Advancing User Research in Naturalistic Gambling Environments Through Behaviour Tracking. A Pilot Study

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Abstract. User research has widely employed ethnography to gain insights into the player-gaming terminal interaction in naturalistic gambling settings. However, inconsistencies in operationalisation and a lack of rigour in research procedures have been identified as limitations. In this paper, we address these issues by first advocating for the use of behavioural recording technology to support user research. We present a set of quantitative metrics extracted from non-invasive techniques, including video and audio recordings, that capture facial expressions, paralinguistic cues, proxemics, kinesics, and interactive haptic behaviours. Next, we examine the expert evaluation process as a structured analysis framework, including the mapping of environmental variables, the transparent and reproducible operationalization of a research protocol, and the interpretation of data. A pilot study is presented to provide practical guidelines for conducting user research in natural gambling environments. Our findings contribute to user research methodologies and highlight the potential advantages of the proposed approach, including its applicability, ethical considerations, and reliability.

Keywords: Electronic gaming machine · User experience · Ethnography · Biometrics · Methodology

1 Introduction

User research has found numerous applications in naturalistic gambling settings by means of ethnography to study the interaction between the player and the gaming terminal [1–4]. Being characterized by its indirect engagement with study participants and non-manipulative analysis context, ethnographic research is widely recognized as a valuable technique for investigating user behaviour in gambling settings. Its non-intrusive nature makes it a suitable approach for studying complex and sensitive human behaviours, particularly in gambling contexts [5, 6]. The adoption of observational research in the study of electronic gaming machines (EGMs) has been demonstrated in several noteworthy cases [4, 7–9]. However, despite relying on similar methodological premises, these studies tend to vary in their operationalisation practices. For instance, Griffiths (1991) examined the behavioural characteristics and the social nature of arcade patrons

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through participant and non-participant observation gathering tape-recorded data and retrospective notes [8]. With a similar research objective, Fisher (1993) carried out an observational study with the researcher positioned as a cashier in the change box of an arcade [9]. Although divergent operationalisations do not represent an issue per se, the absence of shared practices may hamper cross-study comparability in user research. A lack of a common method may also hinder replicability and lead to fragmentation within the same field of research. Such a lack of consensus on methodological best practices has been repeatedly evidenced in previous studies. For instance, Parke and Griffiths (2008) and Griffiths (2011) argue that numerous studies track discrete bits of data ("units") while watching or chatting with the gamblers, either during or after the investigated action [10, 11]. Analogous arguments are advanced by Landon et al. (2017) who also posit that the pace of EGM spins poses an additional element of concern [6]. Indeed, fast-paced spins are accounted as a substantial barrier to the manual recording of every event and player response.

The present paper intends to address such methodological issues to advance user research in gambling settings. We focus on EGM naturalistic settings and develop a discussion based on two elements. First, we advance an argument in favour of behavioural recording technology to support user research in gambling environments. Behavioural recording implies low measurement invasiveness and provides quantitative metrics with higher granularity in terms of event timing. We discuss a set of techniques based on video recordings that gather behavioural data including facial expressions, paralinguistic cues, proxemics, kinesics, and interactive haptic behaviours. The second element involves the process of expert evaluation as the methodological procedure to frame a structured analysis. We examine the researcher as the figure that can anticipate problematics, expectations, and potential impacts on the user experience when it comes to interactions between the player and the gaming terminal. Next, we report a pilot study to illustrate a practical application of the approach described. Our discussion aims to contribute to the methodological debate concerning the process of data collection and analysis, thus answering current calls for advancing user experience research [10, 11]. From a theoretical perspective, we ground our argumentation on the ethnographic research cycle [12], circumscribing our attention to data collection and data analysis phases. Accordingly, we discuss an approach that may complement other qualitative observational techniques to support future user research in the gambling context.

2 Behaviour Analysis Applied to EGM

Applied behaviour observation shares notable features with the practice of ethnography [13]. This research approach has found many previous adoptions in gambling investigations in naturalistic settings [8, 9, 11]. Such a practice of behaviour observation follows a codified process, which encompasses a sequence of recursive steps starting with the formulation of research questions, followed by a data collection stage, data analysis, conclusion drawing and reporting, which are iteratively performed [12]. The specific phase of data collection involves the act of participant observation and the creation of an ethnographic record. Whereas the phase of data analysis relies on one or more techniques to delve into behavioural variables. These embrace an ample spectrum of variables linked to human behaviour [14]. Regarding EGM settings, we claim that a specific subset of responses can find a suitable application. The proposition of a subgroup of variables is motivated by the fast pace of EGM, which demands consonant high response speed. We identify accordingly four individual responses belonging to the spectrum of behaviours, which, at the same time, have found previous application in EGM research [6, 15]. These include facial expressions, paralinguistic cues, proxemics and kinesics, and interactive haptic behaviours performed during an interaction with the gaming terminal. These behavioural responses and their related metrics are discussed in the following.

2.1 Behavioural Metrics Related to Facial Expressions

Facial expressions as a means to convey information have been widely investigated in previous literature [14]. Different typologies of coding have been proposed and can be clustered into two main typologies, namely expert manual coding and data-driven analyses. Expert manual coding is traditionally performed by an expert during the post-processing of video recordings resorting to different reference standards, which have evolved over time. Today the recognised standards are based on the analysis of conjoint movements of individual facial muscles ("action units") and include the Facial Affect Scoring Technique [16], the Facial Action Coding System [17] or the Special Affect Coding System [18]. On the other hand, data-driven analyses rely on data collected either through surface electromyography, namely the recording and quantification of the electrical signal generated by facial muscular fibres [19], or real-time software analyses which are designed to automatically recognise facial landmarks and associate their movements to a discrete set of facial expression [20]. These, in turn, are linked to either discreet categories of emotions deemed universal to all individuals [21] or in terms of a bidimensional framework encompassing activation and pleasantness levels [22]. Comprehensively, the information provided from facial expressions allows inferring specific affective states of the individual and thus an assessment in terms of arousal and valence.

The assessment of affective states through facial expressions has found previous applications in ethnographic studies involving naturalistic videotaping. In a study aiming at investigating the congruency between subjective feelings and external assessment through behavioural responses, Scherer and Ceschi (2000) carried out an empirical study involving passengers waiting in vain for their luggage on conveyor belts in airports [23]. The authors performed video and audio recordings through a hidden camera placed on luggage carts to track images of the participants' faces and upper torso. Such videos were subsequently analysed to code facial expression cues according to the Facial Action Coding System and linked to enjoyment.

Previous studies employing facial expression analysis in the naturalistic gambling field are rare. However, distinctive work has been performed in controlled laboratory settings. For instance, electromyography was employed to study the facial reaction of gamblers on a simulated EGM [24]. The authors investigated the activity of facial muscles (i.e., Corrugator Supercilli and Zygomaticus Major) traditionally associated with the dimension of emotional valence to evaluate responses of gamblers to game events including wins, losses, and near-misses. Electromyography was further employed in a laboratory gambling task by Gentsch et al. (2015) who tracked facial muscular activity changes in conjunction with different simulated gambling outcomes [25]. As shown by both studies, the analysis of facial expression appears suited to assess individual responses to single-game events. This is due to the significant temporal reactivity related to the facial muscular activity (e.g., electromyographic changes can be observed in relation to a stimulus lasting 0.5 s [26]).

While the existing body of literature using facial expressions to study EGM gambling behaviours is seemingly limited to laboratory environments, previous evidence from other fields shows that this class of analysis is applicable also in dynamic contexts. Also because the gaming terminal is static, the body positions of the players are mostly bounded to a seated or a standing position facing the EGM screen. Accordingly, we hypothesise the possibility of video recording the player's facial activity to observe her facial expressions resulting from the appraisal of a given game event. The recorded facial activity may hence be analysed either through expert or automatic coding to infer discreet categories of emotions (e.g., anger, contempt, disgust, fear, happiness, sadness, and surprise) or information concerning the affective arousal and valence of the gambler. We conjecture that the recording activity may be performed unobtrusively throughout the whole game experience, where environmental conditions of lighting and participants' head orientation prove to be adequate to coding standards.

2.2 Behavioural Metrics Related to Paralinguistic Cues

Paralinguistic cues represent a second parameter for behaviour analyses. This category of analysis encompasses vocal cues such as pitch, fundamental frequency, voice intensity, and speech rate which are traditionally observed in conjunction with an external stimulus [27]. This behaviour analysis is grounded on the assumption that vocal behaviour acts as a marker of individual affective processes which, in turn, can be objectively assessed through expert coding [14]. To date, many coding schemes for paralinguistic phenomena have been proposed [28]. These articulate the paralinguistic cues according to different levels (i.e., physiological, phonatory-articulatory, and acoustic levels) and are either related to affective states such as frustration, annoyance, tiredness, or amusement classifiable either through discrete categories or a continuous level in terms of valence, arousal and potency [29, 30]. Paralinguistic cues share notable similarities with facial expressions. Indeed, the two sets of individual responses are characterised by a constrained physical structure that conveys information about the affective states of the observed individual. However, different from the study of facial expressions, the analysis of vocal expressions tends to be more effective over large distances and in dim lighting conditions.

In observational research, paralinguistic cues have been adopted to study either interactive episodes between two or more individuals or vocal expressions of singles. In interactive settings, these metrics have been widely used to examine marital functioning, where different investigations focused on the fundamental frequency during couple conflicts as a measure of emotional arousal. For instance, Weusthoff et al. (2013) employed continuous speech recordings of couples during problem discussions to analyse the nonverbal transmission of distress [31]. The same metric was employed to delve into affective responses of individuals interacting with a digital interface [32]. Based on the automatic inference of expressions in speech, the author extracted different features from utterances and brief vocalisations of single individuals in conjunction with triggered interactive events.

The tendency to attribute human-like characteristics to an EGM and hence talk is a recurring trait observed in gamblers [33]. Such a tendency has been evidenced already in early observational studies carried out in arcades [8], where vocalisations towards the gaming terminal were pointed out as either irrational or rational verbalisations. The former encompasses swearing or solicitations at the machine, whereas the latter includes utterances referring to game events such as wins or losses. In the gambling context, such gamblers' utterances were gathered through portable microphones, thus granting portability and minimising intrusiveness [34].

Taken together, previous studies underscore the possibility of investigating paralinguistic cues in gambling venues. Quantitative investigations may not just delve into complete verbalisation but also examine utterances and brief vocalisations elicited during the interaction between the player and the gaming terminal. Paralinguistic cues such as the fundamental frequency of an audio signal or the vocal intensity provide quantitative metrics to infer states of psychological arousal in conjunction with specific game events (e.g., wins, losses, bonus game activations, etc.). This argumentation is specifically supported by the high temporal accuracy of paralinguistic expressions, that is the existence of a limited time lag between the recognition of a stimulus and the individual reaction [35]. At the same time, the adoption of paralinguistic cues should be evaluated in relation to the presence of crowds or external noise which may impair behavioural recordings.

2.3 Behavioural Metrics Related to Proxemics and Kinesics

Proxemics and kinesics represent a further class of nonverbal cues where individual behaviour is exercised to convey information. Proxemics embrace individual perception and structuring of interpersonal and environmental space, whereas kinesics refers to the actions of the human body, head, and limbs [14]. Unlike facial expressions, it should be noted that few body movements are expected to have invariant meaning within or across cultures [36]. Second, like verbal communication, the notion of intention is not uniquely defined. Accordingly, situational and volitional aspects should be considered when dealing with proxemics and kinesics.

Contrary to facial expressions and paralinguistic cues, which display a robust connection to specific affective states, proxemics and kinesics alone do not convey clear-cut affective content. However, their analysis is intended to accent or emphasise information regarding the intensity of the affective state and perceptions of decoders in terms of individual engagement or psychological stress [37]. More specifically, investigations analysing proxemics (i.e., body positions) of healthy participants are traditionally carried out in interactional settings, where two or more individuals interrelate or where a single individual interacts with an environment [38]. Common measures of proxemics include the distance or the frontal body orientation and are traditionally labelled through expert coding [39]. On the other hand, the analysis of kinesics (i.e., body actions) is centred on discrete actions performed by body units. These include the movements of the trunk, arms, and legs in terms of leaning, orientation, or rotation changes. For instance, investigations focused on the trunk code and its movements in terms of leaning forward or backward [27] or concerning its orientation as the degree to which an encoder's frontal body surface faces another encoder [40].

Proxemics and kinesics are well-established factors in observational research. Posture is often recognised as a modality for expressing engagement during interactions with devices, where postural behaviours coding may be performed either automatically or through expert observation to infer states of engagement from leaning forward or backward trunk movements [41]. These observational techniques are also applied in gambling venues. Braun and Giroux (1989) recorded adolescents' use of personal space in arcades, while Landon et al. (2017) report the tendency of patrons to look around or show frustration through abrupt movements such as during spin button hit [6, 42]. The vigour and moving frequency of limbs and the physical energy employed in pushing the spin button represented further observed variables in previous research as expressions of motor excitability during simulated or actual EGM gambling behaviours [8].

This evidence supports the adoption of behaviour analyses involving proxemics and kinesics in natural gambling environments. Applied studies may use such parameters to infer states of engagement from individual postural settings or pinpoint intense arousal from abrupt body moments. These metrics show a significant temporal accuracy since the expression of a physical action typically occurs following an external trigger. Hence, these behavioural metrics could conceivably be applied to spin-by-spin analyses. Furthermore, given the possibility to record body actions from distance, the related invasiveness or disturbance to the gambler is deemed significantly limited.

2.4 Behavioural Metrics Related to Interactive Haptic Behaviours

Interactive haptic behaviours refer to the relational aspects occurring between the individual, the object of investigation, and the environment. Interactive patterns provide information about the exploration processes in terms of sequences of actions and reactions to specific events or temporary halts. Such a variety of aspects is commonly codified through selective structural observation carried out along with the interaction development [43]. The study of interactive patterns between the observed person and a device has been often studied as a vehicle to convey information related to engagement or psychological stress, for instance occurring whenever an individual feels overwhelmed by the presented information [44].

Various interactive patterns are often investigated during the use of EGMs. For instance, relevant factors include the bet size, the cash-out frequency, the spin button hit frequency, the total time of play, the insertion of money, the change of betting lines, the access of player information, and the use of automatic betting [6, 15, 34]. Individual reactions are often evaluated in conjunction with specific outcomes. Besides wins and losses, these include bonus games, as in-game features activated when specific symbols are lined in a winning combination, near-misses, as unsuccessful outcomes proximal to the jackpot or a win, or losses disguised as wins, as outcomes where the cashed-in amount results lower than the bet amount [45].

The tracking of the sequence of interactive actions represents a well-rooted practice in observational research in naturalistic gambling environments. Though, the tracing of spin-by-spin activity might represent a hindrance to the researcher [6]. To solve this issue, we claim that video recording technology may support the researcher to gather observational material. The placement of a rear camera pointing to the screen of the EGM can record the gambling activity at a distance without constituting a means of hindrance or disturbance to the player. The recording of the whole screen activity has two significant advantages for observational research. First, the gambling activity may be coded in retrospect, either manually or automatically. Manual coding may involve significant effort but can be suited to small sample sizes. On the other hand, automatic coding allows the processing of larger sets of observations in the face of adequate model training. An example of automatic coding of EGM gambling events is advanced by Mandolfo et al. (2019), who tracked gamblers' bets and game events through screen capture and an optical character recognition algorithm [46]. Once trained the recognition algorithm on the screen area related to the wallet, the algorithm was able to detect changes in credit during the spin button hit and automatically detect wins and losses.

The second advantage related to the use of ambient cameras is to allow the observer to better mingle in the gambling venue without resorting to continuous manual coding. Indeed, manual coding may represent an element of disturbance not only for the observed gambler but may attract the attention of further patrons, thus influencing the context of analysis. Overall, the adoption of ambient recording instruments for video and audio grants low invasiveness and provides quantitative metrics with higher time accuracy. The four behavioural variables previously discussed are summarised in Table 1.

3 The Role of the Expert Evaluation

Ethnographic research carried out in gambling venues typically aims at understanding the experience of the gambler during the interaction with the gaming terminal by mapping the reactions of the gambler. Such mapping activity requires a description of the solution and identification of the main interaction flows it enables. The expert evaluation deals with this mapping activity performed by researchers, who provide inputs for the creation of observation protocols and data processing guides, which further contribute to the evaluation of the gambling experience. The researcher has the role to anticipate problems, expectations, and potential impacts on the gambling experiences when it comes to the interplay between the gambler and the gaming terminal. To this end, the investigator can prefigure the scenarios of use, expressing a critical evaluation of contextual variables and their influence on gambling behaviour. The expert plays multiple roles in structuring observational research. First, a preliminary activity is represented by the description of a system in terms of tasks and paths of users, flows of activities, and processes. In these terms, expert evaluation grounds its roots in user research and heuristic evaluation [43]. Second, the expert is involved in the definition of a research protocol. The expert should identify an observation protocol targeted at specific research questions. This should create an environment supporting the natural behaviour of the observed gamblers. The study protocol should ensure homogeneous test conditions for all the participants involved and it should be robust with respect to the variety of possible behaviours. Furthermore, it should include the definition of the unit of analysis (e.g., gambler's behaviours to predefined game outcomes), which ought to allow comparability

Table 1. Behavioural variables for observational research in naturalistic gambling environments.

Behavioural variable	Description	Information provided	Metrics
Facial expressions	Momentary facial movements as vehicles for information about affective states	• Discreet categories of emotions (e.g., anger, contempt, disgust, fear, happiness, sadness, and surprise) • Affective arousal and valence	• Expert or automatic coding based on action units' conjoint movements • Electric activity of facial muscles
Paralinguistic cues	Qualities of speech devoid of the actual verbal content	• Discreet categories of emotions (e.g., anger, happiness, sadness, and surprise) • Affective arousal, valence, and potency	• Fundamental frequency • Voice intensity • Vocal pitch • Speech rate
Proxemics and kinesics	Structuring of interpersonal and environmental space and actions of the body	• Accent or emphasise the intensity of engagement or psychological stress	• Physical distance between the participant and the object • Frontal body orientation • Truck leaning • Limbs abrupt movements
Interactive haptic behaviours	Relational aspects occurring between the individual, the object of investigation and the environment	• Psychological processes related to engagement and psychological stress	• Sequences of actions (e.g., spin button hit frequency, change of betting lines or size, cash-out frequency) • Temporary halts

with previous studies addressing a similar research question. The observation protocol should also ensure each participant's autonomy and set the data collection process to allow efficient and effective processing of information. Third, the expert has the role of the interpreter. To understand complex behaviour phenomena, the expert should triangulate data sources or theoretical perspectives to quantify the observed behaviours and provide inferences on common behavioural patterns among the different observations [47]. In particular, pattern matching involves the identification of similarities, sequences, correspondences or causation between events. The process of data interpretation should also ensure an emphasis on the presence of biases within the study design or confounding as alternative explanations of the results.

4 Applied Pilot Study

We report in the following a pilot study to illustrate a practical application of the approach described. In line with our discourse, we focus on the methodological aspects concerning research structuring, observation setting, data processing and result interpretation. We centred our study on the behavioural responses in conjunction with different EGM outcomes and select the individual as a unit of analysis. The described research was supported by one of the leading authorised gambling companies in Italy, as part of a research project delving into the behavioural manifestations of EGM players and investigating phenomena connected to the onset of problematic relationships with gambling activities. The procedures of this study were approved by the ethical committee of the university institution to which the authors refer.

4.1 Methodological Considerations Concerning Research Structuring

We structured our observational procedure intending to limit external biases related to the day and time of the investigation, the influence of the location, and the potential payroll day. Accordingly, the study involved four observation sessions, each lasting four hours. The observations were carried out in four different slot halls located in a major Italian city, with two sites belonging to central districts of the city and two located in a suburban area. Two sessions were carried out on weekdays during night openings, while two rounds of observations were undertaken during the morning opening hours. To control for bias related to the payroll day, the observation sessions took place on different monthly dates. Acknowledged the potential experimental barrier of player-specific factors [48], the pilot study involved non-participant behavioural recordings of single players.

4.2 Methodological Considerations Concerning the Observation Set

The observation set was structured to limit noise in the process of data collection. Potential sources of noise were deemed related to the typology of graphic interface, game features as well as ambient lighting, external sounds, and observation angles. To limit ambiguity related to the gaming terminal, each participant was invited to play on a single five-reel stand-alone slot machine chosen as the analysed stimulus in each slot hall. The selection of the specific EGM was advised by the slot hall owner on the criterion of the most used five-reel slot machine in the previous month. Before the research deployment, a preliminary inspection of each slot hall was performed during closing hours to describe the environment in terms of gamblers' paths as well as to map the possible interaction flows occurring between the gambler and the chosen gaming terminals. The selected EGMs were characterised by five fixed paylines and included free spins as bonus features activated when specific symbols were lined in a winning combination. Each terminal allowed a minimum bet of € 0.25 per spin and a maximum of € 1.00. The maximum payout of the EGM was €100.00. During the game session, the participant was observed at an adequate distance by the research team to avoid interference with the game. Overall, the behavioural recordings involved 19 adult voluntary players with a male prevalence and an estimated age range of 19–60. Each volunteer played with their own money and did not receive any sort of incentive to participate.

As concerns the observation technology, two high frame rate micro-cameras were employed to record the activity of the players. One was attached to the chosen EGM at head high in front of the player. Such a device included a mechanism for adjusting the recording angle and was employed to gather facial recordings as well as the vocal expressions of the participant. The EGM screen backlight provided suitable lighting conditions to detect the subject's facial landmarks. The second camera was attached to the wall behind the player to record the whole body of the participant and the game events displayed on the gaming terminal. The positioning of the instruments was done in such a way as to ensure that the second camera had a complete view of the EGM screen, as shown in Fig. 1.

Fig. 1. Illustrative observation setting employed. Ambient cameras are circled in red. (Color figure online)

4.3 Selected Measures and Data Processing

We analysed recursive behavioural variables of the player during the interaction with the EGM and the surrounding environment. These included the analysis of facial expressions, paralinguistic cues, proxemics and kinesics, and interactive haptic behaviours, as previously outlined. Facial expressions were extracted from frontal camera recordings and analysed through Noldus FaceReader 7. The analysis was carried out during the game session and data were extracted when the conditions in terms of lighting and participants' head orientation satisfied the General Face Model minimum requirements for detection. To control for individual differences in baseline facial expression, facial expressions were analysed after a face model calibration for each participant considering a resting state face frame recorded at the beginning of the game session. Facial states were analysed employing General Face Model with smoothening classifications through Noldus FaceReader analysis software, which implements the Facial Action Coding System to extract seven basic facial expressions [21]. The software analyses and assigns to each frame of the recording an estimation of the intensity of facial expression of the extracted emotions a score ranging from 0 (minimum) to 1 (maximum). Each facial expression was tallied as relevant if it was detected in a latency window of 3 s from the considered stimulus onset and the signal assumed a value above 0.1. The length of the latency window was set equal to the average lapse of time between consecutive spin button hits.

The analysis of paralinguistic cues involved the extraction of the fundamental frequency (f0) of each utterance in conjunction with all the recorded game events as a measure of arousal. f0 range was obtained from the audio signal extracted from the frontal camera after a bandpass filtering (high pass = 75 Hz; low pass = 300 Hz) to cut off potential external noise [49]. f0 range was calculated for each gambler as the difference between the individual minimum and maximum f0 values, generated by analysing audio recordings. Behavioural responses were classified based on the emergence of recurring vocal patterns in conjunction with specific game events.

Body proxemics was evaluated with respect to a single axis between the player and the gaming device and compared to the anatomical standard position, observed before the onset of the gaming session. Such information was manually coded and extracted from the second camera. Posture shifts were tallied and coded according to whole-body posture units and body action units in line with the Body Action and Posture Coding System [39]. Accordingly, players were reported with a leant back, forward, or neutral posture if at the occurrence of specific game events displayed a recurring tendency of the whole body to move or lean forward relative to the anatomical standard position.

Lastly, interactive haptic behaviours focused on the analysis of hit frequencies. These were tracked from the video recordings and measured as the time interval in seconds between two consecutive spin button clicks. It was observed that the pressing vigour depended significantly on the pressing style, where players tended to alternate spin button hits either with the fingers or with the palm of the hand. The recurring behavioural variables were scrutinized in conjunction with five events, namely (i) a simple loss, (ii) a win, (iii) a repetitive loss, as the series of at least ten consecutive losses during back-to-back spins; (iv) a near-miss, as and (v) a bonus game activation. Such game events were manually coded from the video recordings gathered from the rear camera and synchronised with information recorded from the frontal camera.

4.4 Data Analysis and Result Interpretation

The collected observations were analysed to highlight recurring behavioural patterns. Recurring patterns were intended as behaviours that show affinity in terms of similarities, frequencies, and sequences. The affinity was assessed across the four behavioural variables during post-processing data analysis through pattern matching carried out by two researchers. Given the limited sample size, the analysis followed a qualitative stance. The triangulation process required the comparison of (i) the main facial expression coded, (ii) the individual f0 extracted, (iii) the category of assumed posture, and (iv) the specific hit frequency. All the metrics were compared in conjunction with each game outcome, independently from the length of the gaming session. Two examples of patterns for the same game session of 39 spins are reported in the following. Figure 2 shows the pattern of hit frequency combined with posture coding, while Fig. 3 displays the pattern of hit frequency combined with the dominant facial expression coded.

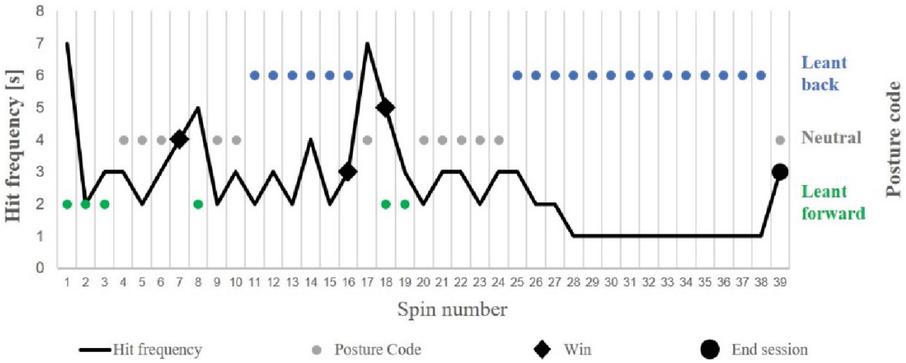

Fig. 2. Illustrative pattern of hit frequency combined with posture coding.

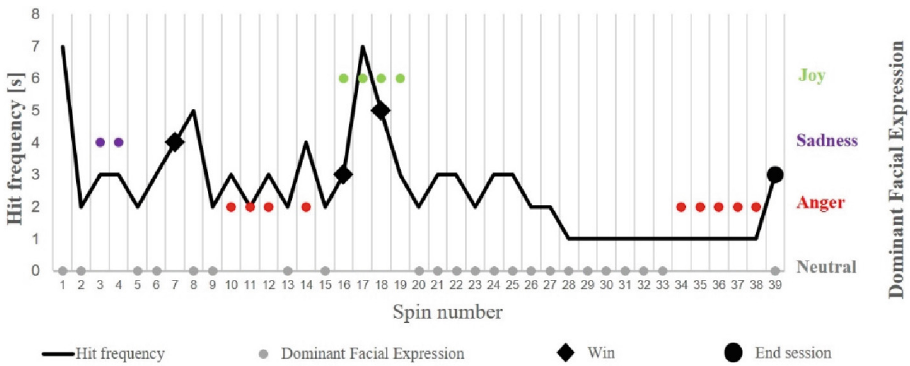

Fig. 3. Illustrative pattern of hit frequency combined with dominant facial expression.

Overall, results showed that two of the five analysed game events triggered recursive responses, namely behaviours showing similarities with a significant frequency in conjunction with the same game event. Specifically, repetitive losses and bonus game activations elicited distinct recurring patterns. In response to repetitive losses, notable behavioural patterns included at least one of the following behaviours: a change in the player proxemics characterised by a tendency to lean the body forward towards the slot machine, an intensification of the button hit frequency, or an increase in negative valence facial expressions (i.e., contempt, anger, and disgust). Concurrently with bonus game activations, we observed a propensity to lean the upper body forward towards the slot machine and a variation of the verbal behaviour towards a higher frequency.

Overall, none of the four behavioural variables resulted significantly dominant, underscoring the complexity of the studied behaviour. However, the continuous spin-to-spin behavioural tracking across four dimensions allowed the detection of multivariate patterns. Accordingly, though observed in a limited sample, the results support the argument that multimodal analyses are likely to enrich observational studies.

5 Discussion and Conclusions

The interest in the manners in which people gamble is sparked by several parties. First, the growing emergence of gambling as a societal issue in the public domain has fuelled arguments on its societal consequences [50]. Second, behavioural research focusing on the causes of addictive activities such as EGM gambling and the structural features of the EGM game experience, that act as a reinforcement of the gambling activity, has attracted the attention of social researchers [51]. Furthermore, the recognition of gambling as a rather mainstream recreational activity shed interest in the role of social factors [52]. In the present paper, we discussed how current ethnographic research in gambling venues might be enriched by using a set of behavioural measures and relying on expert evaluation. The discussed metrics are gathered from non-invasive measurement techniques based on video and audio recording and a subsequent structured coding process, which can be automatised recurring to algorithms for facial landmarks recognition, vocal spectrum analysis or optical recognition of game events. The low invasiveness of the measures results central in order not to denature the context of analysis. We claim that the adoption of such recording technology may help to complement current ethnographic research by observing player-specific responses to spin-to-spin analyses otherwise barely unachievable by the traditional observer.

The illustrative case study contributes to user research in gambling venues. We demonstrated the feasibility of performing unobtrusive behavioural recording that analyses multiple behavioural manifestations (i.e., facial expressions, paralinguistic cues, proxemics and kinesics, and interactive haptic behaviours). The introduction of behaviour tracking through video cameras would enable scaling up observations beyond the traditional sample sizes [4, 9], due to the possible data gathering on multiple gaming terminals concurrently. Relying on multiple data sources gathered automatically, would also support the ethnographer in systematically identifying aspects of the situation under study that have been excluded from first-hand observation. Thus, limiting possible sources of acknowledged biases in the ethnographic practice [53]. Social scientists can potentially use real-time behaviour tracking to investigate gamblers' behaviours. For instance, future user research might be carried out in naturalistic gambling venues to draft planimetric maps of these premises and show how the disposition of gaming terminals might affect gamblers' behaviours. Also, researchers can potentially use behaviour tracking to explore how interactive patterns emerge not only between the user and the EGM but also among different patrons. Future research might investigate how social dynamics reinforce or deter specific gambling behaviours.

However, we underscore that the technology placement should respect rigorous protocols. Video recordings require adequate lighting conditions to allow satisfactory data quality to be input into models for facial expression analysis. This should be ensured both in terms of frontal and lateral lighting in order not to create artificial shadows on the gambler's face or body. At the same time, an adequate distance between the recording device and the body of the subject is suggested to ensure reliable accuracy in facial landmark detection. Video recording should also respect definite recording angles in order not to cause erroneous visual perspectives. Similarly, audio recordings should ensure satisfactory quality in terms of loudness, sharpness, fluctuation strength and cut-out disturbing echoes.

To carry out preliminary activities according to a structured procedure, we further have underscored the role of expert evaluation. A structured research process encompasses multiple steps in observational research including the preliminary inspection and the mapping of both the environment and the gaming terminal. In these terms, preliminary research activities involve the understanding of potential biases affecting the observation protocol or the presence of confounding. Furthermore, the expert has the role to conceive and operationalise a study protocol to guide and govern the conduction of the observations. A study protocol directs the execution of a study to help ensure the validity of the final study results. Moreover, it should allow transparency in the methodological steps adopted to grant the observations' future reproducibility and replicability, thus potentially increasing and validity of the observed outcomes.

Lastly, our discussion proposed a descriptive pilot study. This was aimed at presenting a set of methodological aspects concerning research structuring, observation setting, data processing and results interpretation. We emphasise how the structuring of the observation setting in terms of preliminary analysis, instrumentation employed, and choice of behavioural metrics. Second, we have shown that multimodal analyses are likely to enrich observational studies. Specifically, user research in naturalistic gambling environments may benefit from higher objectivity associated with the observed phenomena through a rigorous process of continuous data collection. At the same time, we underscore how the researcher should embody the role of the interpreter, namely triangulating punctual data to translate them into knowledge to support practical applications. We stress that observational research has the potential to uncover contextualised data, often inaccessible through different approaches. In so doing, the outcome of observational studies should be employed to empower the same user, who is the object of the study, whenever behavioural phenomena appear to be connected to the onset of problematic relationships with gambling activities.

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