Would you bet on your physiological response? An analysis of the physiological and behavioural characteristics of online electronic gaming machine players

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Extended abstract

From a sheer economic standpoint, gambling on electronic gaming machines (EGMs) is an activity characterised by a negative expected payoff. The outcome of each terminal is electronically determined by a random number generator and each device has to return only a percentage of the money wagered by players, thus granting the house edge. Notwithstanding such a feature that limits any classical economics modelisation, EGM is accounted among the most thriving forms of gambling worldwide.

The proliferation of gambling possibilities is further sustained by the rise of the internet and mobile technology. Novel technologically-enabled gambling opportunities offer greater accessibility and convenience enabling greater flexibility for game experimentation (Griffiths 2003; Wood, Williams, & Lawton 2007; McCormack & Griffiths 2012). At the same time, online gambling often satisfies privacy concerns by guaranteeing anonymity to players motivated to circumvent the patrons and the atmosphere of physical gambling halls (Griffiths & Barnes 2008; Gainsbury et al. 2013). The flipside of the coin to the increase and improvement in gambling solutions lies in their overuse and thus in the potential genesis of problematic behavioural patterns (Griffiths 1999, Hing et al. 2015).

Reasons for EGM gambling are variegated. Behavioural drives of both recreational gamblers and problematic gamblers include variables such as economic (Herman 1976), symbolic (Bloch 1951), and hedonic motives (Kusyszyn 1984) or psychological motives such as escapism or excitement

seeking (Rockloff & Dyer 2006). On even terms, a large body of literature explores the critical success factors of slot machines in terms of structural characteristics (Griffiths 1993; Parke & Griffiths 2006; Schüll 2012). Following such a line of thought, the alluring traits of EGMs are described in terms of psycho-structural interaction between the user and the device (Griffiths 1999). EGM design elements include the number of play lines allowing for different winning modalities (Delfabbro et al., 2005), the engineering of sounds (Loba et al. 2001; Schüll 2012), lights and color effects (Griffiths 1993), structural features of the jackpot (Rockloff & Hing 2013; Quilty et al. 2016), the gameplay speed (Delfabbro et al. 2005), or the display of money or credit (Loba et al. 2001).

Studies over the past two decades have provided important information on the motivation to gamble delving into the neural activations involved during different gambling events (Clark et al. 2009; Chase & Clark 2010) as well as the autonomic responses to specific outcomes (Dixon et al. 2010; Dixon et al. 2013) to investigate how physiological responses were linked to gambling drive and motivation. However, a substantial amount of the experimental studies was carried out on simulated EGM (see Barton et al. 2017 for a review), where ad hoc simplified slot machine paradigms were employed, thus limiting the ecological validity and potentially the results generalizability. Furthermore, even acknowledging the multitude of responses involved during gambling activity, the large majority of previous studies adopted a single physiological measure, such as electrodermal activity or cardiac or cerebral only.

The present study aimed at expanding such research stream by delving into the interrelation between physiological responses and game design elements to eventually shed light on the reinforcer role of cognitive and affective reactions. The major contribution of the present work lies in the integration of physiological and behavioural measures in a faithfully-reproduced online EGM gambling setting. Experimental ecological validity was granted in terms of gaming complexity, player choice possibility and spending options. This research set out to investigate physiological and behavioural patterns in terms of autonomic arousal, attention and engagement in conjunction with specific game events along a gambling session. Physiological arousal is among the major bodily responses

investigated in EGM gambling and it is believed to be the most important reinforcer moderating the gambling activity (Anderson & Brown 1984; Raylu & Oei 2002 for a review). Attention and engagement have been often linked to flow and immersive states experienced by players (Murch et al. 2017; Dixon et al. 2018), thus deemed a crucial element characterising the gambling experience. Physiological and behavioural patterns were analysed in conjunction with specific game outcomes including (i) wins, (ii) losses, (iii) losses disguised as wins (LDW), as outcomes where the cashed in amount resulted lower than the bet amount (Dixon et al. 2010), and (iv) bonus game activations, as specific in game features, activated if the combination of certain symbols occurred.

The study involved 60 subjects aged between 25 and 55, including 10 women and 50 men, representative of the average Italian gamblers population. All recruited participants were holders of active online gambling accounts and were divided on the basis of their previous online slot gambling experience in three groups (i.e. high, medium, and low frequency gamblers). The screening phase was carried out by an appointed provider to ensure that no pathological subject or individual with a history of problem gambling was involved. Each subject played with own money and did not receive any sort of incentive to participate. Complete anonymity during the experimental phase was granted to every participant. The procedures of this study were approved by the Ethics Committee of the university institution to which the authors refer.

Three online five-reels multi-line slot machine games (i.e. “Halloween Fortune®”, “Starburst®”, and “King of Olympus®”) were chosen as experimental stimulus. The selection was advised by one of the main gambling companies authorized in Italy and was carried out on the basis of game popularity in Italy. Participants selected one of the three games and underwent a single gambling session selecting €50,00 as a starting budget. Unless subjects run out of budget earlier, each game session had a minimum duration of 30 minutes, expired which the player could choose to leave the game, and a maximum of 40 minutes, after which the session was terminated. The experimental sessions were carried out in a laboratory setting devoid of distracting elements where each subject interacted with a computer in separated cubes.

During the game session three different signals were acquired, namely (i) electroencephalogram (EEG) by means of a portable system equipped with a 64-channels pre-cabled cap, where 25 chosen electrodes were activated, recording at a sampling rate equal to 256 Hz; (ii) a single ECG lead by means of a dedicated software, adopting a recording sampling rate of 256 Hz; and (iii) Eye-tracking signal through a remote eye-tracking bar attached to the computer monitor, recording at a sampling rate of 60 Hz.

Muscular and ocular artefacts were identified and removed from the EEG signal through independent component analysis and the resultant signal was processed to compute attention and pleasantness indices (Vecchiato et al. 2011; Vecchiato et al. 2012); moreover, engagement index was computed as the ratio between spectral power in beta and alpha bands (Coelli et al. 2018).

Heart rate variability signal (HRV, time distance between consecutive R-peaks) was extracted from ECG and mean heart rate was computed for each spin. An increase in heart rate is often associated with increased level of physiological arousal (Appelhans & Luecken 2006). Eye tracking signal was processed to detect the percentage of fixations on game features and machine display locations (including reels, wallet, clock, and action buttons) as an indicator of visual attention and their importance to players. Furthermore, the pupil size was adopted as a measure of affective processing (Partala & Surakka 2003). Game sessions were recorded through a screen capture software. An optical character recognition (OCR) algorithm (Matlab, The Mathworks Inc., U.S.A.) was applied on the recorded videos to track subjects' wallet, bets, wins and losses and automatically detect game events of interest. Overall, 16462 single spins were gathered from the 60 subjects.

The effects of game events (independent variables) on the physiological response of the subjects (dependent variable) were tested simultaneously by multiple linear regression models, where events were dummy coded. To account for the game complexity, regression models considered, as independent variables, (i) the individual wallet, as the amount of money available at the moment of the bet; (ii) the theoretical loss, as the product of total bet size and house advantage to allow

comparison across different games (Auer & Griffiths 2014); (iii) the subject group; and (iv) a categorical variable accounting for the individual gambling style of the single player.

Results showed that bonus games elicit significant activation at the arousal level, significantly greater than any other event and independently of subject typology or wallet, thus supporting the hypothesis of their important role in encouraging gambling activity. Secondly, LDWs were shown to elicit comparable responses to wins and bonuses. From group comparisons emerged that low-frequency gamblers display overall greater attentional responses and approach-drive, possibly due to a novelty of the game. Furthermore, in case of LDWs, high-frequency gamblers show lower levels of attention, that may indicate familiarity with such an outcome. Eye tracking analysis showed the slot-reels dominated the visual attention of the player and that wallet and clock areas were the least sought.

Potential applications might leverage on such physiological responses to prevent possible unhealthy gambling behaviours. In particular, we encourage the exploration of in-game pop-up message usage, with different designs, to nudge online responsible gambling behaviours.

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