Title:

Greater Rewards in Videogames Lead to More Presence, Enjoyment and Effort

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Abstract

There is currently limited understanding of whether and how different amounts and diversity of virtual rewards impact on the player experience. A repeated-measures experiment was undertaken in which participants (N = 59) were compared on subjective measures (competence, presence-immersion, tension, effort and enjoyment), as well as psychophysiological measures (electrodermal activity and heart-beat rate), during the play of a videogame with three levels of video game reward (high, medium, low). Effort, enjoyment and presence-immersion significantly varied across conditions such that they were greater when all rewards were present compared to one or both of the other conditions. Heart-beat rate was found to vary across conditions consistent with the explanation that greater rewards lead to greater arousal. Our study suggest a number of advantages to greater amount and diversity of virtual rewards in the context of a casual videogame, with potential application to the design of new gamification systems.

Keywords: videogame, reward, psychophysiology, player experience

Introduction

Real world rewards have been established as key motivators for human behaviour with clear implications for learning and behaviour (Madan, 2013). With the volume of digital interactions steadily increasing, the need to understand virtual rewards also grows. Within the context of videogame play, rewards are designed to drive in-game behaviour as well as mark the progress of the player. Consequently understanding how to deploy rewards, when and how much, is an ongoing consideration for video game designers. Parallel to this, video game rewards have been successfully co-opted to motivate behaviours in other settings via 'gamification', or the integration of game design into non-gaming contexts (Deterding, et al., 2011). Despite the relative importance of game rewards for both recreational and serious aims, to date relatively few studies have attempted to identify the impact of differing types, amounts and diversity of rewards on the player.

Rewards and Motivation

Rewards have been posited to potentially impact both extrinsic motivation (where the activity is undertaken in order to obtain a separable outcome) and intrinsic motivation (wherein the motivation to perform the activity is related to the inherent satisfaction of doing it). Specifically, when providing rewards to motivate a behaviour, some research suggests that while there may be an increase in extrinsic motivation, there may be simultaneous decrease in intrinsic motivation (Deci et al., 1999). This decrease in intrinsic motivation is referred to as the overjustification effect, and is thought to occur because the introduction of an extrinsic reward converts intrinsic motivation into extrinsic motivation (Deci et al., 1999). However, cognitive evaluation theory (CET) asserts that the impact of a reward will depend upon how it influences the underlying psychological drives for autonomy and competence, which whensatisfied produce intrinsic motivation. Where a reward is perceived as controlling it may thwart the need for autonomy, or if perceived as informational it may satisfy the need for competence. In turn, an expected reward may be experienced as controlling, and an unexpected reward, not. Furthermore, the impact of expected rewards (whether verbal or tangible) will also depend upon the relationship between the reward and the task (reward contingencies) (Deci et al., 1999). While, there is a widespread belief that video game rewards are effective at facilitating user engagement and motivation, the impact of video game rewards has most often been investigated in the context of either serious video games (Denny, 2013; Hope & Darrel, 2014; Ronimus, Kujala, Tolvanen, & Lyytinen, 2014; McKernan, 2015; Chen, Kuo, Chang, & Heh, 2017), or gamified applications (i.e. the application of game elements in non-game contexts (Berkovsky, Coombe, Freyne, Bhandari, & Baghaei, 2010; Munson & Consolvo, 2012; Goh, Pe-Than, & Lee, 2015; Harms, Seitz, Wimmer, Kappel, & Grechenig, 2015; Siu & Riedl, 2016; Chen, Kuo, Chang, & Heh, 2017), rather than in the context of recreational gameplay. In the current paper, serious games (where the primary purpose is other than entertainment) and gamifiedapplications will be discussed concurrently and the term 'recreational games' will be used to refer to non-serious games.

Rewards in Serious Games and Gamified Applications

Research in non-recreational videogame contexts suggests that differences in the types of rewards have a variety of positive impacts on the player experience. For example, McKernan and colleagues (2015) contrasted the play of an educational game in low and high reward conditions. The high reward condition featured tokens, prizes, badges, scoring, celebratory audiovisual feedback, positive verbal feedback and cut scenes, while the low reward condition removed these or minimised them. While participants in the high reward condition (larger amount and greater diversityof rewards than in the low reward condition. The authors found that participants' learning outcomes and subjective sense of feeling rewarded, those in the highreward condition felt the game provided more praise and recognition than those in the low reward condition. Additionally, evidence was found of positive associations between feeling rewarded and immersion, positive affect, workload and intrinsic motivation, and negative associations between feeling more rewarded and fatigue and negative affect. The authors concluded that while a higher number of rewardsdid not influence learning in an educational game, players responded more positivelyto the game when they felt more rewarded (regardless of how many rewards were actually present). Providing further evidence for the positive impact of rewards on subjective experience, Goh, Pe-Than and Lee (2015) explored the impact of rewardsin a Human Computation Game (involving a map-based interface for accessing location-based content). Supporting McKernan's findings, Goh and colleagues found that participants reported greater enjoyment in response to both points and badges (in comparison to a control condition). While Goh et al., did not collect data related toparticipant performance found that participants rated the game as providing more accurate and complete information when rewards were provided.

In contrast to McKernan at al., (2015) and Goh et al., (2015) (who found evidence of connections between rewards/feeling rewarded and other positive subjective responses), Mekler, Bruhlmann, Opwis and Tuch (2013) found evidence of behavioural difference in the absence of differences in subjective responses. Mekler and colleagues explored the impact of points, leaderboards and levels in the context of a gamified image annotation task. While the presence of rewards led to improved performance (in terms of number of tags generated) no differences were found between conditions for task interest, enjoyment, competence nor autonomy. Overall, a clear picture of the influence of rewards in gamified applications and serious games is yet to emerge.

Rewards in Recreational Games - Subjective Player Experience

Research specific to recreational videogame rewards has explored the value in being able to distinguish different categories of videogame rewards (Wang and Sun, 2011; Phillips, Johnson, Wyeth, Hides, & Klarkowski, 2015). However, much of the research exploring the impact of rewards on subjective player experience (i.e., that measured through questionnaires, focus groups, interviews etc.) has focussed on the impact of a single reward. Bowey and colleagues investigated the impact of leaderboards, finding that higher leaderboard positions increased player perception of competence, autonomy, presence, enjoyment, and positive affect compared to lower leaderboard positions. Furthermore, emphasising players' leaderboard position (with colour and an individual score) resulted in enhanced positive affect, enjoyment, and autonomy, relative to when their position was not emphasised (Bowey, Birk, & Mandryk, 2015). It is worth noting however, that Bowey's study focussed on comparing leaderboard positions (low vs high) and not on the impact of leaderboards in comparison to their absence. Moving from in-game rewards, Cruz and colleagues (2017) conducted focus groups exploring players opinions of 'meta-game' rewards (badges on the Xbox network and trophies on the Playstation network). They found that participants felt the value of meta-game rewards included boosts to self-esteem and social status as well as positive feedback about gameplay. However, notably, to date, research on the impact of rewards on subjective player experience in recreational games has focussed on single reward types and has not compared the impact of rewards to their absence.

Rewards in Recreational Games - Psychophysiological Player Experience

Alongside research exploring the impact of rewards in games on subjective player experience, researchers have also explored the impact on player psychophysiology. However, in line with research focussed on subjective responses to rewards, this research has, to date, also focussed on the impact of single types of rewards. Ravaja et al. (2006), conducted a phasic[1] event-based assessment of emotional responses in a video game (Super Monkey Ball 2) employing facial electromyography (EMG), electrocardiography (ECG), and electrodermal activity (EDA). Chief among the events studied in the game were those classified by the researchers as rewards: picking up single or bunches of bananas, which translates directly into points earned in the game (Ravaja, Saari, Salminen, Laarni, & Kallinen, 2006). The researchers reported a largely linear relationship between rewards obtained in the game and immediate phasic increases in physiological arousal, as revealed by a decrease in cardiac interbeat intervals (faster heart beat rate; ECG) and an increase in skin conductance amplitude (EDA) directly following the obtainment of rewards. Additionally, the researchers found that the more impactful reward – a bunch of bananas, representing multiple points, as opposed to a single banana – elicited greater arousal (EDA). In this way, Ravaja and colleagues provide initial support for the idea that a greater amount of rewards can be more impactful. Finally, generally increased positive valence (as assessed by an increase in electromyographic activity associated with smiling) was found in response to collecting in-game rewards.

These findings contrast with those of a study by Duarte & Carriço (2012) who compared two types of rewards in the play of an adapted, mobile phone version of Whack-A-Mole. The rewards had a direct influence on gameplay that increased the players' time to respond to challenges in different ways (i.e., by slowing in-game motions or by extending the time available). Participants' heart beat rate, heart rate variability, score and accuracy were measured as they played three games: a baseline game with no introduced rewards and a second and third condition with a different reward included in each. The authors found that both rewards resulted in significantly lower heart beat rate and variability than the game with no rewards, implying that the rewards were experienced as more relaxing. This finding contrasts with those of

[1] A phasic approach refers to an event-based assessment of physiological response to discrete stimuli; this is in contrast to a tonic approach, which captures the average physiological response to the entirety of an experience (Stern et al., 2001).

Ravaja and colleagues (2006), however it is worth noting that Duarte and Carriço's rewards directly reduced the time-related stress inherent to the gameplay while the rewards employed by Ravaja had no influence on gameplay. Regardless, both studies suggest that differing rewards directly impact the player experience (as measured by player physiology). However, neither study explores theimpact of multiple, diverse rewards. The tendency, in the existing literature, to focus on the impact of single rewards, makes sense in terms of isolating the impact of a single construct in a controlled manner, but obviously comes at the cost of greater ecological validity (in almost all games, multiple types of rewards are presented tothe player).

Current Study

The present study aimed to make a unique contribution bybuilding on the gaps in the existing literature related to:

- Assessing the impact of digital rewards in the context of a recreational videogame (that is, not a serious game or gamified application)
- Assessing the impact of multiple rewards types presented concurrently
- Comparing the presence of rewards to their (relative) absence
- Comparing different amounts and diversity of rewards
- Assessing outcomes using both subjective (questionnaire) and objective (psychophysiological) measures of the player experience

It is worth noting two corollaries in relation to the above. Firstly, it is difficult (perhaps impossible) to create a videogame that is completely devoid of rewards. As a result, what might have been our 'no reward' condition became a 'low reward' condition in which a minimum of rewards were present. Secondly, we prioritised ecological validity (in terms of assessing the impact of multiple concurrent rewards) at the cost of being able to independently control the amount and diversity of rewards. In other words, our conditions with increased rewards had both a higher number and greater diversity of rewards than our conditions with decreased rewards (in contrast to including conditions that had, for example, a high number of a single type of rewards to conditions that had the same high number of rewards of differing types).

Given the range of findings in the existing literature, including conflicting evidence regarding the impact of individual reward types on specific aspects of subjective and objective player experience, we aimed to answer a research question (with 3 sub-components) related to the impact of the amount and diversity of rewards on the player experience, rather than to generate specific hypotheses. The existing research provides mixed evidence of potential positive impacts of rewards on the subjective player experience and increases in arousal. In addition to exploring these variables we also sought to assess the impact of rewards on player perceptions on tension and effort. On the one hand, rewards might be expected to reduce the sense of effort and tension through creating a more positive player experience. Alternatively, it may be that the potential for greater rewards increases the players sense of striving to receive the rewards with associated increases in effort and tension.

Research Questions:
Does the amount and diversity of rewards in a recreational videogame

1) Impact positive affective components of the player experience (competence, presence-immersion[2] and enjoyment)?
2) Influence player arousal (as measured by Electrodermal Activity and Heart Rate)?
3) Impact player perceptions of tension and effort during play?

Method

The research featured a repeated-measures study design, employing three video game conditions representing “low”, “medium”, and “high” reward play sessions. A mixed-methods approach was undertaken, employing physiological measures of arousal and subjective measures of motivation and needs satisfaction to investigate the possible influence of rewards on the player experience.

Participants

Approval was granted by a university ethical review board to recruit individuals aged 17 years or older, who had some interest in videogames and did not have heart arrhythmia. Participants were recruited using an email list of participants who were happy to be contacted regarding videogame play research. Fifty-nine participants took part in the study, 83.1% male, aged between 17 to 64 year old (M = 21.33, SD = 7.9). On average, they reported playing videogames 14.1 hours per week (SD = 10.95)

Procedure

Upon arrival at the laboratory, participants were provided a brief overview of their role throughout the experiment. After providing consent, participants were instructed to wash and dry their hands and were seated at the experiment computer. EDA and ECG electrodes were then attached, with light cleaning and abrasion in the ECG sites before the electrodes were fastened. Following a demographics questionnaire, participants played the game three times (‘high’ level of rewards, ‘medium’ level of rewards, and ‘low’ level of rewards) in fully counter-balanced order. Before playing their first game level, participants completed the in-game tutorial that took them

[2] While presence and immersion are often defined as separate constructs, the measure used in the current study (the Player Experience of Need Satisfaction) includes a subscale designed to measure both player experiences. As a result the term presence-immersion is used in this paper.

through the gameplay controls. After finishing each eight to ten-minute play session, participants would complete self-report measures including the PENS and IMI (see below). Throughout the play and survey sessions, the researcher sat at a separate machine monitoring the play session (streamed to the researcher PC) and real-time physiological recording; direct vision of the participant was intentionally obfuscated by a partition to improve participant comfort. When all play and survey sessions were completed, participants were debriefed, thanked, and compensated for their time. Experiment runtime (from participant arrival to departure) was approximately 70 minutes (Consent forms and electrode preparation and attachment - 20 minutes; Demographic surveys - 4 minutes; Game Tutorial - 5 minutes; First gameplay session - 8-10 minutes; Surveys - 4-6 minutes; Second gameplay session - 8-10 minutes; Surveys - 4-6 minutes; Third gameplay session - 8-10 minutes; Survey 4-6 minutes; Debrief, thanks and payment - 2-4 minutes). The ambient temperature recorded in the lab was 23.4 degrees celsius.

The game

The game, ‘Fox Run’, is a simple platform runner (developed for the purposes of the study) featuring a fox being chased by a dog. The fox must pass under, over or through a series of obstacles in order to reach safety. To ensure a consistent experience across participants, in the version of the game used for study, the dog cannot actually catch the fox (it remains a short but variable distance behind the fox). Three conditions were created with varying rewards. Being able to reach the next level was required in all conditions. As many reward definitions and typologies (Hallford & Hallford, 2001; Phillips et al., 2015) include access to a new level as a type of reward we refer to the condition that only features this type of reward as a low (rather than control or ‘no reward’ condition). Based on Phillips and colleagues (2015) typology we included only rewards of access in the ‘low’ reward condition; rewards of access, facility and sustenance’ in the ‘medium’ reward condition; and rewards of access, facility, sustenance, glory, praise and sensory feedback in the ‘high’ reward condition (for definitions of each reward type see Phillips et al., 2015). The rewards used in each condition are shown in Table 1, below.

Reward Type	**Condition 3 ("High")**	**Condition 2 ("Medium")**	**Condition 1 ("Low")**
Next level	Yes	Yes	Yes
Hammer (used to break obstacles to progression)	Yes	Yes	
Feather (Unlocks Bonus Level)	Yes	Yes	
Decoy/Extra Life	Yes	Yes	
Comparison to previous game time	Yes		
Visual Rewards (e.g. fireworks at end of game)	Yes		
Achievements	Yes		
Speedboost	Yes		
"Congratulations" (text displayed at end of level)	Yes		
"Good Jump" (text displayed after successful jump)	Yes		
Leaderboards	Yes		

Table 1. Rewards included in each study condition.

The game contains an inbuilt tutorial that takes the participant through the keyboard controls, with each level of the tutorial introducing a new skill such as dashing, jumping, and jump-dashing. Once the tutorial has been completed, the participant progresses to actual gameplay. The game features five main levels, with a further unlockable five bonus missions immediately following each mission if the participant picks up the "bonus level" token. The participant progresses through these levels for eight to ten minutes per condition. Please refer to Figure 1 for a screenshot of the game featuring the 'feather' reward, and Figure 2 for a screenshot of the visual rewards displayed at the end of the level from the 'high' reward condition.

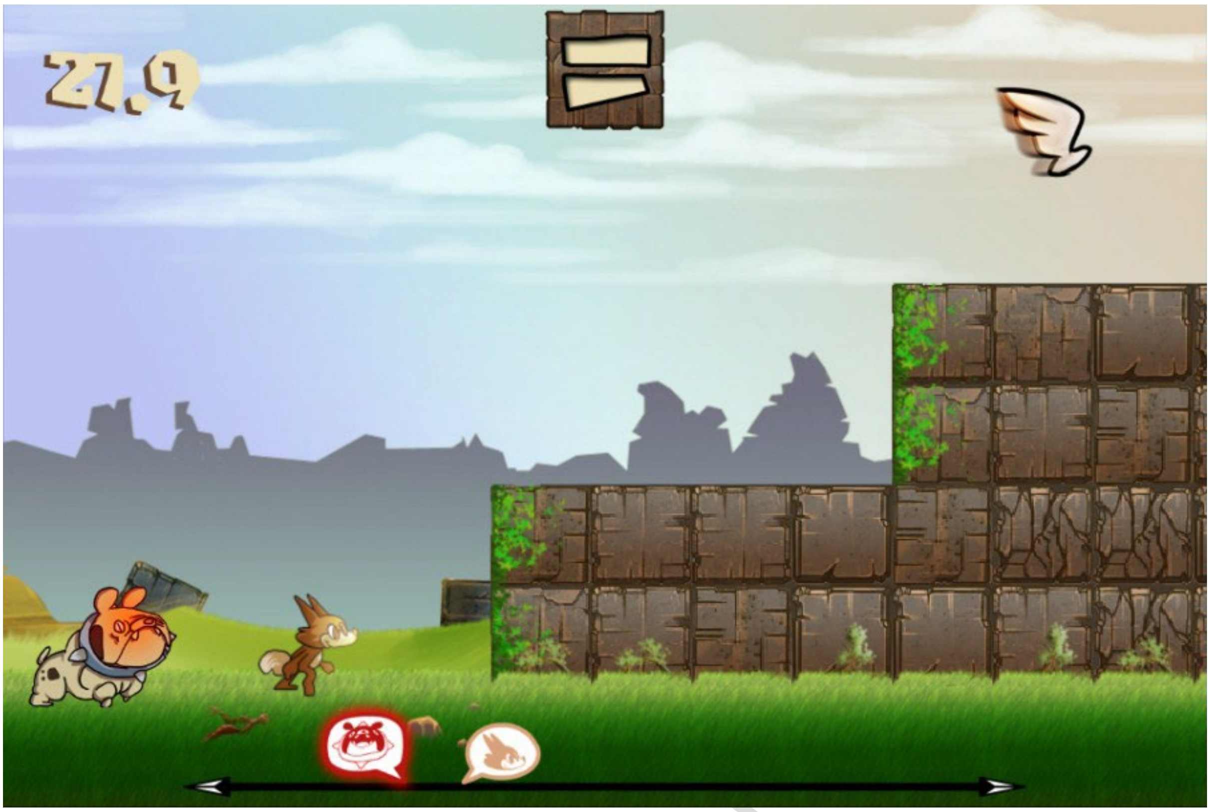

Figure 1. Game level featuring the feather reward.

Figure 2. End of level visual rewards.

Measures

Subjective Measures

Competence, enjoyment, effort, and tension were measured using the Post-experimental Intrinsic Motivation Inventory (IMI). The IMI is a validated measure of a participant's subjective experience of intrinsic motivation for an activity (McAuley, Duncan, & Tammen, 1987). The four sub-scales used consisted of 23 items in total, measured on a 7-point scale, an example being "I think I am pretty good at this activity" (competence).

The in-game experience of presence-immersion was measured using the relevant subscale of the Player Experience of Need Satisfaction Scale (PENS). The presence-immersion subscale consists of 9 items measured on a 7-point scale, an example being: 'When moving through the game world I feel as if I am actually there'.

Physiological Measures

ECG

Electrocardiographic activity (ECG) is an umbrella term for a multitude of analyses of heart rhythm, pace, and variation. In terms of psychophysiological assessment, ECG activity can be used as a measure of both arousal and valence dependent on the method of analysis; within this paper, the average interbeat interval (IBI) - the period of time that occurs between each R-wave, or heartbeat - is reported. Decreases in IBI, indicative of a faster heart rate, are associated with increases in stress, anxiety, excitement, and mental workload (Andreassi, 2007; Melillo, Bracale, & Pecchia, 2011).

Participants' cardiac activity was recorded from a two-lead montage using disposable self-adhesive electrodes with one electrode placed five cm below the right clavicle and the second electrode placed on the V6 location (i.e., left midaxillary line). The electrode cavities were filled with a conductive gel prior to application. The skin where the electrodes were located was lightly cleaned and abraded before attaching the electrodes. The impedance of all electrode pairings was below 5 kΩ during the testing sessions

EDA

Electrodermal activity (EDA) is a widely used physiological measure of emotional arousal, owing to its sensitivity to psychological stimuli (Dawson, Schell, & Fillion, 2000). EDA is the study of electrical activity of the skin, as generated by eccrine sweat gland activity and recorded with cutaneous electrodes. While EDA can be measured both exosomatically (skin conductance and resistance) and endosomatically (skin potential), the exosomatic method is primarily used in contemporary research. EDA is responsive to a breadth of stimuli, including surprise,anxiety, stress, and novelty (Dawson et al., 2000), and as such, has been widely adopted in the analysis of player experience (Mandryk, 2008; Nacke, 2013).

Participants' electrodermal activity was recorded with two disposable snap electrodes pre-filled with a 0.05 M sodium chloride electrolyte gel. Exosomatic electrodermal activity was measured with a constant voltage of 0.5 V and was sampled at 500 Hz. The two electrodes were placed on the thenar and hypothenareminences of the left hand, due to the concentrated presence of eccrine sweat glands located at these sites. Prior to application, participants' washed their handswith hypoallergenic soap-free handwash.

Initial analyses

All analyses were carried out using SPSS 24.0. Pearson correlations and Cronbach's alpha for the dependent measures can be seen in Tables 2-4 (below).The primary analysis was conducted using a combination of analysis of variance (ANOVA), and multivariate analysis of variance (MANOVA). Reward type was entered as the within-subjects factor.

	1. Competence	2. Effort	3. Enjoyment	4. Tension	5. Pres-Imm	6. ECG	7. EDA
Cohens' Alpha	.905	.785	.869	.808	.874		
1	-	.103	.110	-.126	-.070	-.266*	-.006
2		-	.571**	.449**	.351**	.014	-.094
3			-	.383**	.495**	-.148	-.001
4				-	.342**	-.293*	.077
5					-	-.177	-.214
6						-	-.243

Table 2. Pearson's correlations (2- tailed) and Cohen's alpha for scale measures:'High' level of reward

** p < 0.01 * p < 0.05

	1. Competence	2. Effort	3. Enjoyment	4. Tension	5. Pres-Imm	6. ECG	7. EDA
Cohens' Alpha	.901	.887	.877	.866	.856		
1	-	.153	.091	-.102	-.239	-.156	.058
2		-	.511**	.430**	.073	.203	-.055
3			-	.353**	.455**	.100	-.072
4				-	.415**	-.289*	.066
5					-	-.112	-.181
6						-	-.120

Table 3. Pearson's correlations (2- tailed) and Cohen's alpha for scale measures:'Medium' level of reward

** p < 0.01 * p < .05

	1. Competence	2. Effort	3. Enjoyment	4. Tension	5. Pres-Imm	6. ECG	7. EDA
Cohens' Alpha	.901	.887	.877	.866	.856		
1	-	-.317*	-.219	-.489**	-.304*	-.268*	.111
2		-	.520**	.532**	.359**	.222	-.119
3			-	.358**	.618**	-.043	-.031
4				-	.251	-.080	.036
5					-	.098	-.209
6						-	-.189

Table 4. Pearson's correlations (2- tailed) and Cohen's alpha for scale

measures:'Low' level of reward

** $p < 0.01$ * $p < 0.05$

In order to address the assumptions of repeated-measures MANOVA (Tabachnick &Fidell, 2007), the dependent variables were entered into separate tests based upon degree of correlation. Tension was isolated due to an issue with multicollinearity in the low rewards condition (Pearson's correlation of less than -0.4) (Mayers, 2013).

This resulted in two separate tests: one ANOVA contrasting the levels of tension, and one MANOVA containing the outcome measures of EDA, ECG, Competence,Enjoyment, Effort, and Presence-Immersion. To control the experiment-wide errorrate a Bonferroni correction (Field, 2013) was applied at the multivariate level (resulting in a required p-value of 0.025 for the multivariate F value). For the MANOVA, follow-up tests using a series of ANOVAs were used to assess the univariate effects. Effect sizes are reported as partial eta-squared and interpreted using Cohen's [3] criterion of small (.01), medium (.25) and large (.40) effects.

Further to this the EDA data was found to have non-normal distribution and a log transformation was applied. The primary analysis was carried out with the transformed and non-transformed variable. As no substantive differences in results were revealed the results using the non-transformed variables are reported below.All further assumptions regarding collinearity, outliers, linearity, univariate and multivariate normality, sphericity, and homogeneity of variance and covariance matrices (Tabachnick & Fidell, 2007) were satisfied with the exception of ECG violating the assumption of sphericity. This was corrected for with a Greenhouse- Geisser adjustment at the univariate level.

Results

For the one-way RM ANOVA with Tension as a dependent variable the difference between the conditions was non-significant ($F(2, 116) = 0.69$, $p = .504$, ${}_p\eta^2 = .012$). However, the RM MANOVA with the remaining dependent variables revealed a significant multivariate effect of the level of reward ($F(12, 44) = 3.57$, $p < .001$, ${}_p\eta^2 = .492$). As previously noted, the assumption of sphericity was violated for ECG ($W = .881$, $\chi^2(2) = 6.84$, $p = .033$), and so a Greenhouse-Geisser adjustment ($\varepsilon = .894$)was used for its univariate analysis. Step-down analysis revealed significant univariate effects for Presence-Immersion ($F(2, 110) = 5.11$, $p = .008$, ${}_p\eta^2 = .085$)
Enjoyment ($F(2, 110) = 14.1$, $p < .001$, ${}_p\eta^2 = .204$), Effort ($F(2, 110) = 3.74$, $p = .027$, ${}_p\eta^2 = .064$) and ECG ($F(1.79, 98.3) = 3.34$, $p = .045$, $\eta^2 = .057$) . Univariate effects for Competence ($F(2, 110) = 2.49$, $p = .088$, ${}_p\eta^2 = .043$) and EDA ($F(2, 110) = 2.15$,

p
= .122, $_p\eta^2$ = .038) were non-significant.

For the significant effect of Rewards on Presence-Immersion, step-down analysis revealed that participants reported higher presence-immersion playing with High rewards (*M* = 3.02, *SE* = 0.15) than with Low rewards (*M* = 2.69, *SE* = 0.15, *p* = .009,95% CI [0.07, 0.59]). The differences were non-significant between the Medium rewards (*M* = 2.87, *SE* = 0.14) and the High (*p* = .51, 95% CI [-0.42, 0.12]) and Low
(*p* = .187, 95% CI [-0.05, 0.41]) rewards conditions.

For the significant effect of Rewards on Enjoyment, step-down analysis revealed thatparticipants reported lower enjoyment with Low rewards (*M* = 4.06, *SE* = 0.17) than with the High (*M* = 4.68, *SE* = 0.13, *p* < .001, 95% CI [-0.93, -0.32]) or Medium (*M* =
4.46, *SE* = 0.15, *p* < .001, 95% CI [-0.65, -0.15]) rewards conditions. The difference between the High and Medium rewards conditions for Enjoyment, however, was non-significant (*p* = .269, 95% CI [-0.1, 0.54]).

For the significant effect of Rewards on Effort, step-down analysis revealed that participants reported higher effort playing with High rewards (*M* = 4.63, *SE* = 0.16) than with Medium rewards (*M* = 4.31, *SE* = 0.15, *p* = .034, 95% CI [0.02, 0.62]). Thedifferences between the Low rewards (*M* = 4.3, *SE* = 0.18) and both the High (*p* =
.094, 95% CI [-0.71, 0.04]) and Medium (*p* = 1, 95% CI [-0.36, 0.33]) rewards conditions were non-significant.

For the significant effect of Rewards on ECG, step-down analysis revealed no significant differences between the high rewards condition (*M* = 0.769, *SE* = 0.015,) compared to both the medium (*M* = 0.779, *SE* = 0.016, 95%, CI [-.380,.995], *p* =.823)and low rewards conditions (*M* = 0.778, *SE* = 0.016, 95%, CI[-.079,1.106], *p* = .110); nor between the medium and low rewards condition (*M* = 0.778, *SE* = 0.016, 95%, CI[-.356, .768], *p* = 1.000). Estimated marginal means, standard errors and confidence intervals for the full set of dependent variables tested can be reviewed in Table 5. See Figures 3-6 for graphed significant relationships.

Table 5. Estimated marginal means, standard errors and confidence intervals for outcome measures

Measure	Level of Reward	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Presence-Immersion	High	3.018	0.15	2.717	3.318
	Medium	2.866	0.14	2.584	3.147
	Low	2.688	0.145	2.397	2.979
Enjoyment	High	4.684	0.134	4.415	4.953
	Medium	4.462	0.147	4.167	4.757
	Low	4.063	0.171	3.721	4.405
Effort	High	4.629	0.161	4.307	4.95
	Medium	4.308	0.15	4.008	4.608
	Low	4.295	0.184	3.926	4.664
Competence	High	4.683	0.159	4.364	5.001
	Medium	4.985	0.14	4.704	5.266
	Low	4.67	0.174	4.32	5.019
Tension	High	3.304	0.17	2.963	3.645
	Medium	3.231	0.152	2.926	3.535
	Low	3.159	0.186	2.786	3.533
	High	0.769	0.015	0.738	0.8

ECG	Medium	0.779	0.016	0.747	0.81
	Low	0.778	0.016	0.746	0.81
EDA	High	17.779	1.028	15.719	19.839
	Medium	17.471	0.992	15.483	19.46
	Low	17.265	0.952	15.358	19.172

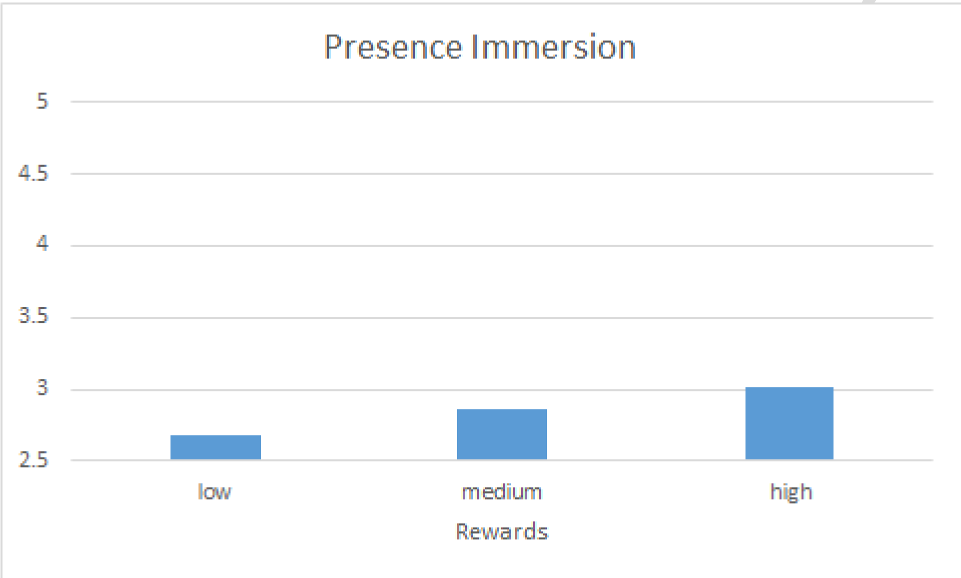

Figure 3. Levels of reported presence-immersion in each condition.

Figure 4. Levels of reported enjoyment in each condition.

Figure 5. Levels of reported effort in each condition.

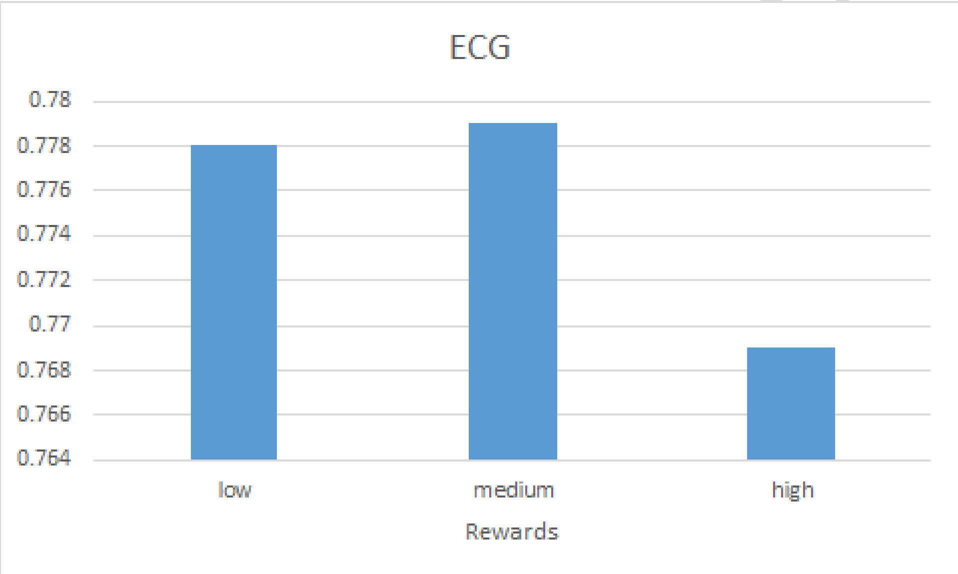

Figure 6. Levels of ECG recorded in each condition.

Discussion

Overall, the study provides insights regarding the impact of digital rewards in a recreational videogame on the subjective and objective player experience. Our findings extend existing research by exploring the impact of multiple reward types concurrently and comparing the impact of varying amounts and diversity of rewards. Broadly, our findings support the notion that a greater amount and diversity of rewards improves the player experience of a recreational videogame. With respect to RQ1 (impact of rewards on subjective player experience), evidence was found of a positive impact on presence-immersion and enjoyment but not competence. Turning to RQ2 (impact of rewards on physiological arousal), limited evidence was found of a change in electrocardiographic activity but no support was found for a change in electrodermal activity. Finally, regarding RQ3 (impact of rewards on tension and effort) evidence was found for a change in effort but not tension.

Impact on Subjective Player Experience (RQ1)

The largest effect of varying amounts and diversity of rewards was found for enjoyment. The pattern of results reflected that greater rewards resulted in higher levels of enjoyment (though with respect to pairwise comparisons this did not reach significance for the medium compared to high reward conditions). This confirms the widely accepted intuition that rewards facilitate greater enjoyment for players and aligns with Bowey and colleagues' (2013) findings around leaderboards in recreational games (though there the focus was on leaderboard position and the degree to which this was emphasised). Our findings with respect to enjoyment also align with Goh, Pe-Than and Lee's findings in the context of a serious game (2015).

A smaller, but consistent, effect was found for presence-immersion, such that the high reward condition resulted in greater presence-immersion than the medium reward condition and, in turn, the medium reward condition resulted in greater presence-immersion than the low reward condition. Overall, this suggests that a greater amount and diversity of rewards effectively draws players into the game, increasing their sense of immersion. The underlying mechanism may be related to the fact that conditions with more rewards incorporated more visual and audio content which in turn contributed to the players sense of presence-immersion. Alternatively, it may be that the additional rewards require greater engagement from the user. For example, in the case of the 'hammer' reward the player may be thinking about the optimal path to take through the level to deploy the hammer effectively. In the case of the 'feather' reward (which unlocks the bonus level) the player may become more focussed on reaching the end of the current level, with an associated increase in presence and immersion. Regardless of the underlying mechanism, the pattern of results (greater presence-immersion in response to greater rewards) aligns with McKernan's (2015) findings with a serious game and Bowey and colleagues' findings related to leaderboard position.

In contrast, no impact of the amount and diversity of rewards was found in terms of player's experience of competence. This aligns with existing research by Mekler and colleagues, who found points and leaderboards had no impact on perceived competence within the context of a gamified image-annotation task. This finding could be interpreted as increasing evidence that rewards do not influence feelings of competence, however in the current study it may be that a ceiling effect of sorts occurred such that all participants in the study experienced the maximum amount of competence possible for the style of game (a casual game in which it was not possible to "die"), regardless of the presence or absence of differing rewards.

Alternatively, given the evidence that rewards perceived as informational are more likely to create a sense of competence, it may be that the rewards used in the current game were not perceived by players as providing useful information regarding their performance in the game.

Impact on Physiological Player Experience (RQ2)

No difference between conditions was found for electrodermal activity. In contrast, a multivariate difference was found for electrocardiographic activity. While the pattern of results (as shown in figure 6) suggest greater arousal (faster heart rate) in the medium and high reward conditions compared to the low reward conditions, these univariate differences did not reach significance. Obviously this pattern should be interpreted cautiously, however the increased heart rate within this context could be associated with an increase in mental workload and/or excitement in response to the rewards. The pattern is broadly consistent with the findings of Ravaja and colleagues (2006), who also found participants heart rate increased in response to rewards. It is worth noting that Ravaja and colleagues used a phasic analysis (with changes in heart rate noted immediately after the obtainment of rewards) while our study took a tonic approach (looking at average heart rate across the play session in each condition). It may be that finer-grain detail afforded by phasic analysis is needed for studying the impact of rewards on arousal during videogame play.

Impact on Perceived Tension and Effort (RQ3)

Our results did not reveal any differences in player experience of tension between conditions. However, players indicated feeling as though they expended greater effort in the high reward condition. This fits intuitively with the idea that more rewards means players have a higher number or diversity of game elements for which to strive. This finding may also be related to the specific rewards present in the high reward condition that were absent in the other conditions. For example, the 'speed boost' reward required players to react more quickly, which quite likely required greater effort for many players. Similarly, the inclusion of leaderboards and completion times in the high reward condition could also have led to players expending greater effort. This finding, at first glance, could be interpreted as inconsistent with the greater enjoyment experienced by participants in response to greater rewards (the argument that greater effort would reduce enjoyment). However, given evidence for the value of a balance between challenge and skill for the optimal player experience (Csikszentmihalyi, 1990), the finding that both greater perceived effort and greater enjoyment result from increased rewards can be seen as consistent and intuitive.

Limitations and Future Research

While the methodology for the current study allowed a controlled comparison of varying levels of the amount and diversity of rewards, four limitations are worth noting. Firstly, the study involved a single, specific game and it is possible that some of the patterns of player experience revealed in this study would vary in the context of other games (for example, games in which the player can fail more clearly by "losing a life"). Future research could informatively seek to replicate our findings with other games. Secondly, in the current study, amount and type of rewards was allowed to covary. That is, the high reward condition featured both a greater diversity and a greater amount of rewards than the medium and low conditions (similarly for the medium compared to the low condition). This decision was made to maximise the ecological validity of the game conditions. In general, commercial videogames that feature a high number of rewards also feature quite a diverse range of types of rewards. Future research might usefully eschew ecological validity in favour of better teasing out the impacts of amount and diversity (for example comparing a game level with a high number of a single type of reward to a level with the same total number of rewards made up of varying types). This could also extend to an exploration of the potential impact of varying categories of rewards as outlined in various taxonomies (Wang & Sun, 2011; Phillips et al., 2015). Thirdly, while conducting the study in a laboratory setting with a custom game allowed us to control many factors, it means that the context of play is most equivalent to a players first time playing a new game. The results in the current study may not hold in situations where players are already familiar with a game or have been playing it for a long time. Finally, the current study featured a largely male participant pool. While this is a limitation that is endemic to much player experience literature (Järvelä et al., 2015), future research nonetheless should seek to ensure a more even gender balance to improve the representativeness of the research. This is especially true of research implementing psychophysiological techniques, as there is evidence of discrepancies between genders in terms of psychophysiological response to various stimuli (Cacioppo et al., 2000).

The pattern of results found also indicate promising avenues for future research. No significant difference was found for EDA or competence. However, the pattern of results for EDA fits with the idea that greater rewards led to increased arousal. Future research could explore the possibility that this difference is more pronounced with other genres of games or alternatively, whether a phasic analysis allows greater insight. Similarly, with respect to competence, the pattern of results suggest greater competence in the medium-reward condition. It is possible that this reflects that different types of rewards influence sense of competence differently. Again, future research that separates type and amount of rewards can shed light on this question. Finally, future research could usefully explore the upper limit for amount of rewards in terms of positive impacts on player experience (that is, is there a point at which too many rewards begin to have a negative influence).

Conclusions

Our study provides important initial insight regarding the impact of amount and diversity of rewards on the subjective and objective player experience. Most clearly, the results suggest that in the context of a casual-style platform runner game greater amount and diversity of rewards increases player enjoyment. Additionally, there is emerging evidence of a positive impact on presence-immersion and an increase in feelings of effort. Separately, (for ECG but not EDA) there is evidence of greater arousal in response to rewards. Overall, the results suggest the value of increased amount and diversity of rewards in terms of improving the player experience. Future research is needed to more completely understand the applicability of these findings for other types of games (including serious games and gamification applications) and the associated qualifiers (e.g., upper limits on the amount of rewards) as well as the potential differential impacts of amount and diversity of rewards.

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- Existing research has often focussed on single reward types in videogames
- The current study explored the impact of varying amount and diversity of rewards
- Effort, enjoyment and sense of presence were greater in response to greater rewards
- Heart-rate measures indicate greater arousal in response to greater rewards
- Greater amount and diversity of rewards has a positive influence on player experience