City Research Online

City St George's, University of London

Citation: Denisova, A. & Cook, E. (2019). Power-Ups in Digital Games: The Rewarding Effect of Phantom Game Elementson Player Experience. In: CHI PLAY '19 Proceedings of the Annual Symposium on Computer-Human Interaction in Play. (pp. 161-168). New York, NY: ACM Press. ISBN 9781450366885 doi: 10.1145/3311350.3347173

This is the accepted version of the paper.

This version of the publication may differ from the final published version. To cite this item please consult the publisher's version.

Permanent repository link: https://openaccess.city.ac.uk/id/eprint/23253/

Link to published version: https://doi.org/10.1145/3311350.3347173

Copyright and Reuse: Copyright and Moral Rights remain with the author(s) and/or copyright holders. Copies of full items can be used for personal research or study, educational, or not-for-profit purposes without prior permission or charge, unless otherwise indicated, provided that the authors, title and full bibliographic details are credited, a hyperlink and/or URL is given for the original metadata page and the content is not changed in any way. For full details of reuse please refer to City Research Online policy.

City Research Online: http://openaccess.city.ac.uk/ publications@citystgeorges.ac.uk

Power-Ups in Digital Games: The Rewarding Effect of Phantom Game Elements on Player Experience

Alena Denisova
Department of Computer Science
City, University of London
London, United Kingdom
alena.denisova@city.ac.uk

Eliott Cook
Department of Computer Science
Swansea University
Swansea, United Kingdom
e.cook@ws9.co.uk

ABSTRACT

Power-ups are a type of game reward that allow the player to customise their experience by altering gameplay for a short period of time. Despite the wide use of power-ups in video games, little is known about their effect on gaming experiences. To explore this, we conducted an experimental study that compares the experiences of players depending on their exposure to power-ups in a recreational video game. The results show that players who collected power-ups felt significantly more immersed in the game, experienced more autonomy, but did not feel more competent or challenged than those who played the game without these collectables. Interestingly, a similar effect was observed for those players who picked up 'placebo' power-ups, despite the items having no effect on the gameplay. We provide a discussion of these results and their implications both for games user researchers and game designers.

Author Keywords

Power-ups; rewards; placebo effect; player experience; immersion; autonomy; competence; challenge; digital games.

CCS Concepts

•**Human-centered computing** → **Empirical studies in HCI;**
•**Applied computing** → *Computer games;*

INTRODUCTION

Playing video games is usually a rewarding experience. Part of this experience comes from the player's performance in the game, which is motivated through the use of different mechanics, including providing in-game rewards to commemorate one's achievements, leaderboards to compare how well the player is doing against others playing the same game, though levelling the character up, and many others.

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for components of this work owned by others than the author(s) must be honored. Abstracting with credit is permitted. To copy otherwise, or republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee. Request permissions from Permissions@acm.org.

CHI PLAY '19, October 22–25, 2019, Barcelona, Spain
ACM ISBN 978-1-4503-6688-5/19/10 $15.00
DOI: https://doi.org/10.1145/3311350.3347173

One's performance in the game is not only influenced by their abilities as a player, e.g. their dexterity, problem solving, or decision making skills, but also through in-game parameters, which include the character's health and power, the strength and abilities of enemies, the availability of special items, etc.

Some video games offer in-game rewards in the form of items that give players extra abilities or modify their current skills for a short period of time [1]. These rewards are called power-ups. They can temporarily strengthen a player's attack, helping them to get out of a difficult section within the game, or make the character invincible for a brief period of time.

Power-ups can be viewed as a class of persuasive techniques [14] that work as a boost to a player's performance. Denisova and Cairns [10], however, argue that improvement in one's performance can be achieved without the implementation of the functionality of such in-game features. Instead, players improve their performance or experience through their own skills and expectations, a phenomenon known as the placebo effect, typically used in medical and wellbeing contexts [17].

Empirical research studying the effect of power-ups on player experience and performance is, however, limited. Moreover, the research into the role of expectations of players in shaping their gaming experience has only been recently covered in games user research (see [9]).

To explore the influence of power-ups on player experience and performance in the game, and to evaluate the extent to which the experiences of a player are due to the game or the player's expectations about the game, we conducted an experimental study using some of the most commonly found power-ups in video games. By augmenting a game with power-ups and comparing it to the same game without power-ups, and to a version with placebo power-ups (visually identical power-ups, but without the actual benefits), we aimed to understand whether this phenomenon existed, and, if so, what its effects were. We measured widely recognised subjective player experiences: immersion, competence, and autonomy.

POWER-UPS AND PLAYER EXPERIENCES

Player experience is not shaped by one, overarching factor, but by a multitude of in-game elements which combine together to create a complete, immersive game. These different game elements and their effects on player experience make up a large proportion of research in video games. Game user researchers have been exploring how gaming experiences are affected by different game mechanics, including the selection of game controllers [2], the point of view through which the player is interacting with the game world [8], the use of diegetic and non-diegetic game elements [19], points [5] or badges [3] received by the player according to their performance.

Rewards are one way to encourage the player to invest time and effort into playing a game. Rewarding the player through in-game mechanics has been shown to have an effect on their performance [26] and to promote positive experience [6]. Rewards advancing the feeling of competence can increase the player's intrinsic motivation [6], while rewards that are not linked to gameplay could have a negative impact on autonomy [27] and detract from intrinsic motivation [7].

Defining Power-ups in Video Games

Power-ups are a type of reward that is linked directly to gameplay, which allows the player to experience increased capabilities by giving their character additional powers [1]. This game mechanic is used to alter gameplay and influence the behaviour or availability of other game mechanics [16]. Typically, the player can find power-ups pre-placed or randomly spawned around the game world, and some dropped by defeated enemies. When picked up, their effects usually last for a specified period of time. Sometimes their effect can disappear after a certain number of uses or last until the player is hit or killed [24]. In some games, players can also 'earn' power-ups, e.g. certain exergames grant power-ups for reaching a target heart rate [23] or some racing games (e.g., *Mario Kart*) offer power-ups when a player falls far behind – they provide a speed boost or grant additional ways to damage and slow down the player's opponents.

Video games offer different types of power-ups that modify different in-game parameters. Offensive abilities allow the player to pick up a new weapon, increase the players' attack power or, conversely, make the enemies weaker or more vulnerable. Perhaps the most widely known example of such power-up is Power Pellets in *Pac-Man*, which offers Pac-Man temporary invincibility and ability to attack ghosts.

Defensive abilities help to safeguard the character by surrounding them with a shield that deflects or absorbs damage, or provides invincibility to the character for a short period of time. Various examples of such power-ups are found in *Overwatch* or *Sonic* franchise, e.g. a Shield would offer one-off protection from harm caused by enemy snipers or abilities.

Evasive abilities allow the player to avoid enemies. These are also common in *Sonic* franchise, e.g. Speed Shoes, in *Sonic Adventures*, allow Sonic to accelerate for a period of time to bypass any enemies he encounters along the way. Similarly, in *Mario Kart*, the mushroom provides a temporary speed boost to the player, which can be used to overtake others or cut corners whenever needed.

Another form of power-ups is linked to the players' stats. Health and life reserves regenerate lost health, temporarily increase health capacity, or add an extra life. Similarly, a player can restore some of or increase the capacity for their resources by collecting a power-up. These typically include ammunition, fuel, mana (magic), or stamina points. These power-ups can also be found in other forms, such as health or magic potions commonly used in RPGs. For example, in the *The Legend of Zelda* series, the player can refill Link's magic meter with a Green potion.

Another mechanic, which does not rely on the player picking a power-up in the game world and is often used in platformers, allows players to acquire a new life by collecting a specific number of items, e.g. in *Sonic Adventure*, collecting 100 gold rings grants the player an extra life.

Depending on the behaviour of these power-ups in the game, they can be further classified into the four categories proposed by Lange-Nielsen [24]:

Expendable and stored Power-ups that are stored in the inventory and which disappear from it once consumed, e.g. health replenishing potions in *Final Fantasy VII*;

Expendable and instant Power-ups that take an immediate effect once picked up. They cannot be stored for later and disappear once consumed. However, another item of this kind might resurface, e.g. Star Power in *Super Mario Bros*;

Constant Also known as the "Upgrade" - a power-up that permanently modifies gameplay features, e.g. spells-based modifications to weapons in *Oblivion*;

Re-chargeable Power-ups that are similar to constant, but need other items to be refilled, e.g. Missile Launcher in *Metroid Prime*.

Player Experience and Performance

While the effect of rewards, in a broader sense, has been shown to have a positive effect on player experience and performance in some cases, little is yet known about the effects of power-ups specifically.

Bonus rewards, as described by Duarte and Carriço [13], appear to have similar properties to power-ups. This research demonstrated the influence of such rewards on physiological responses of players when engaged in a casual game play. Nonetheless, the subjective experiences of players were not explored in these studies.

Power-ups, being a prominent example of in-game rewards, is linked to positive gaming experiences, as it offers temporary abilities that can improve players' performance or allows them to bypass difficult sections of the game. Not only it can be used as a way to achieve a goal, but it also is often perceived as a goal in its own right to be achieved by the player [24].

Other game elements aimed at altering player performance include difficulty adjustment, which has been shown to have a positive effect on player experience [10]. However, another interesting finding described in this paper suggests that only some of this effect was due to the implemented algorithms. Part of this experience was also due to the players' positive expectations and perceptions of this feature. The same phenomenon might occur when using power-ups in video games.

Being visually 'juicy' [29], these items can motivate the player to gather many of them throughout their game journey. Juicy rewards provide a fun and interesting way for the players to collect these aesthetically pleasing items and making it a part of their goal in the game [18].

This 'juiciness' has received little attention with regards to studying the role that power-up aesthetics plays in shaping gaming experiences. According to Juul [22], feedback in the form of visuals, animations, and sounds does not only provide the player with information about their performance, but also "*gives the player an immediate, pleasurable experience [...] enhancing the experience of feeling competent, or clever, when playing a game*". Hence, addressing the aesthetic value of power-ups in addition to their natural ability to improve the performance of players is of high priority for our research.

Power-ups can be viewed through two lenses: aesthetic lens and performative lens. Hence, two questions arise: To what extent is the positive experience of players shaped by their newly acquired temporary abilities? and To what extent do they feel rewarded as a result of collecting a 'juicy' power-up? To our knowledge, these questions have not yet been empirically tested.

We expect several player experiences to be affected by the presence of power-ups in a game. Competence [28] and perceived challenge [11] are linked to one's performance in the game, which means they might be directly influenced by the presence of power-ups. Similarly, autonomy [28] is influenced by the player's experience of choice in the game, which power-ups offer. Finally, immersion [4, 20] is influenced not only by the physical attributes of a video game, but also through the player's expectations of the game [25]. If we wish to test the effect of power-ups' aesthetic value on player experience, measuring immersion is paramount to our research.

Hypotheses

Based on our review of existing literature on in-game rewards and their effects on player experience and performance in games, we propose the following hypotheses:

H1a: Power-ups increase a player's immersion.

H1b: Power-ups lead to a higher sense of autonomy.

H1c: Power-ups lead to a higher sense of competence.

H1d: Power-ups lower a player's perceived challenge.

H2: Power-ups improve player performance.

H3: Real power-ups provide a more immersive experience to the player than placebo power-ups.

H4: Players perform better in a game with real power-ups than when playing with placebo power-ups.

EXPERIMENTAL METHOD

To test the hypotheses, we conducted a between-subject design study with power-ups being the experimental manipulation in the game. For the purpose of this experiment, we focus only on the 'expendable and instant' power-ups, as defined by Lange-Nielsen [24].

Overall, there were three groups of participants:

1. A group playing the base game without power-ups;
2. A group playing the game with power-ups; and
3. A group playing the base game with placebo power-ups.

The dependent variables were player experience, which included immersion, competence, autonomy, and challenge; as well as in-game scores as a measure of one's performance.

Participants

Overall, 36 participants took part in the study (12 in each condition). 12 participants were female and 20 were male, with the age range between 18 and 24 years ($M = 20.52$, $SD = 1.88$). Opportunity sampling was used to recruit participants from a variety of different locations within the UK, including Birmingham, Swansea, Bath, and Cardiff.

Participants were split equally across three groups based on their background and level of gaming experience. The majority were educated to a higher education degree level, and the remaining few had a secondary education degree. Our participants also had varying levels of gaming experience: all groups of players had 6-8 players who had previous gaming experience that could be considered as intermediate or higher; and 4-6 participants who were casual players or had little to no previous experience of playing video games.

Materials

In this study, we recorded in-game scores of all players as a measurement of their objective performance. We also measured different aspects of player experience to explore to which extent each of them could be influenced by the manipulation.

Based on the previous research conducted by Denisova and Cairns [9], we hypothesised that immersion would be affected by the presence of placebo features. We measured immersion and its components using the Immersive Experience Questionnaire (IEQ) [20].

As power-ups aim to influence the performance of players [1], we wanted to find out whether players' perceived competence, autonomy, and challenge change based on this manipulation. We measured one's feeling of competence and autonomy using the Player Experience of Need Satisfaction (PENS) scales [28]. However, we did not include the control, relatedness, or immersion sub-scales, as these experiences were already covered by the IEQ [12]. All items from both questionnaires were ranked from 1 to 7 on a Likert scale.

Game

The game used for this study was a modified version of a survival shooter game, Nightmares. The player controls a little boy in a nightgown who has to defend himself from procedurally generated zombie toys attacking him. The objective of the game is to kill as many enemies as possible before they deal damage to the player. The performance of the player is measured as an overall score in the game based on the number of enemies killed as a positive increment of the score and the damage dealt to the player as the negative increment. More difficult enemies yielded more points.

Figure 1. Power-ups resulting in a temporary change in game state: Laser Cannon (red), Double Gun (blue), Laser Gun (green); and Power-ups resulting in a permanent change in game state: Life (pink) and Health (green-grey) in *Nightmares* video game (from left to right).

Nightmares was chosen to ensure a similar entry-level experience for all players, as none of our participants had had previous experience with this game. The same level of control cannot always be achieved when using a commercial video game. Second, the game controls and rules were simple enough for participants with different expertise levels to learn within a short period of time. Finally, the gameplay and mechanics of the chosen game allowed for a variety of different power-ups to be implemented.

To begin with, we made the following modifications to the base game:

1. The game world was expanded to provide a more varied experience for the players;
2. Five lives were introduced to the game to allow for more prolonged gameplay;
3. Two expendable power-ups were created: one increased the health of the main character and another one offered an extra life (see Figure 1).

We then used this modified game to create three versions to test our hypotheses. The first 'control' condition provided players with the base game, including the three modifications. We kept the life and health pick-ups for the control group as a means of prolonging the gaming session. However, they were not counted as a part of our manipulation. As previously discussed, these items provide permanent alterations to the game states, which is outside of the scope of this experiment – the focus of our study was on expendable power-ups with temporary modifications to the game state.

The 'regular power-ups' condition offered the base game with three different temporary power-ups in addition to the permanent items available to all participants in the three conditions (Health and Life). The temporary power-ups modified the original gun with regular bullets shooting at a set interval, speed, and range. Each player could collect one of the following power-ups (Figure 1):

Green power-up: Continuous, more powerful laser;

Blue power-up: Double bullets dealing double damage;

Red power-up: Shotgun style laser with a slower rate of fire that causes more damage.

Once collected, these power-ups changed the appearance, sound, speed, damage, and fire interval of the bullets. Each power-up lasted for 10 seconds before switching back to the standard gun.

Finally, the players in the 'placebo power-ups' condition played the base game with added visual representations of the power-ups, just like in the 'regular power-ups'. However, these items had no effect on the game state, i.e. selecting a double-bullets power-up would have the visual representation of this item, but would not deal the double damage it would be expected to.

A broad range of power-up options was considered before selecting these, as the game provided many opportunities for varying different parameters. After careful consideration of these options and the review of literature on power-up types, we chose the ones that temporarily altered the player's performance in the game, in this case, it was the attack-related parameters. This was also based on the idea that the placebo effect occurs in situations where performance is the key.

Procedure

The study was conducted online. All participants were sent a link to an online survey created in Google Forms, which was also linked to one of the versions of the game that they played on their devices (tabletop computers).

Each participant was provided with an informed consent form at the start of the study, which they digitally signed if they agreed with the terms outlined in the document. They then were prompted to start the game, which began with a tutorial that introduced the players to the controls and goals of the game. After that, they completed the main part of the study: a 10-minute gaming session in one of the three experimental conditions. The chosen session time was on par with the findings of Brown and Cairns [4], who argue that short-term involvement with the game, such as this one, would be enough to immerse the player.

Upon completion of the gaming session, each participant filled out the online survey. At the end of the survey, each participant was prompted to upload a file generated upon completion of the game containing the performance data for that participant, including their overall score, number of deaths, amount of lost health, number of kills, and number of power-ups picked up (and their type).

RESULTS

The quantitative measures were then analysed using one-way ANOVA in SPSS 24 to calculate the effects of the experimental manipulation on a range of player experiences (significance level at $p = 0.05$). Where applicable, pairwise comparisons were made using Tukey HSD.

Immersion

Immersion level, as measured by the IEQ, differed significantly between the three groups of players (Table 1), supporting **H1a**. The players in the control group (no power-ups) felt significantly less immersed in the game than the participants playing with real power-ups: $p = 0.043$. Similarly, the players who picked up placebo power-ups during their gaming sessions felt significantly more immersed in the game play than the players in the control group: $p = 0.033$. However, no significant difference was found between immersion scores collected from players in real power-ups and placebo power-ups groups. Hence, **H3** cannot be supported.

Out of the five components of immersion, cognitive and emotional involvement differed significantly between the three groups of players. However, the sense of control and challenge, as well as players' sense of dissociation from the real world (Table 1), were similar across all three groups, regardless of whether they played with power-ups or not. Thus, **H1d** cannot be supported.

Autonomy and Competence

Interestingly, the sense of competence did not differ between participants in the three conditions, which means that **H1c** cannot be supported.

However, the level of perceived autonomy differed significantly between the groups of players (Table 1), supporting **H1b**. Players experienced higher levels of autonomy when playing with real power-ups than the players who were in the control group: $p = 0.003$. Similarly, players who were in the placebo power-ups condition also experienced significantly higher autonomy than the players in the control group: $p = 0.002$. However, the sense of autonomy did not differ between the players who experienced real power-ups and players who picked up placebo power-ups in the game: $p = 0.991$ (**H3** cannot be supported).

In-game performance

The data collected at the end of the gaming session allowed us to compare the performance of players in the three groups based on their overall score, which was calculated based on the number of character deaths, their health, and the number of enemies they killed. There was no significant difference between the players' scores in the three groups (Table 1). Hence, both **H2** and **H4** cannot be supported.

Power-up collection

One factor that was outside of our direct control was the frequency of picking up power-ups by players in different groups. Hence, a possibility remained that players in some groups might not collect as many power-ups as the players in other conditions, which could confound our results.

However, the frequency of picking up permanent power-ups (Health and Life) in the game was similar across the three groups of players (Table 2).

	No Power-Ups (Control)	Real Power-Ups	Placebo Power-Ups
Health	9.92 ± 10.31	5.25 ± 6.14	6.83 ± 4.57
Life	7.00 ± 4.92	5.42 ± 4.12	6.50 ± 4.87

Table 2. ***M*** $\pm$ ***SD*** **of permanent power-ups collected by players in three experimental conditions.**

Similarly, the frequency of picking up temporary power-ups (Guns) did not differ between the two groups with experimental manipulations (Table 3).

	Real Power-Ups	Placebo Power-Ups
Laser Gun (Green)	5.33 ± 6.64	8.25 ± 6.00
Laser Cannon (Red)	4.83 ± 3.90	6.67 ± 4.03
Double Bullets (Blue)	5.75 ± 5.61	6.92 ± 6.32

Table 3. ***M*** $\pm$ ***SD*** **of temporary power-ups collected by players in two experimental conditions.**

This demonstrates that all three groups of players used their opportunity to collect power-ups in a similar manner. Therefore, the possibility that the lack of differences in performance, competence, or challenge being attributed to the different exposure or usage of the power-ups can be eliminated.

DISCUSSION

Player experience and performance in video games can be transformed through the use of different in-game elements, including power-ups. Our literature review of empirical studies in the field of player experience revealed the lack of research into the effects of power-ups on subjective experiences of players, as well as their objective performance in games. We,

	No Power-ups	Real Power-ups	Placebo Power-ups	F (2,33)	p	η^2_p
IEQ (Immersion)	147.08 ± 24.84	169.83 ± 21.88	170.83 ± 19.10	4.448	0.019*	0.212
IEQ (Cognitive Involvement)	47.75 ± 6.40	55.00 ± 5.06	54.00 ± 6.18	5.305	0.010**	0.243
IEQ (Emotional Involvement)	27.33 ± 6.50	33.08 ± 6.11	33.67 ± 4.77	4.308	0.022*	0.207
IEQ (Real World Dissociation)	29.50 ± 8.12	33.33 ± 5.42	35.33 ± 5.82	2.450	0.102	0.129
IEQ (Challenge)	18.25 ± 3.11	21.17 ± 3.51	21.08 ± 3.63	2.822	0.074	0.146
IEQ (Control)	24.25 ± 5.69	27.25 ± 3.77	26.75 ± 3.55	1.572	0.223	0.087
PENS (Competence)	12.83 ± 3.66	16.25 ± 2.67	14.75 ± 4.16	2.791	0.076	0.145
PENS (Autonomy)	9.83 ± 2.82	14.58 ± 3.12	14.75 ± 3.65	9.056	0.001***	0.354
In-game Score	1925.00 ± 1555.36	2535.50 ± 2170.97	2733.33 ± 1944.23	0.573	0.569	0.034

Table 1. Player experiences and in-game performance (*M* $\pm$ *SD*) in three experimental conditions: no power-ups (control), real power-ups, and placebo power-ups (analysis of variance was calculated using ANOVA. Significant results are shown as follows: *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$).

therefore, proposed four hypotheses linking player experiences and performances with power-ups, as seen in Section 2.3. To put these hypotheses to the test, we conducted an experimental study using a range of different power-ups and measuring some of the most widely researched gaming experiences.

The study provides insights regarding the impact of power-ups in a recreational video game on player experience and performance. More specifically, our findings extend existing research on in-game rewards by exploring how immersion, autonomy, competence, and challenge are affected by the presence of power-ups with and without actual functionality that alters gameplay being implemented.

Our findings support the notion of power-ups having a positive effect on one's sense of immersion and autonomy, while having no effect on their perception of challenge or competence. These results are on par with the findings from Johnson et al. [21], who showed that in a recreational video game, immersion and enjoyment were influenced by reward types, but not the feeling of competence.

Interestingly, the increased feeling of immersion in the game as a result of playing with power-ups was observed in both groups of players who experienced real and placebo power-ups. This was in step with the findings of Denisova and Cairns [10] who showed that game features that aim to enhance player performance lead to more positive player experiences regardless of whether their functionality is present or not. In their study, a similar pattern emerged when players were presented with a difficulty adjustment in a game and a placebo difficulty adjustment that did not have the functionality implemented.

Another gaming experience that was influenced by the presence of power-ups was a sense of autonomy. This is, perhaps, less surprising due to the nature of this experience – having the choice to pick up consumable items in the game provides players with more autonomy than offering no power-ups.

Contrary to our expectations, the performance of players, as well as their perceived competence and challenge, were not affected by the power-ups. The literature we reviewed for this study describes power-ups as special items aimed at providing the player with a temporary boost in their performance. However, we found no such difference between the scores that players received depending on the experimental manipulation. This, in turn, resulted in similar experiences of challenge and competence by players in different conditions, as these experiences are directly linked to one's performance. This could, perhaps, be explained through the lens of autonomy: offering players power-ups does not necessarily result in players collecting them frequently enough to make a difference to their performance. Therefore, it is not guaranteed that the scores of players exposed to power-ups would be significantly higher than of those who did not get this option in the game.

Implications

Overall then, these findings bear several implications for game developers, testers, and user researchers. First, the findings provide evidence that players experience the game both through the lens of their own performance (competence and challenge), as well as through the lens of aesthetic values and the perception of choice (autonomy and immersion). In the case of power-ups, the second lens plays a more vital role in shaping the positive experience of players than the performance lens, as shown in our study. For game design, this finding provides evidence that offering players temporary rewards that aim to boost their performance would have a positive impact on their gaming experience.

This affords a potentially interesting 'subverted' mechanic for a video game: having some 'empty' power-ups available to the player could result in new ways to increase players' uncertainty in the game. Finding out about receiving an 'empty' power-up from a player/non-player character might test the player's trust and could be used in games that rely on hidden information as a means of providing suspense, particularly in competitive or even team-based environments.

Second, our findings provide further insights into the persuasive nature of power-ups and their effect on player experience. It is evident that player experience, in our set-up, was influenced solely by the expectation of power-up functionality, which was not present for some players. This is an interesting discovery, as it offers further evidence of immersion being dependent on player expectations [25] and broadens our current understanding of autonomy experienced by players when collecting such items.

Third, our work has implications for experimental study design: our findings suggest that it is possible to test game features that aim to enhance player performance without having to implement the functionality to full extent, i.e. it is possible to trial different in-game rewards and performance-enhancing characteristics of games using Wizard-of-Oz studies that provide the looks but not the functionality of the game elements.

This, certainly, raises some questions from the ethical point of view, whether it would be acceptable for game companies to include 'empty' features in games. The aim of our work is not to make such suggestions. However, we propose that further work is needed to evaluate to what extent it is acceptable to use placebo rewards, if at all.

Limitations and Future Work

The long-term effects of different in-game elements on player experience is a relatively underrepresented area of games user research. Our study is not an exception. Perhaps, if players were exposed to the power-ups for longer periods of time, if they played in a more controlled environment (e.g. in a lab), or if they were already familiar with the game, their performance in and experience with the game could be different.

Despite the sample size in this study being on par with the sample quality of other experimental studies in games user research, collecting data from a larger sample would have provided more confidence in our findings, particularly with respect to the small effect sizes [15]. In general, a minimum of 30 participants per condition is recommended to obtain a power of 80% given the effect size is medium to large [30]. Hence, gathering a considerably larger number of players will be necessary to further test our findings.

Furthermore, a within-subject design might provide more insights into this phenomenon. Having played through the three versions of the game, the players might experience the placebo power-ups differently. This could lead to different findings with regards to the performance of players, as well as their confidence and experience of challenge.

Our current set-up focuses only on one genre and one version of gameplay. Perhaps, if the game had a winning condition, the players would notice the lack of functionality in the 'placebo' condition. Similarly, this could lead to a different experience of competence and performance, with the real power-ups group being the most likely group to win the game.

Furthermore, other platformer games, where power-ups are a commonly used mechanic, should be researched. Similarly, as power-ups are not limited to only platformers, exploring their effects on players experiences in role-playing games, first-person shooters, dungeon-crawlers, and other game genres is equally as important for this research area.

Finally, the focus of this study was on expendable and instant power-ups with temporary effects. Exploring the other three types of power-ups in games, as defined by Lange-Nielsen [24], would be another interesting area for future exploration.

CONCLUSION

Our research provides preliminary insights regarding the impact of power-ups in a recreational video game on player experience and performance. We examined the nature of the effect of power-ups through the lens of performative metrics and aesthetic 'juiciness'. To separate the two, real power-ups were compared to placebo power-ups – visually identical items without the anticipated changes to the gameplay. The results of our exploratory work demonstrate that players' sense of autonomy and immersion in the game are directly linked to the presence of power-ups, regardless of whether the functionality was coded in or not. Conversely to our initial hypothesis, the performance of players experiencing the game with real and placebo power-ups did not differ significantly. Similarly, the perceived challenge and the feeling of competence during game play were not significantly different depending on the experimental manipulation.

We hope our research provides helpful insights for game user researchers studying player experiences or video games in a broader sense, as well as for game developers looking for evidence suggesting that power-ups are a valuable addition to their game. Specifically, we discuss different game designs using alternative mechanics that could provide certain benefits for a range of video games. We aim to broaden the discussion of player experiences to include the notion of player expectations that play a vital role in shaping these experiences, which we study through the use of phantom mechanics, in this case, placebo power-ups.

ACKNOWLEDGEMENTS

We would like to thank our participants for their time and valuable feedback. We would also like to thank our reviewers for providing constructive comments that helped to make this paper stronger.

REFERENCES

[1] Ernest Adams. 2014. *Fundamentals of game design*. Pearson Education.

[2] Max Birk and Regan L Mandryk. 2013. Control your game-self: effects of controller type on enjoyment, motivation, and personality in game. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. ACM, 685–694. DOI: http://dx.doi.org/10.1145/2470654.2470752

[3] Barbaros Bostan and Sertaç Öğüt. 2009. Game challenges and difficulty levels: lessons learned from RPGs. In *International simulation and gaming association conference*.

[4] Emily Brown and Paul Cairns. 2004. A grounded investigation of game immersion. In *CHI'04 extended abstracts on Human factors in computing systems*. ACM, 1297–1300. DOI: http://dx.doi.org/10.1145/985921.986048

[5] Ben Cowley, Darryl Charles, Michaela Black, and Ray Hickey. 2008. Toward an Understanding of Flow in Video Games. *Entertainment Computing* 6, 2, Article 20 (July 2008), 27 pages. DOI: http://dx.doi.org/10.1145/1371216.1371223

[6] Edward L Deci, Richard Koestner, and Richard M Ryan. 1999. A meta-analytic review of experiments examining the effects of extrinsic rewards on intrinsic motivation. *Psychological bulletin* 125, 6 (1999), 627. DOI: http://dx.doi.org/10.1037/0033-2909.125.6.627

[7] Edward L Deci and Richard M Ryan. 1985. The general causality orientations scale: Self-determination in personality. *Journal of research in personality* 19, 2 (1985), 109–134. DOI: http://dx.doi.org/10.1016/0092-6566(85)90023-6

[8] Alena Denisova and Paul Cairns. 2015a. First person vs. third person perspective in digital games: do player preferences affect immersion?. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*. ACM, 145–148. DOI: http://dx.doi.org/10.1145/2702123.2702256

[9] Alena Denisova and Paul Cairns. 2015b. The placebo effect in digital games: Phantom perception of adaptive artificial intelligence. In *Proceedings of the 2015 Annual Symposium on Computer-Human Interaction in Play*. ACM, 23–33. DOI: http://dx.doi.org/10.1145/2793107.2793109

[10] Alena Denisova and Paul Cairns. 2019. Player experience and deceptive expectations of difficulty adaptation in digital games. *Entertainment Computing* 29 (2019), 56–68. DOI: http://dx.doi.org/10.1016/j.entcom.2018.12.001

[11] Alena Denisova, Paul Cairns, Christian Guckelsberger, and David Zendle. 2019. Measuring Perceived Challenge in Digital Games: Development and Validation of the Challenge Originating from Recent

Gameplay Interaction Scale (CORGIS). *To appear in International Journal of Human-Computer Studies* (2019).

[12] Alena Denisova, A Imran Nordin, and Paul Cairns. 2016. The convergence of player experience questionnaires. In *Proceedings of the 2016 Annual Symposium on Computer-Human Interaction in Play*. ACM, 33–37. DOI:http://dx.doi.org/10.1145/2967934.2968095

[13] Luís Duarte and Luís Carriço. 2012. Power me Up!: an interactive and physiological perspective on videogames' temporary bonus rewards. In *Proceedings of the 4th International Conference on Fun and Games*. ACM, 55–63. DOI:http://dx.doi.org/10.1145/2367616.2367623

[14] Luís Duarte and Luis Carriço. 2013. The cake can be a lie: placebos as persuasive videogame elements. In *CHI'13 Extended Abstracts on Human Factors in Computing Systems*. ACM, 1113–1118. DOI: http://dx.doi.org/10.1145/2468356.2468555

[15] Catherine O Fritz, Peter E Morris, and Jennifer J Richler. 2012. Effect size estimates: current use, calculations, and interpretation. *Journal of experimental psychology: General* 141, 1 (2012), 2. DOI: http://dx.doi.org/10.1037/a0024338

[16] Tracy Fullerton. 2014. *Game design workshop: a playcentric approach to creating innovative games*. AK Peters/CRC Press.

[17] Ben Goldacre. 2010. *Bad science: Quacks, hacks, and big pharma flacks*. McClelland & Stewart.

[18] Kieran Hicks, Kathrin Gerling, Graham Richardson, Tom Pike, Oliver Burman, and Patrick Dickinson. 2019. Understanding the Effects of Gamification and Juiciness on Players. *IEEE* (2019).

[19] Ioanna Iacovides, Anna Cox, Richard Kennedy, Paul Cairns, and Charlene Jennett. 2015. Removing the HUD: the impact of non-diegetic game elements and expertise on player involvement. In *Proceedings of the 2015 Annual Symposium on Computer-Human Interaction in Play*. ACM, 13–22. DOI: http://dx.doi.org/10.1145/2793107.2793120

[20] Charlene Jennett, Anna L Cox, Paul Cairns, Samira Dhoparee, Andrew Epps, Tim Tijs, and Alison Walton. 2008. Measuring and defining the experience of immersion in games. *International journal of human-computer studies* 66, 9 (2008), 641–661. DOI: http://dx.doi.org/10.1016/j.ijhcs.2008.04.004

[21] Daniel Johnson, Madison Klarkowski, Kellie Vella, Cody Phillips, Mitchell McEwan, and Christopher N Watling. 2018. Greater rewards in videogames lead to more presence, enjoyment and effort. *Computers in Human Behavior* 87 (2018), 66–74. DOI: http://dx.doi.org/10.1016/j.chb.2018.05.025

[22] Jesper Juul. 2010. *A casual revolution: Reinventing video games and their players*. MIT press.

[23] Mallory Ketcheson, Zi Ye, and TC Graham. 2015. Designing for exertion: how heart-rate power-ups increase physical activity in exergames. In *Proceedings of the 2015 Annual Symposium on Computer-Human Interaction in Play*. ACM, 79–89. DOI: http://dx.doi.org/10.1145/2793107.2793122

[24] Filip Lange-Nielsen. 2011. The Power-up Experience: A study of Power-ups in Games and their Effect on Player Experience. In *DiGRA Conference*.

[25] Alison McMahan. 2013. Immersion, engagement, and presence: A method for analyzing 3-D video games. In *The video game theory reader*. Routledge, 89–108.

[26] Cody Phillips, Daniel Johnson, Peta Wyeth, Leanne Hides, and Madison Klarkowski. 2015. Redefining videogame reward types. In *Proceedings of the Annual Meeting of the Australian Special Interest Group for Computer Human Interaction*. ACM, 83–91. DOI: http://dx.doi.org/10.1145/2838739.2838782

[27] Richard M Ryan and Edward L Deci. 2000. Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary educational psychology* 25, 1 (2000), 54–67. DOI: http://dx.doi.org/10.1006/ceps.1999.1020

[28] Richard M Ryan, C Scott Rigby, and Andrew Przybylski. 2006. The motivational pull of video games: A self-determination theory approach. *Motivation and emotion* 30, 4 (2006), 344–360. DOI: http://dx.doi.org/10.1007/s11031-006-9051-8

[29] Jesse Schell. 2014. One Kind of Experience is the Story. In *The Art of Game Design: A book of lenses*. AK Peters/CRC Press.

[30] Carmen R Wilson VanVoorhis and Betsy L Morgan. 2007. Understanding power and rules of thumb for determining sample sizes. *Tutorials in quantitative methods for psychology* 3, 2 (2007), 43–50. DOI: http://dx.doi.org/10.20982/tqmp.03.2.p043