Operationalising and Evaluating Sub-Optimal and Optimal Play Experiences through Challenge-Skill Manipulation

Madison Klarkowski, Daniel Johnson, Peta Wyeth,
Mitchell McEwan, Cody Phillips, Simon Smith
Queensland University of Technology (QUT), Brisbane, Australia
{m15.clark, dm.johnson, peta.wyeth, m1.mcewan, c1.phillips, simon.smith}@qut.edu.au

ABSTRACT
The study examines the relationship of challenge-skill balance and the player experience through evaluation of competence, autonomy, presence, interest/enjoyment, and positive and negative affect states. To manipulate challenge-skill balance, three video game modes – boredom (low challenge), balance (medium challenge), and overload (high challenge) – were developed and experimentally tested (n = 45). The study showed that self-reported positive affect, autonomy, presence, and interest/enjoyment differed between the levels. The balance condition generally performed well in terms of positive player experiences, confirming the key role challenge-skill balance plays in designing for optimal play experiences. Interestingly, the study found significantly lower negative affect scores when playing the boredom condition. Greater feelings of competence were also reported for the boredom condition than the balance and overload conditions. Finally, some measures point to overload as a more enjoyable experience than boredom, suggesting possible player preference for challenge > skill imbalance over skill > challenge imbalance. Implications for design and future research are presented.

Author Keywords
Video games; player experience; self-determination; presence; challenge.

ACM Classification Keywords
K.8.0 Personal Computing: General- games.

INTRODUCTION
One of the most prominent challenges in player experience research is finding or designing video games that allow for useful player experience comparisons to be made. Comparing the player experience across two different video games is sometimes valuable, but it is usually difficult to find games that only differ on the variable of interest. This creates a challenge for researchers seeking to better understand the player experience in terms of isolating which features of games and contexts of play influence the player experience in particular ways.

The current study forms part of a larger program of research seeking to understand the psychophysiological states associated with different aspects of the player experience. The first step in this research was to create video game play experiences that provide useful points of comparison. One accessible aspect of games that is commonly manipulated is challenge-skill balance, a core contributor to the player experience in that it is considered a robust predictor of game enjoyment that emerges through flow [33]. While the impact of challenge-skill balance on flow has been investigated in previous work, the understanding of the influence of challenge-skill on other constructs of the play experiences is still being developed.

As such, the aim of the current study is to explore the role of challenge-skill balance on the player experience. To do this, three video game conditions were manipulated to be representative of challenge-skill balance and imbalance, so that the impact of boredom (low challenge), balance (medium challenge) and overload (high challenge) could be examined. Various subjective measures associated with the player experience were used, including need satisfaction, presence, interest and enjoyment, and positive and negative affect states. While there is an assumed understanding of the role that challenge-skill has in the player experience, understanding of how challenge-skill balance influences different aspects of the player experience is still being developed. By employing various player experience measures to investigate experiential phenomena associated with the play experience, a novel understanding of challenge-skill balance can be gained. This will allow greater insight into how challenge-skill balance should be designed to facilitate positive player experiences

Our results show greater positive affect, autonomy, presence, and interest/enjoyment when playing the balance condition as opposed to the boredom and overload conditions. Interestingly, results also showed less negative affect in the boredom condition than in the balance and overload conditions, possibly speaking to impact on emotional engagement or mental stimulation in low-challenge game experiences. Similar rated levels of competence between the balance and boredom conditions indicates that competence may be limited as a predictor of a positive play experience.

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Finally, participants reported greater enjoyment and positive affect for the overload condition than the boredom condition, suggesting that some challenge-skill imbalances are preferable to others.

This study represents an effort to examine the impact of challenge-skill balance and imbalance on wider subjective experiential phenomena. Our findings allow for a better understanding of the player experience associated with differing levels of challenge-skill balance. Our findings also present implications for game designers seeking to build optimal game experiences, strengthening the role of challenge-skill balance as a core element of a positive play-experience and as a precursor to many positive experiential phenomena, such as presence and autonomy. This research is also useful for researchers aiming to build or evaluate games or game levels for use in experimental studies, revealing that greater negative affect does not necessarily indicate a negative play experience and reported competence does not necessarily indicate a positive play experience. The reported process for altering the challenge-skill variable in a complex game environment may also be beneficial to experimental designs. Finally, challenge-skill balance is potentially relevant to a breadth of activities; as such the broader research community may benefit from these results by considering our findings in serious games or work-based software (for example, vocational training games), gamification, or in non-gaming contexts such as pedagogical and learning research, particularly when considering optimal challenge.

BACKGROUND

Self-Determination Theory and Needs Satisfaction

The player experience poses a notable challenge for evaluation [19]. As the concept of 'fun' is difficult to define and partial to personal preference, research instead examines the experience through the lens of experiential phenomena associated with video game play [5]. Amongst the phenomena commonly evaluated include presence, motivation, engagement, and affect.

Motivation and needs satisfaction in video games has been evaluated through the application of Self-Determination Theory (SDT), an established psychological theory of motivation concerned with the fulfillment of universal needs of competence, relatedness, and autonomy. SDT primarily addresses factors that enable intrinsic motivation, a core motivation for play and sport [27]. The development of the Player Experience of Needs Satisfaction (PENS) scale has allowed researchers to examine SDT through a measure uniquely developed for player experience evaluation [27]. Through SDT, PENS evaluates autonomy, competence, and relatedness.

Autonomy speaks to the sense of volition or willingness when doing a task [9], and is positively associated with increased intrinsic motivation. Enabling a sense of freedom and choice for players, the provision of opportunities that interest them, and the avoidance of factors that diminish volition (such as controlling or limited tasks) promotes autonomy, in turn promoting willingness to engage in the activity [27].

Competence addresses feelings of effectiveness and a need for challenge within the game [27]. To achieve satisfied competence, players should be optimally challenged, receive positive feedback to enhance perceived competence, and be presented with the opportunity to improve on his/her abilities and skills. The need for optimal challenge is perhaps best satisfied by careful consideration for challenge-skill balance, in which the skill of the player does not either exceed or fail to meet the challenges presented by the game (see Challenge-Skill Balance).

Finally, *relatedness* investigates feelings of connection to others [27]. Within games, this primarily pertains to experiences of relatedness to human others in multiplayer games; however, this also addresses the sense of connection to computer-controlled non-player characters (NPCs) [27].

PENS also evaluates presence and intuitive controls, core influences on the player experience [27]. Presence is described as the feeling of being 'within' the game world, facilitated by engaging narrative and visually pleasing aesthetics; it is described by the International Society of Presence Research as *"[occurring] when part or all of a person's perception fails to accurately acknowledge the role of technology that makes it appear that s/he is in a physical location and environment different from her/his actual location and environment in the physical world."* [12] Presence is theorised to be positively associated with increased intrinsic motivation. Intuitive controls assists in enabling feelings of competence, autonomy (by not stymieing the player with awkward or difficult controls), and presence (by facilitating feelings of 'being there' through to provision of an intuitive control scheme that does not require active consideration) [27].

PENS has revealed less competence and autonomy when engaged in co-located play with others than solo play or play online [32]. Studies have also revealed autonomy, competence, and relatedness as positive predictors of game enjoyment and future play, and positive association between autonomy and competence and post-play mood [27].

The concept of presence in games has been explored beyond PENS literature. Presence is positively related to space exploration and the need for discovery within game worlds [31], and has been identified as a key contributor to greater enjoyment of games [18]. Games played on higher difficulties (that is, games that have not been identified as 'easy'), in first-person view, or with realistic environments have also been identified as more likely to provoke feelings of presence [22].

Affect

Another experiential phenomena of the play experience is impact on affect; or, the state feelings or emotions of the player throughout the experience. There is some ambiguity

within literature concerning 'mood' and 'affect'. While the terms are often used interchangeably, such as in Ravaja et al.'s study of phasic emotional responses [23], there is an important distinction between the two. While affective states are emotions experienced during an event (or, in the context of this research topic, within player experience), mood is a lasting disposition that may impact on a person's overall perception of an event [30]. The glossary of the American Psychiatric Association states, "*affect is momentary (like weather), while, mood is a prolonged emotion (like climate)"*. Within the context of player experience evaluation, it is necessary to measure affective states, as these are the emotions experienced during play [19].

Positive affect has been linked with positive player experiences, such as competence satisfaction [27], convergence between the player's experiences of self and the player's ideal self during play [21], and prosocial play [28]. Conversely, a study by Jennett et al. [13] examined the relationship between fast-paced games, negative affect, and state anxiety; while they found negative affect and state anxiety was higher for faster-paced games than slow games, the results were not significant. As such, Jennett et al. recommends negative affect and emotions for further study [28] [5].

Enjoyment

Research has consistently identified enjoyment as a central reason for, and a core aspect of, playing video games [10]. While it is pervasively understood that video games provide an enjoyable experience, the dimensions of this experience and how to design for this experience are still not fully understood [33]. Enjoyment has been identified as a multifaceted construct that relates to physiological, affective, cognitive, and behavioural dimensions [10] [33]. Research has also coupled enjoyment with intrinsic motivation [26].

Challenge and Challenge-Skill Balance

Much of game design is rooted in the concept that players seek, and are driven by, challenge [17]. Successfully completing challenging tasks in game environments generates a sense of greater self-efficacy and accomplishment for players [17]. Research also suggests that simply undertaking optimally challenging activities – not just the experience of succeeding at the task – is an enjoyable experience in itself [1], establishing challenge-based game play as an intrinsically motivating activity.

Abuhamdeh and Csikszentmihalyi found that optimal enjoyment of an activity occurs during moderately challenging experiences, in which the activity is perceived as neither too easy nor too difficult [1]. Likewise, challenge-skill balance is achieved when the skills or abilities of the player are evenly met by the challenges represented by the game or task. Should a game be too difficult or too easy for the player, the player experience is assumed to be negatively impacted [2].

Despite this, the notion of challenge is not yet well-defined within games literature, and consequently has been the nexus of much research investigating the play experience [7]. Experience of challenge has been found to be dependent on both game genre (as well as the advent of emotional challenge in narrative-driven titles) [6], and the relationship of the player with the game or gaming in general [2] [17]. Research investigating engagement in an educational game found that players were more engaged, and played longer, when the game presented an easy challenge as opposed to a moderate challenge [17], which contradicts the aforementioned notion of optimal challenge. The researchers suggested that a possible explanation for the outcome was the lack of prior experience amongst their players, and that it is possible that challenge-seeking behaviours may only occur after some level of expertise is acquired. This is supported by other research that discovered that 'casual' players of a game gained more enjoyment out of easier difficulties, regardless of their aptitude in the game, whereas 'experienced' players' enjoyment of the game was predicated upon challenge [2].

Flow

Flow describes a mental state characterised by total absorption in and enjoyment of an activity [8]. Flow is often achieved in instances of challenge-skill balance [15], in which the challenge or demands of the task are adequately met by the skill or ability of the person completing the task. Should the participant find the task overwhelming or too simple, the potential for flow is lessened. While some literature suggests that challenge-skill balance is a necessary antecedent to the experience of flow [8], other research suggests it is simply a robust predictor of flow [24] [11]. A revisited model of flow suggests that the original model conflagrates antecedents, states, and consequences, and that antecedents (such as challenge-skill balance) should instead be construed as predictors of, and not a part of, the flow state [4]. Video games have been identified as possessing ideal characteristics to invoke and maintain the flow experience, with the caveat that only games that provide a match between difficulty and player skill are likely achieve a flow state [29].

PREVIOUS RESEARCH

This study builds upon our previous research [16], in which the challenges of operationalising and measuring flow in video games are discussed. While the overload condition prompted significantly less flow than the balance and boredom conditions, no significant differences were found between balance and boredom. Some proposed explanations for this include improper condition design (the boredom condition may still have allowed for a positive play experience), the potential for high ratings of flow to not actually be occurring in the scale used due to the wording of some items, or that, as suggested in some literature, challenge-skill balance plays a more diminished role in flow than assumed. The boredom condition has since been altered towards greater skill > challenge imbalance through the removal of enemy agents entirely. Multiple measures of the

player experience were evaluated against the redesigned conditions. A gap was identified in the literature on evaluation of challenge-skill balance and imbalance impact on play constructs other than flow, immersion, and performance; as such, the experience of presence, competence, autonomy, interest/enjoyment and affect are reported for this paper.

STUDY DESCRIPTION

A within-subjects experiment was designed to measure the effects of challenge-skill balance and imbalance on the play experience. The study made use of three game conditions modified to be representative of dimensions of challenge-skill balance and challenge-skill imbalance. The impact of challenge-skill balance and imbalance on the player experienced was measured across multiple subjective self-report surveys that evaluate the experience of experiential phenomena commonly associated with play.

Measures

PANAS

The Positive and Negative Affect Schedule (PANAS) is a subjective measure of affect, which uses two subscales: positive affect and negative affect. Each of the subscales contains 10 adjective items, which are rated on a 1-5 Likert scale, with 5 being "Extremely". The positive affect subscale includes adjective items such as "Interested", "Enthusiastic" and "Alert", while the negative affect subscale includes adjective items such as "Irritable", "Ashamed" and "Afraid". Scores for each subscale can range from 10-50, with higher scores being indicative of higher positive affect or higher negative affect. It is important to note that positive affect and negative affect exist in parallel rather than on a continuum of affect.

PENS

Three of the needs-satisfaction subscales were included in the study design: competence, autonomy, and presence, which are thought to be core components of the player experience [27]. The Player Experience of Needs Satisfaction scale has been shown to be a statistically reliable measure [14]. While the Player Experience of Needs Satisfaction contains a subscale for relatedness, this subscale was excluded from the study on the grounds that the game is a single player experience and no non-player characters were present in the game. Similarly, the intuitive controls subscale was excluded from the study as the control setup was not being manipulated in any way.

Items are rated on a Likert scale of 1 – 7 ('7' representing 'Strongly Agree'), and are as are as follows:

- Competence: *"I felt very capable and effective when playing."*
- Autonomy: *"I did things in the game because they interested me."*
- Presence: *"I experienced feelings as deeply in the game as I have in real life."*

IMI

Rooted in self-determination theory, the Intrinsic Motivation Inventory (IMI) is a scale for measuring subjective experiences in relation to an activity [26]. It is considered to be a reliable measure of its subscales, interest/enjoyment, competence, effort, value, pressure and perceived choice (autonomy). An additional subscale has since been added, though has not yet been validated (relatedness). As the Intrinsic Motivation Inventory and Player Experience of Needs Satisfaction are similarly rooted in Self-Determination Theory, it was determined that inclusion of the needs-satisfaction subscales from the Intrinsic Motivation Inventory would be largely repetitious, and that those subscales (competence, autonomy, relatedness) should not be included in the study design. However the interest/enjoyment subscale of the Intrinsic Motivation Inventory does not have an analogue in the Player Experience of Needs Satisfaction, and will be used to gauge the interest and enjoyment of participants across the experimental conditions. Items are rated on a Likert scale of 1 – 7 ('7' representing 'very true'), and are as follows:

- *"I would describe this activity as very interesting."*
- *"I enjoyed doing this activity very much."*

Game

The game chosen for this study was Valve Corporation's *Left 4 Dead 2,* a post-apocalyptic zombie first-person shooter. This was due to its high production levels, popularity within the gaming community, and intuitive gameplay. The game was also chosen due to its native inclusion of Dynamic Difficulty Adjustment (DDA) in the form of an entity known as the 'AI Director'. DDA provides real-time adjustment of the game's difficulty in response to player performance, ensuring a similar play experience regardless of individual ability or expertise.

The three modified game conditions all took place within a map named 'The Port'. In this level, participants explored an industrial complex to retrieve sixteen gas canisters with the help of three companion AI. Once all sixteen gas canisters were emptied into a fuel tank, a bridge would lower, granting access to a car and finishing the level. As this mission generally took longer than the ten-minute gameplay sessions, no participants completed this mission; this was intended to prevent a victory condition from occurring for the more skilled players, and to ensure all participant had identical play durations. An exception to this is five participants who completed the objectives in the boredom condition before the allotted time passed, requiring early termination of the play session before reaching the car ('beating' the level).

Manipulations

Game conditions that only differed on the challenge-skill variable were required for the study. To achieve this, three conditions were designed towards manipulating challenge-skill balance and imbalance: 'balance' (medium challenge), 'boredom' (low challenge), and 'overload' (high challenge). The challenge of each game condition was directly altered to

accomplish this. The game level chosen featured two key challenges: successfully collecting and delivering sixteen gas canisters, and surviving combat with enemy agents (zombies). The challenge of gas canister collection was dependent on the challenge of enemy agents: canisters were clearly marked and highlighted in the map, and canister collection was only inhibited through the presence of enemy AI. To this end, combat was the only feature of the game directly altered.

	Balance	Boredom	Overload
Common enemy agents	Standard	None	Extreme
Special enemy agents	Standard	None	Extreme
Collecting canisters	Standard	Standard	Standard
DDA	Enabled	Disabled	Disabled

Table 1. Challenge manipulation in the game conditions.

Left 4 Dead 2 features two types of enemy agents: common and special. Common enemy zombies are slow-moving, attack through melee hits only, often move in 'herds', and natively have low health. Special enemy zombies have unique abilities (such as spitting pools of acid, or pouncing on the player), move alone, require special tactics to eliminate, and have lower spawn rates than common enemy zombies. Both these enemy types were modified for each game condition: in boredom, they were removed entirely; in balance, they appeared as they would in standard *Left 4 Dead 2* and were influenced by DDA; finally, in overload, spawn rates, health, responsiveness, herd size, and damage dealt were radically increased. For challenge manipulated across all conditions, please refer to Table 1.

The conditions were developed so as to be extreme enough in difference that players of any skill level would experience challenge > skill in the Overload condition, skill > challenge in the Boredom condition, and a match of skill and challenge in the Balance condition. As such, the paper operates under the assumption that the conditions were successful in achieving this.

Some features of *Left 4 Dead 2* were altered for all conditions for the preservation of experimental integrity and inhibition of potential confounds. These alterations include:

- The achievement system was disabled to ensure no players experienced a reward for achieving something that other players did not (for example, killing five 'Hunter' type special enemies).
- Sprays, player-chosen images that can be 'pasted' into the game world by pressing a button, were also disabled.
- Players were restricted to only one of four playable characters ('Nick').
- Weapon choice was eliminated from the game. In the default game, players may choose to play with a sniper rifle, machete, assault rifle, chainsaw, and so on. To ensure a similar experience across all conditions and experiments, only the assault rifle as the primary weapon and pistol as the secondary weapon were enabled.
- In all conditions, the 'Witch'- a rare special enemy type with the ability to instantly kill a novice player and their AI teammates –was removed.

Balance Condition

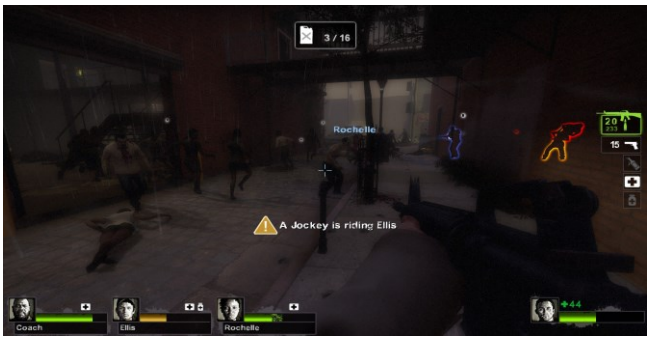

Figure 1. Screenshot of the 'balance' condition.

The balance condition was designed for challenge-skill balance. This condition remained almost identical to the standard version of *Left 4 Dead 2*, with the exception of the alterations made for all conditions as detailed previously, as the native presence of DDA (in the form of the 'AI director') allowed for challenge-skill match for each participant. DDA is often used in video games as a solution to challenge-skill imbalance in both single player [2] and multiplayer [3] contexts, ensuring that the play experience is neither too easy nor too difficult. As such, this condition design assumes that the AI Director is successful in promoting a challenge-skill match experience.

To this end, game difficulty was set to 'normal' in the map editor. Common enemy zombies had 50 health, and would spawn in herd sizes respective to the player performance as judged by the AI director. The player and their AI-controlled teammates had 100 points of health each, and would take 2 damage per hit to their front and 1 damage per hit to their back. The AI Director (DDA) was enabled. Refer to Figure 1 for a screenshot of the typical play experience for the balance condition.

Boredom Condition

Figure 2. Screenshot of the 'boredom' condition.

The boredom was designed for challenge-skill imbalance, where the skill of the player far exceeded the challenge of the game. In this condition, enemies were removed entirely from the game. The gameplay in this condition consisted entirely of retrieving the gas canisters scattered throughout the map. As the gas canisters are highlighted in the map in all conditions, finding the canisters did not represent much challenge; additionally, the large size of the map and the distribution of the canisters ensured a repetitive experience. Despite the removal of combat altogether, the inclusion of canister collection and travel in the virtual world ensures the game remains sufficiently game-like. Refer to Figure 2 for a screenshot of the typical play experience for the boredom condition.

Overload Condition

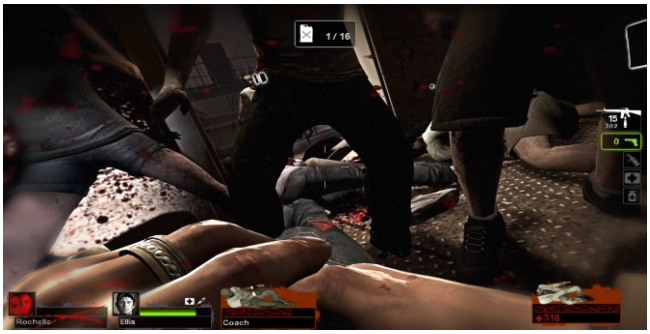

Figure 3. Screenshot of the 'Overload' condition.

Similar to the boredom condition, the overload condition was also designed for challenge-skill imbalance. In this condition, the challenge-skill imbalance was accomplished through challenge outstripping player skill. This was achieved through extra enemy health, drastically increased enemy count, extra damage taken from enemy hits and friendly fire, and reduced friendly AI line-of-sight range. The high spawn rate of enemy AI also reduced the potential for 'cooldown spots' [20] that allow players time to heal, regroup, and restock on ammunition.

To this end, game difficulty was set to 'expert' in the map editor. Common enemy health was raised from 50 (in the balance condition) to 1000. The player and their AI-controlled teammates had 100 points of health each, and would take 20 damage per hit to their front and 10 damage per hit to their back. All special enemies, including the 'tank', had their health multiplied by 4; this gave tanks 16,000 health points. In addition to this, zombies were more likely to spawn behind the player, there was no game-enforced limit on how many zombies could be present in the map at a time, and special infected spawn rate was increased. Refer to Figure 3 for a screenshot of the typical play experience for the overload condition.

Participants

Forty-five participants (thirty-three male), aged 17 – 29 (mean age of 22.1, *SD* = 3.75), volunteered for the study. A demographics survey distributed at the start of the experiment asked for their estimation of their experience with video games; on a Likert scale of 1 – 7, with '7' representing 'extremely experienced' and '1' 'not at all experienced'. Participants self-rated as an average of 6.1 (*SD* = 1.08) for 'general experience with video games' and 5.2 (*SD* = 1.85) for 'experience with first-person shooters'. Participants were recruited through word-of-mouth, undergraduate lectures, and online flyers, and were compensated for their time with video game keys.

Experimental Environment

The experiments took place in a laboratory environment on gaming PCs. The experimenter sat behind a partition in the corner of the laboratory, facilitating participant comfort through lack of direct observation. Experiments were conducted on one participant at a time, ensuring that only the participant and one researcher were present in the room during data collection.

Process

Upon entering the laboratory, participants were briefed on the experiment procedure and the tasks they were to undertake. Participants were then set-up with instruments used to record their physiological signals, of which the results are not reported for this paper. Participants would then answer a short demographics survey and spend approximately five minutes playing a custom tutorial for the game. The tutorial took place in the same map as the game conditions, and introduced the player to game mechanic basics such as shooting, using medkits, interacting with doors, and picking up gas canisters.

The study employed a repeated measures experiment design to offset learning effect; as such, 23 participants played the balance condition first, and 22 participants played the boredom condition first. The overload condition was always played last to prevent residual frustration influencing the experience of the boredom and flow conditions. Each condition self-terminated after ten minutes of playtime.

After each of the three game conditions, participants would spend five to ten minutes completing a questionnaire on their player experience. The results from the competence, autonomy, and presence subscales of PENS, the interest/enjoyment subscale of the IMI, and the results from PANAS are reported in this paper.

RESULTS

No issues were found with singularity or multicollinearity, and so a repeated measures multivariate analysis of variance was conducted on all the subjective self-response measures using the experimental condition as the within-subjects factor. Outliers were assessed by inspection of a box plot. One extreme outlier was identified for negative affect that was causing violations to the assumption of normality for that measure, but analysis with and without the participant revealed no changes in the pattern of results so the full sample was included in all analyses. Mauchly's Test indicated that the assumption of sphericity had been violated for PENS Autonomy ($W = .865$, $\chi2(2) = 6.071$, $p = .048$), IMI Interest/Enjoyment ($W = .767$, $\chi2(2) = 11.115$, $p = .004$), and PANAS Positive Affect ($W = .637$, $\chi2(2) = 18.973$, $p < .001$), so Greenhouse-Geisser adjustments ($\varepsilon = .881$, $\varepsilon = .881$, $\varepsilon = .733$) were used for their within-subjects univariate analyses. Wilk's Lambda and an alpha level of $p < .05$ was used as the significance test for the RM MANOVA results, while a Bonferroni adjustment was applied to pairwise comparisons to control the experiment-wise error rate. The repeated-measures MANOVA revealed a significant multivariate within-subjects effect of condition on the subjective response measures ($F(12, 32) = 12.572$, $p < .001$, $\eta p2 = .825$).

PANAS: Positive & Negative Affect

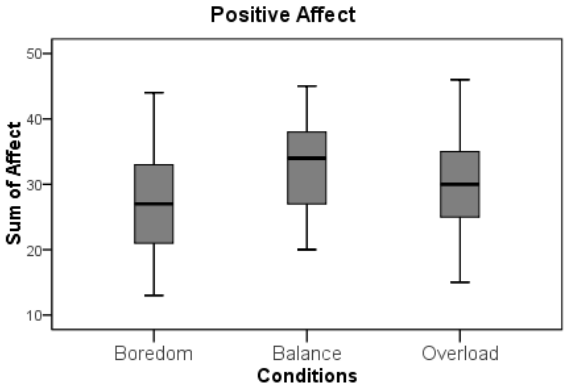

Figure 4. Sum of positive affect across each play condition

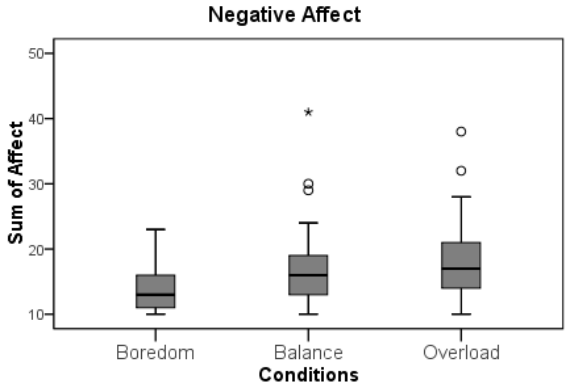

Figure 5. Sum of negative affect across each play condition

Significant univariate main effects were observed for both PANAS positive affect ($F(1.450, 63.799) = 15.884$, $p < .001$, $\eta p2 = .265$) and negative Affect ($F(2, 88) = 10.616$, $p < .001$, $\eta p2 = .194$). Post-hoc analysis revealed that participants reported significantly greater positive affect in the balance ($M = 33.49$, $SD = 6.97$) condition than in both the boredom ($M = 26.25$, $SD = 7.91$, $p < .001$) and overload ($M = 30.27$, $SD = 7.91$, $p = .002$) conditions. Additionally, participants reported significantly greater positive affect in the overload condition than in the boredom condition ($p = <.05$). In terms of negative affect, participants reported significantly less negative affect in the boredom ($M = 14.09$, $SD = 3.76$) condition than in both the balance ($M = 17.11$, $SD = 5.84$, $p = .005$) and overload ($M = 17.60$, $SD = 6.10$, $p < .001$) conditions. No significant difference in negative affect was found between the overload and balance conditions. Please refer to Figures 4 and 5 for graphs presenting affect findings.

IMI: Interest/Enjoyment

Post-hoc analysis revealed that for the main effect on IMI Interest/Enjoyment participants reported significant differences between all three conditions, such that the balanced condition ($M = 5.5$, $SD = .955$) showed significantly higher interest/enjoyment levels than both the boredom ($M = 3.49$, $SD = 1.56$, $p < .001$) and overload ($M = 4.99$, $SD = 1.36$, $p = .015$) conditions, and the overload condition also showed higher interest/enjoyment than the boredom condition ($p < .001$). Please refer to Figure 6 for a graph representing the results for interest/enjoyment.

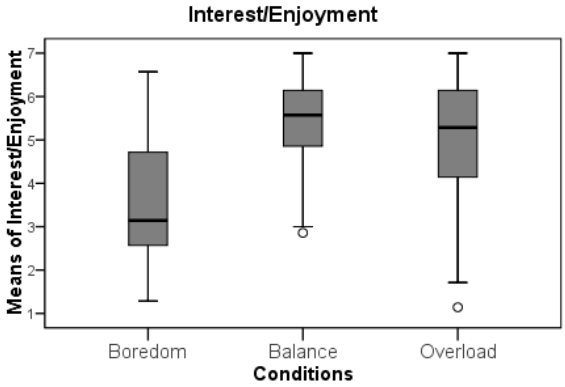

Figure 6. Means of interest/enjoyment across each play condition

PENS: Competence, Autonomy, & Presence

Significant univariate main effects were observed for competence ($F(2, 88) = 37.842$, $p < .001$, $\eta p2 = .462$), autonomy ($F(1.727, 75.978) = 15.441$, $p < .001$, $\eta p2 = .26$), and presence ($F(2, 88) = 17.019$, $p < .001$, $\eta p2 = .279$). Post-hoc analysis revealed that for the main effect on competence, participants reported significantly less competence in the overload condition ($M = 2.98$, $SD = 1.46$) than in the balance ($M = 4.90$, $SD = 1.58$, $p < .001$) and boredom ($M = 5.13$, $SD = 1.39$, $p < .001$) conditions. No significant difference found between balance and boredom. For main effect on autonomy,

the balance condition (M = 4.30, SD = 1.31) showed significantly higher autonomy than both the boredom (M = 3.38, SD = 1.49, p = .001) and overload conditions (M = 3.19, SD = 1.22, p < .001), with no significant difference reported between the boredom and overload conditions. Finally, the main effect on presence revealed that the balance condition (M = 3.93, SD = 1.28) showed significantly higher presence than both the boredom (M = 3.06, SD = 1.14, p < .001) and overload (M = 3.24, SD = 1.24, p < .001) conditions, with no significant difference revealed between the boredom and overload conditions. Refer to Figures 7 - 9 for the graph presenting competence, autonomy, and presence findings.

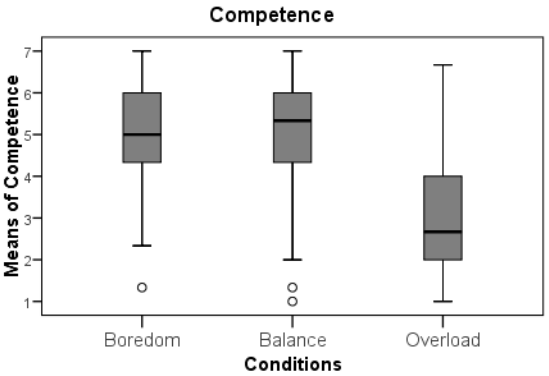

Figure 7. Means of competence across each play condition

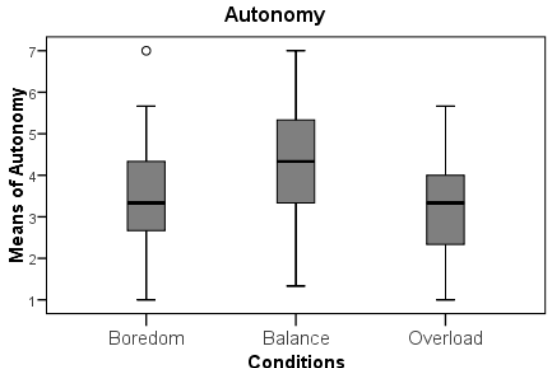

Figure 8. Means of autonomy across each play condition

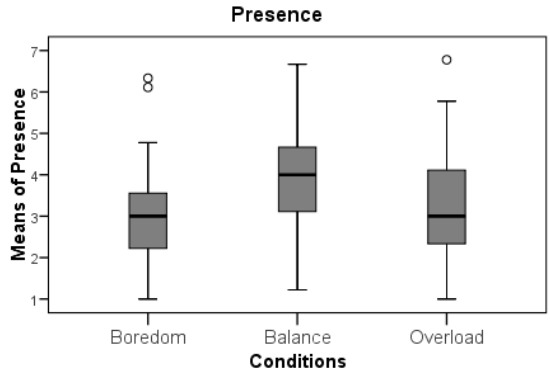

Figure 9. Means of presence across each play condition

DISCUSSION

Generally, the self-report measures supported the balance condition as the optimal play experience amongst the three conditions. The balance condition rated higher for measures indicative of a positive play experience for almost all measures, with surprising exceptions for negative affect and competence. The impact of overload and boredom on the experience of play was also interesting, and points to disparities in sub-optimal play experiences in that different sub-optimal experiences may not be reported the same way.

Affect

While participants reported greater positive affect in the balance and overload condition than the boredom condition, and greater positive affect in the balance condition than the overload condition, greater negative affect was also found in the balance and overload conditions than in the boredom condition. This could be attributed to less emotional engagement for both positive and negative affect: the boredom condition, through absence of any challenge, did not implicitly evoke feelings of pride (through achievement, or overcoming a difficult obstacle), enthusiasm, or excitement; likewise, the banal nature of the task potentially did not allow for feelings of shame, nervousness, or distress due to absence of threat or failure. The boring nature of the boredom condition was corroborated anecdotally through comments made by participants in a 'General Comments' field in the respective condition surveys, including:

"No zombies or challenges makes it boring"

"Only boring due to the easiness and repetitiveness of the task at hand."

"No enemys (sic) *not as much fun"*

Increased negative affect in the balance and overload conditions support Jennett et al.'s hypothesis that faster-paced games lead to greater negative affect [13]. In terms of games design and research, it may be pertinent to be aware that less negative affect does not necessarily translate to a more optimal play experience, and, in fact, could be indicative of a sub-optimal experience through lessened mental stimulation or emotional engagement.

Positive affect appears to remain a reliable predictor of optimal play experiences, with a caveat in that those who experienced challenge > skill imbalance still reported greater positive affect than those who experienced skill > challenge imbalance. Again, anecdotal participant feedback in the surveys indicated that the condition performed as expected in terms of providing an overwhelming play experience:

"Wasn't expecting it to be that hard."

"I died 3 times, I really suck :("

"... the amount of zombies seemed overwhelming for the task requested by the game."

"Overall this session was frustrating and I definitely felt a sense of 'lack of control', such that I didn't see a point in

trying to complete the level, knowing that it wasn't going to happen."

Despite this, it is possible that the experience remained 'fun' despite the excessive challenge of the condition. Some feedback indicated that participants may have had fun despite the challenge-skill imbalance:

"I had more determination to complete the objective even though I kept dying. Just getting one or two cans was enough"

"It had its moments, such as when everyone was away from me and I was healing up myself, only at the VERY LAST MOMENT a zombie hitting me in the back - that was kind of cool."

Interestingly, this may tentatively point to challenge > skill imbalance as a more enjoyable experience than the reverse; that is, overwhelming the player may lead to more positive experiences or affect than underwhelming or boring the player. Another explanation may be that the presence of combat in a combat-based game, regardless of challenge-skill balance or imbalance, is inherently more fun than or preferable to the complete absence of combat. However, when considering previous research that suggests a preference amongst casual or inexperienced players for low challenge [17] [2], it is important to consider that the findings in the present study may reflect the relatively high levels of self-reported experience among participants.

Interest/Enjoyment

Participants reported significantly greater interest/enjoyment for the balance condition than for both the boredom and overload conditions, and was rated highly overall, supporting the balance condition as the optimal play experience in terms of interest/enjoyment. On the surface, this result contradicts the findings of greater negative affect in the balance condition than the boredom condition; however, as previously discussed, this can likely be attributed to generally heightened mental or emotional stimulation in the balance condition. This finding also represents further evidence that challenge-skill balance plays an important role in the player experience, as other research supports [15] [20].

As with positive affect, participants also reported greater interest/enjoyment in the overload condition than for the boredom condition, again possibly pointing to a more positive play experience with challenge > skill imbalance than skill > challenge imbalance. It is also possible that the inclusion of combat mechanics was sufficient to elicit this improvement.

Competence, Autonomy, and Presence

No significant differences were found for competence between the boredom and balance conditions. This may be because some PENS competence items are able to be rated highly for both experiences of challenge-skill balance and skill > challenge imbalance. For example:

- *I felt very capable and effective when playing.*

The absence of sufficient challenge in the boredom condition removes opportunity for failure or error. As such, it may be that feelings of competence are not inhibited, allowing players to experience mastery over the condition's simple fetch task.

Another item more directly addresses challenge-skill balance, however, academic use of the commercial PENS scale does not extend to publishing this item. The item enquires about the player's experience of challenge-skill balance, but does not specify if the absence of balance is the result of challenge exceeding skill or skill exceeding challenge. It is possible that participants responded to this item using either interpretation. That is, disagreement with the item could be indicative of both ability exceeding the challenge, or challenge exceeding ability. It is possible that participants interpreted disagreement with this item as representative of an inability to meet the condition's challenges, potentially affecting rating for this subscale. Another possibility is that participants may have sought out their own challenge for this condition – for example, attempting to collect all the fuel canisters before the condition self-terminated. This is supported by anecdotal comments provided to the experimenter through the survey comments, as follows:

"… given the trivial difficulty, I set a challenge to myself to speedrun the game as quickly as possible (given my limited skills) …"

"I kinda made my own game out of juggling the canisters."

Finally, experience of competence in instances of sub-optimal or low challenge has been identified in previous PENS literature. Described as 'mastery in action', this experience occurs when players are granted the opportunity to "*deliver a superlative performance without having to work too hard*" [25]. Importantly, these authors note this is not intended to represent the whole of the gameplay experience – rather, developers should provide opportunities for mastery in action as well as optimally challenging play. Thus, it is possible that the findings in the current study reflect participants' experience of 'mastery in action' during the boredom condition and this resulted in high ratings of competence. However, this is arguably less likely given that the whole gameplay experience (in the boredom condition) was low challenge and 'mastery in action' is more likely to occur in situations where it is a 'break' from more optimally challenging play.

All potential explanations point to implications for designers and player experience researchers. Firstly, a high competence rating may not be indicative of challenge-skill balance; researchers should take care to ensure the game artefact does not feature skill > challenge imbalance even in the event of a positive competence rating (unless the intention is to provide a 'mastery in action' experience). Secondly, should the players be setting their own challenge within an intentional skill > challenge imbalance condition,

this highlights challenges associated with designing for a boring play experience while keeping the game artefact 'game-like' (that is, not negating potential for invented challenge through the removal of interactive elements). Researchers and designers may wish to evaluate if players are creating their own challenges within a post-game interview.

Participants reported significantly greater autonomy in the balance condition than in the boredom and overload condition, potentially positioning challenge-skill balance as a precursor of autonomy (or challenge-skill imbalance as inhibitors of autonomy). In the boredom condition, the linear task and absence of combat may have contributed to this: instead of being able to defeat enemy agents in interesting or entertaining ways, participants were relegated to the repetitive task of canister collection. Likewise, in the overload condition, participants were almost immediately overwhelmed by a large number of enemy agents, and thus constrained to the starting area of the map. Often, participant movement was restricted either through incapacitation or enemy AI body blocking. As the enemy presence was continuous and overwhelming, it is also possible that the condition left no room for strategy or target prioritization, forcing the player to simply 'spray and pray' (shoot randomly at enemies).

It is notable that the boredom condition did not elicit greater autonomy than the overload condition, as the boredom condition provided participants with the ability to freely explore the game world, choose their own routes, and not remain near their AI teammates for safety. It is possible that the presence of a clear challenge, even one that is overwhelming for the participant, was able to balance this. Alternatively, the absence of an achievable goal in both the boredom and overload conditions may have prompted participants to feel as though there are no meaningful choices to be made.

Finally, participants reported significantly greater presence in the balance condition than the boredom and overload conditions. This again supports challenge-skill balance as a possible antecedent to the experience of presence, or challenge-skill imbalance as inhibitors of presence, as supported by other research [22]. It is likely that the overload condition interrupted or obstructed the experience of presence due to unrealistic or notably skewed gameplay, thus taking players 'out of' the game. Similarly, the complete absence of zombies in boredom condition is at odds with the story of the game world (as told by NPC commentary, world assets, and prior knowledge of the game), again potentially breaking the illusion of being transported to within the game. It is also possible that a lack of mental stimulation in the boredom condition prompted participants' minds to wander, impeding focus on the game itself. When designing for presence in the game world, this points to the importance of obtaining challenge-skill balance.

IMPLICATIONS FOR FUTURE RESEARCH

While this study attempted to gain insight on the general play experience through evaluation of multiple common experiential phenomena associated with play, experimental limits and time constraints prevented measurement of some constructs. These include immersion, engagement, and relatedness. Study of the impact of challenge-skill balance on these constructs is a recommended path of inquiry for future research. Additionally, the discovery of relatively increased negative affect in 'fast-paced' games (as present in the overload and balance conditions) supports the hypothesis of previous research [13]. Further investigation is needed before any firm conclusions can be made about the presence and implications of negative-affect in either optimal or fast-paced play experiences. The potential challenges of measuring competence in games, especially as the experience of competence may not be indicative of an optimal game experience, also warrant further exploration. Additionally, future research may benefit from a direct measure of individual player skill or performance. This would allow for a robust examination of the skill-challenge relationship. Manipulation of challenge beyond game combat mechanics would also allow for greater insight to the effect of challenge-skill balance and imbalance in video game play. The preservation of consistent play styles (i.e. not removing difficult mechanics) may also prove beneficial for future research.

CONCLUSION

The comparison and evaluation of challenge-skill balance and imbalance on competence, autonomy, presence, affect, and interest/enjoyment has revealed implications of the effect of challenge-skill balance on the play experience. The current study highlights the important role challenge-skill balance plays in achieving the optimal play experience through presence, autonomy, interest/enjoyment, and positive affect. The challenges of designing game conditions that only differ on the variable of interest are discussed, pointing to unexpected player experiences such as competence through easy tasks, invented challenge, and preference for challenge > skill imbalance over skill > challenge imbalance. Greater reported competence for the boredom condition also points to challenges in measuring and interpreting competence in situations in which challenge-skill balance may be compromised. Greater negative affect is also identified as not contradictory to positive affect and play experiences. Finally, further research is recommended in regards to the impact of challenge-skill on other play experience constructs (such as immersion or engagement), the measurement of challenge-skill balance and imbalance, and the measurement of competence in challenge-skill balance.

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