DEPARTMENT OF PSYCHOLOGY

WHAT DRIVES THE GAMBLE? UNVEILING THE PSYCHOPATHIC TRAITS AND MOTIVATIONAL FORCES BEHIND GAMBLING SEVERITY: AN EXPERIMENTAL PSYCHOPHYSIOLOGICAL STUDY

DOCTOR OF PHILOSOPHY DISSERTATION

TONIA – FLERY ARTEMI

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TONIA – FLERY ARTEMI

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DECLARATION OF THE DOCTORAL CANDIDATE

The present doctoral dissertation was submitted in partial fulfillment of the requirements of the degree of Doctor of Philosophy of the University of Cyprus. It is a product of original work of my own, unless otherwise mentioned through references, notes, or any other statements.

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ABSTRACT IN GREEK (ΠΕΡΙΛΗΨΗ)

Η παρούσα διατριβή εξετάζει πώς οι παίκτες τυχερών παιχνιδιών με διάφορα επίπεδα σοβαρότητας στοιχηματικής συμπεριφοράς (ΣΣ) ανταποκρίνονται σε διάφορες συνθήκες κέρδους (Ενθουσιασμού) ή ήττας (Απογοήτευσης) που προκύπτουν από ένα εικονικής πραγματικότητας κουλοχέρη και σε συναισθηματικά ερεθίσματα μέσω εικόνων (Χαρά, Αηδία, Φόβος, Ουδετερότητα). Η μελέτη επίσης εξετάζει την επιρροή των ψυχοπαθητικών χαρακτηριστικών (ΨΧ), της ευαισθησίας στην τιμωρία (ΕΤ) και της ευαισθησίας στην ανταμοιβή (ΕΑ) στις αντιδράσεις αυτές χρησιμοποιώντας ψυχοφυσιολογικές μετρήσεις και μετρήσεις αυτοαναφοράς.

Στην πρώτη μελέτη, χρησιμοποιώντας ένα εικονικό κουλοχέρη, οι συμμετέχοντες εκτέθηκαν σε συνθήκες ενθουσιασμού/ απογοήτευσης. Οι ψυχοφυσιολογικές μετρήσεις, όπως ο καρδιακός ρυθμός (HR) και το επίπεδο αγωγιμότητας του δέρματος (SCL), καταγράφηκαν, μαζί με μετρήσεις αυτό-αναφοράς. Αντίθετα με την αρχική υπόθεση, ο HR δεν διέφερε σημαντικά μεταξύ των συνθηκών ούτε αλληλοεπίδρασε με τα ΣΣ. Το SCL έδειξε σημαντικές διαφορές μεταξύ των συνθηκών, αντανακλώντας διαφορετικές αντιδράσεις διέγερσης, αν και η σοβαρότητα της ΣΣ δεν επηρέασε αυτές τις αντιδράσεις. Διερευνητικές αναλύσεις έδειξαν ότι οι παίκτες χαμηλής σοβαρότητας παρουσίασαν αυξημένη επιθυμία για να στοιχηματίσουν, μετά το τέλος του παιχνιδιού.

Η δεύτερη μελέτη εξέτασε τη σχέση μεταξύ της σοβαρότητας ΣΣ, της μεταβλητότητας της διακύμανσης του καρδιακού ρυθμού (HRV) και των ΨΧ χρησιμοποιώντας ένα εικονικό κουλοχέρη. Τα υψηλότερα σκορ ΣΣ συσχετίστηκαν με χαμηλότερη HRV, υποδεικνύοντας δυσρυθμισμένη αυτόνομη λειτουργία. Ωστόσο, αυτό το αποτέλεσμα δεν διέφερε σημαντικά μεταξύ των διαφορετικών συνθηκών ήττας και κέρδους. Τα αποτελέσματα υποδεικνύουν πως πιο χαμηλές τιμές HRV κατά τη διάρκεια των συνθηκών υψηλής απογοήτευσης σε παίκτες με υψηλότερη σοβαρότητα ΣΣ, υποδεικνύουν μεγαλύτερη αυτόνομη δυσρύθμιση σε μεγαλύτερες απώλειες.

Η HRV κατά τη διάρκεια της αρχικής χαλάρωσης ήταν υψηλότερη από ό,τι κατά τη διάρκεια των συνθηκών. Οι συνθήκες ενθουσιασμού μείωσαν την HRV, υποδεικνύοντας κυριαρχία του συμπαθητικού συστήματος και αυξημένη διέγερση. Η μεγαλύτερη μείωση HRV παρατηρήθηκε κατά την υψηλή απογοήτευση, αντανακλώντας σημαντική συναισθηματική δυσφορία. Παρά τα ευρήματα αυτά, οι αναμενόμενες αλληλεπιδράσεις μεταξύ της σοβαρότητας της ΣΣ και HRV δεν ήταν στατιστικά σημαντικές.

Η τελική μελέτη ανέλυσε τις ψυχοφυσιολογικές και υποκειμενικές συναισθηματικές αντιδράσεις σε διάφορα ερεθίσματα σε διαφορετικά επίπεδα σοβαρότητας ΣΣ. Αντίθετα με την υπόθεση, δεν παρατηρήθηκαν σημαντικές διαφορές στον HR, το SCL, τη δραστηριότητα του σφιγκτήρα των φρυδιών (COR) ή τη δραστηριότητα του ζυγωματικού μυός (ZYG) μεταξύ των επιπέδων σοβαρότητας. Ωστόσο, οι μετα-ανάλυσεις έδειξαν ότι οι παίκτες με χαμηλή σοβαρότητα παρουσίασαν αυξημένη δραστηριότητα του COR κατά τη διάρκεια φοβικών ερεθισμάτων. Οι παίκτες με υψηλή σοβαρότητα παρουσίασαν μειωμένες αντιδράσεις σε αρνητικά συναισθήματα, πιθανόν λόγω απευαισθητοποίησης.

Η μελέτη επίσης εξέτασε τον ρόλο των ΨΧ και της ΕΑ και ΕΤ σε αυτές τις αντιδράσεις. Τα ΨΧ επηρέασαν τις συναισθηματικές αντιδράσεις, ενώ τα χαρακτηριστικά ΕΑ και ΕΤ δεν επηρέασαν σημαντικά τις φυσιολογικές αντιδράσεις στα συναισθηματικά ερεθίσματα.

Η μελέτη σημείωσε ότι παράγοντες προσωπικότητας, όπως η παρορμητικότητα, η αναζήτηση έντονων αισθήσεων και τα ΨΧ επηρεάζουν τη ΣΣ και τις ψυχοφυσιολογικές αντιδράσεις, με τα υψηλότερα ΨΧ να συνδέονται με αυξημένη σοβαρότητα ΣΣ. Η παρούσα διατριβή παρέχει γνώσεις για τις πολύπλοκες αλληλεπιδράσεις μεταξύ συναισθηματικών και ψυχοφυσιολογικών παραγόντων που αφορούν τη ΣΣ. Τονίζει την ανάγκη για λεπτομερή έρευνα για την ανάπτυξη στοχευμένων παρεμβάσεων με βάση τα επίπεδα σοβαρότητας και τα συναισθηματικά προφίλ των παικτών.

Λέξεις-κλειδιά: Τυχερά παιχνίδια, Ψυχοπάθεια, Ψυχοφυσιολογία, Μεταβλητότητα καρδιακού ρυθμού (HRV), Ενθουσιασμός, Απογοήτευση, Συναίσθημα

ABSTRACT

The current dissertation investigates how gamblers with varying severity levels, assessed by the South Oaks Gambling Screen (SOGS), respond to different slot-machine conditions (Exciting and Frustrating) and emotional imagery stimuli (Happy, Disgust, Fear, Neutral) and explores the influence of psychopathic traits, sensitivity to punishment, and sensitivity to reward on these responses using both subjective and physiological measures. To mimic real-life gambling scenarios, the first study utilized a Virtual Slot-Machine task where participants were exposed to Exciting and Frustrating conditions. Psychophysiological measures, including heart rate (HR) and skin conductance level (SCL), were recorded, alongside self-report measures assessing valence, arousal, control, and desire to play. Contrary to the initial hypothesis, HR did not differ significantly between conditions or interact with SOGS scores, indicating no substantial influence of emotional states or gambling severity on HR. However, SCL exhibited significant differences between conditions, reflecting distinct arousal responses, although gambling severity did not modulate these responses. Exploratory analyses revealed that low severity gamblers experienced increased gambling urges post-task, suggesting a reinforcing gambling experience.

The second study examined the relationship between gambling severity, HR variability (HRV), and psychopathy traits using a simulated slot-machine task and self-report measures. Higher SOGS scores were associated with lower HRV, indicating dysregulated autonomic functioning. However, this effect did not significantly vary across different task conditions. Trends suggested more pronounced HRV reductions during high frustration in severe gamblers, implying heightened autonomic dysregulation in response to significant losses. Baseline HRV was higher than during gambling tasks, indicating a more stable autonomic state without emotional arousal. Excitement conditions decreased HRV, indicating sympathetic dominance and heightened arousal. The most substantial HRV reduction occurred during high frustration, reflecting significant emotional distress. Despite these findings, anticipated interactions between gambling severity and task conditions on HRV were not statistically significant.

The final study analyzed psychophysiological and self-reported emotional responses to various stimuli across different gambling severity levels. Contrary to the hypothesis, no significant differences in HR, SCL, corrugator activity, or zygomatic activity were observed across severity levels. However, post-hoc tests revealed that low severity gamblers exhibited heightened corrugator activity during fearful stimuli, indicating more intense reactions to negative emotions. High severity gamblers displayed blunted responses to negative affect, possibly due to desensitization.

The study also examined the role of psychopathy and sensitivity to punishment/reward in these responses. Psychopathy traits influenced emotional responses, while sensitivity traits did not significantly impact physiological reactions to emotional stimuli. This dissertation provides insights into the complex interactions between emotional, cognitive, and physiological factors in gambling behavior. The study noted that personality factors like impulsivity, sensation-seeking, and psychopathic traits impact gambling behavior and physiological responses, with higher psychopathic traits linked to increased gambling severity. Future research should address potential habituation in high severity gamblers and include broader personality assessments and socio-economic factors influencing gambling responses. These efforts could inform interventions aimed at mitigating problematic gambling behaviors and improving therapeutic approaches.
Keywords: Gambling; Psychopathy; Psychophysiology; HRV; Excitement; Frustration; Emotion

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1.What Drives the Gamble? Unveiling the Psychopathic Traits and Motivational Forces Behind Gambling Severity: An Experimental Psychophysiological Study

1.1. Introduction

For many people, gambling is maintained as a fun, enjoyable and harm-free activity (Griffiths et al., 2006). However, for an estimated 1.5 % of the adult population, gambling progresses into a disorder with serious negative financial, social, health and occupational consequences (Ciccarelli et al., 2021; Wardell et al., 2015). Given the popularity of gambling and its potential to result in serious dysfunction, interpersonal, mental health and financial problems, it is crucial to understand the risk factors that most clearly describe those who progress into pathological gambling. Typical motives for gambling include positive reinforcement, driven by the Reward/approach system, (Sensitivity to Reward-SR) by rewards like gaining money, feeling the arousal, entertainment and excitement associated with winning, or the socialization involved (Francis et al., 2015). However, gambling may also represent a negatively reinforced behavior, as an attempt to cope and escape from difficult emotions, with gambling behavior increasing when one feels distressed (DSM-5). To better understand gamblers who are more at risk to develop problematic gambling behaviors, the application of well-established theories of human motivation needs to be taken into consideration.

Psychopathy, particularly as assessed by the Triarchic Psychopathy Measure (TriPM), encompasses traits such as boldness, meanness, and disinhibition. Studies indicate that individuals scoring high in psychopathy traits, especially those related to disinhibition, exhibit higher tendencies toward problematic gambling behaviors. For example, research by Lopes, et al., (2024), and Snowden, et al., (2017) found a significant association between psychopathy and gambling, Worthy et al., 203 found that higher scores in the TriPM's boldness predict increased risk taking in a gambling task, suggesting that the impulsivity and lack of foresight associated with psychopathy contribute to maladaptive gambling behaviors.

Research indicates that individuals with high levels of psychopathic traits often exhibit a diminished sensitivity to the emotional feedback associated with wins and losses in gambling. This insensitivity can result in a persistence of gambling behavior despite accumulating losses, driven by a heightened need for excitement and a lack of aversive response to negative outcomes (Blaszczynski & Nower, 2002).

Psychopathic traits, particularly impulsivity and the pursuit of high-stimulation activities, are significantly associated with problem gambling (Mishra, Lalumière, & Williams, 2010). These individuals may engage in gambling as a means to achieve the excitement they crave, often disregarding the potential negative consequences resulting to different motivational mechanisms connected to gambling behavior. This behavior is compounded by their impaired emotional regulation and reduced physiological responsiveness to stress, as evidenced by lower heart rate variability (HRV) (Lorber, 2004).

The effects and interactions of different systems of human motivation, and individual differences in the predominance of different motives have been explained in the context of Reinforcement Sensitivity Theory (RST; Gray,1982, 1987), an application of animal learning research to individual differences in human personality. The theory postulates two primary motivational systems: the Behavioral Inhibition System (BIS) and the Behavioral Activation System (BAS). Each system responds to a separate subset of contingencies with specific types of behaviour.

BIS is responsible for organizing behavior in response to stimuli that signal conditioned aversive events, more specifically stimuli associated with punishment and with the omission or termination of reward (i.e., non- reward) but also with extreme novelty, high intensity stimuli, and fear stimuli (e.g., snakes, blood). These stimuli elicit behavioral inhibition (interruption of ongoing behavior), an increase of arousal (such that the next behavior to occur is carried out with extra vigour and/or speed), and inattention.

BAS, the Behavioral Activation System (Fowles, 1980), is responsible for organizing behavior in response to desirable stimuli. BAS is sensitive to stimuli that signal unconditioned reward and the relief from punishment. In general, activity of the BAS is involved in approach behaviors.

Over the years, RST developed to include a third major system: the Fight-Flight System (FFS; Gray, 1987) which responds to unconditioned aversive stimuli, to unconditioned punishment or unconditioned non-reward, whereas the BIS responds to conditioned aversive stimuli. The most recent revision of the RST (rRST; Gray & McNaughton, 2000) postulates the existence of three major motivational systems that respond to reward and punishment and are related to different neurophysiological systems (Kennis et al., 2013).

Behavior elicited by these stimuli consists of unconditioned defensive aggression (fight) or escape behavior (flight). BAS is hypothesized to be sensitive to reward (SR), and thus leads individuals to attain goals (McNaughton, & Corr, 2008).

RST assumes that individuals differ in the intensity of responses of these systems. People characterized by motivation tendencies at the far poles of the BIS and BAS dimensions are at increased risk for developing psychopathology (Pickering & Gray, 1999) and empirical evidence supports the association between extreme self-reported BIS/BAS scores and adjustment problems (Knyazev, Wilson, & Slobodskaya, 2008; Slobodskaya, 2007).

Predictions as to the link between BIS/BAS sensitivity and vulnerability to psychopathology differ according to which version of RST (original versus revised) is taken as frame of reference and whether separable or joint effects of the major motivational systems are expected (separable versus joint sub-systems hypothesis). In broad terms, when using the original RST as the framework, elevated BIS activity has been put forward as a vulnerability factor to internalizing disorders, whereas elevated BAS activity has been assumed to make individuals more prone to externalizing problems (Slobodskaya, 2007). Multiple studies have provided evidence in support of these predictions (O'Connor, Colder, & Hawk, 2004; Muris, Meesters, DeKanter, & Timmerman, 2005; Slobodskaya, 2007).

For example, relative to the opposite system, high BIS engagement has been related to anxiety (Gray, 1982), low BIS engagement to attention-deficit hyperactivity disorder (Quay, 1997) and psychopathy (Fowles, 1980), high BAS engagement to conduct disorder (Quay,1993) and low BAS engagement to depression (Depue, Krauss, & Spoont, 1987).Interactive effects of BIS and BAS have also been linked to psychopathology. It has been hypothesized that lower BIS *and* BAS sensitivity may be associated with low sensitivity to rewards, anhedonia, and probably low arousal during both punishing and rewarding stimuli. These traits might be associated with Primary Psychopathy which is defined as consisting of interpersonal and affective aspects of psychopathy, such as lying, cheating, aggression, callous behavior, and an overall lack of empathy and heightened grandiosity (Hare, 2003; Lilienfeld & Andrews, 1996; McHoskey et al., 1998; Del Casale et al., 2015).

Low BIS and High BAS sensitivity, on the other hand, has been connected to Secondary Psychopathy, which is defined as including high sensitivity to reward, high impulsivity, and thrill/sensation-seeking (Hare, 2003; Lilienfeld & Andrews, 1996; Poythress & Hall, 2011). High BAS and high BIS sensitivity has been associated with externalizing problems and Impulsivity as well as higher risk for suicide and impaired decision making (Bryan et al., 2022), while low BAS and high BIS were linked to increased symptoms of depression and anxiety and inattention (Hundt et al., 2008). However, although some of the expected links between BIS/BAS and psychopathology are supported by empirical evidence, for others the evidence is less consistent.

Adding to this complexity, recent research by Kramer et al. (2022) highlights distinct pathways through which different facets of psychopathy contribute to gambling problems. This study showed, that secondary psychopathy, characterized by impulsivity and emotional dysregulation, predicted the likelihood of an individual developing gambling problems through the mechanism of urgency. In contrast, primary psychopathy, marked by traits such as callousness and manipulativeness, better predicted the severity and number of gambling-related problems an individual might face.

The connection between psychopathy and the Behavioral Inhibition System (BIS) and Behavioral Activation System (BAS) in the context of gambling behavior is intricate, involving multiple psychological dimensions and behavioral tendencies. Both primary and secondary psychopathy traits can be linked to heightened BAS activity, though in different ways. Individuals with secondary psychopathy often have high BAS activity driven by impulsivity and a strong desire for immediate rewards (Hundt et al., 2008). This can lead to increased engagement in gambling as a means to seek excitement and immediate gratification.

Secondary psychopathy is characterized by impulsivity, emotional instability, and a high urgency to act without thinking about the consequences (Kramer et al., 2022). This aligns with heightened BAS activity, where the drive for rewards and positive reinforcement overrides the cautious, inhibitory signals of the BIS. As a result, individuals with secondary psychopathy are more likely to engage in gambling as an impulsive, thrill-seeking activity, regardless of potential negative outcomes.

Primary psychopathy involves traits such as callousness, lack of empathy, and manipulativeness. These individuals also tend to have reduced BIS activity, leading to a decreased sensitivity to potential punishments or losses. However, they may engage in gambling not just for immediate rewards but also as a strategic means to exploit situations for personal gain. Their low BIS activity means they are less deterred by losses, while their high BAS activity drives them toward high-risk, high-reward situations.

Another particularly important indicator of emotion and motivation systems that seems to be associated with psychopathy is that of Heart Rate Variability (HRV). Segara et al, (2022) examined the relationship between HRV and the boldness disposition within the triarchic model of psychopathy. HRV as a well-established physiological index of emotional regulation capacity. The high-frequency band of HRV reflects parasympathetic influence on heart activity and is proposed as a transdiagnostic biomarker of self-regulation and mental health resilience. It highlights how individuals with high boldness exhibit both maladaptive traits and adaptive features like emotional resilience.

A study by Hansel et al. (2007) demonstrated that individuals with lower HRV exhibited higher levels of impulsivity and risk-taking behaviors, which are common in both psychopathy and gambling addiction . This suggests a potential underlying physiological mechanism where diminished HRV contributes to the impaired decision-making processes seen in psychopathy and gambling disorders. Psychopaths might not experience the typical emotional highs and lows associated with winning or losing, potentially leading to more persistent and escalated gambling as they seek more intense stimulation. Furthermore, research by Yechiam et al. (2008) indicates that individuals with high levels of psychopathy display poorer decision-making in gambling tasks, often ignoring the potential negative consequences of their choices. This insensitivity to the emotional feedback typically provided by wins and losses means that psychopathic individuals may continue to gamble despite mounting losses, driven by a need for excitement and a lack of aversive response to negative outcomes. Thus, the interconnections between psychopathy, gambling, and HRV highlight the multifaceted nature of these conditions, underscoring the importance of integrating psychological and physiological assessments in understanding and treating these behaviors (Wendt, & Thayer, 2024).

The differences between reward-sensitive and lower sensitivity to punishment among individuals who seem to exhibit more psychopathic characteristics, as well as conversely, the strong sensitivity to punishment that seems to be associated with a lower capacity for emotion regulation were studied through Reinforcement Sensitivity Theory (RST). The role of RST systems in gambling pathology has also been recently examined. Since winning in gambling is rewarding, individuals with high BAS sensitivity (high SR) can be hypothesized to engage in betting more, motivated to seek these rewards. A small previous literature has examined relationships between BAS and gambling decision-making (Brunborg, Johnsen, Mentzoni, Molde, & Pallesen, 2011; Demaree, DeDonno, Burns, & Everhart, 2008; Kim & Lee, 2011) and gambling severity. Brunborg and colleagues (2011) and Demaree et al. (2008) found a positive associated between BAS sensitivity and the size of the average bet on a laboratory slot machine task. Similarly, Kim and Lee (2011) through BIS/BAS self-report scales (Carver & White, 1994) found that individuals with a high BAS sensitivity bet larger amounts and exhibited greater confidence even in situations with high likelihood of losing.

The findings demonstrate a significant association between BAS and gambling, further supporting the idea that high SR may act as a risk factor for problematic gambling. On the other hand, the link between BIS and gambling motivation may seem less apparent. For this reason, there is an even more limited literature investigating BIS and gambling behavior. BIS is hypothesized to be sensitive to punishment (SP) or nonreward, resulting in anxiety or fear, and thus stops individuals' impulsive actions or resolves approach–avoidance situations (Corr, 2002; Gray, 1991), and may act as a protective factor for problematic gambling. As losing in gambling is often punishing or nonrewarding, individuals with high sensitivity to punishment are expected to abstain from betting. In fact, Demaree et al. (2008) found that SP (BIS) is associated with less risk-taking while SR (BAS) is associated with greater risk-taking. Moreover, in the same study, the influence of high SP (BIS) on risk-taking was greater than high SR (BAS). Similarly, Kim and Lee (2011) found that BAS, or SR, was positively associated with greater risky gambling decisions after a winning experience while BIS, or SP, was negatively associated with risky gambling decisions after the same experience.

However, BIS may, under some circumstances, also have a positive association with gambling severity. Individuals who might be high in the anxiety associated with sensitivity to punishment, or who experience high levels of negative affect due to neuroticism, depression or other individual affective characteristics, as well as individuals who may have difficulties in downregulating these unpleasant emotions, may engage in a variety of risk-taking behaviors, including gambling, to alleviate negative affect and escape reality. Based in this we (Neophytou, Theodorou, Theodorou, Artemi, & Panayiotou, 2021), and many of the main theorists in this field, hypothesized that pathological gamblers have deficits in emotion regulation processes and abilities, that is luck access to healthier ways to deal with distress, and therefore turn to gambling and other addictions (Navas et al., 2016; 2017). If so, this might suggest a positive association between SP and gambling (Hudson, Jacques, & Stewart, 2013). Therefore, BIS may hold different associations with gambling severity, and it has been argued that these opposing mechanisms might explain the null findings in recent literature on associations between BIS and gambling (Brunborg et al., 2011).

As suggested above, in addition to the role of motivation systems, which can be considered as more biologically based, individual differences in gambling behavior may be modulated by the degree to which one is able to regulate intense negative and positive emotions, or the interaction between specific motives and emotion regulation ability. Many mental disorders involve deficits in emotion regulation (e.g., Joormann & Siemer, 2014). Emotion regulation involves managing and accepting undesired and desired emotions (i.e., emotion goals) by using emotion-regulation strategies (Gross, 2015; Millgram, Joormann, Huppert, & Tamir, 2015). However, individuals in the psychopathology spectrum may experience deficits in the ability to modulate or accept their feelings in ways that allow them to reach their goals (Thompson, 2019).

1.2. Current Study

To-date, gambling motives, and emotion regulation deficits in relation to pathological gambling have been studied mostly through self-report methods, surveys, and in rare cases, small behavioral experiments. In the current research we include 2 different experiments to study the motivational and emotional responses of people with different levels of gambling involvement. In experiment 1 we re-create conditions that simulate the gambling environment, through a realistic gambling task and use behavioral and psychophysiological objective measures to study motivational and emotional responses "on-line", as they are dynamically taking place in real time. In experiment 2 we place individuals in different affective contexts, to examine processes of emotional response and regulation in relation to their level of gambling involvement.

Specifically, in the first experiment we used a Slot Machine simulated task to assess the motivational responses of gamblers, using objective indices of arousal, i.e., psychophysiological measures of Heart Rate Variability, Heart Rate and Skin Conductance Level, during different gambling conditions. Conditions were simulated via different types of trials that represent Win, Near to Win, and Lose outcomes, that according to the literature induced responses of Excitement, or Frustration. It was expected that intensity of responses to these different conditions would be correlated with 1.) severity of gambling behavior 2.) dominance of different motivation systems (BIS/BAS) measured though Sensitivity to Punishment/Reward Questionnaire 3) self-reported emotion regulation ability and 4) psychopathic traits.

In the second experiment we aimed to assess the emotional responses of gamblers to different emotional contexts evoked through standardized pictures from the International Affective Picture System (IAPS) (Positive /Negative /Neutral) using different physiological indices of arousal (heart rate, skin conductance level –HR, SCL) and valence (facial electromyography -EMG). Finally, we examined how these emotional reactions of gamblers were associated with 1.) their level of gambling severity 2.) their emotion regulation ability and 3) psychopathic traits.

We expect that the combination of these two experiments would allow us to explore the mechanisms underlying gambling behavior and the emotional/motivational factors that predict its level of severity. The novelty of this study lies in the use of well-controlled experimental tasks to examine emotion and motivation, rather than purely self-report, and the use of physiological measures as objective indices of emotional and motivational responses.

1.3. General Method

Level of gambling occupation and pathological Gambling symptoms was detected using South Oaks Gambling Screen Tool-Revised (SOGS) and Problem- Gambling Severity Index (PGSI), and one added question :1.*"How much money do you gamble every month?" (e.g.* €1 – €25; €26 – €100; €101 – €1000; €1001 – €10,000 , more than €10,000). *According* to several studies (Fong, & Ozorio, 2005; Wood, R. T., & Williams, R. J. 2007), individuals who bet 25 euros or more in a month, tend to be more frequent players. Through this target population, individuals invited to participate in the study in exchange for extra credit or small monetary reimbursement. All participants' age was above 18 years. Approval of all procedures was sought from the National Bioethics Committee in Cyprus before data collection. Written consent was requested from all participants before participating in the experiment.

2. Measures and materials

2.1. Self- Report Measures

South Oaks Gambling Screen Tool-Revised (SOGS)

The South Oaks Gambling Screen (SOGS) is a 20-item questionnaire for pathological gambling (Lesieur, & Blume, 1993). The SOGS is scored by summing the number of items endorsed out of 20, and a cut score of 5 or more indicates that the respondent is a Probable

Pathological Gambler (PPG). The original development study found the SOGS to demonstrate satisfactory reliability - α= .69 and α=.86- in the general population and gambling treatment samples, respectively (Stinchfield, 2002). For this study reliability was satisfactory, α= .77.

Problem Gambling Severity Index (PGSI)

The PGSI is a part of the Canadian Problem Gambling Index (CPGI, Ferris and Wynne 2001). Has been designed so as to serve both as a prevalence measure and a general population screen that is brief, reliable and valid. It encompasses 9 items tapping the frequency with which respondents had a gambling-related experience during the past year. Answers are rated on a four-point scale (0 = never, 1 = sometimes, 2 = most of the time, 3 = almost always) and higher composite scores indicate greater risk of problem gambling. Cut-off scores enable segregation of respondents into different subtypes of gamblers: (1) non-problem gamblers, (2) low-risk gamblers, (3) moderate-risk gamblers and (4) problem gamblers. The PGSI had excellent internal consistency (Cronbach's alpha coefficient: 0.89) and moderate test-retest reliability after 45–60 days (intraclass coefficient: 0.54). (Soa, Matsushita, Kishimoto, & Furukawa, 2019). For this study reliability was satisfactory, α= .79.

Sensitivity to Punishment Sensitivity to Reward Questionnaire (SPSRQ)

The SPSRQ is a 48 yes-no response item questionnaire containing two scales: Sensitivity to Punishment- SP; a 24-item and Sensitivity to Reward -SR; including 24 items (Torrubia et al., 2001). The items included in SP were designed to measure individual differences in some functions dependent on the BIS: 1) behavioral inhibition (passive avoidance) and 2) worry or cognitive processes produced by the threat of punishment or failure (Moltó, 1988). Items in SR of this scale included topics such as money, sex, power, or sensation-seeking, trying to describe situations in which people try to gain rewards (Torrubia et al., 2001). The reported internal consistency of the full SP- and SR-scales are .88 and .81, respectively (Vandeweghe et al., 2016). For this study reliability was satisfactory, α= .74 for the whole scale and .SP- and SR-scales are .72 and .87, respectively.

Difficulties in Emotion Regulation Scale (DERS)

The Difficulties in Emotion Regulation Scale (DERS) is an instrument measuring emotion regulation problem (Gratz & Roemer, 2004). The 36 items self-report scale asks respondents how they relate to their emotions in order to produce scores on the following subscales: 1.

Nonacceptance of emotional responses, 2. Difficulty engaging in goal-directed behaviour, 3. Impulse control difficulties, 4. Lack of emotional awareness, 5. Limited access to emotion regulation strategies, 6. Lack of emotional clarity. The DERS has high internal consistency, good test–retest reliability, and adequate construct and predictive validity (Gratz & Roemer, 2004). Cronbach's alphas in were .91, .90, .88, .85, .91, .83, for the respective subscales (Williams et al., 2012). For this study reliability was satisfactory, α= .89 for the whole scale. Clarity= .84, Goals= .89, Impulse= .86, Non-Acceptance=.81, Strategies= .82, awareness= .63.

The Gambling Urge Scale (GUS)

Gambling Urge Questionnaire (GUS) is a 6-item questionnaire which was based on the 8-item Alcohol Urge Questionnaire (Bohn, Krahn, & Staehler, 1995). The GUS asks participants to indicate how much they agree or disagree with the six statements using a 7-point semantic differential scale. Scoring consists of totalling the values (a score of 0–7 for each item) such that higher scores indicated greater urges to gamble (Raylu, & Oei, 2004). Results showed high internal consistency for GUS ($\alpha = 0.93$) and significant item-rest correlations ranging from 0.72 to 0.86 (Smith, Pols, Battersby, & Harvey, 2013. For this study reliability was satisfactory, pre- GUS, α= .90, post- GUS, α=. 93.

Levenson Self-Reported Psychopathy Scale (LSRP)

is a 26-item questionnaire. Responses are on a 4-point Likert scale ranging from 1 (strongly disagree) to 4 (strongly agree). The LSRP is used to measure psychopathic traits in noninstitutionalized individuals and was created using a college student sample (Levenson et al., 1995). The LSRP assesses both primary and secondary psychopathy, and includes negative characteristics (e.g., "I tell other people what they want to hear so that they will do what I want them to do") as well as positive characteristics (e.g., "Cheating is not justified because it is unfair to others"). Previous research has found good reliability and validity for the LSRP among college students (Levenson et al., 1995; Lynam et al., 1999; Salekin et al., 2014) as well as support for the LSRP factors to be capturing core aspects of primary and secondary psychopathy (Miller et al., 2008). Internal consistency for both primary (α = .83, M =2.08, SD = 0.52) and secondary (α = .76, M = 1.96, SD = 0.54) psychopathic traits were sufficient. For this study reliability for the whole scale, was satisfactory, α= .82. For Primary Psychopathy , α was .77 and for Secondary Psychopathy α was .75

The Triarchic Psychopathy Measure (TriPM): is a 58-item, self-report questionnaire designed to measure psychopathy in terms of three distinct phenotypic constructs (Patrick, Fowles, & Krueger, 2009): *boldness,* defined as the nexus of high dominance, low anxiousness, and venturesomeness; *meanness,* reflecting tendencies toward callousness, cruelty, predatory aggression, and excitement seeking; and *disinhibition,* reflecting tendencies toward impulsiveness, irresponsibility, oppositionality, and anger/hostility. Each construct is measured by a separate subscale. Subscale scores are summed to yield a total psychopathy score. Internal consistency of the TriPM subscales in Fanti et al, (2016a) was acceptable (Boldness: α =.82; Meanness: α =.81; Disinhibition: α =.79) and similar to studies conducted in Spain and North America with community samples (Poy et al., 2014; Strickland et al., 2013). For this study reliability for the whole scale was satisfactory, α= .82, Boldness, α =.79 ; Meanness, α=.84 ; Disinhibition, α= .75.

2.2. Psychophysiological Measures for Slot – Machine task

Heart rate (HR) and Skin Conductance Level (SCL) were used as indices of autonomic nervous system responses. Physiological data were sampled at 1000 Hz and recorded with BIOPAC MP150 for Windows and Acknowledge 3.9.0 software (BIOPAC Systems, Inc., Goleta, CA, USA). Electrodermal activity- Skin Conductance Level (SCL) was recorded continuously on the forefinger of the participant's non-dominant hand using a BIOPAC GSR100C amplifier and transducer (TSD203) in microsiemens (µS), with a high-pass filter set at 0.05 µS. Lead I EKG in beats per minute (BPM) using two Ag/AgC1 disposable electrodes placed on each forearm, filtered by a BIOPAC ECG100C bioamplifier set to record heart rate (HR) between 40 and 140 beats per minute. Resting baseline HRV was measured for 5-minutes prior to the first trial, a period during which participants were asked to sit quietly and relax. HRV was filtered (bandpass, 35Hz high frequency, 1Hz low frequency), and rectified.

2.3. Psychophysiological Measures for Passive Picture Viewing –Task

Psychophysiological measures were utilized in the study. Heart rate (HR) and Skin Conductance Level (SCL) were employed as indices of autonomic nervous system responses. Physiological data were sampled at 1000 Hz and recorded using BIOPAC MP150 for Windows and Acknowledge 3.9.0 software (BIOPAC Systems, Inc., Goleta, CA, USA). Electrodermal activity- Skin Conductance Level (SCL) was continuously recorded on the forefinger of the participant's non-dominant hand using a BIOPAC GSR100C amplifier and transducer (TSD203) in microsiemens (μS), with a high-pass filter set at 0.05 μS. Lead I EKG in beats per minute (BPM) was obtained using two Ag/AgCl disposable electrodes placed on each forearm. Electrocardiogram (ECG) was recorded using two Ag/AgCl electrodes placed on the right and left inner forearms. The signal was amplified by a BIOPAC ECG100C bioamplifier, recording heart rate (HR) between 40 and 140 beats per minute. Raw EMG data were collected using 4-mm Ag/AgCl electrodes placed at the right zygomaticus major (smile) and corrugator (frown) muscles. EMG data were sampled at 1000Hz, amplified, filtered (bandstop, 28Hz high frequency, 500Hz low frequency), and rectified. Auditory stimuli were presented through SONY-MDR-7506 headphones.

3. Procedure (Table 1 ; Figure 1):

Upon arrival at the Clinical Psychology and Psychophysiology Laboratory at the University of Cyprus, participants were verbally informed about the procedure, and informed consent forms were read and signed. Then, participants took part in the Slot-Machine experiment. Initially, participants were asked to sit and relax for 5 minutes. This period acted as a baseline for the experiments. Once the experiment was over, participants were provided with a short break and then proceeded to the passive picture viewing task.

3.1. Virtual Slot Machine Task

Initially, participants answered SOGS, DERS, GMQ, GUS, and SPSRQ, PGSI, LSRP, TriPM questionnaires before the task. During the experimental process, individuals were presented with a computerized Virtual slot machine task via Oculus Set- Meta Quest 2. They were asked to play as they would play in realistic conditions by pressing a button that represented the lever. Using a slot machine in a virtual reality (VR) experiment, rather than a computerized-only setup, offers a more immersive and realistic gambling experience (Detez, et al., 2019). This can lead to more accurate physiological and behavioral responses from participants, closely mimicking real-world scenarios. Conditions (see: Table 1) were equally divided (based on semi-randomly presented outcomes into Win, Lose, Near to Win trials). These were sub-divided into: Low, Medium, Medium-High, High: Excitement = 8 Conditions/ Frustration = 7 Conditions (Table 2) to observe different reactions in each category. These conditions were distributed to cover the whole range-type of conditions

(Low, Medium, High-Medium, High Excitement/Frustration). Having 7 conditions in Frustration phase was necessary for the design in order to have equal trials in equal conditions. There were 15 blocks about (12- 15 seconds each) that contained 60 Trials (Table 1; Figure 1). After each type of trial, participants reported their current subjective emotional reactions using a modified form of the Self-Assessment Manikin assessing (Table 3; Figure 1) subjective Arousal, Dominance, Valence, and Desire to play using a Likert scale with 9 points. For valence: 1 = very unpleasant, to 9 = very pleasant, for arousal: 1 = very relaxed, to 9 = very tense, for the dimension of desire to play: 1 = Low Desire, to 9 = High desire, and the dimension of dominance, 1 = no control over the situation, to 9 = full in control of the situation. In addition to resting baseline, HRV was measured also after each type of trial (Table 3; Figure 1) to evaluate emotion/autonomic regulation at that time. Appelhans and Luecken (2006) highlight that HRV is a sensitive measure of autonomic flexibility and emotional regulation, particularly under conditions of significant emotional arousal. They argue that pronounced emotional states, such as high excitement and high frustration, lead to more distinct changes in HRV compared to less intense emotional states. This is because extreme conditions provoke stronger autonomic responses, making the physiological differences easier to detect and interpret. In contrast, medium levels of arousal may not generate sufficient variation in HRV, potentially complicating the analysis and interpretation of data due to subtler and less distinguishable changes. After the whole task, participants answered the Gambling Urge Scale (GUS) again in order to measure their level of urges to play, before and after the task.

3.2. Passive Picture Viewing Task

Stimuli and apparatus details are presented in Table 2. Participants viewed 16 pictures categorized as Happy, Neutral, Fearful, and Disgusting. Each category contained four emotional images selected from the IAPS- International Affective Picture System. During 75% of the image presentations, a startle probe was included at 2.5, 3, or 4 seconds. Startle probes consisted of 50-ms, 95 dB bursts of white noise with instantaneous rise/fall times. Intertrial intervals (ITIs) lasted either 15 or 18 seconds and included startles at 9 or 12 seconds to reduce predictability. Startles were presented during 75% of the ITIs. After each image, participants rated the arousal, valence, dominance, and perceived emotion category on a Likert scale. Participants were divided into three groups, each viewing the same images in a different order, to ensure random distribution of stimuli. Additionally, stimulus presentation was alternated to prevent habituation.

Table 1. Trials & Conditions based on the outcome

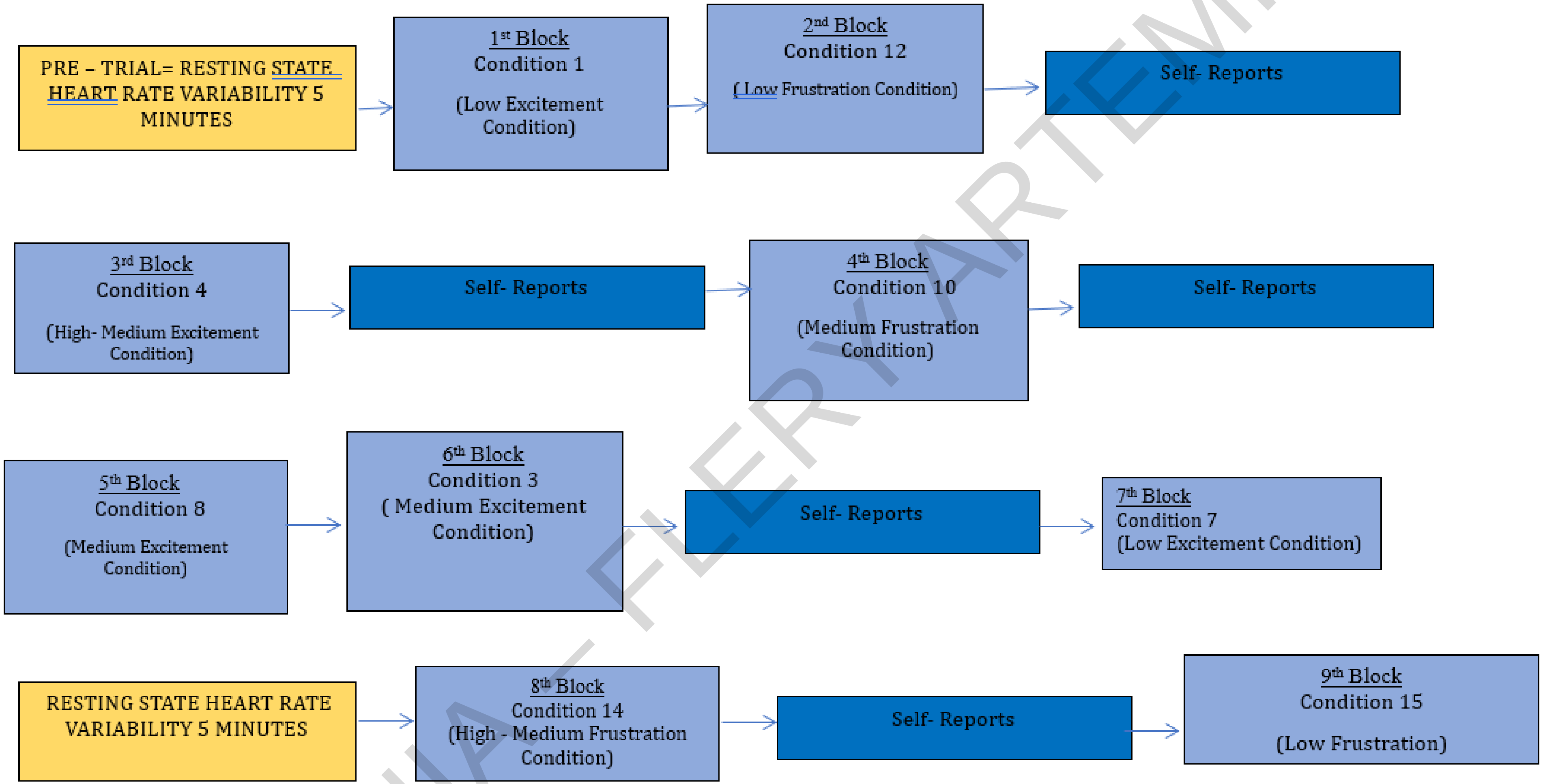
Condition 1 (Low Excitement Condition)	Trial 1: Win	Trial 2: Lose	Trial 3: Near to Win	Trial 4: Win
Condition 2 (High Excitement Condition)	Trial 1: Win	Trial 2: Win	Trial 3: Win	Trial 4: Win
Condition 3 (Medium Excitement Condition)	Trial 1: Near to Win	Trial 2: Win	Trial 3: Win	Trial 4: Near to Win
Condition 4 (High- Medium Excitement Condition)	Trial 1: Lose	Trial 2: Win	Trial 3: Win	Trial 4: Win
Condition 5 (Low Excitement Condition)	Trial 1: Lose	Trial 2: Lose	Trial 3: Lose	Trial 4: Win
Condition 6 (Low Excitement Condition)	Trial 1: Near to Win	Trial 2: Near to Win	Trial 3: Near to Win	Trial 4: Win
Condition 7 (Low Excitement Condition)	Trial 1: Lose	Trial 2: Near to Win	Trial 3: Win	Trial 4: Near to Win

Condition 8 (Medium Excitement Condition)	Trial 1: Lose	Trial 2: Win	Trial 3: Win	Trial 4: Near to Win
Condition 9 (Medium Frustration Condition)	Trial 1: Near to Win	Trial 2: Win	Trial 3: Lose	Trial 4: Near to Win
Condition 10 (Medium Frustration Condition)	Trial 1: Lose	Trial 2: Win	Trial 3: Near to Win	Trial 4: Lose
Condition 11 (High Frustration Condition)	Trial 1: Win	Trial 2: Win	Trial 3: Win	Trial 4: Lose
Condition 12 (Low Frustration Condition)	Trial 1: Lose	Trial 2: Lose	Trial 3: Lose	Trial 4: Near to Win
Condition 13 (High - Medium Frustration Condition)	Trial 1: Near to Win	Trial 2: Win	Trial 3: Win	Trial 4: Lose
Condition 14 (High - Medium Frustration Condition)	Trial 1: Win	Trial 2: Win	Trial 3: Near to Win	Trial 4: Lose
Condition 15 Low Frustration	Trial 1: Near to Win	Trial 2: Near to Win	Trial 3: Lose	Trial 4: Lose

Notes.

Total Number of Near to Win Conditions	5
Total Number of Win Conditions	**5**
Total Number of Lose Conditions	**5**
1 Win in a row = 5 Euros - Low Excitement Condition - 4/8	**No Money Lost but NOT winning - Low Frustration 2/7**
2 Wins in a row = 10 Euros - Medium Excitement Condition - 2/8	**Money Lost= 5 Euros – Medium Frustration 2/7**
3 Wins in a row = 15 Euros - High – Medium Excitement Condition - 1/8	**Money Lost= 10 Euros- High- Medium Frustration 2/7**
4 Wins in a row = 20 Euros - High Excitement Condition - 1/8	**Money Lost= 15 Euros – High Frustration 1/7**
Self- Reports of (Valence, Control, Arousal, Desire to keep playing)	**= In every type of condition (Low, Medium, High- Medium, High Excitement/ Frustration) = 8 times** **2/5 for Near to Win, 3/5 for Win, 3/5 for Lose**
Resting state - HRV	**= 5 minutes pre- task and 3 times during the task after 3 different outcomes (Win/ Near to Win/ Lose)**

Figure 1. Block Series : 15 Blocks X 4 Trials = 60 Trials



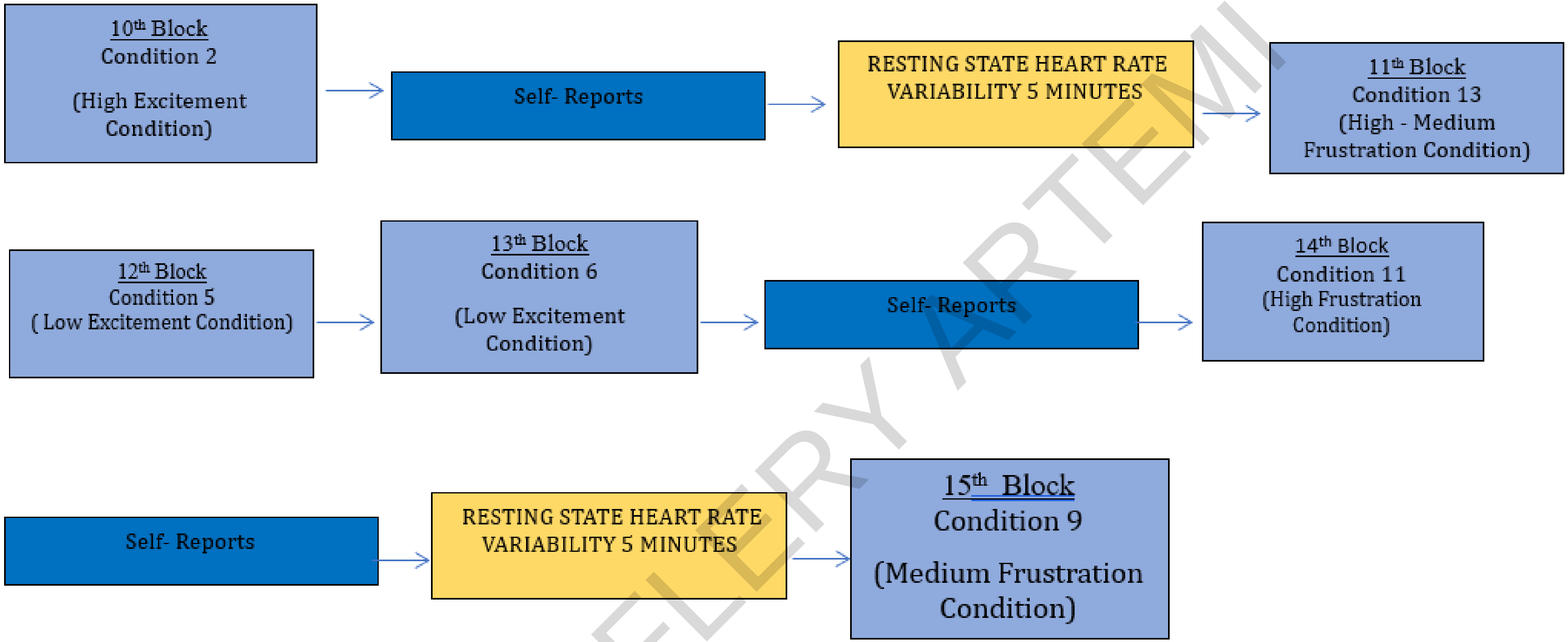

10th Block
Condition 2
(High Excitement Condition)
Self- Reports
RESTING STATE HEART RATE VARIABILITY 5 MINUTES
11th Block
Condition 13
(High - Medium Frustration Condition)
12th Block
Condition 5
(Low Excitement Condition)
13th Block
Condition 6
(Low Excitement Condition)
Self- Reports
14th Block
Condition 11
(High Frustration Condition)
Self- Reports
RESTING STATE HEART RATE VARIABILITY 5 MINUTES
15th Block
Condition 9
(Medium Frustration Condition)

Table 2. Imagery Tak

1st Condition

Trial number	CODE	Type	Ratings	ITI	Stimulus duration
1	3261	Disgust	Ratings	18	6
2	8030	Happiness	Ratings	15	6
3	6550	Fear	Ratings	15	6
4	7025	Neutral	Ratings	18	6
5	8341	Happiness	Ratings	15	6
6	3150	Disgust	Ratings	15	6
7	7052	Neutral	Ratings	18	6
8	6370	Fear	Ratings	18	6
9	7010	Neutral	Ratings	18	6
10	3400	Disgust	Ratings	15	6
11	8179	Happiness	Ratings	15	6
12	7006	Neutral	Ratings	18	6
13	3500	Fear	Ratings	15	6
14	8180	Happiness	Ratings	15	6
15	3100	Disgust	Ratings	18	6
16	6312	Fear	Ratings	18	6

2nd Condition

Trial number	CODE	Type	Ratings	ITI	Stimulus duration
1	8180	Happiness	Ratings	18	6
2	6550	Fear	Ratings	15	6
3	3261	Disgust	Ratings	15	6
4	7025	Neutral	Ratings	18	6
5	8179	Happiness	Ratings	15	6
6	3100	Disgust	Ratings	15	6
7	7052	Neutral	Ratings	18	6
8	6370	Fear	Ratings	18	6
9	8341	Happiness	Ratings	18	6
10	3150	Disgust	Ratings	15	6
11	6312	Fear	Ratings	15	6
12	8030	Happiness	Ratings	18	6
13	7006	Neutral	Ratings	15	6
14	3400	Disgust	Ratings	15	6
15	3500	Fear	Ratings	18	6
16	7010	Neutral	Ratings	18	6

3rd Condition

Trial number	CODE	Type	Ratings	ITI	Stimulus duration
1	3500	Fear	Ratings	18	6
2	7006	Neutral	Ratings	15	6
3	3261	Disgust	Ratings	15	6
4	8030	Happiness	Ratings	18	6
5	7052	Neutral	Ratings	15	6
6	6312	Fear	Ratings	15	6
7	8341	Happiness	Ratings	18	6
8	3100	Disgust	Ratings	18	6
9	8179	Happiness	Ratings	18	6
10	6550	Fear	Ratings	15	6
11	7010	Neutral	Ratings	15	6
12	8180	Happiness	Ratings	18	6
13	3400	Disgust	Ratings	15	6
14	7025	Neutral	Ratings	15	6
15	6370	Fear	Ratings	18	6
16	3150	Disgust	Ratings	18	6

Note. Table describes 3 conditions presented for randomization purposes, stimulus duration, ITIs seconds and specific codes from IAPS pictures.

4. Participants- General Information & Demographics

The sample comprised N= 131 participants, with 32.1% (N= 42) identified as males and 67.9% (N= 89) as females, ranging in age from 18 to 64 years (Minimum-Maximum), with a mean age of M= 23.77 years and a standard deviation of SD= 7.57.

Participants' monthly expenditure on gambling spanned various spending categories. The majority (75.6%) reported expenditures between €1 and €25 per month. Furthermore, 17.6% indicated spending between €26 to €100 monthly. In addition, a smaller proportion reported expenses ranging from €101 to €1000 (5.3%), with an even smaller minority (1.5%) reporting expenditures exceeding €1000 per month.

Regarding gambling habits, participants' weekly hours spent differed across multiple time intervals. The largest proportion (86.3%) reported spending one hour or less per week on gambling activities, while 6.9% dedicated one to three hours weekly. Additionally, 2.3% and 3.8% spent four to five and six to ten hours per week, respectively. Only 0.8% reported spending more than twenty hours weekly engaging in gambling.

The educational background of participants varied across different levels of attainment. The majority (67.9%) reported graduating from high school, followed by 27.5% who attained a university degree. A smaller percentage reported completing college (3.8%), with an even smaller portion (0.8%) graduating from a technical school.

Ethnicity distribution among participants revealed Cypriots as the majority (80.2%), with Greeks representing a significant minority (13.7%). Other ethnicities, including Bangladeshi, Bulgarian, Cypriot-Australian, Cypriot/British, Italian, Kurdish, Polish, and Spanish, each constituted 0.8% of the sample. Participants' residential locations were diverse, with the majority (72.5%) residing in Nicosia. Limassol (9.9%) and Larnaca (6.9%) were also notable residential areas, with fewer participants reporting Paphos as their place of residence (6.1%). A small percentage resided in other European countries (0.8% each).

In terms of employment status, the majority (67.2%) identified as students, while others were employed in various sectors. The private sector employed 19.1% of participants, with smaller proportions in the banking sector (1.5%), semi-public sector (2.3%), and public/wider public sector (4.6%). A minority reported being self-employed (0.8%) or unemployed (4.6%).

Monthly income distribution varied, with 58.0% reporting no income and relying on familial support. A significant proportion (13.7%) had incomes below €800, with smaller percentages falling into different income brackets, including between €800-1200 (6.1%) and exceeding €3200 (1.5%). Additionally, 1.5% reported no income but relied on family support.

4.1. Scales – Descriptives

Table 5 shows values for different questionnaires regarding total sample, minimum value, maximum value, mean and standard deviation.

South Oaks Gambling Screen Tool-Revised (SOGS)

Distribution of SOGS (South Oaks Gambling Screen) scores among a sample of 131 individuals illustrates different severity levels of gambling problems. The categories are as follows: 76 individuals (58.0% of the sample) were classified as having Low Severity (1.00). Medium-High Severity (2.00) was identified in 40 individuals (30.5% of the sample). High Severity (3.00) was observed in 15 individuals (11.5% of the sample).

Problem Gambling Severity Index (PGSI)

Distribution of PGSI (Problem Gambling Severity Index) scores among a sample of 131 individuals, classified into different severity levels of gambling problems. The categories are as follows: 1.00 represents Low Severity, encompassing 42 individuals, which is 32.1% of the sample; 2.00 represents Medium-High Severity, including 37 individuals, or 28.2% of the sample; 3.00 represents High Severity, with 44 individuals, making up 33.6% of the sample; and 4.00 represents Very High Severity, with 8 individuals, accounting for 6.1% of the sample.

Sensitivity to Punishment Sensitivity to Reward Questionnaire (SPSRQ)

The distribution of scores on the SPSR Questionnaire among a sample of 131 individuals illustrates varying levels of punishment tendencies. Within the sample, 16 individuals, accounting for 12.2%, scored 1.00 on the SPSR, indicating low punishment tendencies. Moderate levels of punishment tendencies, represented by a score of 2.00, were observed in 47 individuals, comprising 35.9% of the sample. Higher levels of punishment tendencies, categorized by scores of 3.00 and 4.00, were identified in 53 and 15 individuals, respectively, making up 40.5% and 11.5% of the sample.

The distribution of scores on the SPSR Questionnaire among a sample of 131 individuals illustrates varying levels of reward tendencies. Within the sample, 32 individuals, accounting for 24.4%, scored 1.00 on the SPSR, indicating low reward tendencies. Moderate levels of reward tendencies, represented by a score of 2.00, were observed in 33 individuals, comprising 25.2% of the sample. Higher levels of reward tendencies, categorized by scores of 3.00 and 4.00, were identified in 44 and 22 individuals, respectively, making up 33.6% and 16.8% of the sample.

Levenson Self-Reported Psychopathy Scale (LSRP)

Distribution of LSRP (Levenson Self-Report Psychopathy Scale) scores among a sample of 131 individuals highlights different levels of psychopathy traits. In the sample, 18 individuals, constituting 13.7%, scored 1.00 on the LSRP, indicating Low Psychopathy traits. Medium levels of psychopathy traits, represented by a score of 2.00, were observed in 95 individuals, comprising 72.5% of the sample. High levels of psychopathy traits, categorized by a score of 3.00, were identified in 18 individuals, making up another 13.7% of the sample.

The Triarchic Psychopathy Measure (TriPM)

Distribution of TriPM (Triarchic Psychopathy Measure) scores among a sample of 131 individuals illustrates varying levels of psychopathy traits. Among the participants, 24 individuals, accounting for 18.3% of the sample, scored 1.00 on the TriPM, indicative of Low Psychopathy traits. Medium levels of psychopathy traits, represented by a score of 2.00, were observed in 90 individuals, comprising 68.7% of the sample.High levels of psychopathy traits, categorized by a score of 3.00, were identified in 17 individuals, making up 13.0% of the sample.

Table 5. Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
SPSR_REWARD	131	0	23	11,42	5,541
SPSR_PUNISHMENT	131	0	22	10,86	3,855
SOGS	131	0	15	1,44	2,542
TriPM	131	29	102	60,37	13,938
LSRP	131	29	75	48,63	9,820
PGSI	131	0	16	2,48	2,886

5. Association between gambling severity, sensitivity to punishment and reward, emotion regulation and psychopathy scales

Pearson correlations were conducted to see the relationship between Gambling Severity, Sensitivity to Punishment and Reward, Emotion Regulation and Psychopathy Scales (Table 1). Gambling Severity Scales PGSI and SOGS have strong positive correlation with each other, as well as psychopathy scales totals and subscales (LSRP & TriPM) and Sensitivity to Punishment but no significant relationship with Sensitivity to reward or Emotion Dysregulation. Emotion Dysregulation scales are significantly positively correlated with LSRP total score, Secondary psychopathy scale, TriPM disinhibition, Sensitivity to reward, are negatively correlated with TriPM boldness. Sensitivity to punishment was found to be in general significantly positively correlated with psychopathic traits in every scale except Boldness, while sensitivity to reward found to be more positively correlated with secondary psychopathy, disinhibition, and meanness. Regarding gambling urges before and after the slot- machine game, Pre- GUS demonstrated high positive correlation with post-GUS, with gambling severity through SOGS and PGSI, psychopathic traits, sensitivity to punishment and emotion regulation total score, focusing in positive correlations in difficulty engaging in goal directed behavior and difficulties in effectively using strategies to regulate emotions. Post – GUS was shown to be positively correlated with SOGS and PGSI, sensitivity to punishment, secondary psychopathy, DERS total and all the DERS emotion dysregulation subscales except difficulties in emotional awareness.

Table 1. Correlations between Scales

Note. N= 131 *. Correlation is significant at the 0.05 level (2-tailed).; **. Correlation is significant at the 0.01 level (2-tailed).

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1. SOGS_ TOTAL_SCORE	1																			
2. DERS18_AWARENESS	0,155	1																		
3. DERS18_CLARITY	0,116	,219*	1																	
4. DERS18_GOALS	0,049	-0,004	,469**	1																
5. DERS18_IMPULSE	0,154	0,105	,389**	,586**	1															
6. DERS18_NONACCEPTANCE	0,140	0,087	,427**	,413**	,507**	1														
7. DERS18_STRATEGIES	0,036	0,083	,486**	,570**	,656**	,590**	1													
8. DERS18_TOTAL_SCORE	0,150	,319**	,697**	,759**	,794**	,738**	,829**	1												
9. SPSR_REWARD	-0,006	0,134	,457**	,463**	,398**	,431**	,592**	,600**	1											
10. SPSR_PUNISHMENT	,364**	0,096	,309**	,327**	,383**	,279**	,322**	,415**	0,168	1										
11. TriPM_BOLDNESS	0,071	-,182*	-,339**	-,320**	-,338**	-,305**	-,462**	-,468**	-,687**	-0,030	1									
12. TriPM_MEANNESS	,474**	,200*	0,151	0,101	,266**	0,098	0,099	,213*	0,076	,339**	0,037	1								
13. TriPM_DISINHIBITION	,350**	,198*	,338**	,309**	,422**	,275**	,312**	,443**	,230**	,445**	-0,147	,560**	1							
14. TriPM_TOTAL_SCORE	,444**	0,092	0,043	0,014	0,141	0,006	-0,064	0,051	-,241**	,362**	,513**	,791**	,666**	1						
15. LSRP_PRIMARY_PSYCHOPATHY	,387**	,221*	0,159	0,035	0,144	0,085	0,076	0,162	0,043	,269**	0,076	,637**	,373**	,540**	1					
16.LSRP_SECONDARY_PSYCHOPATHY	,263**	,314**	,479**	,315**	,400**	,314**	,448**	,536**	,401**	,323**	-,350**	,539**	,687**	,396**	,453**	1				
17. LSRP_TOTAL_PSYCHOPATHY	,392**	,303**	,340**	,176*	,291**	,210*	,268**	,369**	,222*	,340**	-0,117	,696**	,587**	,561**	,903**	,792**	1			
18. PGSI_TOTAL	,625**	0,112	0,022	0,082	0,155	0,046	0,016	0,103	-0,036	,436**	0,087	,252**	,191*	,266**	,209*	0,150	,216*	1		
19. PRE_GUS_TOTAL	,339**	0,006	0,161	,174*	0,146	0,130	,182*	,195*	0,087	,318**	0,048	,172*	,259**	,235**	,180*	,256**	,247**	,520**	1	
20. POST_GUS_TOTAL	,210*	0,034	,187*	,285**	,188*	,192*	,242**	,278**	0,159	,184*	-0,028	0,052	0,137	0,074	0,036	,190*	0,116	,542**	,642**	1

5.1. Conclusion- Correlations Explained

Our findings revealed several significant correlations. Firstly, the gambling severity scales PGSI and SOGS demonstrated a strong positive correlation with each other, indicating convergent validity between these measures. This result is consistent with previous research demonstrating the robustness of PGSI and SOGS in assessing gambling severity (Lesieur & Blume, 1993; Williams, Volberg, & Stevens, 2012). Furthermore, the gambling severity scales showed a significant positive correlation with psychopathic traits, as measured by the LSRP and TriPM scales. This suggests that individuals with higher levels of psychopathic traits are more likely to experience gambling problems. This finding is in line with previous research suggesting a link between psychopathy and gambling (Blanco, Myers, & Kendler, 2012; Buelow & Suhr, 2014; Levenson, Kiehl, & Fitzpatrick, 1995; Patton, Stanford, & Barratt, 1995). Individuals with higher levels of psychopathic traits may be more inclined to engage in risky behaviors such as gambling. Psychopathic traits are associated with impulsivity, sensation-seeking, and risk-taking behavior, which could contribute to increased gambling severity (Blanco, Myers, & Kendler, 2012; Buelow & Suhr, 2014).

The lack of a significant relationship between gambling severity and sensitivity to reward or emotion dysregulation may be due to several factors. Individuals who are highly sensitive to reward may have better cognitive control and decision-making abilities, allowing them to regulate their gambling behavior more effectively. They may be better able to resist the urge to gamble when it conflicts with other goals or losing money (Toneatto & Ladoceur, 2003). Individuals who are highly sensitive to reward may have higher psychopathic traits, more effective emotion regulation strategies, allowing them to cope better with negative emotions or stressful situations. As a result, the relationship between emotion dysregulation and gambling severity may be weakened or masked by the use of these other coping strategies (Gratz & Roemer, 2004).

Individuals with higher sensitivity to punishment may be more hypervigilant to potential threats or negative outcomes. They may perceive situations that others might not find threatening as highly punishing (Gaher et al., 2015). However, Individuals with higher levels of psychopathic traits may have a different perception of what constitutes punishment, or reward that’s why Individuals high in boldness may be less sensitive to rewards, are less likely to experience fear, anxiety, or other negative emotions, and may be less motivated by the pursuit of rewards leading to increased risk-taking behavior and sensation-seeking (Satchell, et al., 2018). Emotion dysregulation is characterized by difficulties in managing and responding to emotions effectively (Gratz & Roemer, 2004). Individuals high in boldness may be less prone to experiencing emotional distress or dysregulation because they are less sensitive to negative emotions and less likely to experience fear or anxiety.

On the other side, sensitive to punishment individuals with high psychopathic traits, may be less affected by traditional forms of punishment and may only perceive very severe consequences or personal threats as truly punishing (Levenson, Kiehl, & Fitzpatrick, 1995) and may have dysfunction in threat processing systems in the brain, leading to heightened sensitivity to certain types of punishment (Blair, 2010). While individuals with psychopathic traits may be less sensitive to certain types of punishment, such as social disapproval or legal consequences, or may be less affected by them compared to individuals with lower levels of psychopathic traits (Patton, Stanford, & Barratt, 1995), however they may still be sensitive to other forms of punishment, such as physical harm or loss of resources. Their hypervigilance to these types of punishment may contribute to their risk-taking behavior and sensation-seeking tendencies and may still engage in risky behaviors such as gambling (Satchell, 2018). This could be due to their tolerance to punishment, perception of punishment, or their focus on potential rewards rather than potential punishments (Blanco, Myers, & Kendler, 2012; Buelow & Suhr, 2014). In summary, individuals with psychopathic traits may exhibit hypervigilance or heightened sensitivity to punishment due to anticipation of negative outcomes, fearlessness, sensation-seeking tendencies, differential sensitivity to punishment, and dysfunction in threat processing systems in the brain (Ploe, et al., 2023).

The high positive correlation between Pre-GUS (gambling urges before the slot-machine game) and Post-GUS (gambling urges after the slot-machine game) suggests that individuals who experience high levels of gambling urges before the game are also more likely to experience high levels of urges after the game. Engaging in the slot-machine game may reinforce gambling urges in individuals who already experience high levels of urges. Winning or even the anticipation of winning during the game can further heighten these urges, leading to continued or increased desire to gamble (Dixon, Harrigan, Sandhu, Collins, & Fugelsang, 2010). The positive correlation between Pre-GUS and emotion regulation total score, particularly focusing on difficulties in engaging in goal-directed behavior and effectively using strategies to regulate emotions, suggests that emotion dysregulation may play a role in the maintenance of gambling urges. Individuals who have difficulty regulating their emotions may be more prone to experiencing strong and persistent gambling urges, both before and after engaging in gambling activities (Gaher et al., 2015). Secondary psychopathy is characterized by a lack of impulse control, a tendency towards antisocial behavior, and difficulties in regulating emotions (Hicks, Markon, Patrick, Krueger, & Newman, 2004). Individuals high in secondary psychopathy may have a greater propensity to engage in impulsive and risky behaviors, including gambling (Fischer & Smith, 2008). Individuals high in secondary psychopathy may be more likely to act on their urges to continue playing after the game, even if they are aware of the potential negative consequences individuals high in secondary psychopathy may also have difficulties in regulating their emotions (Hicks et al., 2004). They may use gambling to cope with negative emotions or to seek excitement and stimulation and this explain the positive correlation of secondary psychopathy and gambling severity with sensitivity to punishment. Secondary psychopathy is associated with cognitive distortions such as the illusion of control and the gambler's fallacy (Goodie & Fortune, 2013). Individuals high in secondary psychopathy may be more susceptible to these distortions, leading them to believe that they have control over the outcome of the game or that they are due for a win.

6. Descriptive statistics

One way ANOVA was conducted to see differences between gambling severity levels (SOGS) in psychopathy (TriPM & LSRP)**.** The dependent variables consist of the Triarchic Psychopathy Measure (TriPM)- total score and different psychopathy categories (Boldness, Meanness, Disinhibition), Levenson Self-Report Psychopathy Scale as well as Sensitivity to punishment and sensitivity to Reward questionnaire (SPSR) divided in sensitivity to punishment and sensitivity to reward scales (SP & SR). The South Oaks Gambling Questionnaire (SOGS) with three different levels of gambling severity (1= low, 2= medium, 3= high) based on clinical cut-offs is the independent variable. SOGS) was used instead of the PGSI to assess different levels of gambling behavior. SOGS might be more suitable for capturing the specific gambling behaviors and psychological patterns of interest in this study. SOGS has been widely validated and is known for its comprehensive approach to identifying pathological gambling across diverse populations, making it a valuable tool for detailed assessments of gambling severity. Correlation between SOGS and PGSI was high (See correlation's chapter) showing that both scales effectively measure gambling severity and can be used interchangeably for assessing different levels of gambling behavior. This strong correlation indicates that the SOGS is a reliable alternative to the PGSI in capturing the extent and impact of gambling issues (Loo, Oei, & Raylu, 2010).

These ANOVA results indicate that there are significant differences in all the measured variables across different levels of gambling severity as classified by SOGS. (Table 1).

Table 1. ANOVA- Gambling Levels associated with Psychopathy

		Sum of Squares	df	Mean Square	F	Sig.
SOGS_TOTAL_SCORE	Between Groups	690,012	2	345,006	293,801	**<,001**
	Within Groups	150,308	128	1,174		
	Total	840,321	130			
TriPM_BOLDNESS	Between Groups	405,701	2	202,851	3,430	**,035**
	Within Groups	7570,360	128	59,143		
	Total	7976,061	130			
TriPM_MEANNESS	Between Groups	1558,607	2	779,304	19,913	**<,001**
	Within Groups	5009,408	128	39,136		
	Total	6568,015	130			
TriPM_DISINHIBITION	Between Groups	874,562	2	437,281	12,303	**<,001**
	Within Groups	4549,408	128	35,542		
	Total	5423,969	130			
TriPM_TOTAL_SCORE	Between Groups	6811,312	2	3405,656	23,636	**<,001**
	Within Groups	18443,360	128	144,089		
	Total	25254,672	130			
LSRP_PRIMARY_PSY	Between Groups	701,896	2	350,948	8,678	**<,001**

CHOPATHY	Within Groups	5176,181	128	40,439		
	Total	5878,076	130			
LSRP_SECONDARY_PSYCHOPATHY	Between Groups	232,389	2	116,194	5,549	**,005**
	Within Groups	2680,130	128	20,939		
	Total	2912,519	130			
LSRP_TOTAL_PSYCHOPATHY	Between Groups	1689,229	2	844,615	9,966	**<,001**
	Within Groups	10847,443	128	84,746		
	Total	12536,672	130			

The descriptive statistics for the variables at different levels of SOGS (1 = low severity, 2 = medium severity, 3 = high severity) are reported below.

SOGS Total Score was zero for low severity (M = 0.00, SD = 0.00, SE = 0.00), increased to medium severity (M = 1.98, SD = 1.17, SE = 0.18), and further increased at high severity (M = 7.33, SD = 2.64, SE = 0.68).

For TriPM Boldness, the mean scores increased from low severity (M = 28.08, SD = 7.56, SE = 0.87) to medium severity (M = 31.75, SD = 7.60, SE = 1.20) and were similar at high severity (M = 31.33, SD = 8.59, SE = 2.22). In TriPM Meanness, there was a notable increase in mean scores from low severity (M = 11.86, SD = 5.17, SE = 0.59) to medium severity (M = 14.00, SD = 7.42, SE = 1.17), with a substantial increase at high severity (M = 23.00, SD = 7.84, SE = 2.02). The mean scores for TriPM Disinhibition showed an increasing trend from low severity (M = 15.64, SD = 5.41, SE = 0.62) to medium severity (M = 17.00, SD = 6.27, SE = 0.99), and significantly higher at high severity (M = 24.00, SD = 7.66, SE = 1.98). TriPM Total Score also followed an increasing trend from low severity (M = 55.58, SD = 11.13, SE = 1.28) to medium severity (M = 62.75, SD = 11.83, SE = 1.87), and peaked at high severity (M = 78.33, SD = 16.25, SE = 4.20).

For LSRP Primary Psychopathy, mean scores rose from low severity (M = 28.47, SD = 5.85, SE = 0.67) to medium severity (M = 31.05, SD = 7.09, SE = 1.12), and were highest at high severity (M = 35.67, SD = 6.83, SE = 1.76). LSRP Secondary Psychopathy showed a similar increasing pattern from low severity (M = 17.91, SD = 3.90, SE = 0.45) to medium severity (M = 18.38, SD = 5.61, SE = 0.89), with a notable increase at high severity (M = 22.20, SD =

4.74, SE = 1.22). Finally, LSRP Total Psychopathy mean scores increased from low severity (M = 46.38, SD = 8.32, SE = 0.96) to medium severity (M = 49.43, SD = 10.94, SE = 1.73), and were highest at high severity (M = 57.87, SD = 8.40, SE = 2.17).

Table 2. ANOVA- Gambling Levels associated with Sensitivity to Punishment & Reward

		Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
SPSR_REWARD	Between Groups	9,613	2	4,807	,154	,857
	Within Groups	3982,295	128	31,112		
	Total	3991,908	130			
SPSR_PUNISHMENT	Between Groups	,284	2	,142	,009	,991
	Within Groups	1931,243	128	15,088		
	Total	1931,527	130			

The descriptive statistics for SPSR Reward and Punishment scores were analyzed across different levels of SOGS. For SPSR Reward, individuals in SOGS Level 1 had a mean score of 11.51 (SD = 5.73, SE = 0.66), those in SOGS Level 2 had a mean score of 11.53 (SD = 5.29, SE = 0.84), and those in SOGS Level 3 had a mean score of 10.67 (SD = 5.55, SE = 1.43). The overall mean score for SPSR Reward was 11.42 (SD = 5.54, SE = 0.48). For SPSR Punishment, individuals in SOGS Level 1 had a mean score of 10.88 (SD = 3.83, SE = 0.44), those in SOGS Level 2 also had a mean score of 10.88 (SD = 4.04, SE = 0.64), and those in SOGS Level 3 had a mean score of 10.73 (SD = 3.71, SE = 0.96). The overall mean score for SPSR Punishment was 10.86 (SD = 3.86, SE = 0.34).

These ANOVA results indicate that there are not significant differences in all the measured variables across different levels of gambling severity as classified by SOGS. (Table 2). Results indicated, that as hypothesized, gambling severity is associated with increased psychopathy, including all facets and dimensions of the latter construct. However, it remains unclear if this is related to associations between severity and self-reported activity of motivation systems, as no significant group differences were observed in SPSR scores.

A potential explanation could consider the inclusion of low severity gamblers in the study. Therefore, when assessing self-reported activity of motivation systems (SPSR scores), which may reflect a broader range of motivational behaviors including those unrelated to impulsivity or sensation-seeking, the differences between groups categorized by gambling severity may not be sufficiently pronounced to reach statistical significance (Blaszczynski & Nower, 2002). Another possible explanation is that the association between gambling severity and psychopathy is primarily driven by impulsivity and sensation-seeking behaviors inherent in psychopathy, which are critical factors in both pathological gambling and psychopathic traits. This implies that while individuals with severe gambling issues and high psychopathy scores may exhibit similar impulsive and sensation-seeking behaviors, these traits are not necessarily captured by SPSR scores, which might be more focused on conscious motivational states rather than underlying impulsive drives (Verdejo-Garcia et al., 2008).

7. Study 1: The desire to play: Motivational Mechanisms in Gamblers during Virtual Slot- Machine Task

7.1.Introduction

Most individuals with Gambling Disorder (APA, 2013; GD) are characterized as highly impulsive (Yip, & Potenza, 2014) and have been found to show temperament traits such as high sensation seeking (Mitchell & Potenza, 2014). Sensation seeking is defined by the desire to approach potential immediate rewards (Martinotti, et al., 2012). Nonetheless, high avoidance (shy, fearful behavior, with the tendency to avoid perceived punishment) has also been identified in GD patients (Lobo et al., 2014; Moragas et al., 2015). These opposing traits have led to the proposal that different motives may exist that give rise to gambling (Blaszczynski & Nower 2002; Moragas et al., 2015), either as individual differences (i.e. different people gambling for primarily different reasons), or at different times and phases of the addiction within the same individual.

Gray's Reinforcement Sensitivity Theory (RST; Gray, 1991) proposes two different main motivation systems: the behavioral activation system (BAS) and the behavioral inhibition system (BIS; Gray, 1991). BAS is hypothesized to be sensitive to reward (SR) and thus leads individuals to attain goals. BIS is hypothesized to be sensitive to punishment (SP) and leads to anxiety or fear resulting to avoidance and inhibition (Gaher, Hahn, Shishido, Simons, &

Gaster, 2015). Since winning in gambling is a reward, individuals with high BAS are likely to engage in betting more. Brunborg et al. (2011) and Demaree et al. (2008) found a positive association between BAS and the size of the average bet on a laboratory slot machine task. Similarly, Kim and Lee (2011) found that individuals with a high BAS bet larger amounts and exhibit greater confidence even in situations with a high likelihood of losing. The findings above show an association between BAS and gambling, further supporting the idea that high SR may be a risk factor for gambling. As a result, high SP may act as a protective factor for problematic gambling or a factor that leads to gambling for coping with undesired emotions or thoughts (Gray, 1991). As losing in gambling is often punishing or nonrewarding, individuals with high sensitivity to punishment are expected to show lower involvement in betting. In fact, Demaree et al. (2008) found that SP (BIS) is associated with less risk-taking while SR (BAS) is associated with greater risk-taking. Moreover, in that study, the influence of high SP (BIS) on risk-taking was greater than high SR (BAS).

Kim and Lee (2011) found that BAS, or SR, was positively associated with greater risky gambling decisions after a winning experience while BIS, or SP, was negatively associated with risky gambling decisions after the same experience. Alternatively, individuals who might be high in the anxiety associated with sensitivity to punishment engage in a variety of risk-taking behaviors, including gambling, to alleviate negative affect and escape reality. If so, this might suggest a positive association between sensitivity to punishment and gambling (Hudson, Jacques, & Stewart, 2013). These opposing mechanisms might explain the null findings in recent literature on associations between BIS and gambling (Brunborg et al., 2011). Simons and Arens (2007) found that sensitivity to punishment moderated the relationship between SR and marijuana use among college students. Similarly, Genovese and Wallace (2007) found the highest rates of substance use among adolescents with high SR and low SP. Given the established addictive nature of gambling, substance use studies such as those previously mentioned may provide important theoretical framework for the relationships between SR, SP, and gambling.

7.2.Slot Machine and Psychophysiology

Based on previous research, the basic physiological measures that will be obtained and evaluated are the peripheral measures of cardiac and electrodermal reactivity. Both measures are excellent indices of autonomic arousal, with SCL reflecting sympathetic system arousal, and HR reflecting activation of both sympathetic and parasympathetic systems. According to some theorists the two systems are also basic indices of the two biological systems. Fowles (1980) has suggested that the activation of the BIS is associated with increased electrodermal activity (EDA) after exposure to punishing or negative stimuli. On the contrary, the activation of the BAS is associated with increased Heart Rate (HR) during rewarding or positive stimuli. Empirical findings are, however, not consistent about the expected arousal level in the two systems regarding rewarding-pleasurable conditions or punishing- negative conditions, especially with regards to a gambling situation. In general, most authors report that arousal levels are increased during near misses and losses (Anderson & Brown 1984), relative to wins. Changes in heart rate (HR) have consistently been used to index excitement from slot machine gambling (Bradley &Lang 2000).

Research has suggested that the seeking of aroused state and rewards may be the primary motivation for gambling (Brown, 1986). The role of surface similarity in triggering reward was highlighted by Peters, Hunt and Harper (2010). The pathophysiology of addiction has been postulated to comprise sensitization of the appetitive system (i.e. 'wanting'), but habituation of the consummatory system (i.e. 'liking') when people are chronically exposed to powerful sources of hedonic reward such as drugs of abuse (Koob & LeMoal, 2008).

A significant component of the reinforcing properties of gambling behavior, especially during slot-machine play, is physiological arousal (Coventry & Hudson, 2001; Dixon et al., 2010; Lole, Gonsalvez, Blaszczynski, & Clarke, 2012; Sharpe, Tarrier, Schotte, & Spence, 1995). Indeed Brown, underscored its significance by calling it "a major, if not the major reinforcer of gambling behavior for regular gamblers" (Brown, 1986, p. 1001). During a slot-machine session, players' arousal levels have been shown to fluctuate according to the outcomes they experience. Specifically, players typically demonstrate higher arousal levels following wins (Coventry & Hudson, 2001; Dixon, Harrigan, Sandhu, Fugelsang, & Collins 2015; Dixon et al., 2010) compared to losses. So there appears to be a systematic relation between win size and arousal level, with larger wins typically leading to more arousal than smaller wins (Dixon et al., 2010; Lole et al., 2012). This may happen because individuals experience much greater excitement when they win and thus their arousal levels increase reinforcing and enhancing the desire to play.

Previous research indicates that frustration can engender large increases in physiological arousal. Hokanson and Burgess (1964) and Burgess and Hokanson (1968) found that inducing frustration in a laboratory increased participants' tonic heart rates by over 20 beats per minute, values far larger than heart rate increases noted for players who won while playing a slot machine (Coventry & Hudson, 2001; Coventry & Norman, 1998; Leary & Dickerson, 1985). In all of these studies, researchers measured tonic psychophysiological arousal – changes measured over durations of 60 seconds or more. In real slot machine play, gamblers spin about once every 3–6 seconds and either lose or win on each spin. Researchers have only recently begun to show phasic, event-related psychophysical changes accompanying winning spins and compare these changes to losing spins. Dixon, Harrigan, Sandhu, Collins and Fugelsang (2010) showed that wins led to greater event-related skin conductance responses (SCRs) than losses during multi-line slot machine play. Similar event-related findings have been shown by Wilkes, Gonsalvez and Blaszczynsky (2010). In addition, the magnitude of event-related SCRs have been shown to directly increase with subjective reports of increasing arousal (Lang, Greenwald, Bradley & Hamm, 1993; Lang, Bradley, & Cuthbert, 1998), and are directly related to the sympathetic nervous system activity that leads to arousal (Wallin, 1981). Importantly, there appears to be a systematic relation between win size and arousal level, with larger wins typically leading to more arousal than smaller wins (Dixon et al., 2011; Lole et al., 2012). Although there is a consensus that arousal is a consequence and reinforcer of gambling behavior (and indeed seems to be an intrinsic part of why players find it exciting and enjoyable), it is less clear whether levels of arousal at each type of outcome predict gambling severity.

7.3.Current Study

Although differences in self-report measures of the activity of SP and SR motivational systems were not observed in Chapter 1 (introduction) the present study delves deeper into this issue, by using psychophysiological indices of motivation, instead of self-report, which are more objective and less subject to willful control.

This study examines the gaps and ambiguity in the previous literature by creating in well-controlled experimental conditions, a situation that simulates the experience of slot machine gambling via a Virtual Slot-Machine task inspired by Detez et al., 2019, that used a virtual slot machine task with different blocks. However, we redesigned this task according to ensure that all possible outcomes would be represented. Excitement/Frustration conditions of different types (from low to high) combined with psychophysiological response measures and self-report of affective experiences, allow us to examine the potential heterogeneity in the motives of players. The conditions reflect different types of motivation because they show a range of how the player can be exposed to different intensities of rewards or punishments (Low, Medium, High/Medium, High) based on monetary gain. The gradation of excitement or frustration is expressed according to the monetary gain, since as it appears from the literature, the monetary gain acts in a reinforcing way so that individuals continue to play.

The presence of different trials each time (Win, Near Win, Lose) as an outcome also expresses how the different conditions work so that the person continues to play. In addition to this, literature shows that frustration that comes as a result of a loss, despite the fact that it could be assumed that it acts punitive towards individuals, it does not discourage them from continuing to play, so with different degrees of motivation we will be able to detect if the intensity of the punitive stimulus is a factor that explains this phenomenon. Specifically, we want to examine which are the emotional reactions and arousal levels assessed with HR and SCL during a slot machine task in gamblers in different kind of trials (Win, Near to Win, Lose) and conditions (Frustration/ Punishment); Excitement (Reward) and how the emotional reactions of gamblers are influenced different patterns of motivation BIS/BAS, assessed through questionnaires. Finally, we examine how the emotional reactions of gamblers are related to severity of gambling behavior. Based on the above, we proposed the following hypotheses:

7.4. Hypotheses

Hypothesis 1: Players will show high arousal as indicated by psychophysiological measures (HR, SCL) in the Excitement conditions as well as in Frustration conditions but with different self-report ratings, with positive valence in self- reports compared to frustration conditions and negative valence in self-reports compared to the Excitement conditions; (Putwain, Langdale, Woods, & Nicholson, 2020) depending on gambling severity.

Hypothesis 2: Higher sensitivity to reward will be associated higher gambling severity and higher gambling severity will result in tendency to keep playing (Brevers, Cleeremans, Hermant, Tibboel, Kornreich, Verbanck, & Noël, 2012; McCormick, Delfabbro, & Denson, 2011) even after Frustrating Conditions and the frustrating final result (SAM & Gambling Urge Questionnaire- GUS).

7.5. Method

For description of the participants, their allocation into gambling severity groups and the measures used in this study, please refer to "General Introduction & Demographics".

Statistical Analyses

Descriptive Statistics: For SOGS group differences in SPSR, please refer to "General Introduction & Demographics". SOGS groups did not differed in SPSR aspects contrary to our hypotheses.

Main Analyses: To address the study's hypotheses, the main analysis constituted a mixed repeated measures ANOVA, with SOGS groups as the between factor, and emotional contexts as the within factor, in a 3 X 2 design.

Repeated measures ANOVA was used to examine differences between different levels of gambling behavior based on SOGS (low- medium-high defined by splitting the sample based on $\pm$ 1SD from the mean) in different psychophysiological reactions (HR, SCL) during different conditions (Excitement/Frustration- EF). Responses to each physiological measure were averaged across conditions of the same content (low,medium.high).

A 3 X 2 Repeated measures analysis of variance (ANOVA) was conducted to evaluate the effect of SOGS (South Oaks Gambling Screen) scores as between factor on physiological responses, specifically heart rate (HR) and skin conductance level (SCL), and self – reports (Valence, Arousal, Control, Desire to play) as within subjects across two different conditions in slot machine: excitement and frustration (2 levels). A 3 X 3 Repeated measures analysis of variance (ANOVA) was conducted to evaluate the effect of SOGS as between factor on physiological responses, specifically heart rate (HR) and skin conductance level (SCL) as within subjects across three different trials (Win, Near to win, Lose) Participants were divided into groups based on their SOGS scores (e.g., high, medium, low). Finally a 3 X 2 Repeated measures analysis of variance (ANOVA) was conducted to assess the impact of SOGS scores on responses to the Gambling Urge Scale (GUS) as within- subjects variables before and after the Slot- Machine task (pre-GUS vs. post-GUS).

7.6. Results

Mauchly's Test of Sphericity was conducted to evaluate the assumption of sphericity for the within-subjects factor HR. The results indicated that the assumption was not violated, $W=1.000$. Therefore, no adjustments to the degrees of freedom were necessary for the averaged tests of significance.

Heart Rate (HR)

In the within-subjects effects analysis, the main effect of Excitement- Frustration (EF) conditions regarding heart rate (HR) was not significant $F(1,128)=0.044$, $p=0.833$ and a partial eta squared of 0.000, indicating a negligible effect size and very low power to detect a true effect (observed power = 0.055). The interaction between EF and SOGS was also not significant $F(2,128)=0$, $p=0.661$, partial eta squared = 0.006, observed power = 0.116), indicating a very small effect size and low power to detect the interaction effect. The effect of SOGS was also not significant $F(2,128)=0.853$, $p=0.428$, partial eta squared = 0.013, observed power = 0.194, indicating a very small effect size and low power to detect the effect.

Skin Conductance Level (SCL)

The within-subjects effects analysis for SCL revealed a significant main effect of excitement and frustration conditions (EF), $F(1, 128) = 57.750$, $p < 0.001$, $\eta p^2 = 0.311$.

However, the interaction effect between EF and SOGS was not significant, $F(2, 128) = 0.257$, $p = 0.774$, $\eta p^2 = 0.004$. This suggests that while excitement and frustration conditions significantly influenced SCL, there was no significant interaction between these conditions and SOGS. In the between-subjects effects analysis the effect of SOGS was not significant, $F(2, 128) = 1.022$, $p = 0.363$, $\eta p^2 = 0.016$. EF conditions for SCL revealed a significant mean difference of -1.028 ($SE = 0.135$, $p < 0.001$, 95% CI [-1.295, -0.760]). This indicates that participants exhibited significantly lower skin conductance levels during the excitement condition ($M= 10.246$, $SE= 0.937$) compared to the frustration condition ($M= 11.274$, $SE= 0.983$).

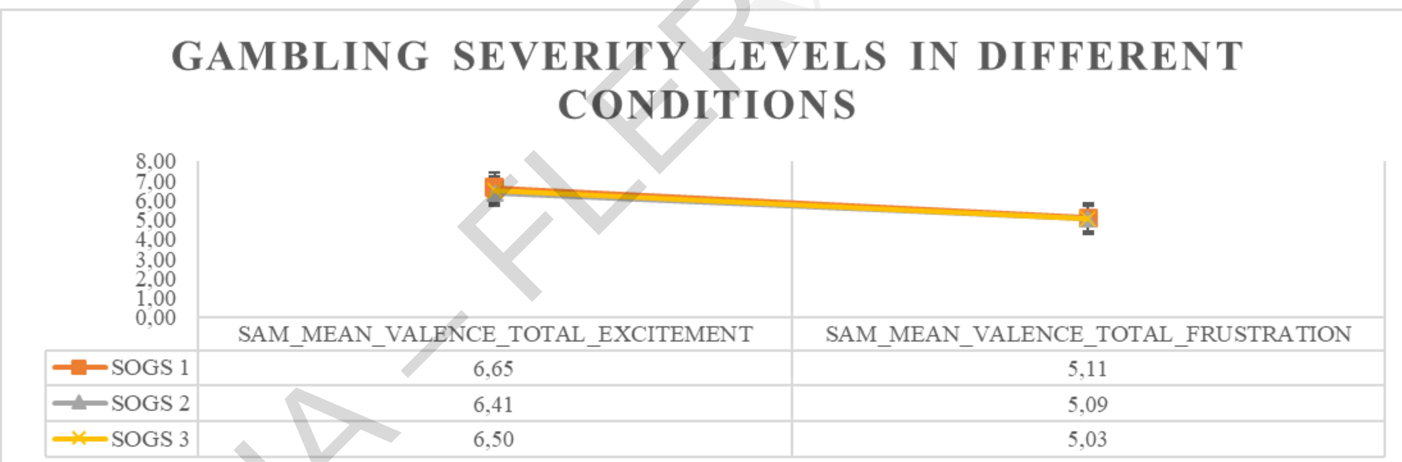
Self – Reports

Valence

The effect of EF conditions on self- report valence is significant with a very high F-value

(93.287) and p-value < .001, indicating a strong effect. The partial eta squared (.422) suggests a large effect size. The observed power (1.000) indicates that the test is very likely to detect a true effect. The interaction between conditions and SOGS was not significant (F = .364, p = .696). The partial eta squared (.006) suggests a very small effect size, and the observed power (.107) indicates low power to detect the effect. The effect of SOGS was not significant (F = .232, p = .793). The partial eta squared (.004) suggests a very small effect size, and the observed power (.086) indicates low power to detect the effect. Pairwise comparisons between excitement (Level 1) and frustration (Level 2) conditions for valence showed that there is a significant difference in means between excitement and frustration conditions (Mean Difference = 1.441, SE= .149, p < .001, 95% [1.146, 1.736]). This indicates that participants exhibited significantly more positive valence during the excitement condition (M=6.518,SE=0.134) compared to the frustration condition (M=5.077,SE=0.131) (Figure 1)

Figure 1.

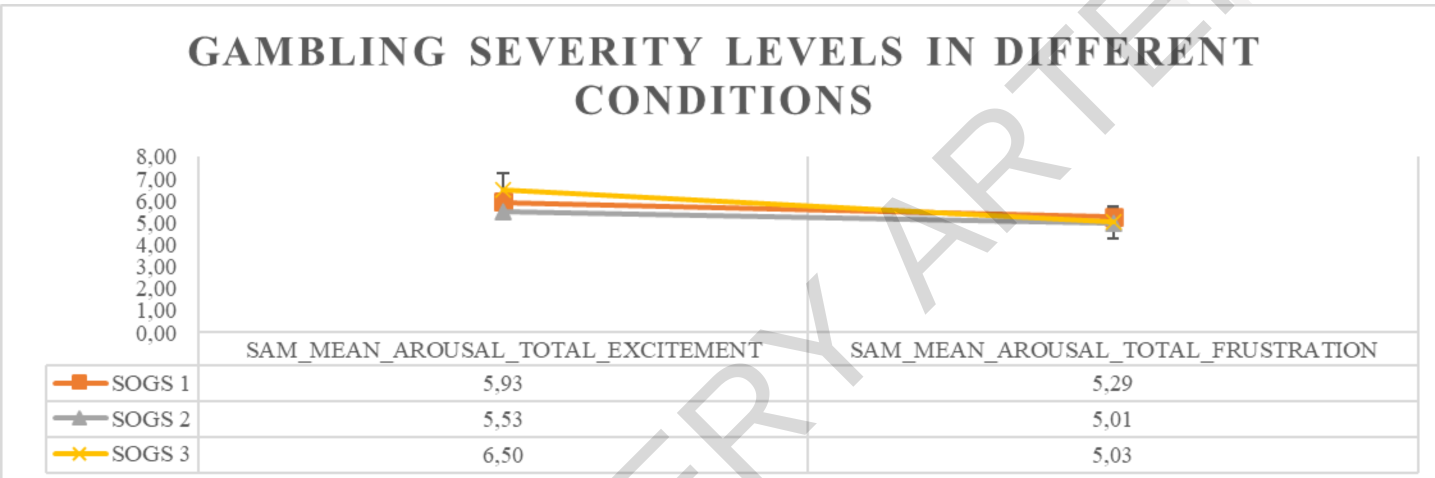


Arousal

In the within-subjects effects, the main effect of EF conditions regarding arousal was found to be significant F(1,128)=37.690, p<.001, and a partial eta squared of .227. This indicates a moderate to large effect size, and the observed power was 1.000, suggesting a very high likelihood of detecting a true effect. Specifically, the mean difference between excitement (M=5.766,SE=0.193) and frustration (M=5.138,SE=0.179) was .628 (SE= .102, p<.001), with a 95% confidence interval ranging from .425 to .830 with higher arousal observed in excitement conditions (Figure 2).However, the interaction between EF conditions and SOGS was not significant F(2,128)=.339, p = .713, partial eta squared = .005, observed power =

.103), indicating a very small effect size and low power to detect the interaction effect. In the between-subjects effects, the effect of SOGS was not significant F(2,128)=.545, p=.581p = .581p=.581, partial eta squared = .008, observed power = .139), indicating a very small effect size and low power to detect the effect.

Figure 2.



Control

In the within-subjects effects analysis, the main effect of control in EF conditions was significant F(1,128)=13.325, p<.001p < .001p<.001, and a partial eta squared of .094. This indicates a moderate effect size, and the observed power was .952, suggesting a high likelihood of detecting a true effect. Specifically, the mean difference between Excitement (M=6.560, SE=0.252) and Frustration (M=6.270, SE=0.262) conditions was .290 (SE= .079, p<.001), with a 95% confidence interval ranging from .133 to .447 showing higher self-reporting control in excitement conditions (Figure 3). However, the interaction between EF conditions regarding control and SOGS was not significant F(2,128)=1.666, p=.193, partial eta squared = .025, observed power = .346), indicating a small effect size and low power to detect the interaction effect. The effect of SOGS was not significant F(2,128) =.338, p=.714, partial eta squared = .005, observed power = .103), indicating a very small effect size and low power to detect the effect.

Figure 3.

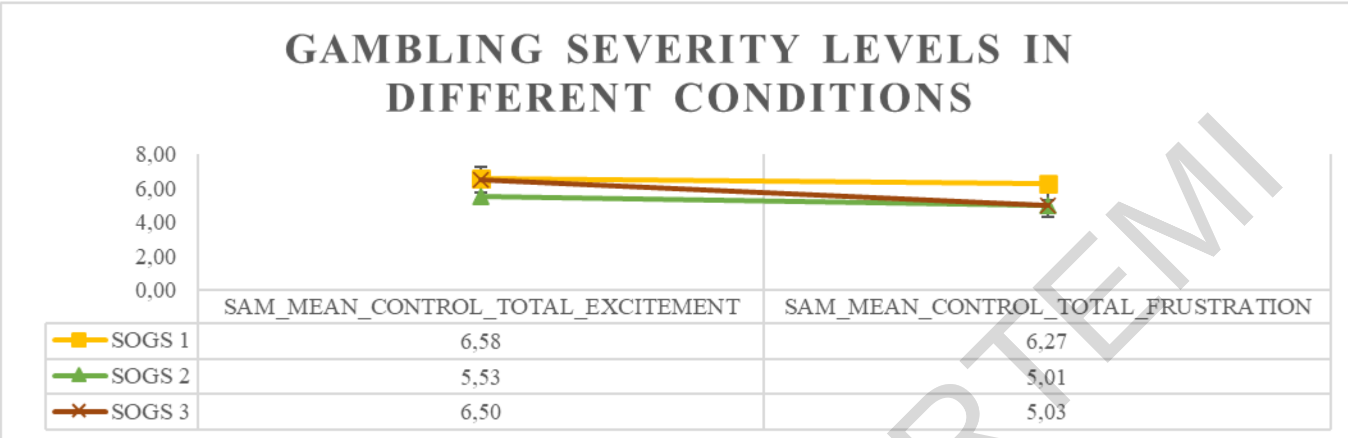
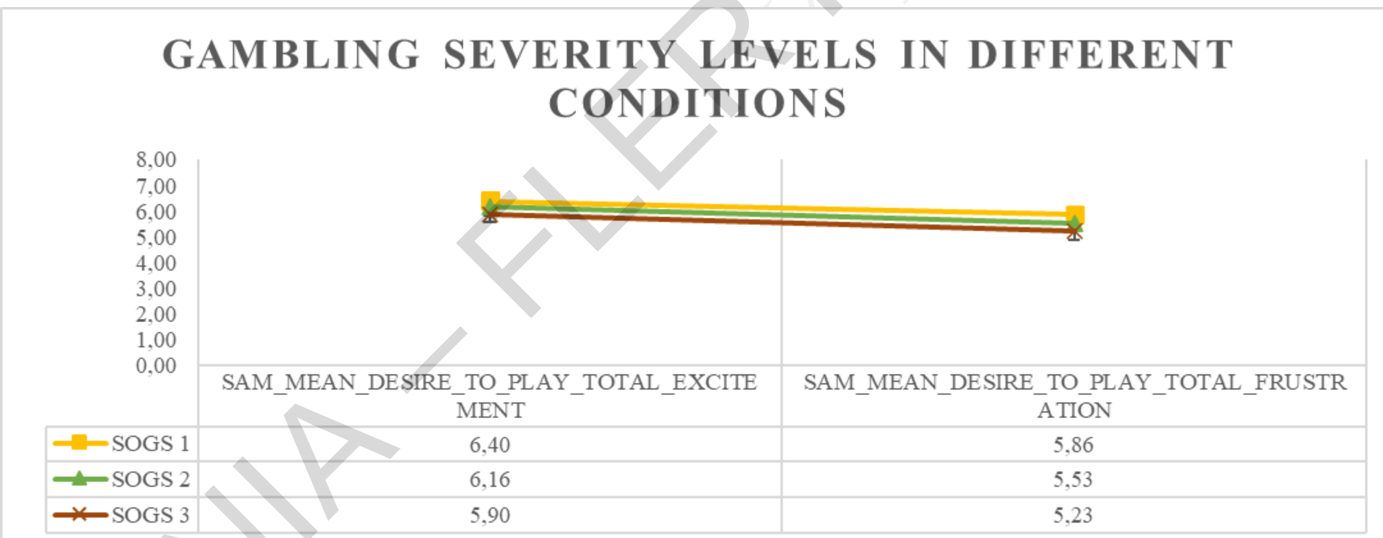


Figure 4.



Desire to play

In the within-subjects effects analysis, the main effect of EF conditions regarding desire to play was significant $F(1,128)=42.430$, $p<.001$ and a partial eta squared of .249. This indicates a large effect size, and the observed power was 1.000, suggesting a very high likelihood of detecting a true effect. However, the interaction between EF and SOGS on desire to play was not significant $F(2,128)=.211$, p=.810p = .810p=.810, partial eta squared = .003, observed power = .082), indicating a very small effect size and low power to detect the interaction effect. The effect of SOGS was not significant $F(2,128)=.675$, $p=.511$, partial eta squared = .010, observed power = .161), indicating a very small effect size and low power to detect the effect. Specifically, the mean difference between Excitement (M=6.151, SE=0.211) and Frustration conditions (M=5.538, SE=0.214) (Figure 4).

Gambling Urges Questionnaire (GUS)

In the within-subjects effects analysis, the main effect of time regarding GUS pre and post the slot-machine task was not significant $F(1,128)=2.084$, $p=0.151$, and a partial eta squared of 0.016, indicating a small effect size and low power to detect a true effect (observed power = 0.299). The interaction between GUS measurement time and SOGS was also not significant $F(2,128)=0.819$, $p=0.443$ partial eta squared = 0.013, observed power = 0.188, indicating a very small effect size and low power to detect the interaction effect.

In the between-subjects effects analysis, the effect of SOGS was not significant $F(2,128)=0.342$, $p=0.711$, partial eta squared = 0.005, observed power = 0.104, indicating a very small effect size and low power to detect the effect.

7.7.Win, Near to Win, Lose Conditions and Psychophysiological Measures

Heart Rate (HR)

The results of Mauchly's Test of Sphericity indicated that the assumption of sphericity was not violated for the within-subjects effect of HR, $\chi2(2,131)=0.331, p=.847$. The results of the Tests of Within-Subjects Effects showed that the effect of Win, Lose, Near to win regarding HR was not statistically significant, $F(2,256)=0.085, p=.918, \eta p2=.001$. The observed power was 0.063. Regarding the interaction with SOGS, the interaction effect was not statistically significant, $F(4,256)=0.599, p=.663, \eta p2=.009$. The observed power was 0.197. Tests of Between-Subjects Effects showed that the effect of SOGS was not statistically significant, $F(2,128)=0.859, p=.426, \eta p2=.013$. The observed power was 0.195.

Skin Conductance Level (SCL)

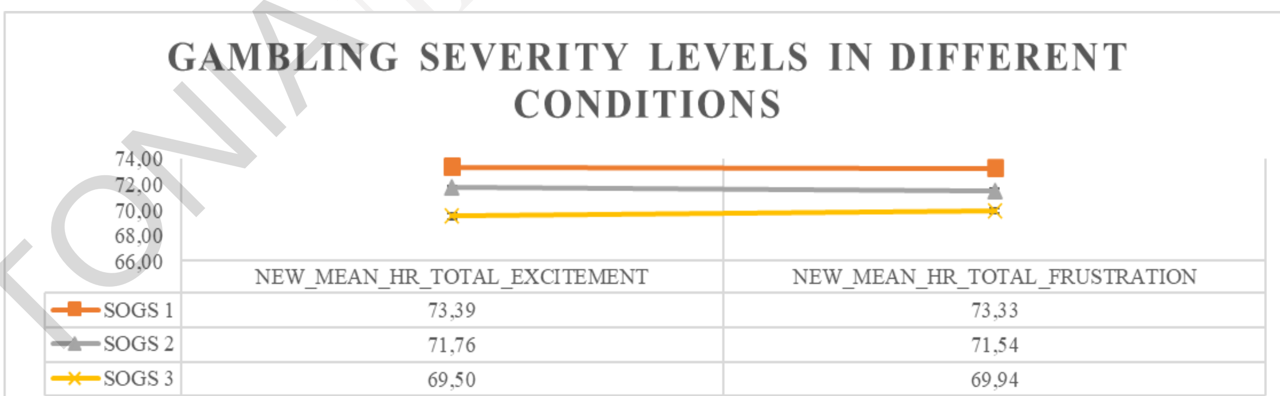
The results of Mauchly's Test of Sphericity indicated that the assumption of sphericity was violated $\chi^2(2) = 5.075$, $p = .079$ so Greenhouse-Geisser epsilon correction was used, $\varepsilon = .962$. For the within-subjects effects there was not a significant main effect of Win, Near win, Lose conditions regarding SCL $F(1.925, 246.350) = 0.906$, $p = .402$, $\eta p^2 = .007$. The interaction between SCL and SOGS was also not significant, $F(3.849, 246.350) = 0.818$, $p = .511$, $\eta p^2 = .013$. For the between-subjects effects SOGS did not yield a significant main effect, $F(2, 128) = 1.035$, $p = .358$, $\eta p^2 = .016$.

7.8. Exploration Analyses based on Gambling Severity Profiles

A Bonferroni correction was applied to account for the multiple comparisons made among the three groups of SOGS severity. The standard significance level of $\alpha=0.05$ was divided by the number of comparisons (3), resulting in an adjusted significance level of $\alpha'=0.017$. Therefore, p-values less than 0.017 were considered statistically significant to reduce the risk of Type I errors. In case these analyses resulted in significant effects of EF conditions these were further explored to identify the specific emotion categories associated with aberrant emotional responses, using post hoc pairwise comparisons and Bonferroni corrected levels of significance. The standard significance level of $\alpha=0.017$ was divided by the number of comparisons (12), resulting in an adjusted significance level of $p=0.0014166$.

In HR no significant differences were observed between E and F conditions in any gambling severity level ($p > 0.017$; Figure 5).

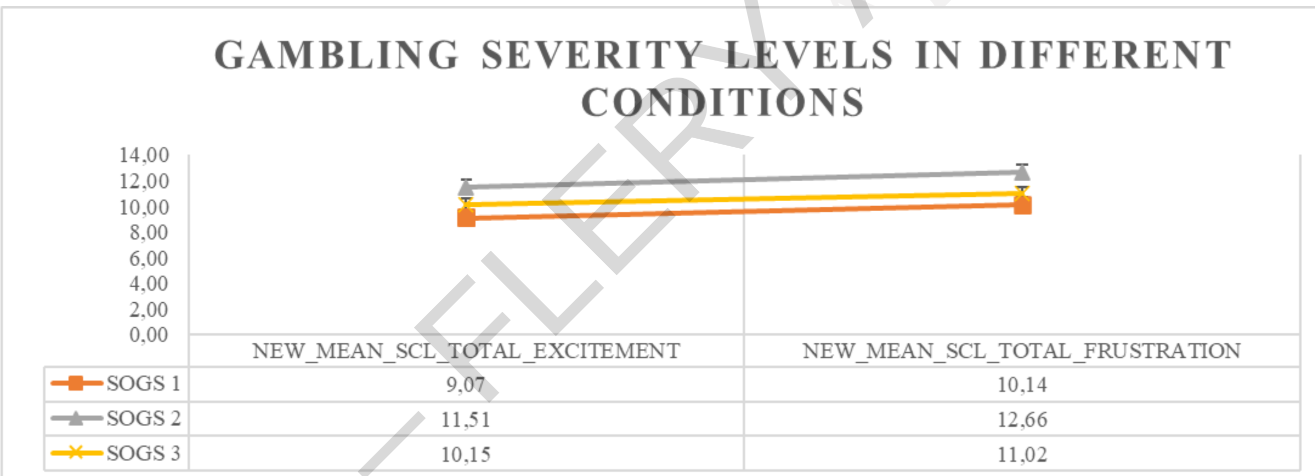
Figure 5.



Regarding Skin Conductance, in the low severity gamblers, the within-subjects main effect of EF conditions in SCL was significant, $F(1, 75) = 50.190$, $p < .001$, $\eta p^2 = .401$. Participants in

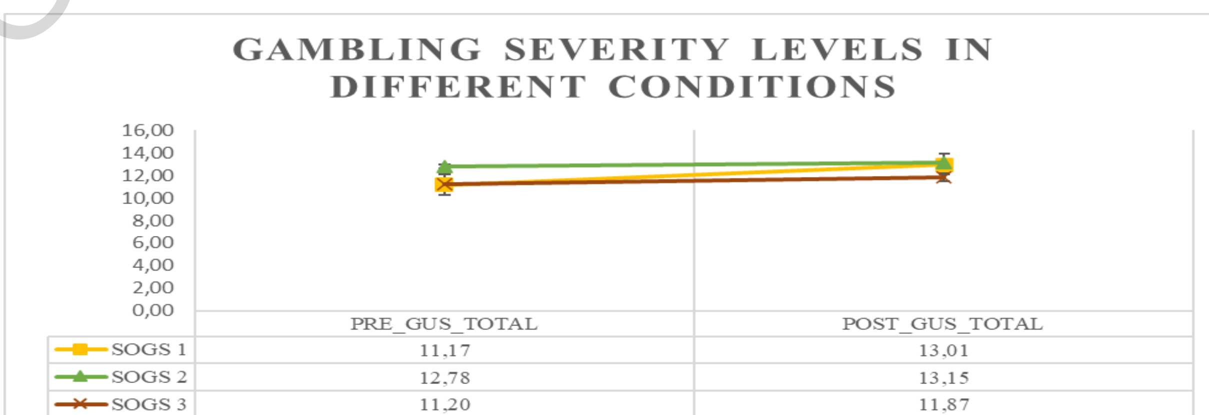
Excitement condition showed significantly lower scores than those in Frustration condition, with a mean difference of -1.072 (SE = 0.151, $p < .001$, 95% CI [-1.373, -0.770]) (Figure 2). In Medium Severity gamblers the within-subjects main effect of EF conditions in SCL was also significant, $F(1, 39) = 38.410$, $p < .001$, $\eta p^2 = .496$. Participants in Excitement condition showed significantly lower scores than those in Frustration condition, with a mean difference of 1.141 (SE = 0.184, $p < .001$, 95% CI [0.769, 1.514]) (Figure 2). In High Severity gamblers the within-subjects main effect of EF conditions in SCL was again significant, $F(1, 14) = 9.033$, $p = .009$, $\eta p^2 = .392$. Participants in Excitement condition showed significantly lower scores than those in Frustration condition, with a mean difference -0.870 (SE = 0.289, $p = .009$, 95% CI [-1.490, -0.249]). (Figure 6).

Figure 6.



Gambling Urges Questionnaire (GUS)

Figure 7.

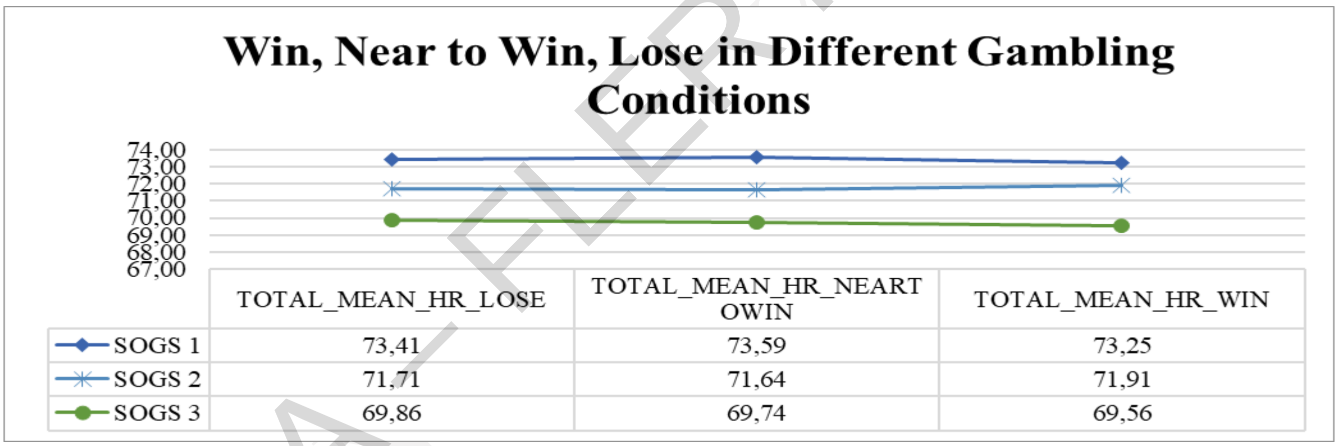


Regarding gambling urges pre and post slot-machine task in low severity gamblers, there was a significant within-subjects effect of time regarding GUS, $F(1, 75) = 5.926$, $p = .017$, $\eta p^2 = .073$. However, there was not significant differences in pairwise comparisons with a mean difference of -1.842 (SE = 0.757, p = .017, 95% CI [-3.350, -0.335]). However, in general, in all groups a slight increase in urge to gamble again was obvious from pre to post especially in low severity group (Figure 7).

Win, Lose and Near to Win Trials

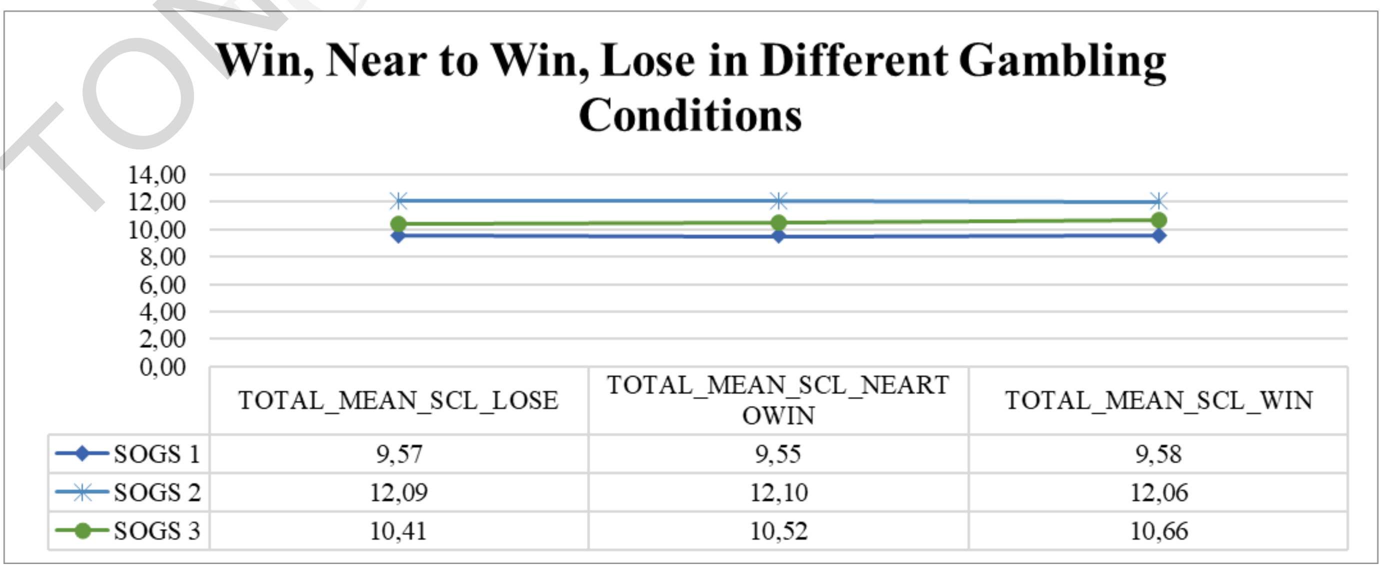
No significant differences were observed in different gambling levels regarding Heart Rate and Skin Conductance level in any trial separately (win,lose, near to win) ($p > 0.017$). Actual differences can be seen in Figures 8 & 9.

Figure 8.



	TOTAL_MEAN_HR_LOSE	TOTAL_MEAN_HR_NEARTOWIN	TOTAL_MEAN_HR_WIN
SOGS 1	73,41	73,59	73,25
SOGS 2	71,71	71,64	71,91
SOGS 3	69,86	69,74	69,56

Figure 9.



	TOTAL_MEAN_SCL_LOSE	TOTAL_MEAN_SCL_NEARTOWIN	TOTAL_MEAN_SCL_WIN
SOGS 1	9,57	9,55	9,58
SOGS 2	12,09	12,10	12,06
SOGS 3	10,41	10,52	10,66

7.9. Discussion

The current study aimed to explore the emotional and physiological responses of gamblers under different conditions of excitement and frustration during a slot-machine task, considering various levels of gambling severity. The study utilized a well-controlled experimental design, employing a Virtual Slot-Machine task to simulate the experience of slot machine gambling. Participants were exposed to different conditions of excitement and frustration, with varying levels of monetary gain or loss. Psychophysiological measures, including heart rate (HR) and skin conductance level (SCL), were recorded to assess arousal levels, while self-report measures were used to evaluate affective experiences such as valence, arousal, control, and desire to play. Participants were also divided into groups based on their South Oaks Gambling Screen (SOGS) scores to explore the influence of gambling severity on emotional and physiological responses. The hypotheses proposed that players would exhibit high arousal in both excitement and frustration conditions but with different self-report ratings, and that higher sensitivity to reward would be associated with higher gambling severity, leading to a tendency to continue playing even after experiencing frustrating conditions. However, the results showed mixed findings regarding these hypotheses.

The first hypothesis posited that players would demonstrate higher arousal, as measured by psychophysiological responses (HR, SCL), in both excitement and frustration conditions, with varying self-report ratings depending on gambling severity levels. Contrary to the hypothesis, the main effect analysis of heart rate (HR) did not reveal significant differences between excitement and frustration conditions. Similarly, the interaction between EF and South Oaks Gambling Screen (SOGS) scores, representing gambling severity levels, was not significant. These results suggest that neither the motivational states nor individual differences in gambling severity significantly influenced HR. Regarding skin conductance level (SCL), the main effect analysis showed a significant difference between excitement and frustration conditions, indicating distinct arousal responses to these emotional states. However, the interaction effect between excitement/frustration conditions and SOGS scores was not significant, suggesting that gambling severity did not modulate the influence of emotional states on SCL. Between-subjects analysis also did not reveal a significant effect of SOGS on SCL.

The study investigates how different gambling outcomes—win, near-win, and lose conditions—affect players' psychophysiological responses, with a focus on how gambling severity levels (as measured by SOGS) interact with these effects. The lack of significant findings suggests that HR is not a sensitive measure of the emotional impact of win, near-win, and lose conditions in this context. This aligns with some literature indicating that HR may not always show significant variations in response to different gambling outcomes (Clark, 2010). The non-significant interaction with SOGS further suggests that gambling severity does not modulate HR responses to these outcomes.

Similar to HR, the non-significant results for SCL indicate that skin conductance did not vary significantly across different gambling outcomes, nor did it interact significantly with gambling severity. These findings are consistent with research suggesting that SCL may not always detect subtle differences in emotional arousal in gambling contexts (Wilkes et al., 2010; Lole et al., 2014).

The significant differences in self-reported valence, arousal, control, and desire to play between excitement and frustration conditions indicate that participants' subjective experiences were affected by the emotional context. However, the lack of significant interactions with SOGS suggests that these subjective experiences were not influenced by gambling severity. This finding aligns with some previous research suggesting that emotional responses to gambling can be relatively consistent across different levels of gambling severity (Brevers et al., 2013; Limbrick-Oldfield et al., 2017).

Personality factors, which were not measured in this study, could have influenced the results. Traits such as impulsivity and risk-taking are known to affect gambling behavior and physiological responses (Nower et al., 2004). Additionally, psychopathic traits, which can include a lack of emotional responsiveness and high risk-taking behaviors, may have affected the results (Blaszczynski & Nower, 2002).

Our Second hypothesis suggested that higher sensitivity to reward will be associated higher gambling severity and higher gambling severity will result in tendency to keep playing even after Frustrating Conditions and the frustrating final result. The absence of significant effects for GUS and the absence of significance between SOGS and SPSR (see one- way ANOVA analyses) indicates that neither gambling urges nor sensitivity to reward/punishment were significantly influenced by gambling severity or the EF conditions. This suggests that higher sensitivity to reward does not necessarily lead to a greater tendency to continue playing after frustrating conditions, contrary to the hypothesis. Previous research has indicated that while sensitivity to reward can influence gambling behavior, its effect may be more nuanced and context-dependent (Brevers et al., 2013; McCormick, Delfabbro, & Denson, 2011; Kräplin et al., 2014).

Exploration Analyses Based on Gambling Severity Profiles explored the effects of gambling severity on psychophysiological measures (Heart Rate, Skin Conductance Level) and self-reported measures (Gambling Urge Questionnaire) under different gambling conditions (excitement/frustration) and trials (win, near-win, lose). The consistent finding across all severity levels that excitement conditions result in lower SCL than frustration conditions suggests that skin conductance is a reliable measure of arousal related to emotional states in gambling. The higher arousal in frustration conditions may reflect heightened stress or anxiety in response to losses or near-wins.

The significant within-subjects effect of GUS in low severity gamblers indicates an increase in gambling urges post-task, which could reflect the reinforcing nature of the gambling experience, for some players but not for others Who may be more influenced by the losses involved. The lack of significant pairwise differences suggests that this increase might be subtle but consistent, aligning with the notion that gambling experiences can heighten the desire to continue gambling (Brevers et al., 2012; McCormick et al., 2011). The sample included participants with low, medium, and high gambling severity, including students with low income. Low-income participants may experience higher emotional volatility and stress, influencing their responses and desire to gamble (Abbott et al., 2016). The absence of significant differences in HR and SCL across win, lose, and near-win trials suggests that these physiological measures may not differentiate between these specific gambling outcomes. This finding could indicate that while SCL is responsive to general excitement and frustration conditions, it does not vary significantly with specific gambling outcomes within those broader categories. One potential factor to consider is individual differences in subjective experiences and cognitive interpretations of the gambling outcomes. Participants may perceive wins, losses, and near-wins differently based on their personal gambling history, beliefs about luck, and cognitive biases (Clark et al., 2009).

Furthermore, contextual factors within the experimental setting may also play a role. For instance, the anticipation of outcomes, regardless of whether they are wins, near-wins, or losses, could evoke similar physiological responses due to the inherent uncertainty and excitement associated with gambling (Clark et al., 2013). Additionally, the specific parameters of the slot-machine task, such as the frequency and magnitude of wins and losses, may influence participants' emotional and physiological reactions (Wohl et al., 2010). Differences in task design and presentation could affect how participants engage with the gambling activity and subsequently impact their physiological responses.

The slot-machine task used in this study has several strengths and limitations that are important to consider. One of the key advantages is its ecological validity; it closely mimics real-life gambling scenarios, thereby providing a realistic measure of gamblers' emotional and physiological responses. Similar to findings in other slot-machine task studies, the task effectively differentiated between emotional states such as excitement and frustration, as indicated by significant differences in skin conductance levels (Clark, 2010; Wilkes et al., 2010). However, one limitation is the potential for habituation, particularly among high severity gamblers, who may become desensitized to the emotional highs and lows of gambling due to repeated exposure that comes as a contradictory argument in our hypotheses. This habituation could explain the lack of significant differences in physiological measures like heart rate and SCL in this group, as their bodies may no longer react psychophysiologically strongly to gambling stimuli (Goudriaan et al., 2005).

Traits such as impulsivity and sensation-seeking, which are often elevated in individuals with gambling problems, could amplify emotional responses to both wins and losses (Nower et al., 2004; Billieux et al., 2012). Psychopathic traits, including a lack of empathy and high risk-taking tendencies, may blunt emotional responses, making individuals less sensitive to the highs and lows typically experienced during gambling (Blaszczynski & Nower, 2002; Turner et al., 2013). These traits could contribute to the non-significant findings in physiological measures, as individuals with high levels of these traits might not exhibit the same arousal patterns as those without such traits. Additionally, the interaction of these personality factors with gambling severity underscores the complexity of gambling behavior, highlighting the need for comprehensive assessments that consider both psychological and physiological dimensions.

The study provides valuable insights into the emotional and physiological responses to gambling under different conditions of excitement and frustration. While HR did not vary significantly, SCL proved to be a reliable measure of arousal, highlighting differences between excitement and frustration conditions. The results suggest that gambling experiences can heighten the desire to continue gambling, particularly in lower severity gamblers, and underscore the need for more nuanced research considering personality traits and socio-economic factors. Future research should also address the potential for habituation in high severity gamblers and incorporate a broader range of personality assessments to better understand the complex interplay between emotional, cognitive, and physiological factors in gambling behavior.

8.Study 2: Unveiling the Cards: Exploring Psychopathic Traits, and Heart Rate Variability in Virtual Slots

8.1.Introduction

Gambling Behavior and HRV

Heart rate variability, the variation in the time interval between consecutive heartbeats, is considered a reliable indicator of autonomic nervous system activity and emotional regulation (Thayer et al., 2012). Initial evidence shows that individuals with gambling disorders exhibit alterations in HRV compared to non-gamblers or recreational gamblers. Heart rate variability (HRV) is generally inversely related to various forms of psychopathology, with lower HRV being associated with a higher prevalence and severity of conditions such as anxiety, depression, and post-traumatic stress disorder (PTSD), reflecting dysregulation in autonomic nervous system functioning and impaired physiological adaptability to stress (Chalmers et al., 2014; Kemp et al., 2012). However, reduced HRV has been associated with increased gambling severity and impulsivity as well, suggesting dysregulation in autonomic functioning among problem gamblers (Dixon et al., 2014).

One of the key factors influencing HRV during gambling is the rewarding and punishing nature of gambling activities. For instance, slot-machine gambling, a popular form of gambling, involves intermittent rewards (e.g., winning money) and punishments (e.g., losing money) (Dixon et al., 2014). These reward-punishment contingencies elicit distinct physiological responses, including changes in HRV. Research has demonstrated that the anticipation and experience of rewards increase HRV, reflecting a state of physiological arousal and positive affect (Balconi, Finocchiaro, & Canavesio, 2014). Conversely, the experience of losses or negative outcomes during gambling is associated with decreased HRV, indicative of heightened sympathetic activity and negative emotional states (Gupta & Derevensky, 2004).

Psychopathy Traits and HRV in Gambling Contexts

Psychopathy, characterized by a constellation of personality traits such as callousness, manipulativeness, and lack of empathy, has been implicated in various forms of antisocial behavior, including pathological gambling (Smith & Newman, 1990). Individuals with psychopathic traits often display deficits in emotional processing and regulation, which may influence their physiological responses during gambling activities.

The relationship between psychopathic traits, gambling behavior, and heart rate variability (HRV) is complex and has produced conflicting findings in the literature. Opposing findings and interpretations can be explained by considering different facets of psychopathy and their distinct associations with HRV. Some studies (Beauchaine et al., 2007) suggest that individuals with high levels of psychopathic traits, particularly those related to affective and interpersonal deficits (e.g., lack of empathy, shallow affect), exhibit lower HRV. This theory posits that these traits are linked to a dysregulated autonomic nervous system, resulting in reduced parasympathetic activity and therefore lower HRV (Gao, Raine, & Schug, 2012). For example, low HRV has been associated with traits such as impulsivity and emotional detachment, which are common in psychopathy and may also predispose individuals to maladaptive gambling behaviors (e.g., impulsive gambling, risk-taking). Conversely, other research indicates that certain psychopathic traits, particularly those related to boldness and fearlessness, are associated with higher HRV (Patrick, et al., 2013; Koenigs, et al, 2010). This perspective suggests that these traits might reflect a more adaptive or resilient autonomic profile, characterized by greater parasympathetic dominance and better stress regulation.

Individuals exhibiting high boldness might experience less autonomic arousal in risky situations, such as gambling, which could result in higher HRV measurements.

The inconsistency in the literature can be reconciled by recognizing that psychopathy is not a monolithic construct but rather a collection of distinct traits that can differentially impact autonomic function (Skeem et al., 2011).

Slot machine gambling provides a unique context to study the interplay between psychopathy traits, HRV, and gambling behavior. The fast-paced and repetitive nature of slot machine games, combined with the potential for both rewards and losses, makes them particularly appealing to individuals with psychopathic traits (Lilienfeld, Watts,& Smith, 2015). This multimodal approach allows us to capture the variability in autonomic responses and provides a more comprehensive understanding of how different psychopathic traits modulate HRV in the context of gambling.

For example, some, individuals may be more drawn to the immediate gratification and excitement associated with slot machine gambling, while showing diminished emotional responses to both wins and losses. Specifically, gamblers high in psychopathic traits may show reduced HRV during both the anticipation of wins and the experience of losses.

Understanding the interplay between psychopathy traits, HRV, and gambling behavior has significant implications for the identification and treatment of individuals at risk for developing gambling disorders. By elucidating the underlying physiological mechanisms associated with psychopathic traits in gambling contexts, researchers can inform the development of targeted interventions aimed at improving emotional regulation and reducing problematic gambling behaviors. These techniques help individuals learn how to regulate their physiological responses, thereby improving their emotional regulation and reducing impulsivity and compulsive behaviors. This can be particularly useful for those with high psychopathic traits who may struggle with traditional therapeutic approaches (Thayer, & Lane, 2009).

In this study, we aim to further investigate the relationship between gambling behavior, HRV, and psychopathy traits using a multimodal approach. Specifically, we will employ psychophysiological measures, including HRV, to assess autonomic responses during a simulated slot-machine task. Additionally, we will administer self-report measures to assess gambling severity and psychopathy traits. By examining the interplay between these variables, we seek to gain insights into the underlying mechanisms of gambling behavior and inform personalized interventions for individuals with gambling disorders. Further investigation is necessary because existing research has primarily focused on the relationship between HRV and general psychopathology or specific conditions such as anxiety and depression, leaving a gap in our understanding of how HRV is associated with behaviors that may be driven by complex motivations and characterized by diverse emotional reactions, like gambling. The current literature lacks comprehensive studies that integrate physiological measures with self-report data to explore these associations in the context of gambling, an area where autonomic dysregulation and impulsive traits may significantly impact behavior. This research will specifically address this gap by providing detailed insights into the autonomic and psychological profiles of individuals with problematic gambling, potentially revealing unique patterns of psychophysiological responses that could inform more effective, personalized treatment strategies for gambling disorders.

8.2.Current Study

Measuring HRV is an important addition that allows us to see how players respond to specific conditions that cause frustration and excitement in a range (Low, Mild, High) in relation to their individual differences in psychopathic traits. This study, provides new evidence to that provided in the introductory section where no differences were seen between levels of gambling severity in self-reported activity of motivational systems. Here, going beyond self-report, we induce different motivational conditions experimentally, and measure their impact with objective psychophysiological indices. We examine both resting state HRV, which is known to correlate with individual differences in emotion regulation ability, and changes in HRV during the task, that correspond to each frustration and excitement condition to assess the link between autonomic regulation and psychopathic traits and gambling severity.

8.3.Hypotheses

Hypothesis 1: Gambling severity, as measured by SOGS, will show a significant main effect on HRV across different conditions (baseline, low excitement, high excitement, high frustration). Specifically, higher SOGS scores (indicative of greater gambling severity) will be associated with lower overall HRV, reflecting dysregulated autonomic function (Dixon et al., 2014). Prior research has consistently demonstrated that higher levels of gambling severity are linked to lower HRV, indicating impaired autonomic regulation, and heightened sympathetic activity, especially in response to stressful or emotionally arousing conditions (Chalmers et al., 2014; Kemp et al., 2012).

Hypothesis 2: There will be a significant interaction effect between gambling severity (SOGS) and the conditions of excitement and frustration on HRV. Specifically, individuals with higher SOGS scores will show more pronounced reductions in HRV during high frustration conditions compared to those with lower SOGS scores. The anticipation and experience of losses, which characterize high frustration conditions in gambling, are associated with decreased HRV, particularly in individuals with higher gambling severity. This suggests that the autonomic response to emotional stressors during gambling varies depending on the severity of the gambling problem (Gupta & Derevensky, 2004).

Hypothesis 3: Psychopathy traits, particularly those related to emotional detachment and impulsivity, will explain in part the effect of SOGS levels on HRV during excitement and frustration conditions. Specifically, higher levels of these traits may explain the impact of gambling severity on HRV, reflecting dysregulated responses to emotional stimuli (). Individuals high in psychopathy traits may show reduced HRV regardless of gambling severity, indicating a general dysregulation in autonomic function that predisposes them to maladaptive behaviors like problematic gambling (Gao, Raine, & Schug, 2012).

8.4.Method

For description of the participants, their allocation into gambling severity groups and the measures used in this study, please refer to “General Introduction & Demographics”.

Statistical Analyses

Descriptive Statistics: For SOGS group differences in psychopathy, please refer to “General Introduction & Demographics”. As expected, SOGS groups differed on all psychopathy aspects, with the highest gambling severity group showing the highest level of psychopathy traits overall, and the lowest severity group showing significantly lower psychopathy traits.

Main Analyses: To address the study’s hypotheses, the main analysis constituted a mixed repeated measures ANOVA, with SOGS groups as the between factor, and Conditions based on HRV as the within factor, in a 3 X 4 design. Figure 1 shows the different phases of the task, which was the within subjects’ factor.

Repeated measures ANOVA was used to examine differences between different levels of gambling behavior based on SOGS (low- medium-high defined by splitting the sample based on ± 1SD from the mean) in different psychophysiological reactions (HRV) during different conditions.

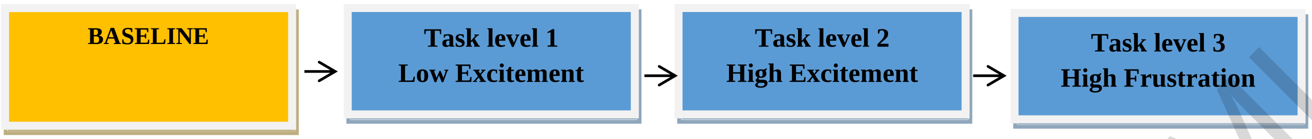
Repeated Measures mixed ANOVA 3 X 4 was employed to compare the effects of the independent variables on HRV focusing on RMSSD index (Root Mean Square of the Successive Differences) which has been widely recognized as a robust index for assessing autonomic regulation and especially parasympathetic function (Shaffer and Ginsberg 2017). The between-subjects categorical factor represented different levels of gambling severity (1- No problem gambler, 2- Low- Moderate Risk Gambler, 3- High Risk Gambler) to examine possible main effects or interactions with slot machine task conditions, namely Baseline, Excitement and Frustration Conditions on HRV (4 levels; baseline, low excitement, high excitement, high frustration) as the within subjects variable. In case main or interactive effects of SOGS level are observed, ANCOVA analyses will be conducted with psychopathy measured with LSRP and TriPM as the covariates, to evaluate the possibility that it explains the effects of SOGS on HRV. Finally, Repeated Measures ANOVA Gambling severity (SOGS) was used also as a splitting variable in exploratory analysis to see actual differences within the gambling severity groups in HRV during excitement and frustration conditions.

8.5. Results

Irrespective of whether significant effects of SOGS level or interactions with task phase were observed, because understanding the impact of SOGS severity on HRV was the main objective of the study, we conducted follow-up exploratory analysis of HRV during different task phases, for each level of SOGS separately.

A Bonferroni correction was applied to account for the multiple comparisons made among the three groups of SOGS severity. The standard significance level of $\alpha=0.05$ was divided by the number of comparisons (3), resulting in an adjusted significance level of $\alpha'=0.017$. Therefore, p-values less than 0.017 were considered statistically significant to reduce the risk of Type I errors.".

Figure 1. Different Slot Machine Task Conditions



Note.

Duration of Heart Rate Variability extraction interval = 5 minutes, 300 seconds

Excitement/Frustration Conditions: Low Excitement- Participants won 5 euros; High Excitement- Participants won 20 euros; High Frustration- Participants lost completely 25 euros.

First, ANOVA assumptions were tested. Mauchly's W statistic tests the assumption of sphericity, which assumes that the variances of the differences between all combinations of related groups are equal. The test yielded a significant result, indicating violation of the sphericity assumption (Mauchly's W = 0.889, $\chi^2(5) = 14.878$, p = 0.011). Therefore, epsilon correction Greenhouse-Geisser was applied ($\varepsilon = 0.931$).

The analysis of within-subjects effects revealed a significant main effect of slot machine task phase , $F(2.792, 384) = 4.680$, $p = 0.004$, $\eta^2 = 0.035$). Post-hoc pairwise tests using Greenhouse-Geisser, Huynh-Feldt, and Lower-bound corrections showed significant differences between phases of the task ($p < 0.017$; Table 1). However, the interaction effect between slot machine task phase and SOGS was not statistically significant ($F(5.584, 384) = 1.149$, $p = 0.334$, $\eta^2 = 0.018$), suggesting that the relationship between task phase and gambling severity did not vary significantly across conditions. Power analysis indicated sufficient statistical power (observed power > 0.80) for detecting significant effects in the main analysis of HRV. Regarding Pairwise comparisons differences were observed between baseline HRV and low excitement condition ($p = 0.005$), with baseline HRV showing higher values than low excitement. However, this comparison, and other pairwise comparisons did not reach statistical significance after Bonferroni correction.

Regarding the between subjects' variable, there was no significant effect of gambling severity categories on HRV ($F(2, 128) = 0.907$, $p = 0.406$, $\eta^2 = 0.014$), suggesting that HRV did not differ significantly among groups categorized by gambling severity.

Table 1. Means and SDs in slot machine task conditions

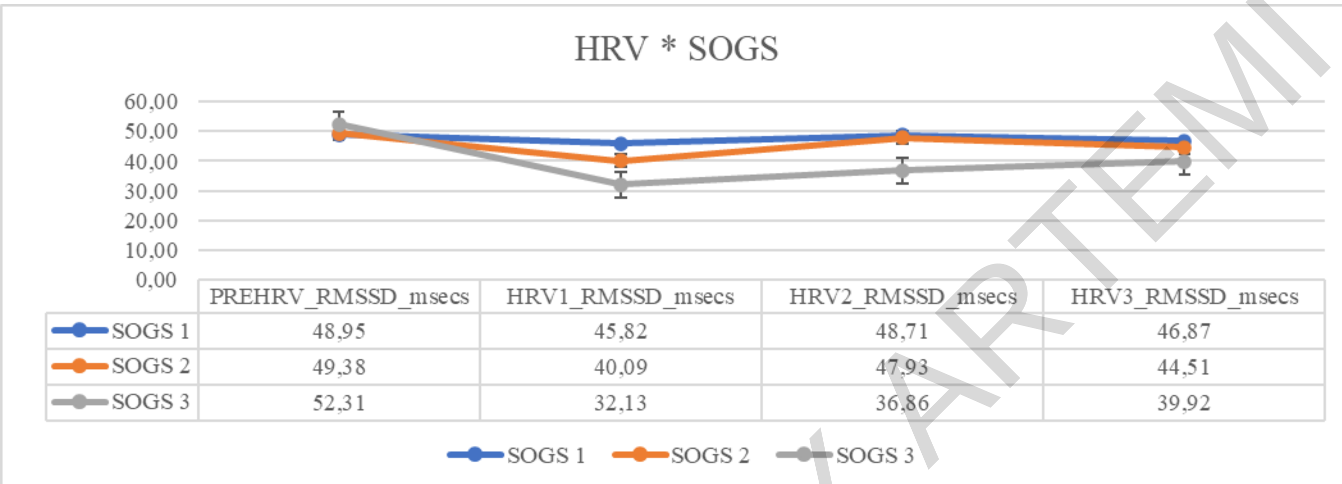
	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	50,213	2,852	44,569	55,857
2	39,349	2,592	34,220	44,478
3	44,499	2,938	38,686	50,311
4	43,766	2,631	38,560	48,972

Note. 1= Baseline, 2= Low-Excitement Condition, 3= High Excitement, 4= High Frustration

8.6.Exploratory Analysis regarding different Gambling levels

In low-gambling severity, the analysis revealed a non-significant effect of slot machine task phase on HRV, $F(3,225)=0.461$, $p=0.710$, $\eta p^2=0.006$. Similarly, in medium Gambling Severity slot machine task phase on HRV ($F(2.150, 117) = 2.017$, $p = 0.136$, $\eta^2 = 0.049$). In the High Gambling Severity HRV exhibited a non-significant trend across conditions, ($F(2.064, 42) = 2.730$, $p = 0.081$, $\eta^2 = 0.163$; Figure 1). Despite the fact that no significant changes were observed, in the high severity group a drop from baseline HRV is observable in all the other conditions but with a slight increase in the high frustration condition compared to the other SOGS groups. This suggests somewhat lower HRV in the negative outcome conditions, for this group only. Because of the non-significant effects of SOGS, no covariation based on psychopathy level was attempted. However, based on the results of Chapter 1, it is notable that groups differences in these traits indeed exist, that may be related to autonomic function, in ways that the present design did not seem to adequately capture.

Figure 1.



Note. *PREHRV*= Baseline, HRV 1= Low-Excitement Condition, HRV 2= High Excitement, HRV 3= High Frustration

8.7. Discussion

This study aimed to investigate the relationship between gambling severity, heart rate variability (HRV), and psychopathy traits using a simulated slot-machine task and self-report measures. We hypothesized that gambling severity, as assessed by the South Oaks Gambling Screen (SOGS), would influence HRV across different conditions of excitement and frustration.

Firstly, the one-way ANOVA analyses (reported in chapter 1) revealed significant differences across multiple psychopathy dimensions, while sensitivity to reward and punishment did not significantly differ across gambling severity levels.

The Triarchic Psychopathy Measure (TriPM; Patrick, 2010) operationalizes psychopathy into three distinct facets: boldness, meanness, and disinhibition. Our findings consistently showed that all TriPM facets increased with higher levels of gambling severity. Boldness reflects confidence and social dominance, meanness relates to callousness and manipulation, and disinhibition involves impulsivity and risk-taking behaviors. These traits are pertinent in understanding how psychopathy manifests across varying degrees of gambling severity (Chamberlain et al., 2018).

Moreover, the Levenson Self-Report Psychopathy Scale (LSRP; Levenson et al., 1995) delineates psychopathy into primary and secondary factors. Primary psychopathy is characterized by affective deficits and interpersonal manipulation, while secondary psychopathy encompasses impulsivity and antisocial behavior. Both primary and secondary psychopathy scores were significantly higher among individuals with greater gambling severity, highlighting distinct pathways of psychopathy's influence on gambling behaviors (Granero et al., 2016).

Furthermore, our study observed that a substantial proportion of individuals classified as having low gambling risk or severity were students. This demographic represents a significant sample within the broader gambling population, often exhibiting lower levels of both gambling severity and psychopathy traits compared to clinical populations. Understanding the behaviors and traits within this group contributes valuable insights into preventive measures and interventions aimed at reducing the potential escalation of gambling problems among young adults (Granero et al., 2014).

Based on the above, our first hypothesis focused on the slot-machine task, posited that gambling severity would show a significant main effect on HRV across different task conditions. Consistent with previous research (Dixon et al., 2014), we found through exploration analyses that higher SOGS scores, indicative of greater gambling severity, were associated with overall lower HRV but this was not statistically significant. This suggests dysregulated autonomic functioning among individuals with problematic gambling behaviors, characterized by reduced parasympathetic activity and increased sympathetic dominance. Notably, the main effect of gambling severity on HRV did not vary significantly across different task conditions, indicating a consistent impact of gambling severity on autonomic responses irrespective of the emotional context during gambling.

Our second hypothesis proposed a significant interaction effect between gambling severity and task conditions (excitement and frustration) on HRV. While we did not find a statistically significant interaction effect, small trends observed in the high gambling severity group suggested more pronounced reductions in HRV during high frustration conditions compared to lower severity groups. This aligns with the notion that heightened emotional stressors, such as losing significant amounts of money, may lead to greater autonomic dysregulation among individuals with more severe gambling problems (Dixon et al., 2014; Lussier, et al., 2014).

During baseline conditions, where participants were not actively engaged in gambling activities, HRV was relatively higher compared to conditions involving excitement and frustration (see Table 1). This finding suggests that the absence of emotional arousal or stressors typically results in a more stable autonomic state characterized by higher parasympathetic activity and overall HRV (Smith et al., 2020).

Conversely, during conditions of excitement, characterized by winning scenarios such as winning 5 euros, HRV tended to decrease compared to baseline levels. This decrease in HRV during excitement conditions indicates a shift towards sympathetic dominance and reduced parasympathetic activity, which is commonly associated with heightened emotional arousal and physiological readiness for action. Moreover, the most pronounced reduction in HRV was observed during conditions of high frustration, in the most severe gambling group, where participants experienced complete loss of 25 euros. This condition elicited the lowest HRV among all task conditions, reflecting heightened sympathetic activation and emotional distress in response to significant negative outcomes (Hilbrecht, et al., 2020), and suggests that it was the severe gambling group that mostly drove the effect of task phase.

Regarding our third hypothesis, which explored psychopathy traits as covariate between SOGS scores and HRV during task conditions. The absence of significant main effects of between factors or interaction did not justify the ANCOVA analysis to explore this. It is possible that the observed group differences in psychopathy are relevant to the trend of lower HRV in the high SOGS group during frustration, a hypothesis we cannot directly test given the non-significant results. The absence of more significant effects of group (and subsequently of their psychopathy differences) may be attributed to several factors, including the specific characteristics of the sample, methodological constraints, and statistical considerations.

HRV is influenced by a complex interplay of physiological, psychological, and environmental factors. Factors such as emotional arousal, stress levels, and individual coping mechanisms can modulate HRV responses during gambling tasks. Variability in these factors among participants, which might not have been fully controlled for, could obscure the expected relationship between gambling severity and HRV.

However, associated with the first hypothesis, significant effects of task conditions were observed within the general sample, indicating variability in autonomic responses across different task conditions. Specifically, participants exhibited varying levels of HRV in response to different emotional states induced during the simulated slot-machine task.Overall, these findings highlight the dynamic nature of autonomic responses during gambling-related emotional states. The trend of reduced HRV during excitement and especially during high frustration underscores the impact of emotional arousal and stress on autonomic regulation. These results align with previous research indicating that gambling activities, particularly those involving monetary outcomes, can evoke significant changes in physiological states, reflecting both the rewarding and aversive aspects of gambling experiences.

In conclusion, this study illuminates the intricate relationships among gambling behavior, heart rate variability (HRV), and psychopathy traits within simulated gambling contexts. While significant effects of HRV were observed across various emotional conditions, indicating notable changes in autonomic regulation during gambling-related stimuli, it's important to note that most expected interactions and main effects were not statistically significant. Future research could delve deeper into individual differences in autonomic responses and consider additional factors such as coping strategies, contextual influences, and the role of other physiological markers to provide a more comprehensive understanding. These insights could inform the development of tailored interventions aimed at mitigating the detrimental impacts of problematic gambling behaviors, potentially integrating biofeedback techniques or personalized therapeutic approaches.

9.Study 3: "The Emotional Pulse of Gamblers”: Psychophysiological Responses to Emotional Stimuli and the connection with Psychopathy and Sensitivity to Punishment and Reward

9.1.Introduction

The phenomenon of problem gambling, characterized by persistent and recurrent maladaptive gambling behavior, often leads to significant psychosocial consequences due to an inability to control gambling urges (Dowling et al., 2015). The link between problem gambling and psychological difficulties is not surprising, given underlying motivational mechanisms that transcend diagnostic boundaries. Pathological gamblers frequently exhibit impulsivity and heightened sensitivity to reward, traits strongly associated with engaging in risky behaviors like gambling (Gray et al., 2019). These tendencies also overlap with other externalizing or disruptive behaviors often seen in individuals with higher levels of psychopathic traits (Kotov et al., 2017).

Psychopathy, a complex construct comprising affective, interpersonal, and behavioral traits, has garnered significant interest in mental health research (Patrick, 2006). Sensitivity to punishment (SP) and sensitivity to reward (SR), two key psychological traits, are integral components of core neurobehavioral motivational systems that influence individuals' emotional and behavioral responses (Gray & McNaughton, 2000). SP refers to the motivation to avoid negative outcomes or punishment, while SR reflects the drive to pursue positive outcomes or rewards (Gray & McNaughton, 2000).

Research indicates that individuals with high SP are prone to heightened emotional and physiological responses to negative stimuli, such as fear and disgust (Bijttebier et al., 2009). Conversely, individuals with high SR exhibit more pronounced responses to positive stimuli, showing enhanced emotional and physiological reactions to rewards (Müller et al., 2014). These findings suggest that individuals with high SP may be more reactive to stress and anxiety experienced during aversive gambling situations, while those with high SR may find gambling particularly reinforcing, especially during winning.

Patrick et al. (1994) initially investigated the psychophysiological responses of individuals with psychopathic traits, finding deficits in emotional imagery responses among those with high levels of psychopathy. Similarly, Fanti, Kyranides, and Panayiotou (2017) observed reduced emotional reactions, including facial expressions of sadness and disgust, in individuals with high callous-unemotional (CU) traits when exposed to violent films. This diminished emotional reactivity, especially to negative emotions, is a consistent characteristic of individuals with psychopathic traits (Fanti, Panayiotou, Kyranides & Avraamides, 2016b). Given these findings, and the anticipated increased representation of individuals sensitive to rewards among gamblers, and among samples high in psychopathic traits, one may expect to find emotional response aberrations in individuals with problem gambling profiles.

The role of Emotions

Negative Stimuli– Disgust & Fear

Disgust is an evolutionary mechanism that originated as a response to potential contamination and putrefaction, enabling the rejection of foods that might otherwise expose one to illness (Rozin, Haidt, & McCauley, 2000). It has been argued that the disgust system adapted to inform human mate choice and social morality (Tybur, Lieberman, Kurzban, & DeScioli, 2013). Research concerning disgust sensitivity focuses on three main areas: core disgust, animal reminder disgust, and contamination-based disgust (Olatunji, Haidt, McKay, & David, 2008). Core disgust reflects the perceived threat of disease through aversive stimuli such as rotting food and vermin (Rozin, Haidt, & McCauley, 2000).

Animal reminder disgust results from an aversion to reminders of our animal origin such as our mortality (Olatunji et al., 2008). Finally, contamination-based disgust emphasizes disgust arising from potential threat of infection, such as using a public bathroom (Olatunji et al., 2008). Disgust sensitivity is related to other personality traits: as a way of avoiding infectious individuals, individuals primed to become worried about diseases rate themselves as less agreeable, less extraverted and less open to experience (Mortensen, Becker, Ackerman, Neuberg, & Kenrick, 2010).

Disgust sensitivity also has implications for aggressive behaviour: individuals with higher disgust sensitivity are less physically and verbally aggressive (Pond et al., 2012). In essence, disgust is a 'defensive' behaviour, and disgust-display avoidance may denote important aspects of character (Pond et al., 2012; Richman, DeWall, Pond, Lambert, & Fincham, 2014). Moral hyper-vigilance may occur in individuals sensitive to, or disgusted by offences of a moral nature, who, in turn, are less willing to hurt, and emotionally distance themselves from antagonistic others (Pond et al., 2012). To date, there has only been two studies that included a measure of disgust sensitivity; and Meere & Egan (2017) who found that lower extraversion and animal reminder disgust, and higher psychopathy scores predicted lower disgust sensitivity.

Fear is a fundamental emotion that serves a critical adaptive function, alerting individuals to potential threats in their environment and motivating defensive responses to ensure survival (LeDoux, 2012). Fearful images, depicting scenes of danger, threat, or harm, are potent stimuli that activate the brain's fear circuitry, triggering a cascade of physiological and behavioral responses aimed at avoiding or mitigating perceived danger (Öhman & Mineka, 2001).

The Fearless Theory posits that certain individuals may exhibit reduced sensitivity to fear-inducing stimuli due to variations in neurobiological mechanisms underlying fear processing and regulation (Blair, 1995). According to this theory, individuals characterized by low fear reactivity, often termed "fearless," may display deficits in recognizing and responding to threat cues, resulting in diminished aversive emotional experiences and attenuated defensive behaviors (Blair, 1995).

Fearful images elicit strong emotional and physiological reactions in most individuals, activating brain regions associated with threat detection, such as the amygdala and insula (Phelps & LeDoux, 2005). However, individuals with low fear reactivity may exhibit blunted responses to fearful stimuli, as evidenced by reduced amygdala activation and diminished subjective reports of fear or anxiety (Blair et al., 2008).

The Fearless Theory has important implications for understanding individual differences in fear processing and their relevance to psychopathology, particularly in conditions characterized by emotional dysregulation or disinhibited behavior, such as psychopathy (Patrick, 2007). Individuals with psychopathic traits are hypothesized to demonstrate reduced fear reactivity and impaired threat detection, contributing to their propensity for risk-taking, sensation-seeking, and antisocial behavior (Blair, 2003).

Positive & Neutral Stimuli

Neutral emotions, often overlooked in favor of more intense feelings, play a crucial role in human cognition and behavior. While not as outwardly expressive as other emotions, they serve as a baseline against which other emotions are contrasted and interpreted (Russell, 2003). Research suggests that neutral emotional states facilitate cognitive processes such as attention, memory, and decision-making by providing a stable mental backdrop (Pessoa, 2008).

Moreover, neutral emotions contribute to social interactions by regulating interpersonal communication and signaling non-threatening intentions (Whalen et al., 1998). In social contexts, individuals exhibiting neutral emotions are perceived as approachable and trustworthy, fostering cooperation and rapport (Dovidio et al., 1988). However, deviations from neutral emotional states, such as excessive emotional blunting or heightened emotional reactivity, can indicate underlying psychological disorders or interpersonal difficulties (Farmer, et al., 2012).

Happy emotions, characterized by feelings of joy, contentment, and satisfaction, play a fundamental role in human well-being and social functioning. Research suggests that experiencing happiness leads to a range of positive outcomes, including improved physical health, enhanced cognitive functioning, and strengthened social relationships (Lyubomirsky et al., 2005). Moreover, happiness is associated with resilience in the face of adversity, as individuals with a more positive outlook tend to cope better with stress and adversity (Fredrickson et al., 2003).

However, excessive or inappropriate displays of happiness can also have negative implications, such as being perceived as insincere or lacking empathy (Keltner & Haidt, 1999). Moreover, in certain contexts, such as when witnessing others' suffering or in situations requiring focused attention and analysis, overly positive emotions may be counterproductive (Fredrickson, 2001). Individuals with high SR tend to exhibit heightened emotional and physiological responses when exposed to such rewarding stimuli, experiencing greater pleasure and positive affect compared to those with lower SR (Bress & Hajcak, 2013).

Individuals with high SR are more likely to engage in approach-oriented behaviors, pursue rewards with greater vigor, and exhibit enhanced motivation to achieve positive outcomes, increased susceptibility to impulsivity, risk-taking, and addictive behaviors (Robbins et al., 2012).This heightened responsiveness to rewarding stimuli may contribute to the reinforcing nature of positive experiences and facilitate the pursuit of goals and aspirations associated with happiness and well-being (Gray, 1987).

Psychophysiological Measures

HR and SCL are the most popular physiological measures, and multiple theories of antisocial behavior have been developed based on these measures (Lorber, 2004). Although both SC and HR reflect general emotional arousal, SCL reflects primarily Sympathetic Nervous System (SNS) activity, while HR reflects both Parasympathetic Nervous System (PNS) and SNS activity.

Facial EMG is associated with facial expressing in response to emotional processing and allows the detection of distinct facial muscle activity during exposure to different emotional stimuli (Hubert and de Jong-Meyer, 1991). In studies or applications involving facial expressions, such as emotion research, measurements of muscle activity play a crucial role. For instance, in corrugator supercilii, the "corrugator max" refers to the maximum level of activity or contraction of the corrugator supercilii muscle during a specific period of observation, representing the peak level of muscle activation (Dimberg, 1990; Hubert & de Jong-Meyer, 1991). Conversely, activation of the zygomatic major region, a muscle involved in smiling facial expressions, signals positive emotion and produces facial displays of happiness (de Wied et al., 2012; Lundqvist & Dimberg, 1995). Similarly, "zygomatic max" captures the peak intensity of muscle activation in the zygomaticus major muscle, often used to assess the strongest instance of smiling or positive facial expressions in response to a particular stimulus. Conversely, "zygomatic mean" provides an overall picture of the muscle activity throughout the observation period, offering insights into the general level of smiling or positive facial expressions over time (Dimberg, 1990; Lundqvist & Dimberg, 1995). This distinction is crucial as "zygomatic max" might be used to identify the strongest smile or response to a specific event or stimulus, while "zygomatic mean" is valuable for understanding overall trends and general emotional states.

Self-Reports

SAM, or Self-Assessment Manikin, is a widely used tool for assessing subjective emotional experiences through self-report measures. Developed by Lang (1980), SAM provides a simple and efficient method for individuals to indicate their emotional state across dimensions of valence, arousal, and dominance using graphical representations of humanoid figures and Likert scales. Participants are typically presented with a set of three identical figures representing different emotional dimensions: valence (positive to negative affect), arousal (level of physiological activation), and dominance (sense of control or power) (Bradley &

Lang, 2000). They are then asked to select the figure that best represents their current emotional state along each dimension. However, it's essential to consider potential limitations of SAM, including the reliance on self-report measures, which may be subject to biases and inaccuracies (Podsakoff et al., 2003).

Combining Self-Assessment Manikin (SAM) with psychophysiological measures offers a comprehensive approach to understanding emotional experiences. SAM provides a direct and intuitive method for individuals to report their subjective emotional states across dimensions such as valence, arousal, and dominance. This self-report tool complements psychophysiological measures, which offer objective assessments of physiological responses associated with emotional arousal, such as heart rate, skin conductance, and facial electromyography (Cacioppo & Tassinary, 1990; Dawson et al., 2000). By integrating SAM with psychophysiological measures, researchers can triangulate subjective and objective indicators of emotional experiences, enhancing the validity and richness of data collection (Lang et al., 1993;). This integrated approach allows for a more nuanced understanding of the relationship between subjective emotional states and physiological responses, facilitating investigations into the mechanisms underlying emotional processing in various contexts (Hodes et al., 1985; Mauss & Robinson, 2009; Kreibig, 2010).

9.2.Current Study

This study aims to examine emotional responses of gamblers to negative emotional contexts such as fear and disgust (atypically increased or decreased arousal, and valence responses) and to positive emotional contexts (atypically high or low response to pleasurable situations). Specifically, we will examine subjective and physiological responses of different levels of gambling behavior to emotional situations, in a picture viewing paradigm. Based on the previous literature showing that individuals with psychopathic traits and with high sensitivity to reward may be over-represented among gamblers, and previous findings of reduced responses to aversive emotions, and, less consistently, amplified responses to appetitive emotions among participants high in psychopathic traits, we anticipated aberrant responses, associated with severity of gambling problems. The proposed study addresses a gap in the existing literature by focusing on the emotional responses of individuals with varying levels of gambling behavior, particularly in response to negative and positive emotional stimuli. While previous research has explored emotional processing in various populations, (Cavedini et al., 2002; Balodis et al., 2012) including those with addictive behaviors, there is limited empirical evidence specifically investigating the emotional responses of individuals with different degrees of gambling involvement. The proposed study aims to address this gap by employing a picture viewing paradigm to assess subjective and physiological responses to both negative emotional contexts, such as fear and disgust, and positive emotional contexts, such as adventure and pleasure, among individuals with varying levels of gambling behavior. This approach is consistent with Lorains et al., (2014), who utilized a similar methodology to investigate emotional reactivity in individuals with gambling disorder but did not specifically examine responses to non-gambling-related emotional stimuli. Furthermore, we aim to investigate whether psychopathic traits and sensitivity to punishment and reward can influence their response in different emotional stimuli. The study will explore the effects of psychopathic traits and sensitivity to punishment and reward on any atypical emotional responses identified among individuals with different gambling behaviors (Clark et al., 2014). By integrating these components, the proposed study seeks to provide a comprehensive understanding of emotional processing in individuals with varying levels of gambling behavior, filling a critical gap in the literature and offering insights that could inform more targeted interventions. Based on the above we hypothesised that:

9.3.Hypotheses

Hypothesis 1: Low severity gamblers will show greater psychophysiological reaction than medium or high severity gamblers, especially in negative stimuli. This aligns with research suggesting that individuals with lower severity of gambling issues might have more pronounced facial expressions in response to negative stimuli, possibly due to heightened sensitivity or lack of desensitization seen in higher-severity gamblers (Raylu & Oei, 2004). The literature also supports the idea that less severe pathological gamblers exhibit more marked emotional and physiological responses to fear-inducing stimuli (Wong et al., 2017).

Hypothesis 2: Differences between gamblers with different levels of gambling severity in emotional responses especially to negative stimuli (hypothesis 1) will be mostly explained by levels of psychopathy. Specifically, adding psychopathy total score as a covariate in the analysis of hypothesis 1 will eliminate any significant gambling group effects (Sebastian et al., 2013; Seara-Cardoso & Viding, 2015). Also adding different psychopathy categories (Boldness, Meanness, Disinhibition) as within subject variables will indicate how psychopathy is associated, interacts or influence gambling severity. This hypothesis is consistent with findings that psychopathy involves deficits in emotional processing and autonomic responses (Fanti et al., 2016b).

Hypothesis 3: Significant main effects of sensitivity to punishment (SP) and sensitivity to reward (SR) traits will influence how gamblers react to different stimuli, showing greater physiological reactivity to emotional stimuli, specifically in fear and disgust. This aligns with literature suggesting that individuals with high SP exhibit stronger emotional and physiological responses to aversive or negative stimuli (Bijttebier et al., 2009). Sensitivity to reward is linked to increased responsiveness to rewarding and pleasurable stimuli, so the main effect of SR will influence how individuals respond to happy images, specifically with increased zygomatic expression Müller et al., 2014. Specifically, adding SP and ST total scores as covariates in the analysis of hypothesis 1 will eliminate any significant gambling group effects. Also adding different SPSR levels (Sensitivity to punishment/ Sensitivity to reward) as within subject variables will indicate how psychopathy is associated, interacts or influence gambling severity.

9.4.Method

For description of the participants, their allocation into gambling severity groups and the measures used in this study, please refer to "General Introduction & Demographics".

Statistical Analyses

Descriptive Statistics: For SOGS group differences in psychopathy, please refer to "General Introduction & Demographics". As expected, SOGS groups differed on all psychopathy aspects, with the highest gambling severity group showing the highest level of psychopathy traits overall, and the lowest severity group showing significantly lower psychopathy traits.

Main Analyses: To address the study's hypotheses, the main analysis constituted a mixed repeated measures ANOVA, with SOGS groups as the between factor, and emotional images as the within factor, in a 3 X 4 design. Repeated measures ANOVA was used to examine differences between different levels of gambling behavior based on SOGS (low- medium-high defined by splitting the sample based on $\pm$ 1SD from the mean) in different psychophysiological reactions (HR, SCL, COR, ZYG) during different emotional stimuli (Happy, Disgust, Fear, Neutral). Responses to each physiological measure were averaged across emotional pictures of the same content.

Repeated Measures ANOVA was conducted 3 X 4 to examine differences between different levels of gambling behavior (low- medium-high) in different psychophysiological reactions (HR, SCL, COR, ZYG) during different emotional stimuli (Happy, Disgust, Fear, Neutral). After this initial examination, and where significant effects of group are observed, in order to address hypotheses 2 and 3, level of psychopathy (TriPM) and sensitivity to punishment and sensitivity to reward (SPSR) were entered as covariates one at a time to examine their potential role in observed group differences.

Following the main analyses and given our specific interest in the role of gambling severity in emotional responses, exploratory analyses were conducted to examine any emotional response differences in different emotional contexts, at each level of gambling behavior even in cases where gambling severity was not significant in the main analyses. A Bonferroni correction was applied to account for the multiple comparisons made among the three groups of SOGS severity. The standard significance level of $\alpha=0.05$ was divided by the number of comparisons (3), resulting in an adjusted significance level of $\alpha'=0.017$. Therefore, p-values less than 0.017 were considered statistically significant to reduce the risk of Type I errors. In case these analyses resulted in significant effects of emotion, these were further explored to identify the specific emotion categories associated with aberrant emotional responses, using post hoc pairwise comparisons and Bonferroni corrected levels of significance. The standard significance level of $\alpha=0.017$ was then further divided by the number of comparisons (12), resulting in an adjusted significance level of $\alpha'=0.0014166$ when pairwise comparisons between levels of the emotion variable, within a specific level of SOGS severity were conducted.

9.5.Results

Heart Rate (HR)

Mauchly's test indicated that the assumption of sphericity had not been violated $\chi^2(5) = 4.163$, $p = 0.525$. The results of the repeated measures ANOVA are presented in Table 1. These results indicate non-significant main effects of emotional conditions, SOGS groups or interaction between emotional conditions and SOGS, suggesting that in this study, neither type of emotion nor gambling significantly affected HR autonomic emotional responses. For more specific results by gambling group, see “Exploratory Analyses” section below.

Table 1.

Model	df	Mean Square	F	p	Partial Eta Squared
SOGS	2	104,312	0,991	0,374	0,015
Emotion Conditions	2,935	45,856	1,511	0,212	0,012
Emotion Conditions * SOGS	5,870	44,095	1,453	0,195	0,022

Note. SOGS: Different Levels of gambling behavior according to SOGS.

Skin Conductance Level (SCL)

Mauchly's test indicated that the assumption of sphericity had been violated $\chi^2(5) = 528.624$, $p = 0.000$. Therefore, the Greenhouse-Geisser correction was applied to the degrees of freedom for the within-subjects effects $\varepsilon = 0.370$. The results of the repeated measures ANOVA are presented in Table 2. These results indicate non-significant effects of group, emotion condition or their interaction.

Table 2.

Model	Df	Mean Square	F	p-value	Partial Eta Squared
SOGS	2	17,226	0,338	0,679	0,006
Emotion Conditions	1,109	11,144	0,400	0,549	0,003
Emotion Conditions * SOGS	2,218	9,936	0,357	0,722	0,006

Note. SOGS: Different Levels of gambling behavior according to SOGS

Corrugator Mean

Mauchly's test indicated that the assumption of sphericity had been violated $\chi^2(5) = 4152.308$, $p \leq 0.001$. Therefore, the Greenhouse-Geisser correction was applied to the degrees of freedom for the within-subjects effects $\varepsilon = 0.333$. The results of the repeated measures

ANOVA are presented in Table 3. These results indicate non-significant results, of SOGS, emotional condition or their interaction.

Table 3.

Model	df	Mean Square	F	p-value	Partial Eta Squared
SOGS	2	0,22	0,264	0,608	0,002
Emotion Conditions	0,053	1,000	0,053	0,214	0,644
Emotion Conditions * SOGS	0,177	2,000	0,089	0,358	0,700

Note. SOGS: Different Levels of gambling behavior according to SOGS

Table 4.

Model	df	Mean Square	F	p-value	Partial Eta Squared
SOGS	2	1,339E-6	2,048	0,133	0,031
Emotion Conditions	2,330	1,016E-06	8,005	**<0, 001**	0,059
Emotion Conditions * SOGS	4,659	1,407E-07	1,109	0,355	0,017

Note. SOGS: Different Levels of gambling behavior according to SOGS.

Corrugator Max

Mauchly's test indicated that the assumption of sphericity had been violated $\chi^2(5) = 49.453$, p = 0.000. Therefore, the Greenhouse-Geisser correction was applied to the degrees of freedom for the within-subjects effects ε= 0.777.

The results of the repeated measures ANOVA are presented in Table 4. These results indicate non-significant results, in main effect of SOGS, interaction between emotional conditions and SOGS but significant effects of emotion condition on corrugator max.

Friedman's test as the alternative method in Repeated Measures ANOVA of non- parametric test showed significant differences in the different conditions in the CORmax as well $\chi2(3,N=131)=25.14, p<.00$. Because of the very small values reported pairwise comparisons were close to 0, non- parametric- tests were used to compare all the values using Mean Ranks

(Smith, 2015). We used Wilcoxon – Signed test as alternative to Pairwise comparisons and the results can be seen in the Table 5. The results indicate significant differences in corrugator peak activity between certain emotional conditions. Specifically, disgust shows distinct patterns showing higher values compared to happiness and neutral conditions. Fear also shows significantly lower values when compared to disgust. However, the differences between fear and happiness, and between neutral and happiness, are not significant, indicating similar corrugator activity levels for these conditions.

Table 5. Conditions		**z**	**p-value**
DISGUST_MEAN_CORmax HAPPY_MEAN_COR max	**-**	-4,693[b]	**<0,001**
FEAR_MEAN_CORmax HAPPY_MEAN_COR max	**-**	-1,746[b]	0,081
NEUTRAL_MEAN_CORmax HAPPY_MEAN_COR max	**-**	-,726[b]	0,468
FEAR_MEAN_CORmax DISGUST_MEAN_COR max	**-**	-3,977[c]	**<0,001**
NEUTRAL_MEAN_CORmax DISGUST_MEAN_COR max	**-**	-4,427[c]	**<0,001**
NEUTRAL_MEAN_CORmax FEAR_MEAN_COR max	**-**	-1,082[c]	0,279

Note. a. Wilcoxon Signed Ranks Test; b. Based on negative ranks; c. Based on positive ranks.

Zygomatic Mean

Mauchly's test indicated that the assumption of sphericity had been violated $\chi^2(5) = 50.270$, p = 0.000. Therefore, the Greenhouse-Geisser correction was applied to the degrees of freedom for the within-subjects effects ε= 0.786.

Table 6.

Model	df	Mean Square	F	p-value	Partial Eta Squared
SOGS	2	0,007	0,522	0,594	0,008
Emotion Conditions	2,358	0,000	1,457	0,232	0,011
Emotion Conditions * SOGS	4,716	0,000	1,384	0,233	0,021

Note. SOGS: Different Levels of gambling behavior according to SOGS.

These results in Zygomatic mean indicate non-significant results, in main effect of SOGS, any emotional condition and between emotional conditions and SOGS.

Zygomatic Maximum

Table 7.

Model	df	Mean Square	F	p-value	Partial Eta Squared
SOGS	2	0,008	0,513	0,600	0,008
Emotion Conditions	2,861	0	1,736	0,162	0,013
Emotion Conditions * SOGS	5,723	0	1,292	0,262	0,02

Note. SOGS: Different Levels of gambling behavior according to SOGS.

Mauchly's test indicated that the assumption of sphericity had not been violated $\chi^2(5) = 9.455$, $p = 0.092$. These results indicate non-significant results, in main effect of SOGS, emotional condition and their interaction (Table 7).

Self- Reports - Valence, Arousal & Control

Repeated measures ANOVA was conducted to see differences between different levels of gambling behavior (low- medium-high) in different self-reports (Valence, Arousal, Control) during different emotional stimuli (Happy, Disgust, Fear, Neutral).

Valence Mauchly's test indicated that the assumption of sphericity had been violated $\chi^2(5) =$

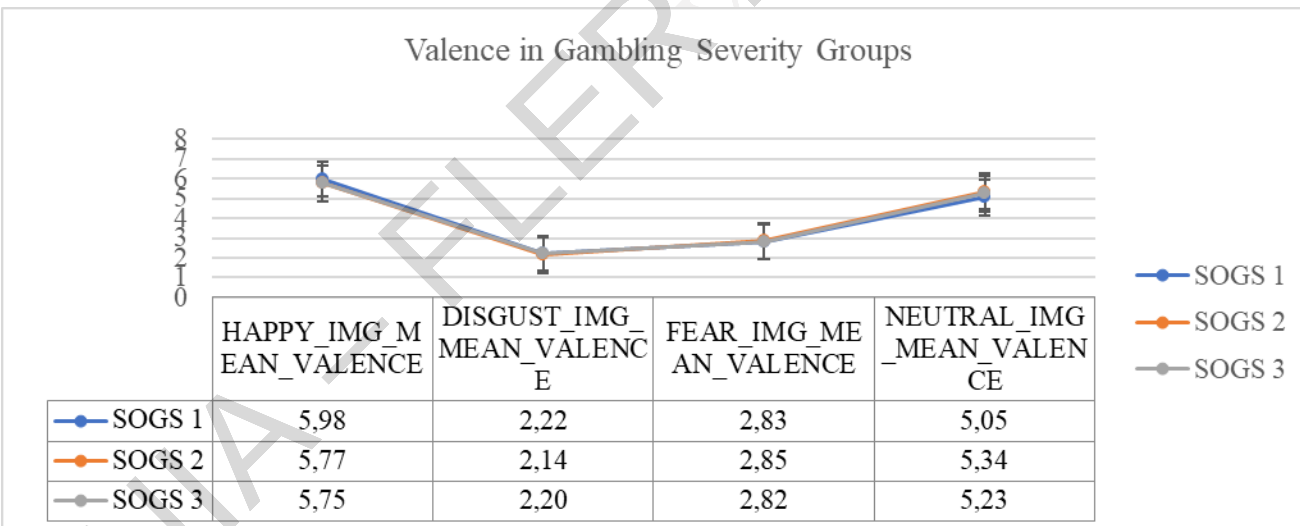
72.353, p = 0.000. Therefore, the Greenhouse-Geisser correction was applied to the degrees of freedom for the within-subjects effects ε= 0.731.

Table 8.

Model	df	Mean Square	F	p-value	Partial Eta Squared
SOGS	2	0,012	0,009	0,991	0,000
Emotion Conditions	2,193	370,953	277,036	**<0,001**	0,684
Emotion Conditions * SOGS	4,387	0,897	0,670	0,627	0,010

Note. SOGS: Different Levels of gambling behavior according to SOGS.

Figure 7.



These results indicate non-significant results, in main effect of SOGS, and the interaction between emotional conditions and SOGS in valence but significant effects of emotion condition on Valence self-reports in the whole sample (Table 8). Pairwise comparisons can be seen in the Table 9 and generally show that Happy pictures are consistently rated the most positive, while Disgusting pictures are rated the most negative. Neutral and Fearful pictures fall in between, with Neutral generally being rated more positively than Fear.

Table 9.

(I) VALENCE		**Mean Difference (I-J)**	**Std. Error**	**Sig.**[b]	**95% Confidence Interval for Difference**[b]	
					Lower Bound	Upper Bound
1	2	3,698*	0,150	**<0,001**	3,297	4,100
	3	3,057*	0,140	**<0,001**	2,682	3,433
	4	,731*	0,117	**<0,001**	3,297	1,045
2	1	-3,698*	0,150	**<0,001**	2,682	-3,297
	3	-,641*	0,078	**<0,001**	3,297	-0,432
	4	-2,968*	0,121	**<0,001**	2,682	-2,643
3	1	-3,057*	0,140	**<0,001**	3,297	-2,682
	2	,641*	0,078	**<0,001**	2,682	0,850
	4	-2,326*	0,113	**<0,001**	3,297	-2,025
4	1	-,731*	0,117	**<0,001**	2,682	-0,417
	2	2,968*	0,121	**<0,001**	3,297	3,292
	3	2,326*	0,113	**<0,001**	2,682	2,628

Note. *. The mean difference is significant at the ,05 level. b. Adjustment for multiple comparisons: Bonferroni. 1.= Happy, 2= Disgust, 3.= Fear, 4= Neutral

Arousal

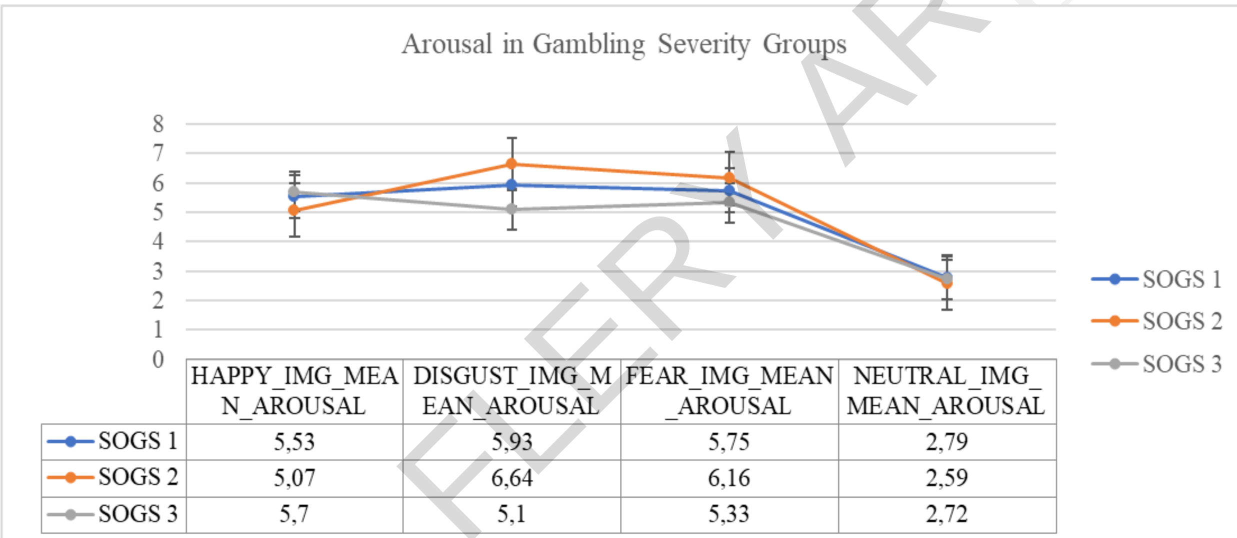
Mauchly's test indicated that the assumption of sphericity had been violated $\chi^2(5) = 84.456$, $p = 0.000$. Therefore, the Greenhouse-Geisser correction was applied to the degrees of freedom for the within-subjects effects $\varepsilon = 0.721$.

Table 10.

Model	df	Mean Square	F	p-value	Partial Eta Squared
SOGS	2	0,894	0,670	0,514	0,010
Emotion Conditions	2,164	270,439	113,377	**<u><0,001</u>**	3,297
Emotion Conditions * SOGS	4,329	8,834	3,704	**<u><0,001</u>**	2,682

Note. SOGS: Different Levels of gambling behavior according to SOGS.

Figure 8.



The results of the statistical analysis (Tables 10 & 11) revealed significant effects of emotion condition on Arousal, with a p-value of <.001 . Additionally, the interaction between Arousal and SOGS was significant (p = 0.005), suggesting that the relationship between Arousal and SOGS is not uniform across all levels of gambling (Figure 8). The main effect of SOGS did not reach statistical significance (p = 0.514).

Table 11.

(I) AROUSAL	(J) AROUSAL	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	-,643*	,189	,005	-1,150	-,136
	3	-,420*	,141	,020	-,797	-,043
	4	2,687*	,151	**<,001**	2,283	3,091
2	1	,643*	,189	,005	,136	1,150
	3	,223	,111	,277	-,074	,520
	4	3,330*	,208	**<,001**	2,773	3,887
3	1	,420*	,141	,020	,043	,797
	2	-,223	,111	,277	-,520	,074
	4	3,107*	,174	**<,001**	2,641	3,573
4	1	-2,687*	,151	**<,001**	-3,091	-2,283
	2	-3,330*	,208	**<,001**	-3,887	-2,773
	3	-3,107*	,174	**<,001**	-3,573	-2,641

Based on estimated marginal means

*. The mean difference is significant at the ,05 level.

b. Adjustment for multiple comparisons: Bonferroni.

1.= Happy, 2= Disgust, 3.= Fear, 4= Neutral

Based on Figure 8, the mean arousal levels for each category of emotions are compared across three levels of gambling severity as measured by the South Oaks Gambling Screen (SOGS). For Happy Image Mean Arousal, participants with highest severity had the highest mean arousal level followed by low severity participants at 5.53, while high severity participants had the lowest mean arousal at 5.07. In the category of Disgust Image Mean Arousal, participants with medium severity exhibited higher mean arousal levels at 6.64, followed by low severity gamblers 5,93 and high severity gamblers with 5.10.

For Fear Image Mean Arousal, medium severity participants again showed the highest mean arousal level at 6.16, followed by low severity participants at 5.75, while high severity participants had the lowest mean arousal level at 5.33. Lastly, in the category of Neutral Image Mean Arousal, low severity participants had the highest mean arousal level at 2.79, followed by high severity participants at 2.72, with medium severity participants showing the lowest mean arousal level at 2.59. Based on Table 11, Neutral had a significantly lower mean arousal compared to Happy, Disgust, and Fear with all the other comparisons being not significant after Bonferroni correction. The pairwise comparisons (Table 11) for the main effect of Arousal across different picture categories revealed significant differences in arousal levels between various pairs. Happy pictures (1) were significantly different from disgusting pictures (2), with happy pictures evoking lower arousal compared to disgusting pictures. In contrast, happy pictures (1) were significantly different from neutral pictures (4), with happy pictures generating higher arousal levels than neutral images. Disgusting pictures (2) and fearful pictures (3) were not significantly different from each other in terms of arousal levels. Neutral pictures (4) evoked significantly lower arousal compared to happy, disgusting, and fearful pictures. These findings suggest that the emotional content of images influences arousal levels, with happy images generally eliciting lower arousal compared to other emotional categories, and neutral images evoking the lowest arousal overall.

Control

Mauchly's test indicated that the assumption of sphericity had been violated $\chi^2(5) = 92.367$, $p = 0.000$. Therefore, the Greenhouse-Geisser correction was applied to the degrees of freedom for the within-subjects effects $\varepsilon = 0.695$.

Table 12.

Model	**df**	**Mean Square**	**F**	**p-value**	**Partial Eta Squared**
SOGS	2	0,467	0,142	0,868	0,002
Emotion Conditions	2,085	204,183	94,286	**<0,001**	0,424
Emotion Conditions * SOGS	4,169	1,065	0,492	0,749	0,008

Note. SOGS: Different Levels of gambling behavior according to SOGS.

Figure 9.

	HAPPY_IMG_MEAN_CONTROL	DISGUST_IMG_MEAN_CONTROL	FEAR_IMG_MEAN_CONTROL	NEUTRAL_IMG_MEAN_CONTROL
SOGS 1	5,43	3,81	4,35	6,7
SOGS 2	5,59	3,99	4,26	6,74
SOGS 3	5,35	4,27	4,53	7,22

Results showed a significant main effect of emotion category on Control indicating that different types of emotional images (happy, neutral, fear, disgust) significantly influenced the whole sample in terms of self- reporting feelings of control over the situation. The non-significant main effect of SOGS suggests that gambling levels did not differentially affect control ratings (Table 12). The non-interaction effect between emotion and SOGS indicates that the influence of emotional image categories on control levels was consistent across different SOGS categories, (Figure 9). In pairwise comparisons (Table 13) Neutral images consistently evoked the highest control levels compared to all other categories. Fearful images also resulted in higher control levels than happy and disgusting images, but lower than neutral images. Happy images evoked lower control levels than neutral and fearful images, but higher control levels than disgusting images. Disgusting images consistently resulted in the lowest control levels across all categories. These pairwise comparisons highlight that the type of emotional image significantly influences control levels, with neutral images producing the highest and disgusting images the lowest control. Results indicate that control is related inversely to arousal. Overall, ratings results indicate that emotion conditions were appropriately manipulated.

Table 13.

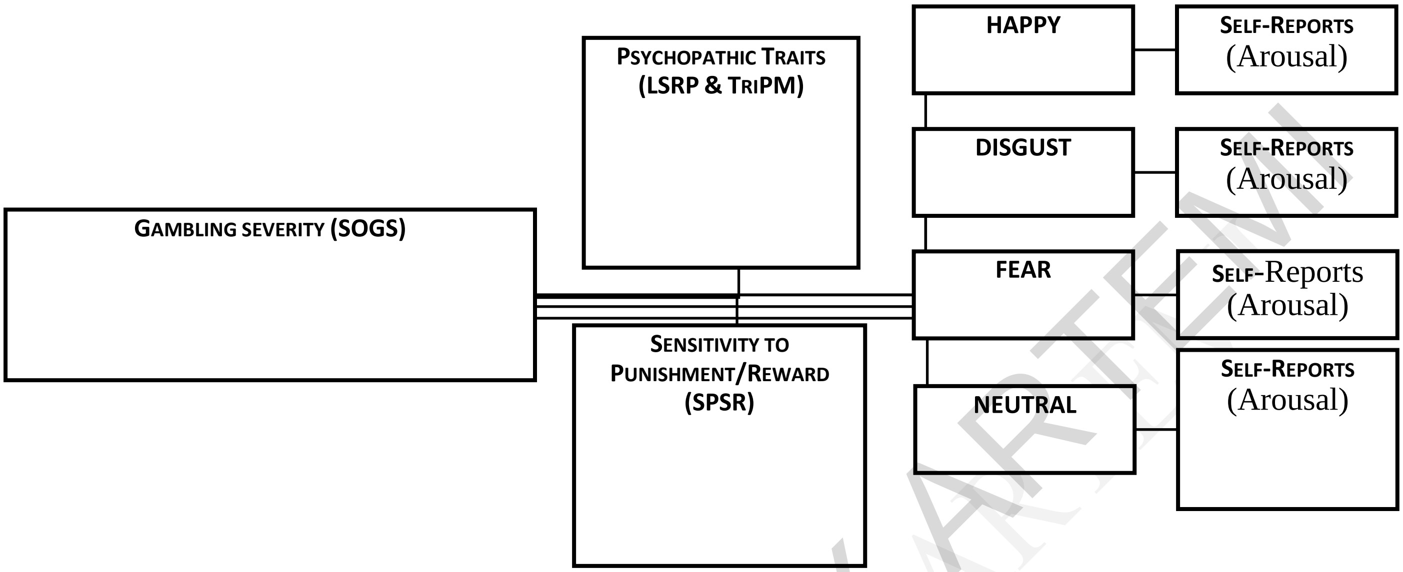
(I) CONTROL	(J) CONTROL	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	1,557*	,145	**<,001**	1,170	1,945
	3	1,128*	,114	**<,001**	,823	1,433
	4	-1,296*	,154	**<,001**	-1,708	-,884
2	1	-1,557*	,145	**<,001**	-1,945	-1,170
	3	-,429*	,100	**<,001**	-,697	-,162
	4	-2,853*	,191	**<,001**	-3,364	-2,342
3	1	-1,128*	,114	**<,001**	-1,433	-,823
	2	,429*	,100	**<,001**	,162	,697
	4	-2,424*	,182	**<,001**	-2,910	-1,937
4	1	1,296*	,154	**<,001**	,884	1,708
	2	2,853*	,191	**<,001**	2,342	3,364
	3	2,424*	,182	**<,001**	1,937	2,910

Note. Based on estimated marginal means *. The mean difference is significant at the ,05 level. b. Adjustment for multiple comparisons: Bonferroni. Level 1 = Happy, Level 2= Disgust, 3= Fear , 4= Neutral

9.6.The influence of psychopathic traits (TriPM) and Sensitivity to punishment (SP) and Sensitivity to reward (SR)

Repeated measures mixed factorial ANCOVA was used in order to examine the effects on psychophysiological and self- report responses to different emotional conditions of psychopathic traits, sensitivity to punishment and sensitivity to reward (used separately as covariates). Analyses focused on Arousal because it's the only measure for which SOGS was involved in any main effects or interactions.

Graph 1. Influence of psychopathic traits, Sensitivity to Punishment and Reward



The Mauchly's test of sphericity was conducted to examine the assumption of sphericity for the within-subjects design of the study. Mauchly's W statistic indicated a violation of the assumption, W = 0.493, $\chi^2(5) = 87.460$, p < .001. Greenhouse-Geisser correction ($\varepsilon = 0.712$) was utilized to adjust the degrees of freedom due to the violation of sphericity. In the analysis of within-subjects effects, the interaction between Arousal and SOGS remained statistically significant, $F(4.275,267.159)=3.670, p=.005, \eta 2=.055$, based on the Greenhouse-Geisser correction. This suggests that the covariates did not sufficiently explain the interaction effect.

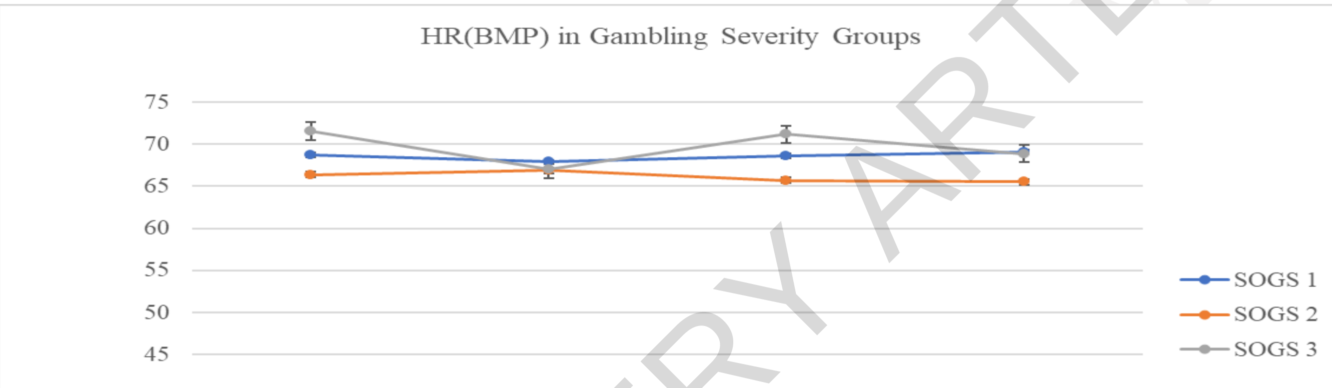
9.7. Exploratory Analyses regarding effects on emotional contents on emotional reactivity in different levels of gambling behavior

A Bonferroni correction was applied to account for the multiple comparisons made among the three groups of SOGS severity. The standard significance level of $\alpha=0.05$ was divided by the number of comparisons (3), resulting in an adjusted significance level of $\alpha'=0.017$. Therefore, p-values less than 0.017 were considered statistically significant to reduce the risk of Type I errors.". A Bonferroni correction was further applied as well to account for the multiple pairwise comparisons made among the three levels of the variable across four different emotions. The standard significance level of $\alpha=0.017$ was divided by the number of comparisons (12), resulting in an adjusted significance level of $\alpha'=0.00141666$.

Heart Rate (HR) & Skin Conductance Level (SCL)

Figure 1 shows very small differences in HR mean regarding arousing stimuli both positive and negative (Happy, Fear) in the High severity group compared to medium and low severity. In High Severity group a drop in HR in disgusting images is also obvious. However, results indicate that regarding HR there was no significant effect in emotional category in any level of gambling behavior (p > 0.017).

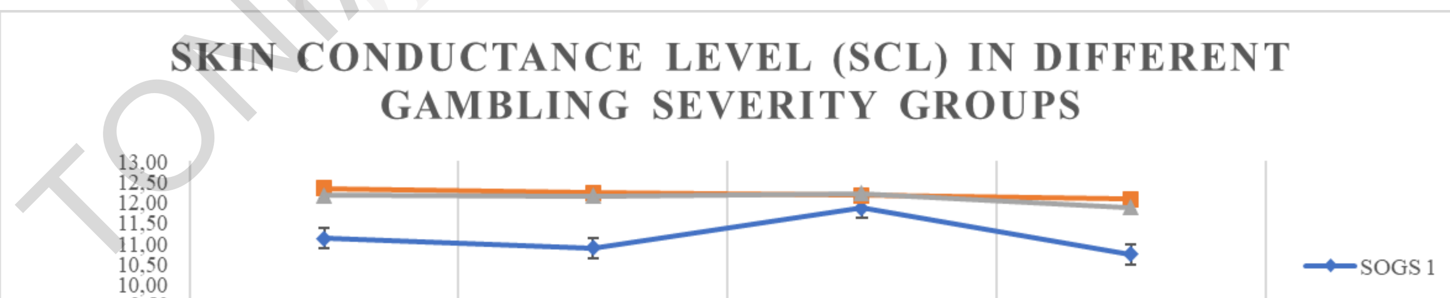
Figure 1.



	HAPPY_MEAN_HR_BPM	DISGUST_MEAN_HR_BPM	FEAR_MEAN_HR_BPM	NEUTRAL_MEAN_HR_BPM
SOGS 1	68,74	67,88	68,59	69,10
SOGS 2	66,38	66,86	65,70	65,50
SOGS 3	71,55	67,00	71,16	68,89

Results indicate that regarding SCL there was no significant effect of emotional category in any level of gambling behavior (p > 0.017). However, we can see small differences in means in the low severity group where individuals had less reported arousal than the more severe levels in every stimulus except fearful (Figure 2).

Figure 2.

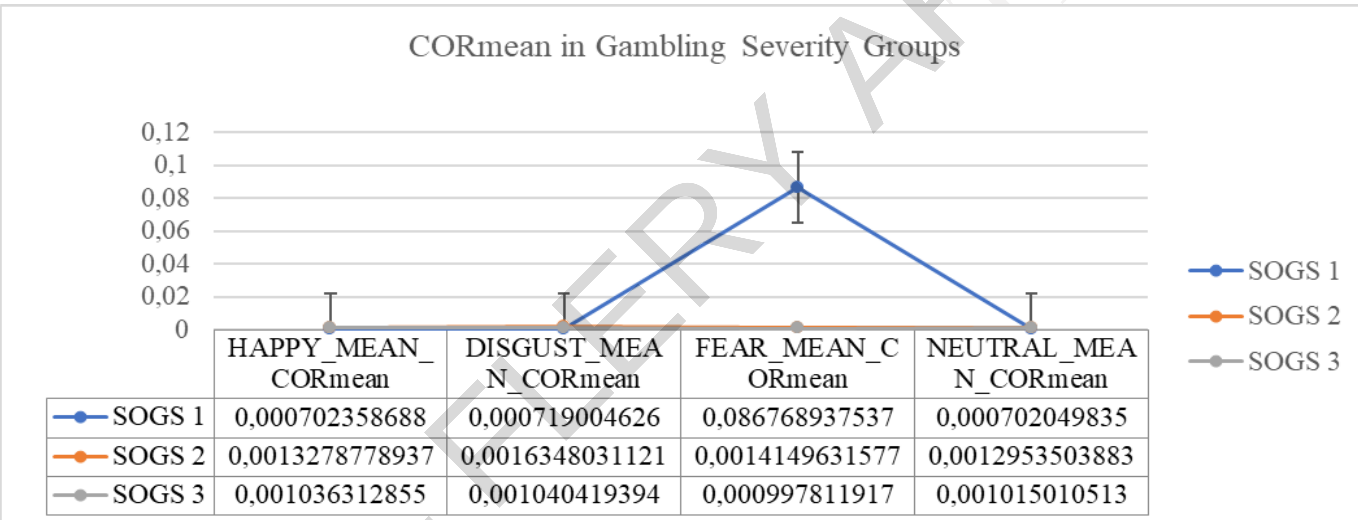


	HAPPY_MEAN_SCLmean	DISGUST_MEAN_SCLmean	FEAR_MEAN_SCLmean	NEUTRAL_MEAN_SCL mean
SOGS 1	11,11592196	10,87474907	11,84975821	10,7167961
SOGS 2	12,33977325	12,23309091	12,16881505	12,07871117
SOGS 3	12,16366294	12,14913276	12,21736013	11,87231467

Corrugator Mean (CORmean) & Corrugator Maximum (CORmax)

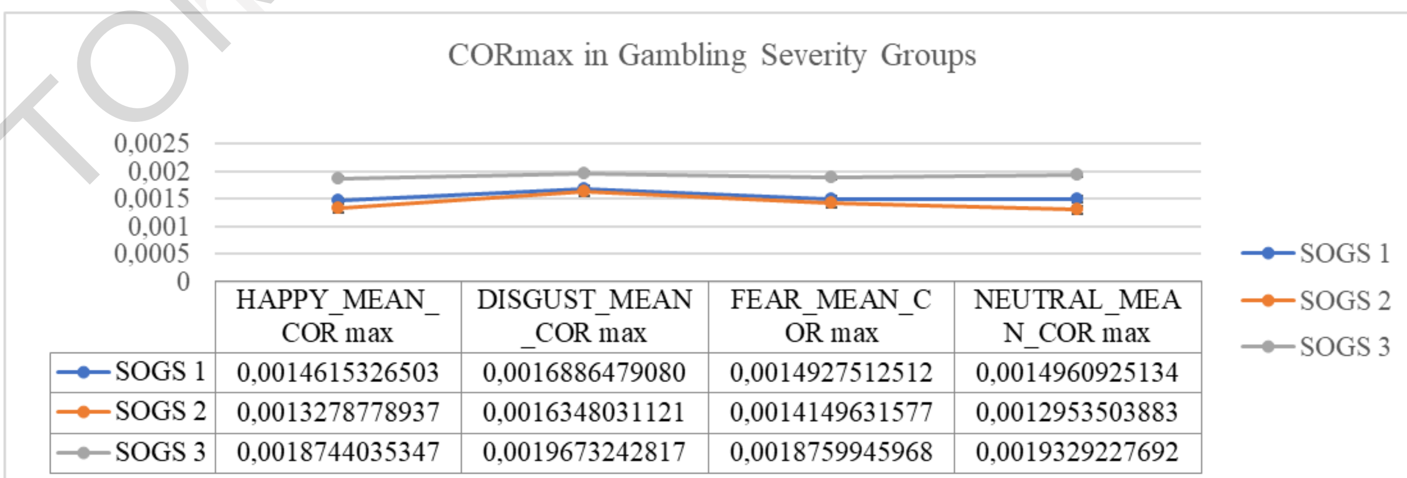
Results indicate that regarding CORmean there was no significant effect in emotional category in any level of gambling behavior ($p > 0.017$). Although there is an obvious increase in corrugator activity during fearful stimuli in the low severity gambling group (Figure 3) compared to groups demonstrating higher severity, exploratory analysis did not show any significant differences between any gambling group.

Figure 3.



	HAPPY_MEAN_CORmean	DISGUST_MEAN_CORmean	FEAR_MEAN_CORmean	NEUTRAL_MEAN_CORmean
SOGS 1	0,000702358688	0,000719004626	0,086768937537	0,000702049835
SOGS 2	0,0013278778937	0,0016348031121	0,0014149631577	0,0012953503883
SOGS 3	0,001036312855	0,001040419394	0,000997811917	0,001015010513

Figure 4.



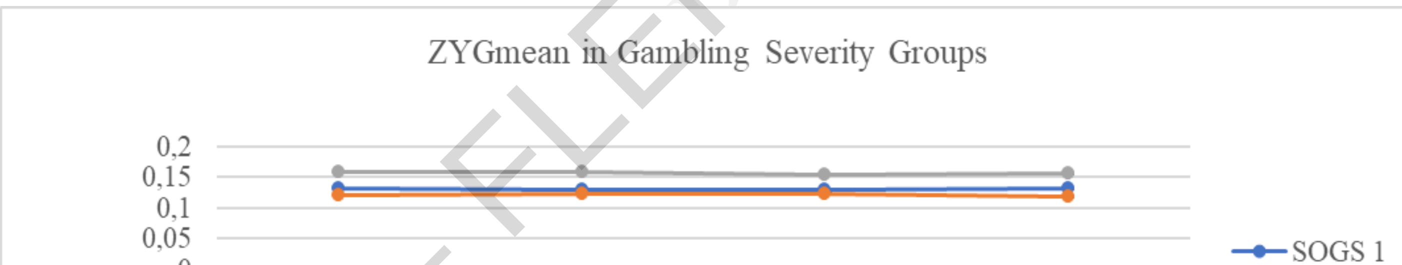
	HAPPY_MEAN_COR max	DISGUST_MEAN_COR max	FEAR_MEAN_COR max	NEUTRAL_MEAN_COR max
SOGS 1	0,0014615326503	0,0016886479080	0,0014927512512	0,0014960925134
SOGS 2	0,0013278778937	0,0016348031121	0,0014149631577	0,0012953503883
SOGS 3	0,0018744035347	0,0019673242817	0,0018759945968	0,0019329227692

To the contrary, regarding CORmax, analysis showed significant effect of emotional condition within different levels of gambling severity First, the effect of emotional condition was significant among low severity gamblers (2.186, 225) = 7.695, $p < .001$, $\eta^2 = .093$ (Greenhouse-Geisser correction), however we can see differences of the high severity group compared to all the others, with high severity showing the highest overall maximum corrugator value (Figure 4).

Zygomatic Mean (ZYGmean) & Zygomatic Maximum (ZYGmax)

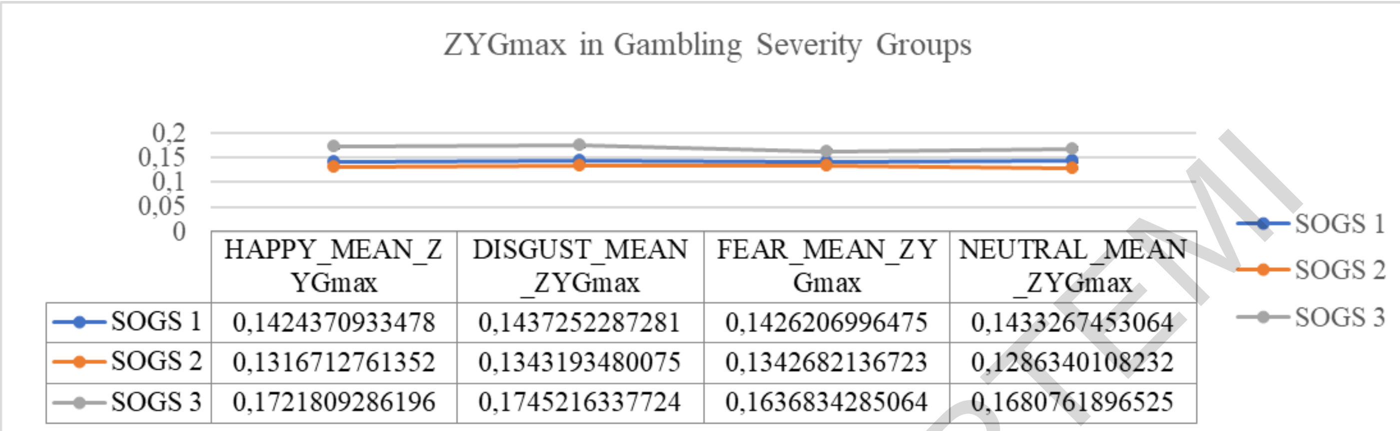
Results indicate that regarding ZYGmean and ZYGmax there was no significant effect of emotional category at any level of gambling severity (Figures 5 & 6); $p > 0.017$) just a slight increase in high gambling severity in all the images.

Figure 5.



	HAPPY_MEAN_ZYGmean	DISGUST_MEAN_ZYGmean	FEAR_MEAN_ZYGmean	NEUTRAL_MEAN_ZYGmean
SOGS 1	0,13298937494967	0,13076945130288	0,12979162636711	0,13236184599142
SOGS 2	0,12198151720674	0,12236597914124	0,12217180011551	0,11789405115862
SOGS 3	0,15984115379135	0,15880935822071	0,15475185783396	0,15676804115663

Figure 6.



	HAPPY_MEAN_ZYGmax	DISGUST_MEAN_ZYGmax	FEAR_MEAN_ZYGmax	NEUTRAL_MEAN_ZYGmax
SOGS 1	0,1424370933478	0,1437252287281	0,1426206996475	0,1433267453064
SOGS 2	0,1316712761352	0,1343193480075	0,1342682136723	0,1286340108232
SOGS 3	0,1721809286196	0,1745216337724	0,1636834285064	0,1680761896525

9.8 Discussion

The current study explores how different profiles of gamblers respond to emotional stimuli (Happy, Disgust, Fear, Neutral) considering both subjective and physiological measures and how their responses and their gambling severity are influenced by psychopathic traits, sensitivity to punishment, and sensitivity to reward. Using a repeated measures ANOVA, the study analyzed the psychophysiological (Heart Rate, Skin Conductance Level, Corrugator activity, and Zygomatic activity) and self-reported emotional responses (Valence, Arousal, Control) across varying levels of gambling severity (low, medium, high).

Overall, the study hypotheses were not supported, suggesting that gamblers of different levels of severity, for the most part, respond similarly to emotional stimulation, suggesting that emotional aberrations are not significantly involved in gambling behavior. However, although the effect of gambling group was not significant, upon exploration to directly address our hypotheses on the effects of gambling severity, some differences in responses to different emotions were noted in different levels of severity, that are consistent with hypotheses. However, they should be interpreted with caution as they are only found in exploratory post hoc comparisons.

Our first hypothesis proposed that individuals with lower severity of gambling issues would exhibit greater psychophysiological reactions, especially in response to negative stimuli, compared to those with medium or high severity gambling problems. This hypothesis was based on previous research suggesting that heightened emotional responses may be more pronounced in individuals with lower gambling severity due to factors such as heightened sensitivity or lack of desensitization seen in higher-severity gamblers (Raylu & Oei, 2004). Consistent with this hypothesis, the literature suggests that less severe pathological gamblers exhibit more marked emotional and physiological responses to fear-inducing stimuli (Wong et al., 2017). Contrary to our hypothesis, the results did not reveal significant differences in heart rate (HR), skin conductance level (SCL), corrugator activity (COR) or zygomatic (ZYG) among individuals with different levels of gambling severity across various emotional stimuli. However, while significant main effects were not observed, post- hoc tests, - that must be interpreted with caution- indicated that low-severity gamblers exhibited somewhat more heightened corrugator mean activity during fearful stimuli, suggesting more intense frowning in this negative emotion compared to positive or neutral emotions. This aligns with research suggesting that individuals with lower severity of gambling issues might have more pronounced facial expressions in response to negative stimuli, possibly due to heightened sensitivity or lack of desensitization seen in higher-severity gamblers (Raylu & Oei, 2004). Further, Wong et al. (2017) support the idea that less severe pathological gamblers exhibit more marked emotional and physiological responses to fear-inducing stimuli. The emotional responses or this group are normative, i.e. appropriate for the negative affective contexts, showing overall intact emotion processing and sensitivity to potential threats and aversive stimuli (Raylu & Oei, 2004).

In contrast, high severity gamblers showed no significant differences in corrugator activity, between negative emotional contexts and positive or neutral ones, pointing to a possible desensitization to fear-inducing stimuli, or potentially to negative affect in general. Similar patterns were observed with disgusting images. Low severity gamblers again demonstrated higher physiological responses, indicating a stronger reaction to aversive stimuli than other types of affective contents. This suggests that their emotional reactivity to disgust is more typical and less blunted, which may help them avoid maladaptive behaviors like excessive gambling (Cavedini et al., 2002).This desensitization could be due to chronic exposure to the stress and excitement inherent in gambling, leading to an overall blunting of their physiological responses to fear (Balodis et al., 2012). Additionally, high severity gamblers might have developed coping mechanisms or a psychological numbness to manage the negative emotions associated with their gambling behavior. Blunted responses to negative affect are also consistently found among individuals high in psychopathic traits, suggesting that these traits might be higher among severe gamblers. This reduced sensitivity might contribute to their propensity to engage in risky behaviors despite potential negative consequences. The blunted response to disgust could also be a factor in their continued gambling behavior, as they might not fully experience the aversive emotions that could otherwise deter them from such activities (Clark et al., 2014).

The drop in heart rate (HR) in response to disgusting images observed in the high severity gambling group could be attributed to desensitization or emotional blunting commonly seen in individuals with addictive behaviors, including gambling addiction . High severity gamblers may have developed tolerance to aversive stimuli due to repeated exposure to gambling-related stressors or negative consequences of their behavior (Rømer Thomsen et al., 2015). This desensitization may manifest as reduced physiological arousal, reflected by a decrease in HR during emotionally distressing stimuli.

However while not significant, in post- hoc comparisons we found slight higher values in psychophysiological responses such as corrugator and Zygomatic. The differences in zygomatic activity (ZYGmean and ZYGmax) across gambling severity groups, with high severity gamblers showing increased zygomatic values compared to other groups, suggest heightened positive emotional responses in individuals with severe gambling issues. Despite being exposed to aversive stimuli like fear and disgust, high severity gamblers may exhibit elevated zygomatic activity, indicating a tendency to experience positive emotions even in negative contexts. This finding aligns with previous research indicating blunted affective responses and reward sensitivity in individuals with addictive disorders, including gambling addiction (Balodis et al., 2012).

The observation that high severity gamblers exhibit higher maximum corrugator activity (CORmax) across emotional stimuli, despite previously suggesting they may have blunted responses, highlights the complexity of emotional reactivity in this population. Heart rate (HR) primarily reflects autonomic nervous system activity and might be more sensitive to general arousal. In contrast, corrugator muscle activity (COR) reflects more specific affective responses, particularly related to negative emotions like anger or disgust (Cacioppo et al., 2007). High severity gamblers might have blunted autonomic responses while still displaying strong affective reactions, as evidenced by increased corrugator max. Severe gamblers often exhibit emotional dysregulation, characterized by difficulty in managing and responding to emotional experiences appropriately (Williams et al., 2012). For example, they might overreact facially to negative stimuli as a compensatory mechanism for their overall emotional blunting. Also, High severity gamblers might show exaggerated facial responses in a controlled experimental setting, where the focus is on specific emotional stimuli, compared to their general day-to-day emotional blunting (Koob & Le Moal, 2011).

Our second hypothesis was that any significant main effects of gambling groups, or interactions between gambling group and emotion condition might in part be attributed to differences in psychopathy. The findings indicated that including psychopathy as a covariate in self-reporting arousal did not significantly account for the differences observed. However differences can be seen in one-way ANOVA analyses where psychopathy increases as gambling severity increases. The association between TriPM and SOGS severity levels further highlight the nuanced relationship between psychopathic traits and gambling severity in shaping emotional responses. Specifically, these results suggest that the influence of psychopathic traits on emotional processing varies across different levels of gambling severity. For example, individuals with high levels of psychopathic traits seems to demonstrate higher severity gambling issues. However, the relationship between psychopathy and gambling severity is complex, and other factors such as impulsivity and emotional regulation may also play significant roles gamblers (Fanti et al., 2016a; Seara-Cardoso & Viding, 2015).

The third hypothesis proposed that SP or SR traits would act as covariates or influence as within subjects any differential responses between SOGS groups in emotion reactivity, or their interaction with emotion condition. This hypothesis was grounded in the reinforcement sensitivity theory (Gray & McNaughton, 2000), which posits that individuals with high SP are more responsive to aversive stimuli and there for SP acts as a covariate. According to this theory, heightened SP would lead to increased physiological responses such as elevated heart rate or galvanic skin response when exposed to negative emotional stimuli. However, the data did not support this hypothesis, suggesting that SP may not significantly influence physiological reactions to emotional stimuli in gamblers. Individuals with high SR would show increased physiological responses, specifically zygomatic activity (associated with smiling), in response to rewarding and pleasurable stimuli such as happy images. This hypothesis aligns with previous research indicating that SR is linked to approach behavior and positive affect (Depue & Collins, 1999). For instance, individuals with high SR have been found to exhibit more pronounced positive emotional and physiological responses to rewarding stimuli (Beaver et al., 2006). Despite this theoretical foundation, the findings did not confirm the hypothesis, indicating that SR might not be directly associated with increased zygomatic activity in response to positive emotional stimuli in the context of gambling.

The lack of support for these hypotheses in the current study may suggest several possibilities. First, the specific context of gambling and the stimuli used might play a role. While SP and SR have been shown to influence physiological responses in general settings, the unique emotional and psychological dynamics of gambling might attenuate these effects (Goudriaan, Oosterlaan, de Beurs, & Van Den Brink, 2005). Additionally, individual differences in gambling behavior and the types of emotional stimuli used could impact the generalizability (Brevers et al., 2013).

Moreover, the discrepancy between the theoretical predictions and our findings might indicate the need for a more nuanced understanding of how SP and SR interact with specific types of stimuli in gambling contexts. For instance, gamblers might habituate to emotional stimuli differently than non-gamblers, potentially due to the unique reinforcement patterns in gambling environments (Lole, Gonsalvez, & Barry, De Blasio, 2013).

The study highlighted notable discrepancies between psychophysiological measures and self-reported emotional experiences. High severity gamblers often rated negative stimuli as less distressing in self-reports, yet their physiological responses told a different story. This divergence could be explained by several factors. High severity gamblers might report lower distress due to emotional numbing or desensitization to negative stimuli. This numbing effect can result from repeated exposure to stress and negative outcomes in gambling, leading to a diminished conscious awareness of negative emotions (Lorains, Cowlishaw, & Thomas, 2011). Gamblers with high severity levels might have impaired insight into their own emotional states. This impairment, often seen in individuals with high psychopathic traits, means they may not fully recognize or report their emotional experiences accurately, even though their bodies react physiologically (Sebastian et al., 2012; 2013). High severity gamblers might underreport negative emotions due to motivational biases such as denial or minimization. These biases serve as coping mechanisms to avoid confronting the adverse effects of their gambling behavior (Clark et al., 2014). High sensitivity to reward and low sensitivity to punishment might also play a role in these discrepancies. High severity gamblers are likely more attuned to the rewards of gambling and less responsive to its negative consequences, which can skew their self-reports of emotional distress (Bijttebier et al., 2009).

The study's lack of main effects in psychophysiological measures and self-reports across gambling severity groups and their interactions with emotional stimuli factors may seem counterintuitive. However, several explanations rooted in existing literature and the study's design can help interpret these findings. These explanations consider the complexities of emotional processing, individual differences, and methodological considerations. Gamblers, regardless of severity, may exhibit significant individual differences in emotional reactivity. This heterogeneity can dilute potential group differences when analyzing psychophysiological measures such as skin conductance, heart rate, and facial EMG. Emotional responses are influenced by a multitude of factors including personality traits, coping mechanisms, and comorbid conditions (Raylu & Oei, 2004). The experimental context might not fully replicate the emotional dynamics of actual gambling situations, potentially affecting the ecological validity of the responses observed (Schüll, 2005). Gamblers, especially those with high severity, might underreport negative emotions or lower the intensity of their experiences in self-reports due to social desirability bias or denial mechanisms. This can lead to inconsistencies between self-reported data and physiological measures, masking potential group differences or absence of main effects (Clark et al., 2014).

In conclusion, study underscores the need to further study the role of emotional responses to negative and positive stimuli between gamblers of varying severity to further understand the motivational mechanisms that drive gambling problems.. It's worth mentioning that the sample predominantly consists of individuals with low levels of gambling behavior, which may have contributed to the lack of significant effects due to an insufficient number of participants with self-reported severe gambling problems. Furthermore, as most of the sample comprises students, they may not have engaged in gambling long enough to develop significant issues. However, other factors, discussed before, such as psychopathic traits, might also play a role in the observed outcomes. These findings should be further studied in more clinical samples, and samples with more diverse gambling behaviors. Findings highlight the complex interplay between emotional processing, gambling behavior, and individual psychological traits. Understanding these dynamics is crucial for developing targeted interventions that address the specific needs of gamblers based on their severity levels and emotional profiles.

10.General Discussion and Future Perspectives

The current dissertation explored how different profiles of gamblers, as measured by the South Oaks Gambling Screen (SOGS), respond to Exciting or Frustrating Slot-Machine conditions, as well as to emotional stimuli (Happy, Disgust, Fear, Neutral) considering both subjective and physiological measures and how their responses and their gambling severity are influenced by psychopathic traits, sensitivity to punishment, and sensitivity to reward.

The first study employed a Virtual Slot-Machine task to simulate real-life gambling scenarios, exposing participants to conditions designed to evoke excitement and frustration. Psychophysiological measures such as heart rate (HR) and skin conductance level (SCL) were recorded to assess arousal. Self-report measures evaluated affective experiences, including valence, arousal, control, and desire to play. The hypothesis posited that players would exhibit higher arousal in both excitement and frustration conditions, with different self-report ratings depending on gambling severity levels. However, results were mixed.

For HR, no significant differences were found between excitement and frustration conditions, nor were there significant interactions between HR and SOGS scores, suggesting that neither emotional states nor gambling severity significantly influenced HR (Clark, 2010). In contrast, SCL showed significant differences between excitement and frustration conditions, indicating distinct arousal responses (Wilkes et al., 2010; Lole et al., 2014). However, no significant interaction was found between emotional states and SOGS scores, suggesting that gambling severity did not affect SCL responses (Limbrick-Oldfield et al., 2017).

The second hypothesis suggested that higher sensitivity to reward would be associated with higher gambling severity and a greater tendency to continue playing even after frustrating conditions. The results indicated no significant effects of gambling urges (GUS) and sensitivity to reward/punishment (SPSR) on gambling severity or emotional conditions, suggesting that higher sensitivity to reward does not necessarily lead to a greater tendency to continue playing after frustrating conditions (Brevers et al., 2013; McCormick et al., 2011; Kräplin et al., 2014).

Exploratory analyses examined the effects of gambling severity on psychophysiological measures and self-reported measures across different gambling conditions (win, near-win, lose). SCL was found to be a reliable measure of arousal, with higher levels in frustration conditions than in excitement conditions, indicating heightened stress or anxiety in response to losses or near-wins. Additionally, low severity gamblers showed increased gambling urges post-task, reflecting the reinforcing nature of the gambling experience (Brevers et al., 2012; McCormick et al., 2011).

Personality factors such as impulsivity, sensation-seeking, and psychopathic traits can influence gambling behavior and physiological responses (Nower et al., 2004). Higher levels of psychopathic traits were associated with increased gambling severity (Blanco, Myers, & Kendler, 2012; Buelow & Suhr, 2014). Traits like impulsivity and risk-taking may amplify emotional responses to gambling outcomes (Nower et al., 2004; Billieux et al., 2012). Difficulties in emotional regulation were linked to persistent gambling urges, particularly in individuals with high secondary psychopathy, who may use gambling to cope with negative emotions or seek excitement (Hicks et al., 2004).

The study provided valuable insights into the emotional and physiological responses to gambling, highlighting the complexity of these interactions. While HR did not vary significantly, SCL was a reliable measure of arousal, differentiating between excitement and frustration conditions (Clark, 2010; Wilkes et al., 2010; Dixon et al., 2010). The findings suggest that gambling experiences can heighten the desire to continue gambling, particularly in lower severity gamblers (Brevers et al., 2012a; McCormick et al., 2011).

The second study investigated the relationship between gambling severity, heart rate variability (HRV), and psychopathy traits using a simulated slot-machine task and self-report measures. The hypothesis was that gambling severity, as assessed by SOGS, would influence HRV across different conditions of excitement and frustration.

One-way ANOVA analyses revealed significant differences across multiple psychopathy dimensions, while sensitivity to reward and punishment did not significantly differ across gambling severity levels. The Triarchic Psychopathy Measure (TriPM; Patrick, 2010) operationalizes psychopathy into three distinct facets: boldness, meanness, and disinhibition. Findings consistently showed that all TriPM facets increased with higher levels of gambling severity (Chamberlain et al., 2018). Additionally, the Levenson Self-Report Psychopathy Scale (LSRP; Levenson et al., 1995) delineates psychopathy into primary and secondary factors. Both primary and secondary psychopathy scores were significantly higher among individuals with greater gambling severity (Granero et al., 2016).

A substantial proportion of individuals classified as having low gambling risk or severity were students. This demographic represents a significant sample within the broader gambling population, often exhibiting lower levels of both gambling severity and psychopathy traits compared to clinical populations (Granero et al., 2016).

The first hypothesis posited that gambling severity would show a significant main effect on HRV across different task conditions. Exploration analyses indicated that higher SOGS scores were associated with overall lower HRV, suggesting dysregulated autonomic functioning among individuals with problematic gambling behaviors. However, this was not statistically significant. The second hypothesis suggested a significant interaction effect between gambling severity and task conditions (excitement and frustration) on HRV, but no statistically significant interaction effect was found. Trends in the high gambling severity group suggested more pronounced reductions in HRV during high frustration conditions (Dixon et al., 2014; Lussier et al., 2014).

Baseline HRV was relatively higher compared to excitement and frustration conditions, suggesting a more stable autonomic state in the absence of emotional arousal or stressors (Smith et al., 2020). During conditions of excitement and high frustration, HRV tended to decrease, reflecting heightened emotional arousal and physiological stress (Hilbrecht et al., 2020).

The third hypothesis explored psychopathy traits as a covariate between SOGS scores and HRV during task conditions. The absence of significant main effects or interactions did not justify ANCOVA analysis. However, significant results of TriPM as an independent variable indicate that psychopathic traits play a significant role in modulating emotional responses across the sample (Fanti et al., 2016b).

The final study examined how different profiles of gamblers respond to emotional stimuli (Happy, Disgust, Fear, Neutral) using subjective and physiological measures. Hypotheses suggested that lower gambling severity individuals would exhibit greater psychophysiological reactions to negative stimuli compared to those with medium or high severity gambling problems. Results did not reveal significant differences in HR, SCL, corrugator activity, or zygomatic activity among individuals with different gambling severity levels across various emotional stimuli. However, post-hoc tests indicated that low-severity gamblers exhibited heightened corrugator activity during fearful stimuli, suggesting more intense frowning in response to negative emotions (Raylu & Oei, 2004; Wong et al., 2017).

High severity gamblers showed no significant differences in corrugator activity between negative and positive or neutral emotional contexts, pointing to possible desensitization to fear-inducing stimuli (Balodis et al., 2012; Grant, Odlaug, & Mooney, 2012). Differences in zygomatic activity suggested heightened positive emotional responses in severe gamblers, despite aversive stimuli. This aligns with research indicating blunted affective responses and reward sensitivity in individuals with addictive disorders (Balodis et al., 2012).

The second hypothesis suggested that psychopathy traits would account for differences observed in emotional reactivity across gambling severity groups. Including psychopathy as a covariate did not significantly account for the differences, but significant results of TriPM as an independent variable indicate psychopathic traits play a role in modulating emotional responses (Fanti et al., 2016b).

Conclusion

These findings highlight the intricate relationships among gambling behavior, HRV, and psychopathy traits within simulated gambling contexts. While HRV changes were noted across various emotional conditions, significant interactions and main effects were not statistically significant. Future research should consider individual differences in autonomic responses, coping strategies, and additional physiological markers to provide a more comprehensive understanding. These insights could inform tailored interventions aimed at mitigating the impacts of problematic gambling behaviors, potentially integrating biofeedback techniques or personalized therapeutic approaches.

10.1. Profiling based on Gambling Behavior, Sensitivity to Punishment/Reward (Graph 1 & Graph 2)

The profiles based on gambling behavior, sensitivity to punishment/reward, and psychopathy traits provide a theoretical understanding of how different combinations of these factors influence emotional processing and gambling tendencies. The Pathways Model of problem and pathological gambling, developed by Blaszczynski and Nower (2002) and the revised (Nower, Blaszczynski, & Anthony, 2022) provides a foundational framework to understand the profiles of gamblers based on their sensitivity to punishment/reward and psychopathy traits. This model outlines three primary pathways: behaviorally conditioned gamblers, emotionally vulnerable gamblers, and antisocial impulsivist gamblers, each representing a different etiology of gambling behavior. The findings indicating the relationships between various levels of gambling behavior, facets and dimensions of psychopathy, and sensitivity to punishment and reward provide a robust groundwork for future research. This groundwork is instrumental for testing new hypotheses aimed at profiling individuals based on their gambling behaviors and psychopathic traits. Specifically, these insights pave the way for developing detailed profiles that can predict gambling severity and associated psychological characteristics. These pathways can be closely linked to the profiles described below, and can be explored as hypotheses in future research.

<u>Sensation Seekers-</u> **Low Psychopathy, Low Sensitivity to Punishment, High Sensitivity to Reward, High Gambling severity:** Sensation Seekers align with the behaviorally conditioned gamblers in the Pathways Model. These individuals may exhibit diminished physiological arousal in response to emotionally neutral stimuli, reflecting a deficit in emotional processing. However, they may display heightened emotional reactivity and approach behaviors in response to rewarding stimuli, driven by their high sensitivity to rewards. This profile suggests a tendency to seek out rewarding experiences despite potential negative consequences, such as financial loss in gambling. This profile aligns with individuals who may exhibit traits of primary psychopathy, characterized by low levels of anxiety, fear, and punishment sensitivity, combined with high levels of reward sensitivity. According to the Pathways model, individuals with primary psychopathy may engage in gambling to seek excitement, thrills, and rewarding experiences. Their low sensitivity to punishment may reduce aversive responses to potential losses, while their high sensitivity to reward may drive them to seek out rewarding

experiences, such as those provided by gambling activities.

<u>Vigilant Risk-Takers</u>- Medium Psychopathy, High Sensitivity to Punishment, Low Sensitivity to Reward, Medium Gambling Severity: Vigilant Risk-Takers correspond to the emotionally vulnerable gamblers in the Pathways Model. With medium psychopathy, high sensitivity to punishment, and low sensitivity to reward, these individuals exhibit anxiety and fear, using gambling as a means to alleviate negative emotional states. Individuals in this group exhibit characteristics of secondary psychopathy, marked by higher levels of anxiety, fear, and punishment sensitivity, combined with lower levels of reward sensitivity. Individuals in this group may demonstrate blunted emotional responsiveness to both positive and negative stimuli while gamble, consistent with psychopathic traits but contrary to their anxiety state. According to the Pathways model, individuals with secondary psychopathy may engage in gambling to alleviate negative affective states and cope with stressors. Their heightened sensitivity to punishment may lead to increased aversive responses and physiological arousal, particularly in response to negative or neutral stimuli, while their low sensitivity to reward may attenuate their motivation to pursue rewarding experiences, resulting in a more cautious approach to gambling. Gambling may serve as a moderate risk-taking behavior for them, influenced by their anxiety and fear sensitivity.

<u>Compulsive Risk-Takers</u>- High Psychopathy, High Sensitivity to Punishment, High Sensitivity to Reward, High Gambling Severity:

Compulsive Risk-Takers fit within the antisocial impulsivist gamblers of the Pathways Model. This profile represents a combination of primary and secondary psychopathic traits, characterized by high levels of both punishment and reward sensitivity. According to the Pathways model, individuals with this profile may engage in gambling as a means to seek out both excitement and relief from negative affective states. Their heightened sensitivity to both punishment and reward may lead to a complex pattern of emotional reactivity, characterized by heightened arousal in response to both positive and negative stimuli, and may drive excessive gambling behaviors despite potential negative consequences.

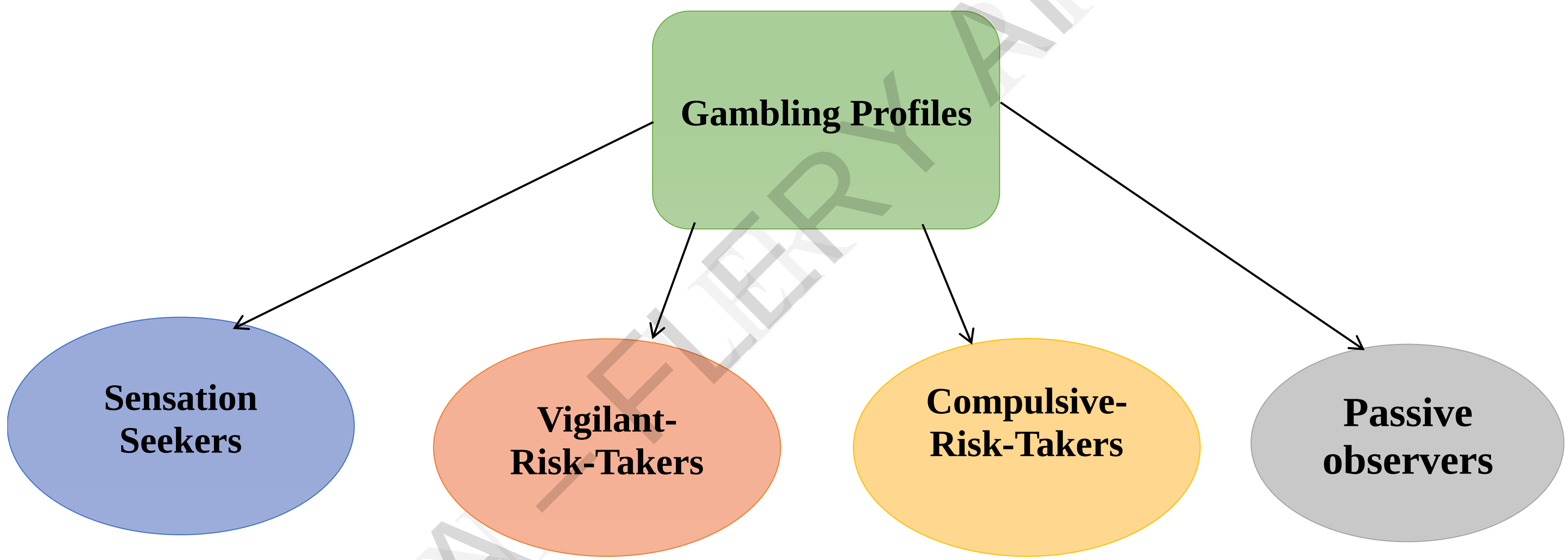
<u>Passive Observers-</u>Low Psychopathy, Low Sensitivity to Punishment, Low Sensitivity to Reward, Lower Gambling Severity: Passive Observers may not fit neatly into the primary pathways described by the Pathways Model but can be considered as a variation of the behaviorally conditioned gamblers with low engagement. With low psychopathy, low sensitivity to punishment, and low sensitivity to reward, these individuals engage in gambling more passively. Individuals in this group exhibit overall blunted emotional responsiveness and physiological arousal, characterized by diminished reactions to both positive and negative stimuli. According to the Pathways model, individuals with this profile may engage in gambling as a form of passive entertainment or social activity, rather than as a means to seek out rewarding experiences or cope with negative affective states. Their low sensitivity to both punishment and reward may result in a lack of motivation to engage in gambling behaviors, leading to a more passive approach to gambling with reduced emotional engagement and risk-taking tendencies. They engage in gambling activities passively, without much emotional engagement or motivation, often participating more for social reasons or as a form of mild entertainment.

10.2. Future Directions

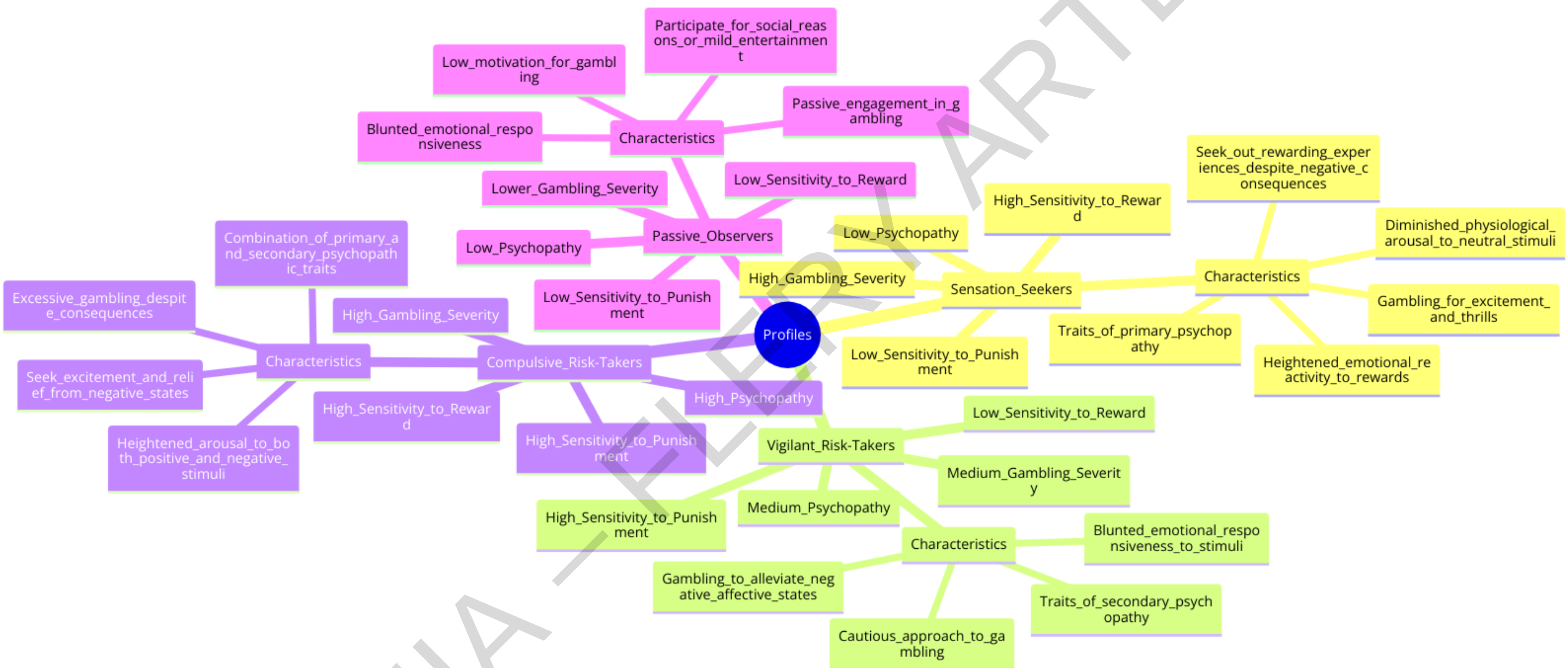
These profiles illustrate the diverse ways in which sensitivity to punishment and reward, combined with psychopathic traits, can influence gambling behavior and emotional processing. Individuals may exhibit varying degrees of emotional reactivity, risk-taking tendencies, and motivation to pursue rewarding experiences, depending on their unique combination of traits and sensitivities. Future research could provide valuable insights into the stability of these profiles and the potential for change, informing the development of early intervention strategies. Moreover, there is a need to explore the efficacy of tailored therapeutic interventions designed to address the specific characteristics of each profile. Understanding the role of environmental and social factors in shaping these profiles is also crucial. Future studies should investigate how external influences, such as peer pressure, cultural attitudes towards gambling, and socioeconomic status, interact with individual traits to affect gambling behavior. This could lead to more comprehensive prevention programs that target both individual vulnerabilities and broader social determinants of health.

By advancing our understanding of the complex interaction between individual traits and environmental factors, future research can contribute to more effective and personalized approaches to preventing and treating problem gambling. These efforts will ultimately support the development of a more holistic understanding of gambling behavior, enhancing both clinical practice and public health strategies.

Graph 1. Different Profiles of Gambling behavior based on Sensitivity to Punishment/Reward and Psychopathic Traits.



Graph 2. Mind Map - Profiling and Traits



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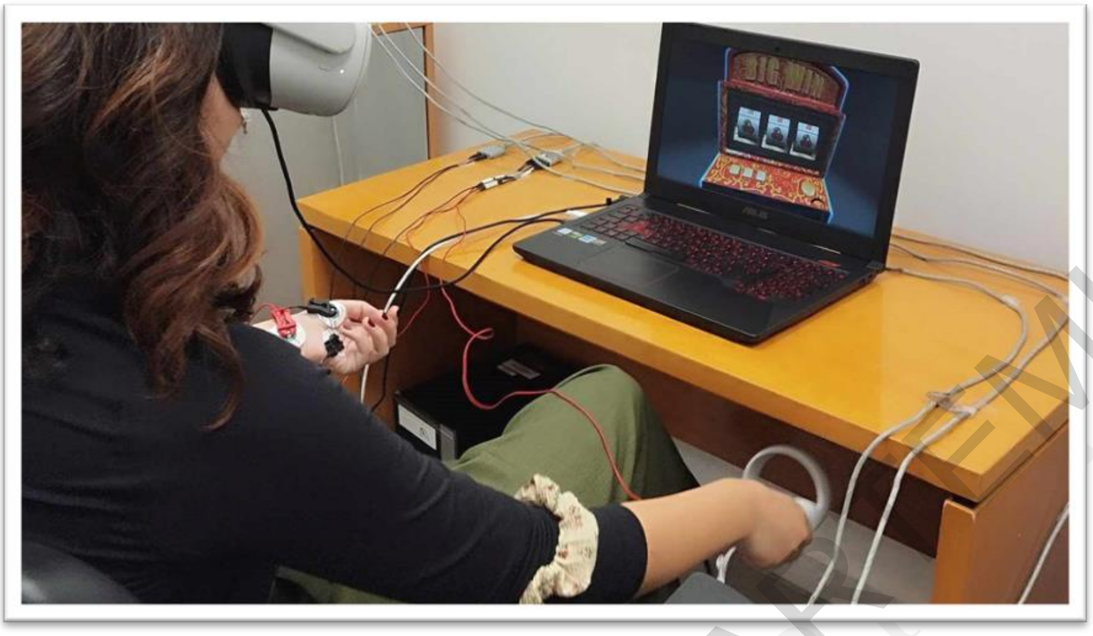
Appendices

Appendix 1. Slot-Machine

Appendix 2. Slot-Machine

Appendix 3. Slot- Machine



Appendix 4. Imagery Procedure