 and 7), and problem gamblers (PGSI of 8 or above) for both previous experiences and reactions to the pictures were investigated using a linear regression. Bayes Factors of the alternative hypothesis over the null hypothesis ($BF_{10}$) were calculated for all comparisons.

The differences regarding previous experiences of abandoning a gambling service or a current inclination to abandon a gambling service due to perceived overexposure to protective measures that the respondent considered unnecessary between non-problem gamblers, low-risk gamblers, moderate-risk gamblers, and problem gamblers were studied using a logistic regression.
Results

Study I

The proportions of limit setters were higher in all intervention groups compared to the control group (at-registration: 45.0%, OR=11.9; pre-deposit: 38.8%, OR=9.2; post-deposit: 21.9%, OR=4.1, control: 6.5%). Men were more likely to set a deposit limit than women (OR(95% CI) = 1.3 (1.1 - 1.5), p = 0.005). Compared to non-setters, NL was higher among limit increasers across all randomization groups and among setters-non-increasers in the control group, and it was lower among setters-non-increasers in the at-registration and the pre-deposit groups.

Most of the gambling activity occurred directly after registration with more than 25% of the customers not returning to the platform after the first gambling day. The median number of active gambling days across all randomization groups was three, only 10% of the analyzed individuals had more than 25 active gambling days during the 90-days period of data collection. The median positive NL among the 10% most intensive players (calculated based on the total number of active gambling days) was around 20 times higher than the median of the whole sample. No effect of the intervention group was found for either the proportion of individuals with positive NL or the size of NL among the individuals with positive NL (whole sample: B (95% CI) =-0.080 (-0.229-0.069), p=.291; 10 % most intensive customers: B (95% CI) =0.042(-0.359-0.442), p =.838). No effect of the randomization group was found on the sum of deposits (B (95% CI) =0.046(-0.068-0.160), p =.429) or the total number of gambling days (B (95% CI) =0.041(-0.042-0.124), p =.329) in the whole sample.

Study II

Out of N=2,686 freezers, N=2,268 (84.4%) used freeze more than once. Among the individuals having registered their gambling account in 2017, N=192 were freezers. For these N=192 freezers, the number of days between the registration date and the date of the first freeze ranged between 0 and 321, with 25% of the freezers only having 5 calendar days or
less between the registration and the freeze and half of the sample having 26 days or less between the registration and the freeze.

Compared to non-freezers, freezers had higher median values in a number of parameters related to time and money spent on gambling, such as total number of sessions, total session length, total number of deposits, total sum of deposits, total number of stakes, total sum of stakes, total number of games played, total NL, total sum of winnings, and total number and duration of work time sessions. In the main analysis, applying the trained model to the testing data set achieved accuracy of 0.615, sensitivity of 0.543 and specificity of 0.686. Partial dependencies for the N=20 most important predictors are shown in Figure 1. The testing accuracy of the model based on the first and second comparison data set equalled 0.695 and 0.717 respectively.
Figure 1. Associations between the values of N=20 most predictive variables and the predicted probability of an individual being a freezer.

Study III

N=1,223 individuals completed the questionnaire (12.0% response rate), with the majority of the sample being moderate-risk gamblers (38.5%), followed by low-risk gamblers (26.8%), non-problem gamblers (18.9%) and problem gamblers (15.8%). The mean PGSI score was M = 3.93 (SD = 4.05). Non-problem gamblers were older than individuals with other levels of gambling problems. Groups with different levels of gambling problems varied in their rates of having experienced the gaming freeze feature, with problem gamblers having reported highest rates of exposure (67.9%).
Moderate-risk gamblers had a more positive overall attitude to the previously experienced protective measures ($B(95\% \text{ CI}) = 0.14 \ (0.03-0.26)$) compared to non-problem gamblers and experienced them as less irritating compared to non-problem gamblers ($B(95\% \text{ CI}) = -0.21 \ (-0.42-0.01)$). Evidence against the null hypothesis according to the $BF_{10}$-value indicates differences lower than barely worth mentioning. Problem gamblers had more negative reactions to RG pictures compared to non-problem gamblers across all dimensions except the overall reaction, but $BF_{10}$-values were either barely worth mentioning, or lower.

Non-problem gamblers and low-risk gamblers had the least experience of having abandoned a gambling service due to overexposure to protective measures that they considered unnecessary (5.2% and 5.8%, respectively). The corresponding proportions were 13.2% for moderate-risk gamblers and 25.9% for problem gamblers, and both moderate-risk gamblers and problem gamblers differed significantly from non-problem gamblers. Problem gamblers rated their inclination to abandon a gambling service higher (21.8%) than non-problem gamblers (11.3%). The proportions were 7.9% among low-risk gamblers and 13.6% among moderate-risk gamblers.
Discussion

Gambling is a non-ordinary consumer commodity related to a psychiatric diagnosis that is classified as an addiction disorder and associated with a range of severe negative consequences. Problem gambling and gambling disorder are typically addressed by preventive efforts, and from the public health perspective there is an interest to design gambling environments in a way that would help gamblers to gamble in a sustainable manner and to avoid gambling-related harms. Currently, evidence of effectiveness of RPG tools is limited, the empirical studies are few, the results of the studies are inconsistent, and the quality of the study designs is low. The aims of the current project were to evaluate the effects of a common pre-commitment design on gambling intensity of the users of an online gambling service, to use data routinely collected in a gambling platform to identify gamblers with potential gambling problems, and to explore non-problem gamblers' experiences of and reactions to protective measures.

Pre-commitment in online gambling

Pre-commitment is one of the frequently discussed strategies related to efforts towards RPG (Bonello & Griffiths, 2017; Ladouceur et al., 2012). The number of studies focusing on pre-commitment (in both online and offline gambling environments) is relatively large, but the lack of randomized trials or true experimental designs makes it difficult to assess the effectiveness of the tools. The diversity in the designs of pre-commitment tools also hinders the generalization of any results to contexts with alternative pre-commitment features.

Study I in the current thesis is the first randomized controlled trial evaluating the effects of a prompt to set a voluntary deposit limit of optional size presented at three different time points on the gambling intensity of users of an online gambling service compared to unprompted customers. The three intervention groups did not differ from each other in terms of proportions of individuals with positive NL (meaning individuals having lost money) or the size of NL among individuals with positive NL. There-
fore, gambling intensity as measured in the current study was not influ-
enced by the point in time when the prompt to set a deposit limit was
introduced. The differences between the three intervention groups were
very small, the gambling intensity shown by their participants was con-
sidered equal, and the groups were pooled together. The pooled inter-
vention group did not differ from the unprompted control group with regard
to the proportion of individuals with positive NL and size of NL among
those with positive NL, meaning that gambling intensity was not affected
by the deposit limit prompt. This result held true even for the subgroup
of the 10% most intensive gamblers calculated based on the number of
gambling days. In addition, gambling intensity measured by number of
active gambling days or sum of deposits was not affected by the prompt.
These findings correspond with previously expressed concern that prob-
lem gamblers are not susceptible to voluntary limits (Auer & Griffiths,
2013).

Previous research provides very little guidance regarding what effect can
be expected when the prompt is introduced. Some studies suggested that
reminders about approaching the self-imposed limits led to decrease in
gambling expenditure (Stewart & Wohl, 2013; Tabri, Hollingshead, &
Wohl, 2019), but the studies were conducted in experimental settings and
were never translated to natural gambling environments. Gamblers do
report positive attitudes towards pre-commitment tools, but the use of
the tools seems to vary in different populations (Nelson et al., 2008). In
their review, Ladouceur et al. (2012) could not find evidence that limit-
setting had any effect on the subsequent gambling intensity, but the lack
of effect could be attributed to the fact that the majority of trials reviewed
in the paper were reports and not peer-reviewed scientific publications.
In addition, the methodology in the reviewed trials was predominantly
poor. Auer and Griffiths (2013) monitored gambling intensity (measured
with theoretical loss) in N=500 users of a gambling website and observed
significant decreases in gambling intensity in different groups of gam-
bler based on their preferred gambling category after having imposed
monetary and time-based limits. The study focused on the 10% most in-
tensive players in the sample, who were expected to be in the most need
of a limit. Although the results are highly relevant, an important question
remains unanswered. Evidently, for highly involved gamblers, setting a
limit is associated with a subsequent decrease in gambling intensity.
However, this is not enough to establish the effect of a limit because the
gamblers prone to decrease their gambling intensity might also be prone
to set a limit when they have an opportunity to do so.

To establish the effects of limit-setting, an experimental design randomly
assigning individuals to either setting or not setting a limit is required.
Auer and Griffiths (2013) did not randomly assign the gamblers to set a limit; they only followed-up on limit setters. On the other hand, in Study I, the individuals were not assigned a limit but only received/did not receive a prompt to set a limit. Therefore, a trial randomizing participants to either set or not set a limit to determine whether setting a limit affects subsequent gambling intensity should be conducted.

Pre-commitment tools are expected to be effective for regulating gambling intensity, because they should be able to stop gamblers from spending more that they had decided in a relatively rational, emotionally unaroused state (Ladouceur et al., 2012). When setting a limit, the influence of establishing operators triggering excessive gambling and delay discounting is expected to be low (Ramnerö et al., 2019). Significant proportions of prompted customers (as many as 45% in the at-registration group) in Study I did set a deposit limit. Therefore, the lack of effect on gambling intensity can be considered somewhat unexpected. However, one plausible explanation could be that those who set a deposit limit when prompted without subsequently increasing/removing the limit were in no need of a limit. Some potentially high intensity players may also tend to set ineffectively high limits. The capacity of problem gamblers to make decisions about limiting their gambling specifically while actively gambling can be decreased due to increased levels of arousal (Wilkes et al., 2010), impaired ability to self-regulate (Ricketts & Macaskill, 2003), experiencing dissociation (Schluter & Hodgins, 2019) and high levels of impulsivity (Bagby et al., 2007). Although prompting gamblers to set a deposit limit before a gambling session encourages them to make their expenditure decisions in an unaroused emotional state without triggering establishing operators, it can be insufficient for making effective decisions. It is possible that in problem gamblers the decision-making needs to be improved from its neutral level in order to be effective. The nature of the prompt used in the current project – one-time prompt introduced with the text “Smart players keep track of their spendings. How much are you prepared to spend?” (or just “How much are you prepared to spend?” in the pre-deposit and post-deposit conditions) is unlikely to be enough to create a verbal rule that would guide a gambler’s behavior (Ramnerö et al., 2019). It does not provide any real normative information about what behavior is considered appropriate (R. J. Martin et al., 2010). A one-time prompt to set a voluntary deposit limit of optional size can simply lack the components derived from the theories behind potentially effective RPG that were described previously in the current thesis. It is noteworthy that the customers in the pre-registration group had higher rates of limit-setting than the ones in the pre-deposit and post-deposit groups (45.0% vs 38.8% and 21.9%). The prompt in the at-registration group was the one stating “Smart players keep track of
their spendings”, and this phrasing could serve the function of creating a verbal rule (Ramnerö et al., 2019) and be perceived as a normative information about setting a limit (R. J. Martin et al., 2010). The results of Study I suggest that effective prompting of gamblers to set a limit is possible, and it can be an important, even if not sufficient, feature of future pre-commitment designs.

Despite the lack of effect of the current design, it is reasonable to suggest that adhering to reasonable limits should have an effect on gambling intensity. For instance, a recently implemented mandatory loss limit at the gambling company that collaborated on the current project is expected to result in a 40-million Swedish krona (or 3.7 million euros) revenue decrease per year (www.breakit.se, 2019).

The main results of Study I have important implications because they reveal that a common design of a pre-commitment tool does not affect subsequent gambling intensity, not even for the most involved gamblers. No previous trial could show any clear advantage of voluntary limit-setting. However, as it seems to be relatively broadly implemented and promoted as an RPG tool (Auer & Griffiths, 2013; Bonello & Griffiths, 2017; Ladouceur et al., 2012), its presence can create an illusion of safety, i.e. an illusion of a fulfilled obligation of protecting the customers, which can slow down the development and implementation of effective RPG tools (Hancock & Smith, 2017). The results of this study should also be reflected in regulatory requirements towards the gambling industry. As the industry often needs to meet certain criteria for customer protection to be allowed to operate in different jurisdictions, prompting customers to set a voluntary deposit limit of an optional size should not be considered a sufficient way to meet the criteria. Unfortunately, because the field of RPG is characterized by an explicit conflict of interest, one could speculate that voluntary pre-commitment tools are relatively broadly implemented not despite the fact they are ineffective but because they are ineffective.

Predicting gambling problems

As previously mentioned, data collected by online gambling platforms is considered to be useful for identifying gamblers at risk of developing or having developed gambling problems. During the past two decades, a number of research projects have been conducted aiming to identify potential problem gamblers with the help of behavioral markers collected in gambling platforms.
The aim of Study II was to predict gaming freeze in an online gambling platform, based on one week of gambling data \((k=105\) predictors) collected one week before the freeze using a Random Forest algorithm. The predictive accuracy of the model applied to the testing dataset was 0.615 which was similar to the accuracies found in another trial predicting self-exclusion due to self-reported gambling problems with a range of machine learning algorithms having achieved accuracies between 0.621 and 0.658 (Philander, 2014). The predictive accuracy of the model used in Study II could be expected to be higher than the ones reported in Philander (2014). The referred study used a relatively small sample of \(N=570\) online account closers (targeting gamblers who closed the account due to gambling problems) which can be expected to be more homogenous than the sample used in the current project and therefore making it harder to achieve high predictive accuracy (Philander, 2014). Another recent study aiming to predict self-exclusion in a sample of online gamblers achieved the accuracy of 0.87 (Percy et al., 2016). The aspects that could have contributed to the high model performance are: 1) applying synthetic minority oversampling techniques to balance the sample, which created synthetic data points based on the existing data; 2) the use of gambling data collected closer than one week to the exclusion; 3) characteristics of the control group. The model's high performance relative to the one achieved in the current project is, however, unlikely to be fully attributed to these three aspects. The performance of the model used in the current study can be considered poor.

Study II aimed at predicting gaming freeze one week before its occurrence, and this aspect can play important role in the poor model performance in the main analysis. A previous study has found that the majority of changes in gambling preferences and intensity occur during the last days before the gamblers choose to close the account (Xuan & Shaffer, 2009). Exclusion of that data could have contributed to the poor model performance. This idea is supported by the results of the secondary analyses in Study II, showing improved model performance when the platform activity up until the moment of gaming freeze was included in the analyses. However, one important feature of potential predictive tools in online gambling is that they should create possibilities to act upon the results they show (Excell et al., 2014). From a public health perspective, it would not be useful to predict the event of the freeze very close in time to the freeze itself, as the goal of a harm-minimization strategy would be to prevent the behaviors causing the freeze (or self-exclusion), not the actual events of freeze or self-exclusion. Predicting the freeze closer in time to the event itself would however be more interesting for the gambling industry in order to prevent customer churn.
Only data collected during one week of gambling was used in the main analysis. The reason for that was that only data collected during 2017 was available for the project, making it impossible to analyse all existing data on gambling activity for all the participants, and making it harder to analyse the data during a fixed period of time – for example two months before the freeze, as some freezes occurred in the beginning of 2017. During one of the steps in preparing the data in Study III, only freezers with at least 14 days between the first day available and the freeze were selected, which reduced the sample of the freezers from 2,686 to 1,709. Limiting the freezer sample to the individuals with even more data available would make it smaller and even less representative for the population of the freezers. Moreover, the data on gambling intensity was not related to the individuals’ disposable income, decreasing the validity of time and money related gambling involvement as a relevant aspect in this context.

The most important predictors in the current project correspond to the ones identified in previous research (Braverman et al., 2011, 2013; Excell et al., 2014; Gray et al., 2012; Haeusler, 2016). Younger age both at the moment of freeze and at registration were more predictive of the probability for the subject to be a freezer, which is expected given that the current evidence suggests higher rates of gambling problems among younger individuals (Abbott et al., 2017; Barbaranelli, Vecchione, Fida, & Podio-Guidugli, 2013; Ekholm et al., 2014). Also, it has been previously shown that higher gambling involvement in general is associated with higher gambling involvement in adolescence (Carbonneau, Vitaro, Brendgen, & Tremblay, 2015). This corresponds to the current finding of the young age at registration being associated with a higher probability of being a freezer. Higher values for money-related variables were more predictive of the probability of being a freezer, which goes in line with the diagnostic criteria for gambling disorder that require presence of high gambling involvement (American Psychiatric Association, 2013), and higher gambling involvement tends to be associated with higher levels of gambling problems (Afifi, LaPlante, Taillieu, Dowd, & Shaffer, 2014; Binde et al., 2017; Yeung & Wraith, 2017). Higher variation in session duration and increase in session duration were also more predictive of the probability of being a freezer, together with the variation in sums of winnings per session, serving as an example of how important it is to consider variability and trajectory of gambling behaviours when aiming to identify gambling problems (Excell et al., 2014; Philander, 2014).

One of the unexpected findings is that gender was not among the N=20 most important predictors (Abbott et al., 2017), and one of the explanations can be that the freezers only partially overlap with the problem gamblers. The same possible explanation can be applied to the finding
that higher average duration of worktime sessions was less predictive of the probability of being a freezer. The finding is unexpected given that one of the symptoms of gambling disorder is the interference with everyday life (American Psychiatric Association, 2013). Higher total session length was less predictive of the probability of being a freezer, which contradicts a previous finding of time spent gambling being associated with higher levels of gambling problems (Gray et al., 2012). However, the latter finding can also be related to the fact that the freezers in the current sample tended to use the freeze quite soon after opening the account – 5 calendar days or less for 25% of the freezers having created their account in 2017. Moreover, a lower absolute gambling involvement (not related to the disposable income) corresponds to the fact that problem gamblers are more likely to belong to economically disadvantaged population groups (Afifi, Cox, Martens, Sareen, & Enns, 2010; Dowling et al., 2017; Faregh & Derevensky, 2013). Individuals with less money to spend are likely to spend too much money faster than the ones with higher disposable income.

With regard to the results of previous research and Study II, using a proxy target variable in an attempt to identify problem gamblers does not seem to be particularly effective. Also, successfully predicting self-exclusion or a gaming freeze in and of itself—even if the variables would be strongly associated with gambling problems—would not have much of an influence on the protection of vulnerable customers. To prevent gambling problems, even the correct identification of problem gamblers is not sufficient. What is needed is early identification of individuals at risk of developing gambling problems (Braverman et al., 2013; Dowling et al., 2017; Haefeli et al., 2011), and intervening on them. This would require analysing the data on behaviors that occur prior to individuals showing clear symptoms of problem gambling to stop the negative development. These analyses would require two conditions: 1) strongly encouraging gamblers to answer questions related to their symptoms of gambling problems (to understand how gambling patterns are associated with symptoms of problem gambling) and 2) accepting the fact that many false-positives would need to be intervened on in order to take care of the majority of true-positives. These conditions require further discussion.

First, information on gamblers’ symptoms of problem gambling would be needed to understand how they are associated with gambling behaviors. Information about one’s symptoms is just as important as an assessment made by an algorithm based solely on data on gambling behaviors. Also, it could be argued that a gambling platform with an infrastructure to collect data on symptoms of gambling problems should primarily use these data to intervene when individuals are in need of help. This would make
sense with regard to the fact that even predictive models that use symptomatic data as target variables still do not perform very well (Excell et al., 2014), and predictive models should not be the only tool used when the goal is to protect vulnerable gamblers. Moreover, gambling problems are highly prevalent in socio-economically weak population groups (Afifi et al., 2010; Dowling et al., 2017; Faregh & Derevensky, 2013) and identifying the problems would require measuring the gambling intensity in relation to the disposable income like it was done in Markham, Young, Doran and Sugden (2017). Having access to the data on disposable income and taking this data into consideration in an online gambling platform can be considered highly unlikely which provides more support to the idea of collecting data on symptoms of problem gambling. Therefore, routinely collecting data on symptoms of problem gambling in gambling platforms would be preferable.

The second condition, suggesting that one would have to intervene on false-positives to protect those at risk, is strongly related to the finding in Study III that indicated that non-problem gamblers (potential false-positives) are not disturbed by protective measures, and this matter is discussed in the next section.

Although attempts to identify problem gamblers or to predict the onset of gambling problems have not yet provided a perfect tool for protecting at-risk individuals, the use of data on gambling activities can be justified for this purpose. As previously mentioned, individuals with different levels of gambling problems have different behavioral patterns (Heiskanen & Toikka, 2016). Study I in the current project contributes to this knowledge, as the most intensive gamblers were the ones pre-committing without a prompt and subsequently increasing/removing their limits, which should be an important behavioral marker for being at risk of developing gambling problems. There is a large number of behavioral markers that can be used to identify potentially vulnerable individuals (Abbott et al., 2017; Cavalera et al., 2018; Challét-Bouju et al., 2016; Heiskanen & Toikka, 2016) and to begin communicating with them about their gambling habits. This does not eliminate the potential benefits of using machine learning algorithms to correctly identify at-risk gamblers (Deng et al., 2019). However, simply using behavioral markers along with the implementation of a self-test can be done by all gambling operators. On the other hand, creating and implementing more sophisticated algorithms can be a way of postponing protective actions, which is something to be aware of given the clear conflict of interest that gambling operators have.
Experiences of RPG tools

The importance of not disturbing recreational gamblers has been expressed by representatives of the gambling industry, policy makers, and researchers. This concern can be an obstacle in developing and implementing effective protective measures. The aim of Study III was to investigate non-problem gamblers’ experiences of and attitudes toward protective measures. The results showed that non-problem gamblers do not seem to be disturbed by protective measures and are the ones least likely to abandon a gambling service due to perceived overexposure to protective measures.

It could be speculated that potentially effective RPG tools are not being implemented precisely due to their effectiveness, and there is some evidence supporting this suggestion (Marionneau & Järvinen-Tassopoulos, 2017). Study III showed that moderate-risk gamblers and problem gamblers were most likely to abandon a gambling service due to overexposure to protective measures that they considered unnecessary. Unfortunately, the study did not explore what happened to the problem gamblers who abandoned the gambling service. However, regardless of this limitation and given gambling companies’ unlimited access to their own data, the true reason for effective tools not being implemented could be their unwanted (from the point of view of the gambling industry) effect on problem gamblers (who also provide the greatest share of the industry’s revenue (Fiedler, Kairouz, Costes, & Weißmüller, 2019; Yani-de-Soriano et al., 2012)) and not their potential effect on recreational gamblers.

The importance of preserving the recreational value of gambling for those not at risk has been emphasized in a number of documents (Productivity commission, 2010; SOU 2017:30, 2017). Study III showed that non-problem gamblers are not particularly disturbed by RPG tools. It could be argued that any level of disturbance for recreational gamblers is unwanted. As disturbance of those at risk can be considered a side effect of protective efforts towards them, the same disturbance of recreational gamblers can be more difficult to justify because it does not benefit recreational gamblers. On the other hand, the disturbance of recreational gamblers that is comparable to the disturbance that problem gamblers experience can be justified by the levels of protection for those in need. The matter would be somewhat more complicated if recreational gamblers would be significantly more disturbed by protective measures, but that is not the case according to the results of Study III.

The disturbance of recreational gamblers could still be a problematic issue from the point of view of industry revenue. If gambling industry is
expected to make legal and fair profit, it is in the interest of many stakeholders that the profit comes from recreational gamblers to the highest possible extent. RPG tools seem to affect recreational gamblers to a much lower extent than problem gamblers. It could be argued that the absolute number of recreational gamblers abandoning a gambling service might be higher than that of problem gamblers because recreational gamblers tend to be a majority even in the population of active gamblers. However, a large proportion of gambling revenue typically comes from a small number of highly involved gamblers (the distribution of NL in Study I supports this notion). Therefore, even assuming that the absolute number of recreational gamblers abandoning gambling services would be higher than the number of problem gamblers, the loss of revenue caused by losing problem gamblers would be expected to be much more substantial. Thus, the loss of non-problem-gambling revenue cannot be a reason for not implementing RPG tools.

The results of Study II also support the idea of needing to target all gamblers with RPG. The analysis conducted in the study had low accuracy when trying to identify gamblers who were about to freeze their account, giving little guidance in what subgroups should be targeted. Moreover, many freezers only have a short time window between the start of gambling activity related to the freeze and the freeze – a week or less – suggesting that for many freezers there is very little time for identification of and intervention upon presumed gambling problems. These findings indicate the need of applying the principles of RPG to the entire population of active gamblers.

To summarize, disturbing recreational gamblers and causing them to abandon a gambling platform should not be considered valid reasons for not implementing effective protective measures. The real reason could be the potential loss of problem gamblers and by that a large proportion of a company’s profit. However, even if the conflict of interest would be removed from the equation, there is an inherent dilemma in the presented issue. Even stakeholders with a pure public health perspective would not want problem gamblers to abandon a gambling service due to overexposure to protective measures that they consider unnecessary, which seems to be relatively common according to the results of Study III. Given that the question was interpreted by the respondents as intended and the reason for abandoning was the perceived overexposure to unnecessary protective measures, these are protective measures that can be considered highly ineffective because they fail to be accepted by the individuals in most need of them.
**Intrusiveness of RPG tools**

Study II failed to accurately identify presumed problem gamblers and a large proportion of freezers only gambled for a short period of time before using gaming freeze. As discussed before, one might therefore need to accept intervening on non-problem gamblers falsely identified as at-risk individuals. When attempting to create models for identifying problem gamblers or future problem gamblers, high sensitivity should be considered more important than high specificity. The results of Study III suggest that this approach might be reasonable and effective.

Also, based on the results of Study III, the intervention in Study I could be more intrusive (mandatory limit-setting, several prompts, longer cooling off period before a removed limit applies). Moreover, 84.4% of freezers used the freeze more than once, suggesting that using only one freeze does not prevent from the need of a subsequent use of a freeze. One of the possible explanations can be the non-intrusiveness of the tool, not providing gamblers with the break in gambling activity they might need. The findings are in line with previous research. One recent study found no effect of a 90 seconds mandatory play break on the length of the subsequent gambling session in video lottery terminal players from Norway (Auer, Hopfgartner, & Griffiths, 2019). Another recent study failed to find an effect of a warning label ("When the FUN stops, stop.") on subsequent gambling behaviors (Newall, Walasek, Singmann, & Ludvig, 2019). At the same time, a brief motivational interviewing-based intervention (a phone call to highly involved gamblers) was both effective leading to a 29% decrease in gambling-related losses, accepted by the ones targeted by it and not associated with the customers abandoning the gambling service (Jonsson, Hodgins, Munch, & Carlbring, 2019). The latter is an example of an intrusive and successful intervention, which might have been effective not only despite its intrusiveness, but because of it. The fact that the gamblers stayed loyal to the gambling company in the latter study is especially noteworthy with regard to the results of Study III showing that problem gamblers had most experience of abandoning a gambling service due to overexposure to protective measures. The results of the studies together suggest that the way a tool is implemented is of great importance for its effectiveness.

Apart from the current evidence suggesting that non-problem gamblers are not disturbed by protective measures (Ivanova, Rafi, Lindner, & Carlbring, 2019), there is evidence that a significant share of gambling-related harms affects individuals with lower levels of gambling problems because the absolute number of these individuals is much higher than those with more severe gambling problems (Browne & Rockloff, 2018). Therefore,
protecting individuals with lower levels of gambling problems can be important from a public health perspective as it would address a large proportion of gambling-related harms.

The use of RPG tools and gambling intensity

The current project sheds light on how RPG tools are being used. In line with previous research, participants in Study I and II who used such a protective tool without being prompted to it (either setting a deposit-limit or using gaming freeze) also showed higher gambling intensity (Gainsbury et al., 2019; Nelson et al., 2008). Interestingly, the higher gambling intensity was detected both prior to the use of the tool (in case with gaming freeze) and after the use of the tool (in case of setting a deposit-limit). This suggests that the higher gambling involvement is associated with higher awareness about one’s own need to regulate one’s gambling activity, and the awareness causes the use of protective measures. The rates of exposure or use of protective measures were not assessed in detail in Study III. However, moderate-risk gamblers and problem gamblers had significantly more experience of gaming freeze features. This difference between non-problem gamblers/low-risk gamblers and moderate-risk gamblers/problem gamblers is especially noteworthy given that the sample in Study III was non-representative for the population of online gamblers as it was self-selected. The ones who were encouraged to participate in the survey were active gamblers interested in winning a prize, suggesting that even non-problem gamblers/low-risk gamblers in the current sample were more involved gamblers than individuals with the same levels of gambling problems in the general population or in a representative sample of online gamblers. Despite this presumed higher involvement of non-problem gamblers/low-risk gamblers, moderate-risk gamblers/problem gamblers still had more experience of gaming freezes, supporting the results of previous research (Gainsbury et al., 2019). Also, the distribution of gambling problems in the sample of Study III was not representative for the population of gamblers (Salonen, Hellman, Latvala, & Castrén, 2018), which can be partly attributed to the chance of winning a gift card, but also to the fact that rates of gambling problems among online gamblers tend to be higher than among offline gamblers (Svensson & Romild, 2011). However, over half of the sample in Study III were either moderate risk gamblers (38.5%) or problem gamblers (15.6%), and one possible explanation for the high rates of gambling problems is that individuals with gambling problems are more acquainted with protective measures, and therefore were more interested in participating in the study. In sum, the current project shows that problem gamblers or gamblers with higher rates of gambling involvement tend to use protective
measures to a higher extent, might be more acquainted to them and have more interest in such measures. This suggests that the use of protective measures, especially unprompted, can be used as a marker of potential gambling problems.

RPG tools and gender

Men were more likely to set a deposit-limit at registration in Study I, which is in line with previous research on the use of protective measures (Forsström et al., 2016). According to the results of Study III, men were more likely to have more negative previous experiences of protective measures and more negative reactions to pictures of protective measures, and another recent study has revealed more positive attitudes towards RG-tools among females (Engebø et al., 2019). Previous research has shown that men tend to value availability, utility and convenience in gambling (Davis, 2014; McCormack, Shorter, & Griffiths, 2014), and RPG tools can influence those features in a negative way. Moreover, men tend to prefer games with an element of skill (Romild, Svensson, & Volberg, 2016; Svensson & Romild, 2014), which can be associated with perception of having control over one’s gambling. RPG communicates the idea of possible loss of control and the need of help, which does not correspond well with the assumptions above.

Surprisingly, gender was not among the strongest predictors of being a freezer in Study II, suggesting that there are gender differences in the use of different protective measures. Setting a deposit-limit at registration can be considered a more proactive measure, applied in a non-aroused emotional state, and it can be more reflective of the distribution of gambling problems in the population (more common among males) and therefore more reflective of awareness of one’s gambling problems. On the contrary, gaming freeze is more of a reactive protective measure, supposedly applied after a period of excessive gambling. Men tend to show higher levels of impulsivity (Stoltenberg, Batien, & Birgenheir, 2008), higher levels of risk-taking (Byrnes & Miller, 1999) and different gambling patterns (Davis, 2014), supposedly making them less likely to interrupt the game. Therefore, the use of gaming freeze can be less reflective of the distribution of gambling problems in the population of gamblers.

Design of RPG tools

To make the process of developing protective measures more efficient, future designs should be theoretically well-grounded. Together with the
current state of evidence, the results of the current project shed light on potentially important principles for designing RPG tools. As described in the introduction of the current thesis, there are several theoretical approaches that can be applicable when trying to understand what influences an individual’s gambling activity. Examples of these approaches are operant conditioning (Ramnerö et al., 2019), relational frame theory (M. R. Dixon et al., 2000), delay and probability discounting (Petry, 2012), theory of planned behavior (J. Lee et al., 2014) and theory of reasoned action (Procter et al., 2019). One could claim that there is no lack of theoretical basis for developing and evaluating potentially effective RPG tools. Also, certain RPG strategies seem to be sound with regard to multiple theoretical approaches. For example, pre-commitment can counteract the weaknesses in decision making that occur in the state of dissociation and when delay and probability discounting come into play. Feedback on time and money spent in the platform can counteract the state of dissociation and enforce extinction of gambling behaviors that is otherwise hindered by LDW and random reinforcing schemes. Normative feedback can both create verbal rules (M. R. Dixon et al., 2000) and guide behaviors based on the principles of theory of planned behavior. In other words, there is no lack of theoretically sound RPG strategies that are waiting to be properly evaluated.

Gambling behaviors are strongly reinforced by the random scheme of winnings, losses disguised as wins, lights and sounds (Ramnerö et al., 2019). In future protective designs, sustainable gambling behaviors can also be reinforced. Some research has focused on characteristics of non-problem gamblers, revealing for instance that they seldom play because they are upset, depressed, or bored, often calculate beforehand how much money they can spend on gambling and seldom have gambling as their primary leisure activity (Wood & Griffiths, 2015; Wood et al., 2017). Another study identified a number of safe gambling practices, such as stopping when not having fun, making a budget beforehand, taking breaks while gambling and quitting after a big win (Hing et al., 2019). Further investigation of behaviors associated with non-problem gambling (session length, number of deposits, absence of chasing losses, login frequency) could help identifying a set of behaviors that can be reinforced in a gambling session. An approach similar to this has been proposed previously: Wohl (2018) has proposed that loyalty programs could be used to reward engagement with protective tools. However, it would also be considered incompatible with the efforts of harm-minimization if sustainable gambling behaviors are rewarded with increased opportunity of using the gambling service. With regard to the latter, sustainable gambling behaviors could be reinforced non-monetarily: for instance, gam-
blers playing shorter sessions, only playing outside working hours, keeping the number of deposits to a minimum could receive notifications reinforcing those behaviors. These notifications might also create new verbal rules like “only depositing once per week is enough” and compete with the aspects preventing gambling behaviors from extinction (Ramnerö et al., 2019). Giving normative feedback like “Recreational gamblers tend to only make one deposit per week” in order to validate a gambler’s behavior and not modify it can serve an important reinforcing function. A study aiming to evaluate a positive feedback tool (a “Thumb-up-study”) was planned as a part of the current PhD-project but could not be conducted.

Providing gamblers with gambling breaks, giving them feedback on their gambling behaviors, and requiring them to set limits are all strategies that are likely to be effective for promoting sustainable gambling. However, they can be designed in various ways that would impact their effectiveness. For instance, both the deposit limit prompt described in the current project and a mandatory deposit limit with an upper limit would be classified as pre-commitment tools. However, the first does not seem to be effective, and the second can be expected to have reasonable effects. The time point for the introduction of the prompt (at-registration, pre-deposit and post-deposit) mattered for the proportion of the customers having set the deposit-limit. Also, a quarter of problem gamblers among the respondents in Study III have previously abandoned a gambling service due to overexposure to protective measures, but Jonsson et al. (2019) managed to make their relatively intrusive intervention both effective and well-accepted by the gamblers. The exact way of designing and implementing RPG tools are likely to be essential for their effectiveness.

In sum, there exists a rigorous theoretical basis for developing potentially effective RPG tools. Also, online gambling environments allow for having very few restrictions when designing RPG tools. The lack of knowledge about how to design protective measures and physical limitations are unlikely to be the reasons for the limited amount of research on these measures and for the blank spots in their implementation. The more likely reason is the lack of incitement for the gambling industry to develop effective protective measures, as making short-term profit is usually prioritized (Luo, Huang, & Lam, 2019).

Limitations
The project has a number of limitations, including both overarching ones and ones only applicable to single studies. First, all three studies were
conducted with subjects from one population: active users of a gambling operator from the Åland Islands living in Finland. This limits the generalizability of the results to other populations of gamblers. Mainland Finland has its own gambling monopoly, which is a rare phenomenon in Europe. This might have led to lower rates of exposure to diverse gambling products and higher rates of exposure to intended protective measures among the participants. The latter notion is especially important for the results of Study III, where possible increased exposure to protective measures could be the cause for both more positive attitudes, as protective measures are perceived as natural, and for higher rates of perceiving protective measures as unnecessary.

Apart from the fact that the entire project was based on samples drawn from one population of gamblers – active users of Paf online platform from Finland – the participants from Study III were self-selected and represented a small fraction (12 %) of the potential respondents. Moreover, the participants were likely to be motivated by the possibility to win a prize. This suggests that the non-problem gamblers presented in the sample were more active than representative non-problem users of an online gambling platform would be. That could lead to a history of higher exposure for protective measures which could influence gamblers’ attitudes towards protective measures and how they behaved due to the exposure. The scales used in Study III were not validated psychometric instruments, decreasing the validity of the results.

It is well-known that there exist subgroups of gamblers with regard to the patterns of gambling activity (Heiskanen & Toikka, 2016), preferred gambling activity (Challet-Bouju et al., 2016) and the use RPG tools (Forsström et al., 2016). The current project did not focus on possible subgroups of gamblers in detail, apart from comparing the different experimental conditions in Study I between the subgroups of the 10% most involved gamblers based on the number of active gambling days. Also, quantile regression based on the size of NL was conducted in Study I, but no subgroups were identified. However, it is likely that the results would be different if the different measures for gambling involvement would be taken into consideration (time and money) and if the trajectories of gambling activity (e.g. chasing losses) would have been studied more closely.

Access to the data for the current project had two important limitations. The first limitation was the prohibition to report real monetary values (NL, theoretical loss, stakes, deposits, withdrawals, and winnings) due to financial confidentiality, which limits the possibility to apply the results in the real world and to compare them to other trials. Also, the data could not be handled outside the server of the gambling company, limiting the
researchers’ possibilities to collaborate on the data handling and statistical analyses. Another limitation is that no data on the gamblers’ activity outside the platform was available in the current project.

Industry generated data is considered to be very valuable as it provides information on gambling behaviors of very high resolution, impossible to access otherwise (Deng et al., 2019). Unfortunately, in Study I and Study II, the data was aggregated to high extents due to computational reasons and due to the limited resources. The data in Study I was aggregated over the whole period of data collection (90 days starting at the account registration) and in Study II there was no information on individual stakes, the data on stakes was aggregated on hourly level. All in all, the potential of the data available in the current project was not fully used.

Although the studies provide valuable results for the future development of RPG tools, very important questions remain unanswered. Study I sheds light on the effects of deposit-limit prompt, but says nothing about the effects of actually setting a deposit limit, and knowing the effects of limit-setting is crucial for developing effective protective regulation. Study II provides information on predictive performance of a machine learning method, but even a method with very high accuracy cannot be used in isolation. Even very precise predictions still need to be used in order to intervene on possible at-risk gamblers, and what kind of interventions could be effective in this case is still underexplored.

One of the most important limitations of the project also results from one of its greatest strengths. The researchers had access to the data on real gamblers using a real gambling service due to their collaboration with a gambling company. This poses a clear ethical problem. Gambling companies attempting to protect vulnerable gamblers while they also are pressed to make profit are presented with a huge conflict of interest. A similar conflict of interest is previously well-known in the fields of tobacco use and alcohol addiction, and unsurprisingly, it has been shown that research conducted in collaboration with the industry is very often corrupted (Cassidy, 2014). There is evidence that the field of gambling is no exception to these tendencies (Cassidy, 2014). Although the results of the current project do not seem to clearly follow the gambling industry’s agenda, it is impossible to know in what way collaboration with the gambling operator influenced the research focus as well as the presentation and interpretation of the results. Possible corruption of the research field can be considered a sufficient reason not to collaborate with the gambling industry. In addition, researchers are unlikely to be able to conduct the experiments they consider the most meaningful using a commercial gambling platform. This leaves researchers with routinely collected data,
which is less valuable. In regulated gambling markets, there can be a possibility for the authorities to access the data as a part of regulation. In this case, researchers would be able to work with the routinely collected data without needing to collaborate with the gambling industry. Collaboration with a specific gambling company only gives access to the data collected in a specific platform, excluding an individual’s activity on other platforms. In other words, access to gamblers’ data via collaboration with a gambling company has its limitations, and the benefits might be overrated. For a gambling company, collaboration with researchers can be used as a marketing strategy.

**Ethical considerations**

Although the gambling company having funded the current PhD-project was not involved in the data analyses or the interpretation of the results, one could argue that researchers’ interpretations are inevitably influenced by the collaboration that involves a very explicit conflict of interest. Collaboration with the gambling industry is not desirable, but is often seen as a necessary compromise when other sources of funding are scarce (Cassidy, 2014; Hancock & Smith, 2017). However, maintaining collaborations with the industry can normalise this pattern, making it easier for the future researchers to accept industry funding and count on it. The practice of avoiding industry funding and finding other funding sources will, on the other hand, remain rare. Also, when the industry already funds research, the chances of an independent stakeholder taking over this function may decrease.

**Future directions**

The current project has revealed a number of gaps in the field of the responsible provision of gambling and online gambling specifically. First, there is a need for clear terminology that can be applied specifically to the tools and design features of gambling platforms that aim to help gamblers use the services in a sustainable manner. The terms consumer protection, prevention, RG, and social corporate responsibility are all relatively ill-fitted for this purpose. Protective measures or harm-minimization tools can be feasible candidates for such a term. Also, the term RPG tools can be suitable to describe the tools that aim to make gambling environments as safe as possible, not limited to helping gamblers take their individual responsibility to make informed choices.
The results of Study III showed that problem gamblers were most likely to abandon a gambling service due to perceived overexposure to protective measures that they consider unnecessary. This suggests that protective measures as they are currently designed are most aversive for the individuals who are in most need of protection, possibly channelling them away to less protective services. Clearly, there is an important future challenge in designing the tools that can guide problem gamblers without being aversive. This might be one of the few contexts when the agenda of stakeholders in public health might overlap with the agenda of commercial gambling operators: neither of the stakeholders has an interest in causing problem gamblers to play using an irresponsible service.

The results of all three studies included in the current project suggest the need for more experimental trials in the field of RPG. The lack of an expected effect in Study I suggests that more common designs should be tested with a randomized controlled study design, and the main results of Study III suggest it is safe to do so without concerns related to potential negative effects on recreational gamblers. The results of Study II also suggest the need for not only attempting to identify at-risk gamblers or to predict the onset of gambling problems but also for using these different strategies to intervene on subgroups of gamblers and to evaluate which strategy leads to the best effects.

Future research needs to focus on defining the goals of RPG. Whether there is a reasonable upper limit for gambling involvement and how it can be measured, whether it should be related to an individual’s disposable income and whether individuals abandoning gambling services should be seen as a success of RPG or failure in channelling customers to responsible services are all important questions to answer. Also, from the public health perspective, information on the gamblers’ total gambling activity – not only connected to a certain platform – is important. RPG tools that use this information – limits and exclusion programs that apply across all the regulated online gambling platforms as well as feedback on spendings that is not platform specific – are likely to be more effective than platform specific measures and online gambling platforms have capacity to create the necessary infrastructure.

It is highly unlikely that the gambling industry will take the lead in developing effective RPG tools (Cowlishaw & Thomas, 2018; Yani-de-Soriano et al., 2012), and policy actions are needed to minimize gambling-related harms (Wardle, Reith, Langham, & Rogers, 2019).
Conclusion

Results of the current project have shown that a common pre-commitment design (a prompt to set a voluntary deposit-limit of optional size) did not appear to be effective in decreasing gambling intensity in online gamblers, indicating that this particular design cannot be classified as a protective measure and that there is a need of evaluating alternative designs. Predicting gaming-freeze in the current project achieved a relatively low accuracy, indicating that gaming freeze is not suitable as a proxy measure for problem gambling and suggesting the need of collecting subjective data on gambling symptoms and combining them with data on tracked gambling activity in the analyses. The results of Study III suggest that protective measures can be tested and implemented without the risk of disturbing recreational gamblers and channelling them away to gambling services lacking customer care agenda. In other words, there is an urgent need for further research on and implementation of effective tools for responsible provision of online gambling, and these efforts should not be hindered by the commonly expressed concerns about negative impact on recreational gamblers.
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