Does it make you shiver under your skin? Stating the importance of psychophysiological measures of well-being in player's experience

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Abstract. *Aspects of eudaimonic well-being are already significant in Player Experience evaluation within Games User Research. To accurately assess how a player's well-being is influenced by their gaming experience, it is crucial to use not only self-report instruments, which rely on users' ability to recall and articulate their experiences, but also psychophysiological measures that can offer more reliable and nuanced data. Although further research is needed to clarify how physiological measures correspond to eudaimonic well-being in PX, this position paper argues that such understanding is essential to advance beyond superficial PX evaluation and explore how games resonate with players on a deeper level.*

Resumo. *Aspectos do bem-estar eudaimônico já são considerados componentes relevantes da avaliação da Player Experience em Games User Research. Para compreender como o bem-estar de um jogador pode ser afetado pela sua experiência em um jogo, é importante avaliá-lo não apenas através de instrumentos de autoreportados, que dependem de como os próprios jogadores conseguem recordar e descrever aspectos subjetivos das suas experiências, mas também por medidas psicofisiológicas, que podem fornecer dados mais confiáveis e ricos. Apesar de mais pesquisas serem necessárias para entender precisamente como as medidas fisiológicas refletem aspectos do bem-estar eudaimônico na PX, neste artigo de opinião argumentamos que esse entendimento é crucial para ir além da avaliação da PX no nível superficial e avaliar como os jogos repercutem no jogador em um nível mais profundo.*

1. Introduction

The Player Experience (PX) is a well-established subject within Human-Computer Interaction (HCI), and research in this area has extensively explored its definitions, metrics, and evaluation techniques and instruments. Digital games require specific attention in user research because their interaction dynamics differ significantly from other software types, mainly due to the high cognitive engagement they demand [Komulainen et al. 2008]. Games can captivate users for extended periods, engaging players through elements distinct from those in other software [Takatalo et al. 2010]. These unique characteristics have drawn the academic community's interest in game experience, spurring recent studies on defining [Wiemeyer et al. 2016], measuring PX, and identifying the factors that influence it [Borges et al. 2020]. Player Experience encompasses the individual and personal experience of playing games, extending beyond playability and game usability. PX operates on

three levels: behavioral, (socio-)psychological, and physiological [Wiemeyer et al. 2016]. This complexity underscores the need for careful consideration of evaluation methods and instruments, as well as the specific PX components being assessed [Borges et al. 2020]. Different tools can yield diverse data types which, when effectively combined, provide a comprehensive assessment of PX. Self-reported instruments, such as questionnaires and scales, are valuable due to their cost-effectiveness and ease of use; however, their reliability depends on the quality of the instrument, the robustness of its psychometric properties, and the accuracy with which users report their experiences [Borges et al. 2020] [Carneiro et al. 2019]. In contrast, psychophysiological instruments, despite their higher costs and time-intensive data collection and analysis processes, can offer richer and more reliable data on physiological responses to emotional states during gameplay. These tools can complement self-reported methods or be used independently to evaluate PX components that self-reports might not adequately capture due to limitations in user recall and reporting accuracy.

Among the many components of PX, some relate not only to immediate emotions evoked during gameplay but also to intrinsic motivational aspects, such as autonomy, competence, and relatedness [Nunes and Darin 2023]. According to the Self-Determination Theory (SDT) by Ryan and Deci [Ryan and Deci 2024], these are the three basic psychological needs from which intrinsic motivation arises. The Self-Determination Theory has gained prominence in HCI games research [Tyack and Mekler 2020], positioning intrinsic motivation and need satisfaction as central to PX, as they affect both the gameplay moment and the broader impact of the experience on player well-being. Games have the potential to fulfill these intrinsic needs, highlighting the importance of considering well-being when evaluating PX. Several PX evaluation instruments specifically address constructs related to Self-Determination Theory. For instance, the Intrinsic Motivation Inventory (IMI) [Nunes and Darin 2023] and the PENS scale [Ryan et al. 2006] assess PX through the lens of basic psychological needs. Nonetheless, most well-being evaluation instruments in PX are self-reported. As with other PX components, psychophysiological instruments can provide reliable and meaningful data when combined with self-reported methods, especially in evaluating well-being in digital games. Intrinsic motivation can induce various physiological states relevant to PX evaluation. Research by [Lee et al. 2012] indicates that decisions driven by intrinsic and extrinsic motivation involve different brain areas. DuPont [DuPont et al. 2020] explored correlations between well-being and stress physiology, while Lindfors [Lindfors 2012] reviewed studies examining physiological correlates of hedonic and eudaimonic well-being. Although these studies suggest associations between these factors, they highlight the need for more evidence to detail how eudaimonic well-being impacts physiological states. Despite limited research directly linking SDT key concepts with physiological measures, evaluating these in the context of digital games is important given recent studies showing how different PX components can be evaluated with psychophysiological instruments and the impact of intrinsic motivation on PX. Understanding how physiological states are influenced by the promotion (or lack) of eudaimonic well-being before, during, and after gameplay (e.g., through the satisfaction or frustration of psychological needs) could contribute to a comprehensive PX evaluation approach, ultimately aiming to design games that foster a balanced and fulfilling player experience.

To better understand how physiological measures are related to well-being in

player experience evaluations, we went through the literature looking for studies that correlates PX evaluation, aspects of eudaimonic well-being, and psychophysiological measures in three databases (ACM, IEEE, and SOL). In order to find studies that combined these three aspects (PX evaluation, well-being and psychophysiological measures), we created strings combining synonyms or correlates for three key terms: (i) SDT (”well-being”, ”eudaimonia”), (ii) Games (”video-games”, ”player experience”), and (iii) Instruments (”psychophysiological instruments”, ”evaluation”). We reviewed the first 30 papers from each database, assessing titles and abstracts to identify studies that included PX evaluations considering both well-being construcs and psychophysiological measures. It is important to note that this is a position paper. In the following sections, we argue that it's essential to move beyond surface-level PX evaluation and assess how the game resonates with the player on a deeper level. Does it make them shiver under their skin and touch their feelings? Does it evoke excitement that feels empowering or, instead, leave them feeling drained? How does the game influence the players after the screen goes dark? These questions encourage us to consider the short and long-term effects of gameplay on the player's well-being and, for that, we consider that the understanding of how psychophysiological measures are related to eudaimonic well-being is important to deeper and richer PX evaluations.

2. Why to consider well-being when evaluating Player Experience

The Self-Determination Theory (SDT) is a foundational psychological framework widely used in Human-Computer Interaction (HCI) to study psychological factors, including those related to Player Experience (PX) in digital games. SDT posits that three basic psychological needs—competence, autonomy, and relatedness—must be satisfied for ongoing personal growth, integrity, and well-being [Ryan and Deci 2024]. The Basic Psychological Needs Theory (BPNT), a mini-theory within SDT, emphasizes both the satisfaction and frustration of these needs, where frustration represents a distinct and more threatening state than mere absence of satisfaction [Vansteenkiste et al. 2020]. Competence, autonomy, and relatedness are essential for developing intrinsic motivation, described by Ryan and Deci [Ryan and Deci 2024] as the energy that drives action. SDT suggests that some motivations reflect personal values or interests, with sports and gaming often exemplifying intrinsic motivation [Ryan and Deci 2024]. SDT has gained prominence in HCI games research, with intrinsic motivation and need satisfaction seen as core concepts of PX [Tyack and Mekler 2020]. These aspects not only relate to the emotions evoked during gameplay but also connect to the player's values and interests, impacting well-being by influencing how needs are satisfied or frustrated. Given that games have the potential to fulfill these intrinsic needs, well-being should be a critical consideration in PX evaluation. Understanding the components of engaging player-game interactions is a key aim of Games User Research (GUR) in HCI [Tyack and Mekler 2020].

Engagement, often linked to motivation, is defined as the quality of user experience characterized by the depth of interaction between user and system, a universal design goal across products, systems, services, and games [O'Brien et al. 2018], [Nunes and Darin 2023]. Although generally viewed as a positive attribute associated with well-being, promoting engagement can also lead to negative outcomes, such as addictive behaviors [Nunes and Darin 2023], [Lindfors 2012]. SDT advocates for designing experiences that promote healthy, satisfying interactions prioritizing user well-being over

mere engagement, to mitigate risks associated with harmful design patterns that may foster addiction [Nunes and Darin 2023]. Nunes and Darin argue for the integration of eudaimonic well-being into HCI design and evaluation methods [Nunes and Darin 2023]. As intrinsic motivation and the satisfaction or frustration of player needs are central to PX, the engagement-addiction dilemma necessitates careful consideration in PX research and practice. Thus, properly addressing SDT concepts in PX evaluations is crucial for promoting player well-being. Several PX evaluation instruments incorporate eudaimonic well-being and related concepts. Tyack and Mekler [Tyack and Mekler 2020] identified the Player Experience Need of Satisfaction (PENS) [Rigby and Ryan 2007] and the Intrinsic Motivation Inventory (IMI) [Ryan and Deci 2006] as the most frequently used self-report questionnaires in HCI Games Research. PENS measures PX through constructs of competence, autonomy, relatedness, controls, and presence/immersion, while IMI assesses intrinsic motivation and self-regulation. Another example is the Basic Needs in Games Scale (BANGS) by Ballou et al. [Ballou et al. 2024], which evaluates the satisfaction and frustration of basic psychological needs during gameplay. Although these questionnaires are based on well-founded psychometric constructs and are easy to use, they rely on self-reports, making their reliability contingent on the accuracy with which players can recall and describe their experiences.

3. Are self-reported instruments enough?

To accurately understand and evaluate the PX, various factors related to psychological characteristics, gameplay performance, and human emotion must be considered [Wiemeyer et al. 2016]. There is a consensus that PX is a multidimensional and multilayered construct [Poels et al. 2007]. To properly evaluate these factors and obtain a reliable measurement, it is necessary to use experimental techniques that involve behavioral (e.g., game logs), physiological (e.g., heart rate and muscle activity), and subjective (e.g., questionnaires) methods [Wiemeyer et al. 2016]. A literature mapping on instruments to evaluate PX cataloged 58 instruments and classified them into three types: (i) questionnaires and scales, (ii) software and equipment, and (iii) two-dimensional graph areas. The study showed that, among the 58 cataloged instruments, 48 were scales and questionnaires [Borges et al. 2020]. The use of post-play surveys or interviews is the simplest and least expensive way to evaluate PX, although information can be lost due to the delay between gameplay and the player's recall [Wiemeyer et al. 2016]. Questionnaires and scales are self-reported evaluation instruments, which means that they gather data only on the conscious reactions of players to the games [Drachen et al. 2018], as players recall and report their experiences. This type of instrument can yield reliable data about player experiences or have superficial quality [Lazar et al. 2017]. Another limitation of self-report instruments is that evaluation results depend on the quality of the questionnaire, the construction and validation of its psychometric properties, and how well the research team understands its use and analysis [Borges et al. 2020]. Because these instruments are convenient, questionnaires are frequently adapted for PX evaluation. However, these adaptations often do not follow proper guidelines or guarantee the psychometric properties of the original instruments. Furthermore, the variety of constructs within PX can exacerbate the issues arising from these adaptations [Carneiro et al. 2019]. Games can, intentionally or not, evoke emotions and sensations such as surprise, stress, and fear in ways different from other types of software, and these attributes are likely not sufficiently explored and evaluated by self-reported instruments, necessitating their combination

with other types of instruments [Borges et al. 2020].

According to [Darin et al. 2020], it is necessary to triangulate data collected through qualitative and quantitative evaluation methods, using both self-reported and objective measures, to obtain a deeper understanding of human characteristics in game evaluation. In the context of GUR, while observations, surveys, and in-game metrics have been used for a longer time, biometric measures are more recent innovations [Drachen et al. 2018]. The psychophysiological measures used in PX evaluation collect human body signals and are mainly based on sensors placed on the surface of the skin to infer players' emotional states [Wiemeyer et al. 2016]. In this context, emotions are related to various psychophysiological measures, and these measures are associated with different emotions and constructs of PX [Darin et al. 2020]. One example of a psychophysiological measure used in PX evaluation is Electromyography (EMG), which involves sensors that measure muscle activity in human tissue. For game user researchers, the main area of interest for this instrument is facial muscle measurement. GUR studies have focused particularly on brow muscles, which may indicate negative emotions, and on cheek muscles, which can indicate positive emotions [Wiemeyer et al. 2016]. In addition to EMG, Electrodermal Activity (EDA) sensors are also used in PX evaluation. EDA measures the passive electrical conductivity of the skin, and its fluctuations can indicate the excitement a player feels during gameplay. Players' electrodermal activity may increase, for example, when they are aroused by an external stimulus, making EDA useful for analyzing players' responses to direct events while playing a game [Wiemeyer et al. 2016]. Behavioral and psychophysiological measures, like EDA and EMG, generally offer more reliability and sensitivity than self-reported evaluation instruments, as affective responses are difficult to articulate verbally and can also influence participants to act differently or report their experiences in varied ways depending on their perception of the evaluation goals [Darin et al. 2020]. While self-report measures can provide the user's perception of their own behavior, psychophysiological measures enable researchers to verify signals of players' actual behavior [Darin et al. 2020]. Physiological responses are typically spontaneous and unprompted, making it challenging for individuals to manipulate their physiological signals, which renders psychophysiological evaluation instruments more objective than other types of instruments [Wiemeyer et al. 2016]. Additionally, physiological metrics can gather and provide data during gameplay rather than after, without distracting the player or interrupting play [Drachen et al. 2018]. Despite the clear advantages of using physiological measures to evaluate PX, it is important to note that this type of evaluation usually requires a controlled experimental environment due to the volatility, variability, and complexity in interpreting and analyzing the data [Wiemeyer et al. 2016]. Furthermore, researchers and practitioners should be aware that mapping physiological responses to discrete emotional states is not straightforward, as psychological effects are not always directly associated with the underlying brain responses [Wiemeyer et al. 2016]. Further exploration is necessary to identify which emotions are best captured and by which physiological measures [Maia and Furtado 2016].

Even with its inherent complexity, the use of psychophysiological instruments provides a rich and overall reliable way to evaluate PX and assess factors of the experience that cannot be adequately measured by self-reported instruments. Self-report methods, while valuable, rely heavily on players' conscious recollection and willingness to share their experiences, which can introduce biases or gaps in the data, particularly

when it comes to subtle or unconscious reactions that players themselves may not fully recognize or articulate. Psychophysiological measures, on the other hand, capture immediate, involuntary responses that provide a more direct window into the player's emotional and physiological state during gameplay. The increasing development and use of this type of instrument in GUR [Borges et al. 2020] could lead to a broader variety of PX components being evaluated, as well as diverse applications beyond assessing momentary emotions during gameplay, including understanding how playing a game affects the user's well-being after gameplay or how it satisfies or frustrates their psychological needs. Furthermore, by integrating these objective measures with self-reported data, researchers can achieve a more holistic understanding of the player experience, triangulating insights to account for both conscious and unconscious reactions. The combination of these methods thus stands as a relevant advancement in accurately capturing the multifaceted nature of player experience, pushing the boundaries of what can be understood about players' experiences.

4. The importance of psychophysiological measurement of well-being in the player's experience

In studies of physiological correlates of well-being across various research areas, some indications have emerged of correlations between physiological responses or states and different aspects of eudaimonic well-being. For example, Lee and Reeve [Lee and Reeve 2017] assessed the effects of intrinsic motivation on the Anterior Insular Cortex (AIC) of the human brain using event-related functional Magnetic Resonance Imaging (fMRI). Their study found that performing intrinsically motivating tasks involves AIC activity, suggesting that brain activity associated with subjective feelings of intrinsic satisfaction and reward processing underlies the actual experience of intrinsic motivation. Lindfors [Lindfors 2012] reviewed research investigating the physiological underpinnings of mental well-being, focusing on two approaches to eudaimonic well-being: the Sense of Coherence (SOC) [Antonovsky 1987] and Ryff's psychological well-being scale [Ryff and Keyes 1995]. The Sense of Coherence refers to an individual's confidence in structure, predictability, and intelligibility [Antonovsky 1987]. Lindfors' review found physiological correlates for this concept, such as cardiovascular indicators (e.g., higher blood pressure in women with a weak SOC). For Ryff's psychological well-being scale [Ryff and Keyes 1995], which encompasses six dimensions (autonomy, environmental mastery, personal growth, positive relations with others, purpose in life, and self-acceptance), the review identified physiological correlates, such as activation of the left prefrontal cortex and total scores for all dimensions of psychological well-being, excluding autonomy. In spite of the importance of these findings, Lindfors [Lindfors 2012] states that among the researches on physiological correlates of mental well-being, most studies relate to the hedonic orientation. While hedonic well-being seems to have clear correlations with different physiological systems, findings related to eudaimonic well-being are still inconclusive [Lindfors 2012]. DuPont[DuPont et al. 2020], in their systematic review and meta-analysis to investigate whether trait indicators of well-being are associated with stressor-evoked changes in physiology, also found that the correlations for eudaimonic well-being needed further investigation. For their review, the author also considered the psychological well-being constructs of Ryff and Keyes [Ryff and Keyes 1995]. The review's result presented existing evidences sugges-

ting correlations between hedonic well-being and physiological effects of psychological stressors, but the author reported that too few studies investigated the relationship between eudaimonic well-being and stress physiology [DuPont et al. 2020]. A deeper understanding of the physiological correlates of eudaimonic well-being, considering different theoretical approaches and definitions, is needed. Some key concepts from Self-Determination Theory [Ryan and Deci 2006] related to eudaimonic well-being already play an important role in GUR, and although there are similarities with other theories (such as [Ryff and Keyes 1995], which also considers autonomy as a component), SDT's perspective on eudaimonic well-being considers specific aspects that are particularly relevant for PX evaluations.

A more accurate understanding of how eudaimonic well-being relates to physiological responses is relevant across various research fields and could significantly transform how PX is evaluated. Questions like how a game satisfies or frustrates a player's psychological needs and the impact of intrinsic motivation on their experience before, during, and after gameplay become central. Although existing self-report instruments capture these aspects of well-being and PX, it is crucial to determine whether psychophysiological measures can assess these components more reliably, independent of players' recall and descriptions of their experiences. Clarifying the psychophysiological correlates of well-being in PX can inform game development, particularly in addressing players' psychological needs. As these correlates become better understood, there is potential for developing psychophysiological instruments tailored specifically for assessing well-being in games, thus broadening PX evaluation. Furthermore, it is necessary to expand the understanding of physiological correlates of well-being specially for instruments more suitable and cost-effective to Player Experience evaluation (like EMG and EDA), rather than relying on less accessible methods like fMRI [Lee and Reeve 2017] and complex cardiovascular or endocrine markers [Lindfors 2012]. While some studies have examined PX through the lens of well-being using psychophysiological measures, they often employ surveys or other instruments to assess well-being aspects, such as autonomy or intrinsic motivation, with psychophysiological instruments used primarily for other PX components like arousal [Grimshaw et al. 2008] [Robb et al. 2017]. In other instances, explicit correlations between well-being-related psychological states and physiological responses are not clearly specified [Ribeiro et al. 2020]. Psychophysiological instruments properly designed to evaluate eudaimonic well-being in the context of games can enable and enrich long-term evaluations of the PX, considering the players' well-being over prolonged game use. When conducting PX evaluations, it's essential to consider not only immediate responses but also the long-term impact on well-being, which is not a trivial task. A comprehensive approach involves understanding how various data types correlate and how to combine and interpret them effectively. Real-time measures, such as physiological tracking and emotional self-reports, can reveal stress, discomfort, or enjoyment during gameplay, while post-game surveys and follow-ups assess how these feelings persist and affect players' mental health over time. Using psychological tools like well-being scales and qualitative feedback can help uncover whether games promote positive emotional engagement or trigger harmful effects, such as anxiety or cognitive dissonance. This holistic approach ensures game design fosters both immediate satisfaction and sustained emotional health, which is critical for responsible PX evaluation. Combining psychological and biometric data into PX evaluations is crucial for a deeper understanding of how games

affect players beyond surface-level engagement. Self-reported measures and qualitative data often miss subtle emotional responses, such as stress, anxiety, or lingering discomfort, which can only be captured through real-time biometric tracking (e.g., heart rate, skin conductance) — data that should later be triangulated with psychological assessments. This approach allows researchers to investigate not just immediate reactions but also the broader influence of games on well-being over time. Leveraging this data can guide the design of games that support emotional health, ensuring that immersive experiences do not lead to long-term negative effects. Expanding our understanding of these metrics is essential for creating responsible, player-centered designs.

Can biometric data together with self-reported feedback help us to investigate how games support or undermine players' basic psychological needs? For autonomy, can measures like heart rate variability and skin conductance reveal stress levels or discomfort during gameplay scenarios that limit player choice or impose excessive constraints? For relatedness, can emotional response data, such as changes in facial expressions or galvanic skin response, provide insights into how players experience social interactions, sense of belonging, or emotional connection with in-game characters? For competence, can physiological indicators like heart rate and sweat response help us understand how players react to challenging tasks and achievements, reflecting their feelings of frustration or satisfaction? Those are just examples of research questions that could help us dig deeper and have a better understanding of psychological factors affecting player's wellbeing. Thereafter, we challenge the community to bring new perspectives on how to deeper investigate PX going beyond its hedonic factors. We can assess whether different types of data effectively uncovers how well games address psychological needs and contribute (or not) to overall well-being. Developing a comprehensive PX evaluation approach helps ensure that games are designed to foster a balanced and fulfilling experience, promoting both immediate enjoyment and long-term well-being by addressing players' intrinsic needs and enhancing their overall satisfaction.

5. Conclusion

In this position paper, we discuss the importance of a deeper and precise understanding of how eudaimonic well-being can be assessed by physiological measures, not only in a broad and general context, but specifically in GUR. To do so, we present arguments on how important the SDT definition of eudaimonic well-being is to PX evaluation, since aspects and constructs of this theory are well suitable for the context of games. Some evaluation instruments used in PX evaluation, like IMI and PENS, already consider constructs such as intrinsic motivation, autonomy, competence and relatedness. Considering these constructs on GUR is also important to elucidate, for both research community and game design industry, the importance of real care with how the player's well-being can be affected by a game. We also argue that, to evaluate these aspects of the PX, self-report instruments are not enough, once its reliability relies on how precisely users can recall and describe subjective aspects of their experiences and also on how well built the instruments are, regarding its psychometric properties and eventual adaptations for different contexts or types of users. Combining psychophysiological measures with self-report instruments in the evaluation of well-being in PX can yield not only rich and reliable results, but also deepen the research community's understanding of the correlation between these evaluation methods and instruments. Such evaluations can, for instance, explore how physio-

logical measures like heart rate or skin conductance relate to players' sense of autonomy, especially when they experience discomfort or heightened stress during gameplay situations that limit their choices. Emotional response metrics, such as facial expressions or galvanic skin response, may be integrated with questionnaires or scales to assess relatedness, particularly during social interactions in gameplay. Additionally, there is potential to investigate brain activity changes related to intrinsic motivation, and combine these findings with well-validated self-report instruments, especially in long-term PX evaluations. Understanding the correlations between psychophysiological measures and eudaimonic well-being in GUR is essential the way we evaluate PX, moving it beyond surface-level and assessing how games resonate with the player on a deeper level. We consider that short and long-term effects of gameplay on the player's well-being must be taken into account and, for that purpose, understanding how psychophysiological measures are related to well-being is crucial to enrich how we evaluate PX.

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