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Do breaks in online gambling affect neuropsychological arousal? Conceptual approach and lessons learned from the TESSA-pilot trial

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ABSTRACT

Introduction: Mandatory breaks have been discussed as a harm reduction strategy in the context of gambling for several years, but their effectiveness remains unclear. The TESSA pilot study examines the association of physiological arousal (PA) and mandatory breaks during gambling with an aim to conceptualize the framework for a subsequent randomized controlled trial.
Material and methods: In a one-armed experimental pilot study 28 participants engaged in a simulated online slot game with mandatory breaks. PA, disentangled into fear, anger, joy, attraction, balance, and retraction, was continuously monitored via skin conductivity and skin temperature. The occurrence of PA in distinct phases (phase 1: initiation, phase 2: pre-break, phase 3: post-break) was contrasted by multilevel logistic regression.
Results: Fear and attraction did not change. Compared to phase 1, anger (OR = 0.698; p = 0.015) and joy (OR = 0.714; p = 0.032) were less likely in phase 2, with joy also being less likely in phase 3 (OR = 0.690; p = 0.023). Balance was more likely in phase 2 (OR = 5.073; p < 0.0001) than in phase 1 and less likely in phase 3 (OR = 0.348; p < 0.0001) whilst retraction declined from phase to phase.
Discussion: Mandatory breaks appear suited to offset changes in PA response evolving during gambling, but a sustained effect on initial PA levels should not to be expected. However, to sensitively judge the role of breaks additional framework conditions that impact on gambling behavior (e. g. wins/losses) should be considered.

1. Introduction

In research on gambling, psychophysiological concepts of stress including physiological arousal (PA) are sparsely applied (Rocco et al., 2020). However, PA is hypothesized to play a central role in the onset and maintenance of problem gambling (Baudinet & Blaszczynski, 2013; Blaszczynski & Nower, 2002; Sharpe, 2002). Namely, the act of gambling can elicit physiological arousal through the presence of specific stimuli (i.e., immediate rewards, visual and auditory cues), and this arousal then moderates one's impulsivity (Herman et al., 2018). Previous experimental studies demonstrated that these stimuli are associated with participants placing more bets and wager more money (Brown et al., 2004; Rockloff & Dyer, 2007; Sharpe, 2002).

Among the different forms of gambling, electronic gaming machines (EGMs) and online arcades especially incorporate such stimuli. As high-frequency games, they provide rapid feedback on rewards and losses to gamblers (LaPlante et al., 2011; Parke et al., 2022). The lack of natural interruptions stimulates dissociative states (Stewart & Zack, 2008),

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carries an extremely high addictive potential (Belisle & Dixon, 2016; Brosowski et al., 2021; Thompson & Corr, 2013), and favors the risk of excessive time and monetary loss (Afifi et al., 2014; LaPlante et al., 2011). Because of the structural characteristics associated with online gambling – like easy access and immediacy – there is a high potential for addiction (Allami et al., 2021; Chóliz, 2016; Hayer et al., 2005).

Considering the empirically established risk posed by online slot machines (Chóliz et al., 2021; Dragicevic et al., 2011; Gainsbury, 2015) effective gambler protection measures are warranted in this area. One structural intervention to curbing this process is the implementation of mandatory breaks within the game, an intervention that has already been adopted in several countries including New Zealand, Germany, and Canada (Ginley et al., 2017; Griffiths, 2012; Palmer du Preez et al., 2016). This measure acts on the presumption that an interruption of the gambling process has a "beneficial" re-focusing effect on the gamblers and prevents maladaptive gambling behavior. Likewise, there is a moderate short-term impact when pop-up messages are presented thus interrupting the gambling behavior (Bjørseth et al., 2020). While recent evidence indicates that mandatory breaks are not an effective tool to reduce monetary stakes or the length of gambling time (Auer & Griffiths, 2023; Hopfgartner et al., 2022; Hopfgartner et al., 2023), money and gambling time might not be the crucial drivers of gambling-related problems. Rather, excitement caused by the activity of gambling was argued to be a more relevant trigger for problematic gambling behavior than monetary gains (Brown, 1986).

Emotion theory offers an important framework through which we can better understand the role of PA on gambling behavior. Namely, specific emotions, such as happiness or anger (Kreibig, 2010), have been associated with distinct physiological responses as observed through changes in heart rate, blood pressure, heart rate variability, respiration rate, and/or skin conductivity (SC) (Mauss & Robinson, 2009). When broadening the theoretical scope of gambling experiences to include concepts and findings from emotions theory, it is important to differentiate between various types of emotional arousal, such as anger, fear, joy, and attraction (Panksepp, 2004), which exhibit distinct physiological signature patterns (Levenson, 1992).

Against this background, this paper presents the results of a pilot study that aimed to:

1) examine if PA responses are an appropriate measurement tool for operationalizing the effect of breaks,
2) investigate which emotions are related to mandatory breaks in gambling, and
3) delineate the conceptual requirements for a follow-up randomized controlled trial (RCT).

2. Material and methods

2.1. Participant recruitment

A convenience sample of adult volunteers without previous or current gambling problems was recruited. Most participants were recruited through a listserv of the Ludwig-Maximilians-University Munich Department of Psychology that included (previous) university students who were interested in participating in psychological studies. In agreement with the terms of use, study information, including a link to the study webpage, was sent to all listserv members. Additionally, snowball sampling was used.

On the study webpage, interested parties had to confirm the absence of current/previous disordered gambling behavior and that their age was ≥ 18 years (inclusion criteria). As an external control for disordered gambling behavior, the validated "Stinchfield questionnaire" had to be completed (Stinchfield, 2003). In the case of scores of ≥ 4 (cut-off for gambling disorder according to DSM-5) (American Psychiatric Association - DSM-5 Task Force, 2013) study participation was denied. In these cases – which did not occur – applicants would have been provided with information material on help offers for gambling problems. To those (potential) study participants who met the inclusion criteria, a six-digit code (pseudonym) was assigned. Participants could then use this pseudonym to schedule an appointment to participate in the experiment through the study webpage, through which they were informed in detail about the voluntariness of participation, the confidentiality of their data, and provided written informed consent to participate.

2.2. Setting

The single-arm pre-post experimental pilot study investigated the impact of mandatory breaks on physiological arousal via a simulated online slot game (see Fig. 1). The set-up comprised one single gambling session on a computer in a laboratory. PA was recorded throughout the gambling session (including mandatory breaks) via continuous body monitoring. The study, called TESSA (Timeout – Effects on Spending, Stimuli, and Arousal), received ethical approval from the ethics committee of the German Association of Psychology (DGPs; Kraus-Ludwig2021-07-22VA).

2.3. Experiment

2.3.1. Simulated online slot game

The experiment consisted of a simulated 3-row 5-column online slot game featuring 11 symbols that enabled multiple paylines per spin (see Fig. 2). The virtual slot game also provided readily available information on point values of the symbols and selectable paylines (1 to 10). A conversion of points into Euros was always displayed. Depending on individual levels of risk-taking and paylines chosen, participants could adjust their stakes (minimum: 10 points; maximum: 100 points). To best replicate an authentic gambling experience, the visual design closely resembled real online slot games including sound effects and animations presented if the participant won.

2.3.2. Experimental procedure

Participants were led into the laboratory, asked to read the study instructions, and signed an informed consent. Throughout, the experimenter was available to answer any questions. Participants were then equipped with the Bodymonitor Smartband device (described below), which measured several physiological parameters. After, participants began playing the virtual online slot machine, which was loaded with a score of 10,000 points - equivalent to a credit balance of € 10.

The experimental session was designed as follows: After 20 minutes of gambling, a message appeared on the screen that participants had to take a mandatory break, regardless of the ongoing spins. The message informed participants that the mandatory break had a minimum length of 5 minutes and that longer pauses were possible if desired. Furthermore, suggestions on how to spend the mandatory break (staying at the computer, getting a drink, taking a breath of fresh air, going outside) were provided. After the minimum mandatory break length of 5 minutes, participants could continue to gamble. The minimum duration of this "post-break" gambling was 5 minutes. After that, the key part of the experiment ended, but participants had the option to proceed. For participants who proceeded with the game, after 20 minutes of "post-break" gambling, the next 5-minute mandatory break was set. Participants could then engage in a final third 20-minute gambling session, after which the game was concluded. Thus, the entire experimental session lasted a minimum of 20 minutes and a maximum of 70 minutes. During the entire experimental session, the participant was left alone by the experimenter and was not allowed to take off the Bodymonitor Smartband device. At the end of the experimental session, the experimenter collected the Bodymonitor Smartband device and participants received payouts based on their final scores but not less than € 5.

2.3.3. Continuous measuring of physiological arousal

PA was measured via a sensor wristband developed by the company

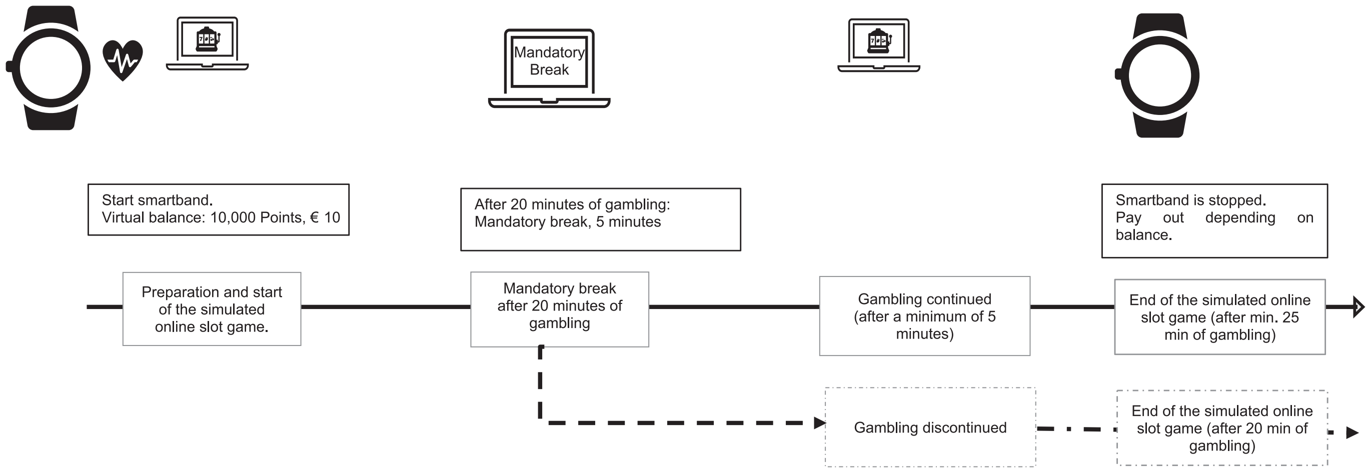

Fig. 1. Schematic Illustration of the experimental procedures with processes and related time frames.

Fig. 2. Screenshot of the simulated online slot game, displaying the distinct features of the game.

"Bodymonitor" – a spin-off of Gesis Leibniz Institute for Social Sciences. This "Bodymonitor Smartband" is widely used and a valid measure to capture electrodermal arousal (Bergner et al., 2011; Engelniederhammer et al., 2019; Li et al., 2016; Xiang et al., 2021). It continuously captures SC and skin temperature (ST) at the wrist. SC reflects eccrine sweat gland activity which is directly innervated by the sympathetic nervous system. ST reflects changes in the diameter of peripheral arterial blood vessels, caused by adrenalin exposure. The device also contains one sensor for ambient temperature and one sensor measuring force exerted on the electrodes by the wristband strap. Changes of force on the electrodes – which can be caused by even light twists of the wrist – indicate changes in the contact quality of skin electrodes which lead to artefactual changes of SC. Thus, automatic detection of and control for artificial changes of SC and ST is feasible post-hoc.

Based on SC and ST, a proprietary Bodymonitor algorithm classifies the combined changes in SC and ST arousal to four types of emotional arousal and two types of arousal homeostasis, which correspond to Panksepp's theory of emotions (Panksepp, 2004). The four types of emotional arousal – fear, anger (both negatively connotated), attraction, and joy (both positively connotated) – must not be interpreted psychologically as feelings (secondary emotions) but as neuro-affective arousal processes triggered by external/internal stimuli. Accordingly, fear refers to a process of anticipating a harmful state/event, accompanied by a tendency towards actions that lead to avoidance ("escape"). Anger refers to a process of perceiving a harmful state/event, accompanied by a tendency towards actions aimed at overcoming that state/event ("attack"). Attraction refers to a process of anticipating a rewarding state/event, accompanied by a tendency towards actions that could support its occurrence ("induce"). Joy refers to a process triggered by the experience of unexpected rewarding states/events. The two homeostatic states assessed were balance and retraction. Balance refers to a state with low-fluctuating neurophysiological arousal changes, i. e.

absence of significant arousal peaks, which is interpreted as neutral, non-mobilized attention. Retraction refers to a state characterized by a sustained reduction or negative change of neurophysiological arousal, which is supposed to be correlated with fatigue, relaxation, and general disinterest (“mental shut down”).

2.4. Statistical analysis

Our interest was to compare the occurrence of PA states (four types of emotional arousal and two types of arousal homeostasis) at set phases of the simulated online slot game. These phases were: a) the first 120 seconds after beginning of the game (Phase 1), b) 120 seconds before the first mandatory break (Phase 2), and c) the first 120 seconds after the first mandatory break (Phase 3).

First, PA level at the distinct phases was descriptively contrasted based on (non–)overlapping 95 %-confidence intervals (CI). For a comparative analysis of a) Phase 2 vs. Phase 1, b) Phase 3 vs. Phase 2, and c) Phase 3 vs. Phase 1, phase was treated as a binary covariate. Subsequently, 18 (six PA states multiplied by three pairwise comparisons of phases) separate models were run using the occurrence of fear, anger, attraction, joy, balance, and retraction as dummy-coded outcome variables and phase as the covariate. Furthermore, we ran three additional models for general PA response – defined as the occurrence of any of the four types of emotional arousal – as the dependent variable. Considering the nested structure of emotional response (first level: phase, second level: participant) we decided on multilevel logistic regression to adequately address intra-subject correlation and to capture both population-level (fixed) as well as individual-level (random) effects (Snijders & Bosker, 2011). Here we assumed an uncorrelated structure of error terms. As an indicator for within-subject variation, we calculated intra-class correlation coefficients (ICC), which reflect the resemblance of observations within a cluster (in our case: distinct assessments on the participant level) on a 0 to 1 scale. The higher the ICC, the higher the homogeneity on the participant level and by implication the lower the within-subject variability. Additionally, we calculated the pseudo R^2 of McKelvey and Zavoina (McKelvey & Zavoina, 1975) to assess the contribution of fixed (between-subject) effects to explained total variation (fixed + random/within effects) based on a previously proposed Stata coding algorithm (Langer, 2017).

All analyses were performed with Stata Version 15 with an exploratory alpha level of 0.05.

3. Results

3.1. Framework of the experiment

Twenty-eight individuals participated in the experiment. All participants continued gambling after the first mandatory break and six participants gambled longer than 15 minutes after the first break. Two participants gambled until the second mandatory break and continued thereafter. Altogether, the average total time spent gambling was 32.1 minutes (Standard Deviation/SD = 6.7), and the average time spent gambling after the first mandatory break was 9.8 minutes (*SD* = 7.2).

At the end of the experiment, all participants had a lower virtual balance than at the beginning. The average loss was 3,798.7 points (equal to € 3.80), with a range of 198.6 points (equal to € 0.20) to 9,203.3 points (equal to € 9.20). The average pay out for study participants was € 5.60, with a range of € 5.00 to € 9.20.

3.2. Physiological arousal level at each observation phases

Within descriptive analyses, the four emotional arousal types did not differ between Phase 1, Phase 2, or Phase 3 (see Table 1). Balance was significantly higher in Phase 2 and Phase 3, relative to Phase 1. Additionally, retraction was significantly lower in Phase 2 relative to Phase 1, and significantly lower in Phase 3 relative to Phase 2. Total PA remained stable.

3.3. Development of physiological arousal level from phase to phase

The multilevel analyses revealed a significantly reduced likelihood of anger, joy, and retraction in Phase 2 compared with Phase 1 (see Table 2). In contrast, the likelihood of balance was significantly increased. Retraction and balance were significantly less likely in Phase 3 compared with Phase 2, and total PA was sigficantly more likely. In Phase 3 there was a significantly lower likelihood of joy and retraction and a significantly increased likelihood of balance when compared with Phase 1.

According to the ICC, variability in both homeostatic arousal types was more strongly related to between-subject variability than variability in the four emotional arousal types. Here, within-subject variability was more pronounced than in both arousal homeostatic types. Consequently, the contribution of fixed effects to total variance was higher for arousal homeostatic types (see Appendix-Table 1).

4. Discussion

Our paper expands the sparse literature on the associations of gambling behavior with neurophysiological arousal processes by investigating the impact of mandatory breaks on four emotional arousal and two homoeostatic arousal responses within a simulated online slot game. Through employing a real-world setting with minimal requirements as to the length or nature of the mandatory breaks, we could maximize the applicability of these findings. Overall, the results of this study suggest existence of many PA changes while gambling. Mandatory breaks appear suited to interrupt PA responses that have evolved during the process of gambling, but a sustained level shift compared with the initial PA response (difference between post-break and start of the game) should not to be expected.

This conclusion is supported by the observation that most of the emotional arousal responses in the post-break phase (Phase 3) were comparable to the emotional arousal response in the initial phase of the

Table 1
Physical arousal level at the distinct phases of the simulated online slot game.

	Phase 1 (first 120 seconds of gambling)			*Phase 2 (120 seconds before the 1st mandatory break)*			*Phase 3 (first 120 seconds after the 1st mandatory break)*		
	Mean	*95 %-CI*	SE	*Mean*	*95 %-CI*	SE	*Mean*	*95 %-CI*	SE
Total PA	0.115	[0.105; 0.126]	0.005	0.088	[0.079; 0.097]	0.005	0.103	[0.093; 0.114]	0.005
Fear	0.026	[0.021; 0.032]	0.003	0.021	[0.016; 0.026]	0.002	0.028	[0.021; 0.032]	0.003
Anger	0.034	[0.028; 0.040]	0.003	0.024	[0.019; 0.029]	0.003	0.028	[0.023; 0.034]	0.003
Attraction	0.027	[0.021; 0.032]	0.003	0.022	[0.017; 0.027]	0.002	0.028	[0.022; 0.034]	0.003
Joy	0.029	[0.023; 0.034]	0.003	0.021	[0.020; 0.025]	0.002	0.020	[0.015; 0.025]	0.002
Balance	0.189	[0.176; 0.202]	0.007	0.453	[0.436; 0.469]	0.008	0.446	[0.429; 0.463]	0.009
Retraction	0.359	[0.343; 0.375]	0.008	0.221	[0.207; 0.235]	0.007	0.165	[0.152; 0.178]	0.007

CI = Confidence interval; PA = Physiological arousal; SE = Standard error.
Non-Overlapping 95%-confidence intervals indicate significant difference between those phases.

Table 2
Model-based comparison of PA-level at distinct phases of the simulated online slot game.

Fixed effects	Phase 2 vs. Phase 1					Phase 3 vs. Phase 2					Phase 3 vs. Phase 1				
	OR	95%-CI	SE	Z-Value	p*	OR	95-%-CI	SE	Z-Value	p*	OR	95-%-CI	SE	Z-Value	p*
Total PA	0.732	[0.624;0.859]	0.06	−3.83	**<0.0001**	1.291	[1.087; 1.535]	0.114	2.9	**0.004**	0.936	[0.797; 1.099]	0.077	−0.81	0.419
fear	0.798	[0.583;1,092]	0.128	−1.41	0.159	1.329	[0.958; 1.843]	0.222	1.7	0.088	1.079	[0.791; 1.471]	0.171	0.48	0.631
anger	0.698	[0.523;0.931]	0.103	−2.44	**0.015**	1.229	[0.901; 1.676]	0.195	1.3	0.194	0.877	[0.657; 1.170]	0.129	−0.89	0.371
attraction	0.825	[0.607;1.122]	0.129	−1.23	0.22	1.366	[0.993; 1.878]	0.222	1.92	0.055	1.105	[0.817; 1.494]	0.17	0.65	0.515
joy	0.714	[0.525;0.972]	0.112	−2.14	**0.032**	1.005	[0.709; 1.424]	0.179	0.03	0.978	0.69	[0.500; 0.951]	0.113	−2.27	**0.023**
balance	5.073	[4.469;5.759]	0.328	25.1	**<0.0001**	0.839	[0.743; 0.950]	0.052	−2.84	**0.005**	4.813	[4.217; 5.494]	0.325	23.29	**<0.0001**
retraction	0.421	[0.373;0.475]	0.026	−14.02	**<0.0001**	0.550	[0.470; 0.643]	0.044	−7.49	**<0.0001**	0.233	[0.204; 0.268]	0.016	−20.89	**<0.0001**
Random effects (Participant)	**ICC**	**95 %-CI**	**SE**			**ICC**	**95-%-CI**	**SE**			**ICC**	**95-%-CI**	**SE**		
Total PA	0.124	[0.069; 0.212]	0.036			0.196	[0.115; 0.314]	0.051			0.118	[0.066; 0.120]	0.033		
fear	0.191	[0.103; 0.327]	0.057			0.252	[0.141; 0.409]	0.069			0.194	[0.105; 0.332]	0.058		
anger	0.181	[0.095; 0.318]	0.056			0.188	[0.099; 0.329]	0.058			0.175	[0.094; 0.301]	0.052		
attraction	0.094	[0.039; 0.213]	0.042			0.121	[0.053; 0.254]	0.049			0.067	[0.024; 0.173]	0.034		
joy	0.063	[0.021; 0.170]	0.034			0.136	[0.055; 0.298]	0.059			0.073	[0.026; 0.184]	0.036		
balance	0.404	[0.278; 0.543]	0.069			0.552	[0.415; 0.681]	0.07			0.348	[0.232; 0.484]	0.066		
retraction	0.411	[0.283; 0.552]	0.070			0.652	[0.503; 0.776]	0.071			0.453	[0.320; 0.592]	0.071		

* p-values ought to be interpreted in a hypothesis generating exploratory manner. They must not be interpreted confirmatorily.
CI = Confidence interval; OR = Odds ratio; PA = Physiological arousal; SE = Standard error; ICC = Intra-class correlation coefficient.

game (Phase 1). Additionally, there was a pronounced difference between the pre-break (Phase 2) and the post-break phase regarding total PA. These findings can be put in context with a previous study that observed a constantly elevated arousal level in the later phases of playing an online slot game compared with the initial phase (Rocco et al., 2020). As Rocco and colleagues applied an uninterrupted phase of gambling, it appears possible that pauses trigger a "cooling down effect" that interrupts previous arousal trends.

The homoeostatic states retraction and balance differ notably between the distinct phases of the simulated online slot game. Acknowledging that physiological systems strive for homeostasis (Davies, 2016), any disturbance by internal and external stressors is supposed to induce adaptation processes (Ramsay & Woods, 2014). Thus, changed balance and retraction combined with the occurrence of distinct directed responses (joy and anger) may mirror attempts to find a new equilibrium. More precisely, balance was more likely to occur immediately before the break and remains thereafter on a level remarkably higher than the initial level. Likewise, retraction reduced step by step across the game. This suggests habituation during the process of gambling which contributes to perceiving the situation of gambling as less "stressful" than in its initial phase when underlying mechanisms were unknown. Thus, it is conceivable that mandatory breaks enhance attention without impacting previously gained calmness. Indeed, previous research indicated that the replacement of repetitive stimuli by new alternate stimuli enhances persistent gambling (Witts & Erickson, 2015). Therefore, it appears conceivable that an interruption of persistent stimuli has an effect similar to changing stimuli during the game.

The assumption of habituation is to some extent supported by a declined likelihood of joy when comparing both later phases of the simulated online slot game with its initial phase, suggesting that the "charm of the new" gets lost. Furthermore, anger most likely occurred in the initial phase of the game which supposedly mirrors the reduction of mental strain due to insecurity about the functioning of the game. Altogether, the results indicate a decline of emotional involvement over time that is however interrupted when setting mandatory recreational breaks. Noteworthily, we did not observe any changes to fear or attraction between the phases of the simulated online slot game. This might reflect that participants had neutral expectations of the game and may differ from a sample of "archetypal" EGM players. Here, the guarantee of a fixed minimum reward of € 5 combined with a presumed lower affinity towards slot games, relative to the regular gambling population, might have promoted a passive attitude of participants regarding efforts to avoid undesired states or to induce desired states.

The results demonstrate that gambling in a simulated online slot game interferes with PA, with distinct PA responses being affected differently. In this context, focusing on several PA responses and not on a general PA response turned out to be sensible, as responses were not unidirectional. Using PA response operationalized as a disaggregated outcome appears advisable for an RCT investigating the effects of pauses.

However, issues raised during the conduct and evaluation of the pilot study ought to be kept in mind, when framing this RCT. First, PA reflects primary emotional responses that are supposed to, but do not necessarily, trigger similarly directed secondary emotional responses (more complex emotions) or even behaviors and judgements (Clark, 1982). According to several researchers, tertiary and secondary emotions are branches and leaves of tree-structured emotions rooting in primary emotions (Parrott, 2001; Shaver et al., 1987) Thus, one distinct PA response might result in different person-individual subsequent reactions. Therefore, it appears warranted to interpret PA data together with participant-reported information on stress, (dis-)satisfaction, and craving within the upcoming RCT. This will enable a more comprehensive interpretation of PA response in context of pauses.

Second, a meaningful appraisal of directional PA changes as "good" or "bad" is impossible if no linkage to gambling behavior (e. g., stakes set) and wins/losses accrued is performed. Evidence suggests that gambling outcomes interfere with distinct PA reactions (Hultman et al., 2023; Lole et al., 2012; Wilkes et al., 2010), but our conceptual approach is not suited to disentangle the effects of mandatory breaks and wins or losses close to the break. Hence, future studies should put PA changes in relation to these framework conditions.

Third, typical for a pilot study which rather aims at feasibility aspects rather than at effectiveness, only a small number of study participants were recruited. As a result, observed differences in likelihood were often not significant despite strong effect sizes. Furthermore, p-values must not be over-interpreted against presence of multiplicity issues (exploratory character). Therefore, a pre-specification of the most decisive PA responses to be analyzed in the upcoming RCT was not feasible and can consequently not serve as a guiding principle for sample size calculation. Considering that the occurrence of the distinct PA responses differs, a power calculation for the RCT might be better when based on the smallest effect size expected for a distinct response (Leon, 2004; Vickerstaff et al., 2019) than at general PA response.

Fourth, the supposed habituation effects might to some extent be explained by the fact that the simulated online slot game consisted of only one type of slot game whilst real-world online slot machines usually offer different types. In reality, gamblers can choose between different slot games which presumably enhances attention and renews interest in the process of gambling itself (Witts & Erickson, 2015). The lack of other options might even have been aggravated by the recruitment strategy that – owing to ethical reasons – did focus on healthy people with presumably low gambling affinity. It seems fair to assume that the preference for distinct gambling forms correlates with more pronounced PA responses within the context of these gambling forms. However, a review indicated mixed evidence in this regard (Baudinet & Blaszczynski, 2013). Hence, to anticipate effects in a "gambler" population, the affinity to online slot games might be defined as a further inclusion criterion of the upcoming RCT and the experiment ought to incorporate different types of slot games.

Lastly, the design of the mandatory break (gaming online, going outside, reading information material on gambling) might influence its effect on post-break arousal. Recent research indicated that incorporation of digital cognitive and dialogue tasks into online gambling sessions is more suited to distract the gamblers' focus on the gambling activity itself than a corresponding assignment of informative, standard, or "no" tasks (Kiyak et al., 2023). Thus, it is perfectly conceivable that how to spend the break is more decisive than the break itself. For purposes of evaluation, a pre-specification on the length and activity of the break could support standardization and enhance internal validity.

5. Conclusion

In conclusion, PA responses change during gambling. Our – highly explorative – results suggest that mandatory breaks are not *per se* suited to mitigate "detrimental" PA reactions that build up during the process of gambling. Therefore, the assumption that mandatory breaks generally prevent intensified gambling behavior and represent an always effective measure of gambler protection needs to be more critically evaluated. RCTs that disentangle the mutual interactions between gambling behavior, wins/losses, and breaks appear necessary to comprehensively put observed PA responses into context. This could provide evidence for the conditions under which mandatory breaks represent a purposeful tool.

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CRediT authorship contribution statement

Larissa Schwarzkopf: Writing – original draft, Writing – review & editing, Supervision. **Andreas Bickl:** Validation, Investigation, Data curation. **Joana Daniel:** Investigation. **Georgios Papastefanou:** Validation, Software, Resources, Methodology, Investigation, Formal analysis. **Marieke A. Neyer:** Investigation. **Elena Gomes de Matos:** Writing – review & editing. **Eva Hoch:** Writing – review & editing, Supervision. **Sally Olderbak:** Writing – review & editing. **Ludwig Kraus:** Project administration, Funding acquisition, Conceptualization. **Johanna K. Loy:** Project administration, Methodology, Data curation, Conceptualization.

Declaration of competing interest

AB, JD, EGM, EH, JL, MN, SO, and LS declare that they do not have any financial or immaterial competing interests related to the subject of this paper. LK was also supported by the Swedish program grant "Responding to and Reducing Gambling Problems—Studies in Help-seeking, Measurement, Comorbidity and Policy Impacts" (REGAPS), funded by the Swedish Research Council for Health, Working Life and Welfare (Forte; grant number 2016–07091). GP is CEO of Bodymonitor GmbH which has property rights on the devices (Smartband) and analysis algorithms (classification of physiological emotion) applied in these analyses. A contract between IFT Centre for Mental Health and Addiction Research and Bodymonitor GmbH ensures that IFT has the full scientific responsibility and the right to publish the results.

Data availability

The authors do not have permission to share data.

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Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.abrep.2024.100530.

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