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The Cost of Play: Designing a Gamified Dynamic Public Goods Game to Test the Effect of Nudges in Video Games

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Questionnaire

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Acknowledgments

French

Avant tout, je tiens à exprimer ma profonde gratitude à mon frère, Alexandre, pour avoir développé l'architecture technique du jeu utilisé dans cette étude. Son savoir-faire et son engagement ont fourni la base essentielle de l'expérimentation. Sans lui, ce projet n'aurait tout simplement pas pu voir le jour.

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English

First and foremost, I would like to express my deepest gratitude to my brother, Alexandre, for developing the technical framework of the experimental game. His skill and dedication provided the essential foundation for this study. Without his contribution, this project would not have been possible.

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Résumé

L'objectif de ce mémoire était d'explorer si la coopération pouvait être améliorée en incitant les participants à contribuer davantage dans un jeu de biens publics dynamique et gamifié.

L'échantillon était composé de 44 participants recrutés à partir du jeu vidéo Cubic Castles, principalement des jeunes (32 avaient moins de 24 ans), majoritairement de sexe masculin (78%) et en majorité joueurs de jeux de rôle (RPG) (21%).

En utilisant une interface minimaliste inspirée des jeux de rôle, enrichie de cinq nudges comportementaux: signaux de rareté, classement, barre de progression, monnaie formatée, et incitation à l'auto-réflexion; l'expérience visait à simuler un environnement vidéoludique réaliste tout en conservant un contrôle expérimental rigoureux.

Les résultats ont permis d'identifier plusieurs constats clés : (i) les individus exposés aux nudges ont fait preuve de davantage de coopération, en contribuant plus que ceux du groupe témoin au bien collectif; (ii) cette coopération accrue a toutefois engendré un coût personnel: les joueurs nudgés ont investi davantage de ressources et ont terminé le jeu avec un gain final plus faible; (iii) les nudges n'ont pas significativement augmenté les dépenses liées aux objets cosmétiques ou incertains; (iv) les participants nudgés ont déclaré une plus grande appréciation du jeu.

Ces résultats soulèvent des enjeux importants pour les politiques publiques et l'éthique numérique. Si de simples éléments visuels peuvent influencer de manière significative la coopération, les dépenses ou le plaisir ressenti, alors le design des jeux ne peut être considéré comme neutre : il constitue un puissant levier comportemental. À ce titre, les décideurs publics devraient envisager des mesures telles que : (1) l'obligation de transparence sur les mécanismes de persuasion intégrés dans les jeux ; (2) la promotion de normes de design éthique protégeant l'autonomie cognitive, notamment chez les plus jeunes ; (3) le soutien au développement de tests expérimentaux ou d'audits automatisés (basés sur l'IA) pour évaluer l'impact psychologique des systèmes monétisés avant leur mise sur le marché.

En définitive, cette recherche propose un cadre expérimental reproductible pour l'étude des nudges dans des environnements interactifs. Mais elle constitue également une mise en garde : à mesure que les jeux deviennent plus immersifs et monétisés, la frontière entre engagement et exploitation devient de plus en plus floue. Les recherches futures devront approfondir cette analyse en testant des environnements vidéoludiques plus complexes et des populations plus larges et diversifiées.

Abstract

The objective of this memoir was to explore whether cooperation could be improved by nudging participants into contributing more in a gamified dynamic public goods game.

The sample consisted of 44 participants recruited from the video game *Cubic Castles*, primarily composed of young individuals (32 under the age of 24), predominantly male (78%) and most playing RPG games (21%).

Using a minimalist, RPG-style game interface layered with 5 behavioral nudges: scarcity cues, leaderboard, progress bar, formated currency and self-reflection prompt, the experiment aimed to simulate real-world video game environments while maintaining experimental control.

The results yielded several key findings: (i) nudged individuals were more cooperative, contributing more to the collective good than those in the control condition; (ii) this increased cooperation came at a personal cost. Nudged players tended to invest more resources and therefore ended the game with lower final payoffs; (iii) nudging did not significantly increase spending on cosmetic and uncertain items; (iv) participants in the nudged condition reported greater enjoyment.

These results carry important implications for public policy and digital ethics. If simple visual cues can meaningfully alter cooperation, spending, and enjoyment, then game design is far from neutral: it is a powerful behavioral tool. As such, policymakers should consider measures such as (1) requiring transparency around persuasive design mechanisms; (2) promoting design standards that protect cognitive autonomy, particularly for younger players; and (3) supporting the development of experimental testing or AI-driven audits that can evaluate the psychological impact of monetized systems before deployment.

Ultimately, this research provides a replicable framework for studying behavioral nudges in interactive environments. But it also serves as a warning: as games grow more immersive and monetized, the boundary between engagement and exploitation grows thinner. Future studies should build on this foundation by testing more complex gaming environments and broader, more diverse populations.

Introduction

The world of video games has changed profoundly over the decades. We went from simple arcade games to intensely monetized games where every pixel is engineered to drive engagement and profit. A prominent example is *Fortnite*, which frequently updates the aesthetics of its in-game store to maintain visual novelty and user interest.

These types of visual changes are no coincidence. Geslin et al. (2016) prove how colors can elicit emotions in video games. For instance, vibrant or rare colors may evoke excitement or a sense of urgency, subtly encouraging users to make impulsive purchases (Hamari and Lehdonvirta, 2010, Hamari, 2015). This psychological leverage plays a critical role in the broader framework of predatory monetization – design practices that exploit players' psychological vulnerabilities to drive spending, often under the guise of personalization or reward (King and Delfabbro, 2018, King and Delfabbro, 2019).

The question arises: what should policymakers do? First, we need to understand whether these subtle design features have a genuine effect, wether it's enhancing user engagement or merely exploit cognitive biases to drive purchases. If evidence supports the latter, it becomes a matter not only of consumer protection but also of ethical responsibility. Indeed, game developers should be encouraged to follow principles of "responsible game design" prioritizing user well-being over profit maximization (Karlsen, 2022).

To bounce back on the *Fortnite* example at the beginning, it would include for instance minimizing the pressure of the artificial scarcity (the rarity system) and building reward systems that support intrinsic motivation rather than compulsive spending. Transparency, informed consent, and respect for cognitive limits should guide how games present purchasing options, particularly when the audience includes children or vulnerable users (Zendle et al., 2019).

Hence, the following research question: To what extent do subtle game design features contribute to compulsive spending behaviors, and how can policy and ethical design principles mitigate these effects?

To understand the effects of these main design features, we have developed a gamified dynamic public goods game with "carry over". In a traditional public goods game, each player receives a fixed endowment at the beginning of every stage and must decide how much to contribute to a common pool. The total contributions are evenly distributed among all players, regardless of individual contributions (Marwell and Ames, 1981).

In our model we use a variant of the traditional game, namely a dynamic public goods game with "carry over" as recommended by Graves (2010) and tested by Cadigan et al. (2011) with a stochastic ending to avoid the endgame effect as suggested by my supervisors. In this setting, the initial endowment at the start of the game is not replenished in subsequent stages. However, in each stage, players earn interest based on their cumulative investments across all previous stages.

The idea was to simulate as much as possible the feeling of playing a video game while keeping it as close as possible within the experimental framework. Indeed, the carry over feature of the experiment is something that we can find frequently in video games (e.g. RPG games such as Baldur's Gate III) where we grow, build our character – we carry over the decisions that we made in the past.

The video game designed in this experiment is strategically as simple as possible: there are no complex mechanics to calculate, such as critical hit rates, attack speed, or elemental synergies commonly found in commercial games. Instead, the gameplay revolves astage a single, transparent metric – raw damage. Players increase this damage by purchasing straightforward upgrades, with each point of strength directly contributing to the team's total output and subsequent payoff. This minimalist design ensures that participants can focus on the economic decision-making at the heart of the experiment, rather than being distracted or confused by intricate game mechanics.

The objective was to see if we could increase cooperation by adding a variety of visual nudges. The nudges test for 6 main visual effects: the leaderboard effect (Landers and Landers, 2014), the "monopoly money" effect (Raghubir and Srivastava, 2008), the scarcity effect (Shah et al., 2015), the "level-up" effect (Hamari and Koivisto, 2015), the aversion of shame (Samak and Sheremeta, 2013) and the prompted self-reflection (Renner et al., 2016).

In a dynamic public goods game setting with carry over, the best strategy to maximize individual payoff is to either free ride from the beginning, or to invest as much as possible until near the end of the game in order to accumulate as much money as possible in the remaining stages.

Hence we suppose, in the case that the presented nudges are effective, that nudged individuals will invest too much money and not save anything because they get too cooperative. We also included loot boxes and skins in our game to see if the scarcity effect can lead people to buy more loot boxes and skins. We get the following main hypothesis:

- H1: Nudged individuals will end up with a lower final payoff because they invested more.
- H2: The game design improves cooperation for nudged individuals.
- H3: Nudged individuals purchased more loot boxes and skins.
- H4: Nudged individuals enjoyed the game more.

The first chapter explores the theoretical foundation of the study, beginning with the principles of public goods games and the social dilemmas they present. It then introduces the concepts of nudges and gamification, examining how they have been used in behavioral research and how they could in the future.

The second chapter outlines the experimental design developed to test the effect of visual nudges on cooperative behavior. It details the game mechanics, the types of nudges implemented, the recruitment of participants, and the procedures followed to ensure experimental rigor and ethical standards.

The third chapter presents the results of the experiment, focusing on the impact of different nudges on cooperation rates and behavioral patterns. It highlights key findings, compares outcomes across conditions, and discusses the implications and limitations of the data in relation to the theoretical framework.

Chapter 1

Theoretical framework

1.1 Public Goods Games and cooperation

A public good is a good that is non-excludable (no one can be prevented from using it) and non-rival (one person's use does not reduce its availability to others) (Samuelson, 1954). Classic examples include clean air, national defense, and public parks. These characteristics often lead to challenges in funding and maintaining public goods, as individuals may benefit without contributing. This is known as the free-rider problem.

The free-rider problem has been extensively discussed by prominent scholars, including Olson (1971) and Hardin (1968). However, the problem was missing experimental proof as it was solely based on theoretical arguments and examples, until Marwell and Ames (1981) proposed a series of experiments expressly designed to test the hypothesis, including the public goods game experiment that we know today.

1.1.1 Dilemma & cooperation

Public Goods Games (PGGs) are widely used in behavioral economics and experimental psychology to model the tension between individual interest and collective welfare. In a typical PGG, individuals decide how much of their private resources to contribute to a public pool. Contributions are multiplied and redistributed, benefiting all participants regardless of individual input. This structure creates an inherent social dilemma: while the group is better off if everyone contributes, individuals have a short-term incentive to free-ride on the contributions of others.

The central dilemma in a PGG arises from the conflict between maximizing personal payoff and maximizing collective benefit. If all players act selfishly, the public good is underfunded, resulting in suboptimal outcomes for all. However, empirical research has shown that cooperation often emerges under certain conditions, such as repeated interactions (Axelrod and Hamilton, 1981, communication (Sally, 1995), punishment mechanisms (Fehr and Gächter, 2000a), or social norms (Ostrom, 1990). Understanding the dynamics that foster or inhibit cooperation is crucial for applying PGG models to real-world collective action problems.

1.1.2 PGG with "carry over"

PGG with "carry over" are a variant of the traditional game introduced by Graves (2010). It consists of introducing a "carry over" mechanism where individual endowments from one round are transferred to the next to add a temporal interdependence. This models scenarios where decisions have long-term consequences, such as in resource conservation or digital platforms with persistent user metrics. The carry-over introduces new strategic considerations, encouraging foresight and possibly enhancing cooperation according to Graves (2010).

This framework was used as the backbone of our game's economic mechanism because it aligns closely with the goals of our experimental design: to simulate long-term decision-making under uncertainty and to assess the effect of behavioral nudges in an environment with persistent consequences. The carry-over structure also allowed us to incorporate features like cumulative damage, upgradeable items, and evolving risk preferences in a game environment closer to what video games typically offer.

1.1.3 Relevance to digital environments

Digital environments, such as online platforms, virtual communities, and multiplayer games, often mirror the dynamics of PGGs with carry over. For instance, contributions to open-source software, content moderation, or reputation systems represent public goods with ongoing impact. The persistence of digital identities and data (e.g., karma, ratings, or history of contributions) effectively creates a form of carry-over. Understanding how cooperative behavior is sustained or eroded in these settings can inform platform design and policy interventions aimed at fostering collective intelligence and sustainable digital ecosystems.

Several studies have emphasized the importance of designing digital systems that encourage sustained cooperation over time. Kraut and Resnick (2012) outline design strategies that enhance prosocial contributions in online communities, including the visibility of effort and cumulative recognition. Likewise, Resnick et al. (2000) stress the role of persistent identity and reputation in sustaining public good contributions. These systems effectively embed a form of "digital carry-over," shaping strategic behavior much like in experimental economic settings.

1.2 Nudges

Definition

Nudges are a term popularized by Thaler and Sunstein (2008). It consists of "nudging" or directing the individuals to the right direction without restraining their freedom of choice. It is a cheap policy intervention that must be easy to avoid by the nudged individual.

For instance, a proposed nudge by Thaler and Sunstein is food positioning. The idea is to meticulously put the more healthy food in cafeterias at eye level to incentivize individuals to eat healthier. Bucher et al. (2016) show evidence that, indeed, food position influences food choice.

The reason why we need nudges is because people often make irrational decisions such as signing up for a saving plan objectively worse than another one that dominates it in every way. These irrational decisions are due to cognitive overload and biases such as loss aversion or status quo bias (Congiu and Moscati, 2022). In that sense, nudges help simplify decision-making in complex situations.

In practice

Nudges became very influential after Thaler and Sunstein (2008), so much that the United Kingdom established the Behavioural Insights Team[1] (commonly known as the “Nudge Unit”) in 2010 to apply behavioral science to public policy. This government-backed initiative aimed to design low-cost, choice-preserving interventions to improve outcomes in areas such as health, finance, education, and environmental sustainability. The success of the UK’s approach inspired similar units in other countries and solidified nudging as a mainstream tool in policy-making. By reframing how governments and institutions influence behavior through choice architecture rather than mandates or incentives, nudging gained traction as a politically palatable and empirically grounded approach to behavioral change.

In a more practical way, nudges have proven successful for increasing retirement savings plan participation rate. Field experiments (Madrian and Shea, 2001; Clark et al., 2014) have been conducted to evaluate the effect of nudges to increase the participation rate of 401(k) savings plan.

[1] https://www.bi.team

Madrian and Shea (2001) show that participants hired under automatic enrollment (the default option is to enroll into a saving plan) stuck with the default investment choices 71% of the time. Clark et al. (2014) show that providing newly hired employees with a simple informational flyer about the benefits of 401(k) participation significantly increased enrollment rates among younger workers.

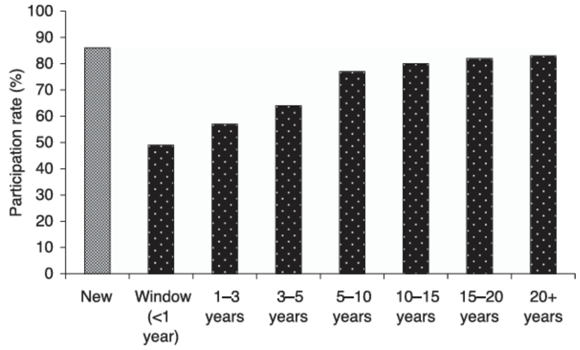

Figure 1.1: 401(k) participation rates before and after default enrollment (Madrian and Shea, 2001).

Johnson and Goldstein (2003) find stark contrasts for organ donation: countries with opt-out policies (e.g., Austria, Belgium) have dramatically higher consent rates, often above 90%, compared to opt-in countries (e.g., Germany, the United States), where rates hover below 30%. Importantly, these differences cannot be explained by cultural attitudes or awareness about organ donation. Instead, the default choice (being a donor by default vs. not) appears to drive behavior..

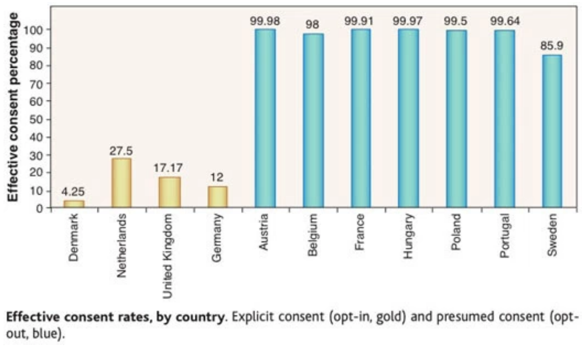

Figure 1.2: Default options increase organ donation rates. (Johnson and Goldstein, 2003).

This study is a foundational example in the nudge literature, illustrating how passive choices, those made by doing nothing, often determine outcomes. It supports the idea that defaults work not by changing preferences, but by leveraging status quo bias, loss aversion, and decision inertia. People often stick with defaults due to perceived endorsement, cognitive effort, or emotional discomfort associated with active decision-making.

From a policy perspective, Johnson and Goldstein's findings highlight the ethical power of carefully designed choice architectures. If a simple shift in the default can lead to significantly more lives saved through organ donation, similar mechanisms may be applied in domains like retirement savings, health insurance, or environmental behavior, always raising the question of when nudging becomes paternalism.

Their field experiment demonstrated that even minimal interventions can nudge behavior when they address gaps in financial literacy or attention. However, the question arises: who decides what's a "good" nudge?

Ethical considerations

To go back to the tendency to stick with the default options, this tendency – even when those defaults are suboptimal – highlights a central paradox in the use of nudges. On one hand, automatic enrollment significantly increases participation in retirement savings plans, particularly among employees who may otherwise procrastinate or avoid making financial decisions altogether. On the other hand, the same inertia that boosts participation can lock individuals into low-performing or poorly matched investment strategies. As shown by Madrian and Shea (2001), 71% of automatically enrolled employees remained with the default contribution rate and investment option, choices that were rarely selected under voluntary enrollment.

This phenomenon underscores a critical limitation of default-based nudges: while they successfully overcome initial behavioral barriers (such as inaction or short-termism), they may inadvertently discourage further engagement or optimization. In effect, the nudge solves one problem (getting people to save), but may create another (locking them into mediocre saving plans). This raises important normative and practical questions about the design of default options: who sets them, how flexible they are, and whether individuals are provided with timely prompts or tools to revisit and revise their choices.

Moreover, the success of nudges in this context relies on a relatively specific behavioral profile: individuals who are time-inconsistent but sophisticated, and who benefit from commitment devices (Thaler and Sunstein, 2008). For individuals who are time-inconsistent and naïve, nudges may not only be ineffective but could potentially reinforce passivity. This reinforces the importance of complementing nudges with education, active choice architectures, or periodic re-enrollment mechanisms to mitigate the risks of behavioral lock-in.

1.3 Gamification in behavioral research

Definition

Gamification refers to the use of game design that we typically find in video games in non-game contexts to influence behavior and engagement. They include for instance points, levels, rewards, challenges, and feedback. In behavioral research, gamification is not merely about making tasks entertaining, but about enhancing motivation or sustaining participation.

In practice

In practice, gamification is most commonly used in education and physical exercise. Cotton and Patel (2019) show that in the top 50 ranked free health and fitness mobile applications, gamification is used by 64% of these applications and 97% of them targeted behaviors related to physical activity and weight loss.

Sardi et al. (2017) highlights the growing interest in applying game mechanics to healthcare contexts, particularly in areas such as chronic disease rehabilitation, physical activity promotion, and mental health support. The review analyzed 46 studies and found that while gamification holds promise for enhancing engagement and motivation, most interventions rely heavily on extrinsic rewards, resulting in only short-term user commitment. The authors note a lack of robust empirical evidence and emphasize the need for gamified health solutions to be grounded in well-established psychological theories to achieve lasting behavioral change and deeper user involvement. Despite its potential, gamification in e-Health remains an emerging field requiring more rigorous design and evaluation.

Fathi Najafi et al. (2025) is a systematic review conducted on both observational and experimental articles on gamification related to education. They find that the effectiveness of education was greater on both digital and non-digital than on traditional education in the reviewed studies.

Gamification can also have marketing implications. For instance, Alanazi et al. (2025) highlight how gamification can be effectively embedded in marketing strategies and service design for the hospitality industry, with practical recommendations such as implementing loyalty programs that reward customers with badges, exclusive perks, and progress-based incentives. These game-like features foster a sense of achievement and social belonging, motivating users to interact more consistently with the brand or service. This suggests that gamification not only enhances user engagement in task-oriented domains but can also be leveraged to deepen customer relationships in experience-based industries.

Limits

While gamification has demonstrated potential in enhancing motivation and engagement across diverse domains, several limitations constrain its effectiveness and generalizability. As highlighted by Hamari et al. (2014), the impact of gamification is highly context-dependent, and its success often varies according to the design of the intervention and the individual characteristics of users. Many studies (Saprikis and Vlachopoulou, 2023; Khaldi et al., 2023) report only partial or short-term effects, particularly when gamification relies heavily on extrinsic rewards such as points or badges, which may fail to sustain long-term behavioral change. Moreover, methodological shortcomings including small sample sizes, lack of control groups, and limited longitudinal data have been noted in the literature, calling for more rigorous and theory-driven research designs.

From a conceptual standpoint, gamification also faces epistemological limitations, especially when game elements are isolated from the broader context of play. González-González and Navarro-Adelantado (2021) argue that gamification often risks reducing complex social behaviors to simplified systems of competition and reward, a process they refer to as "sportification." This selective application of game mechanics can strip gamification of its intrinsic playful nature, reducing its transformative potential. Additionally, the lack of a consistent interpretive model makes it difficult to fully understand how users transition from passive interaction to game-like engagement. Thus, while gamification can be a powerful tool, it must be carefully designed, contextually adapted, and theoretically grounded to avoid shallow implementation and unintended consequences.

1.4 Research gap

1.4.1 Nudges in PGG

The application of nudges within the context of Public Goods Games remains underexplored. Most PGG experiments focus on structural mechanisms such as punishment, reward, or communication to foster cooperation, while relatively few investigate the role of behavioral interventions that subtly guide choices without restricting them.

Nudges, particularly default options, framing, and informational prompts, could be powerful tools to influence contribution behavior in PGGs without altering the underlying payoff structure. However, existing studies tend to isolate economic incentives or social dynamics, leaving open questions about how nudges interact with strategic decision-making in collective action settings.

Moreover, research on PGG variants with temporal components, such as the carry-over mechanism introduced by Graves (2010), has not systematically examined how nudges might influence foresight, long-term cooperation, or intertemporal trade-offs. This creates a gap at the intersection of behavioral economics, cooperation theory, and nudging literature.

Addressing this gap could not only contribute to theoretical understanding but also inform the design of digital environments and policy interventions that rely on voluntary cooperation over time, such as sustainability platforms, collaborative work systems, or online communities.

1.4.2 Experimental support for predatory monetization

Despite the growing concern over predatory monetization strategies such as loot boxes, pay-to-win mechanics, and manipulative in-app purchases, there is still limited experimental research that systematically evaluates their psychological and behavioral effects. Most of the existing literature comes from descriptive studies, industry reports, or correlational analyses, often focusing on self-reported data or observational patterns in user behavior (King and Delfabbro, 2018). While these offer important insights, they fall short of establishing causal relationships between monetization design and user decision-making.

Moreover, the economic and psychological mechanisms underpinning these strategies often remain untested in controlled experimental settings. Features like default spending prompts, artificial scarcity, or reward uncertainty resemble behavioral nudges or dark patterns, yet their effectiveness have not been rigorously modeled in experimental paradigms similar to those used in behavioral economics (e.g., PGGs, delay discounting, or risk aversion tasks).

A crucial gap exists in connecting experimental economics and digital design, particularly to examine how these monetization techniques exploit behavioral biases such as loss aversion, sunk cost fallacy, or time inconsistency. Exploring these questions could provide stronger empirical foundations for policy recommendations, regulatory action, or platform accountability, especially in contexts where vulnerable users, such as adolescents or those with addictive tendencies, are disproportionately affected.

1.4.3 Advanced experimental design

Traditional experimental economics often relies on stylized, abstract environments that allow researchers to isolate specific variables and maximize control. However, this approach can sacrifice ecological validity, especially in studies involving social behavior and cooperation. Most Public Goods Games (PGGs) are conducted in simplified, text-based interfaces, far removed from the complex, stimulus-rich environments in which cooperative decisions typically occur—such as digital platforms and video games.

Such designs can capture nuanced behavioral responses to interface elements, visual feedback, and real-time decision dynamics, all of which are relevant when studying nudges in digital environments.

This study leverages a custom-built video game to embed visual nudges directly within gameplay mechanics and interface design. By simulating a multiplayer PGG with interactive elements, reward feedback, and cosmetic progression systems, we aim to replicate real-world conditions under which players make cooperative or self-interested choices. This approach provides a more ecologically valid testbed for studying behavioral nudges and expands the methodological toolkit available to experimental economists and behavioral scientists.

Chapter 2

Experimental design

2.1 Game design

The game was designed for online experiments via any internet browser. The game can be tested at https://kevin-jeu.click. Click "Press Start" then "Try the game". You will play against bots (AI). You will be able to select your treatment (control or nudge). Important: in the case that you want to replay the game, please refresh the page and click "disconnect", otherwise the game won't work.

2.1.1 Game development

The game was designed to simulate a dynamic public goods environment, where players repeatedly chose between contributing to a common pool or keeping resources for themselves. The design needed to balance realism (to reflect economic decision-making) with simplicity (to isolate the effect of nudges).

The game was developed using a mix of PHP, HTML, JavaScript and SQL for the database. The choice of platform was guided by the need for a simple web game that could be run locally or online with players synchronization in real time. The graphics for the "shop" phase was made using Godot Engine (2025). The animations were assembled with Aseprite (2025).

The use of an existing framework such as z-Tree (Fischbacher, 2007) was seriously considered but rejected because it didn't allow for advanced visual graphics and data collection.

The game's assets were a combination of custom-made and pre-purchased elements. Several visual components, such as UI elements and icons were created specifically for this project to match the experimental goals. Other assets, including characters design and animations, were sourced from licensed asset packs. These were assembled to create a cohesive 2D pixel graphics sci-fi aesthetic that balanced retro visuals with a futuristic theme, enhancing engagement while keeping the environment stylistically consistent.

We collect in-game decisions in real-time, including for instance the items purchased by the player, their respective treatment, their strength, and more intricate decisions such as if they refreshed the items in the in-game store or if they skipped the battle animation. The system also tracked changes in behavior across stages. At the end of the experiment, we also collect various information on the player via a questionnaire (cf. section 2.1.3).

Fine-tuning

Before running the experiment, the game was piloted twice with small test groups to identify usability issues and confirm that the nudges were functioning as intended. Minor revisions were made such as rewards calculation, visual improvements and added features such as a mini-game while waiting for other players to be ready and the ability to skip the battle animation to speed up the duration of the experiment.

To support an online experiment, a feature was added in case a player quits, where the game can continue to run without needing the player to play the game. The player's character is still in the game, but they don't make any purchases in the game. They are marked as "disconnected" in the database so they can be removed from the data analysis.

The game was also updated to be playable on phone, as I predicted that many players would request to play on their phone. Also, as suggested by my supervisors, the game needed sounds. Royalty-free sounds and musics were added in the preparation, shop and battle phases.

While running the experiment, an issue arose where players would get stuck in the waiting room before the battle phase and couldn't play the game. This issue was due to the latency difference due to server location and was quickly fixed by adding a one second delay before accessing the waiting room.

2.1.2 Game rules

Players participated in repeated stages with a 94% chance to continue the game. This means that, on average, a game contains 16.67 stages. This continuation probability ($\delta = 0.94$) introduces strategic uncertainty about the game's end, encouraging players to consider the long-term consequences of their decisions (Aumann, 1981). Such a setup is standard in repeated game theory and is commonly used to test for sustained cooperation under dynamic conditions (Fudenberg and Maskin, 1986).

Players are randomly assigned to a group on each stage. The intuition behind that design choice is to minimize the influence of repeated interactions with the same individuals, which could lead to the formation of alliances or retaliatory behavior. By reshuffling groups, we maintain the anonymity and one-shot-like nature of each interaction, allowing us to isolate the effects of visual nudges on cooperation rather than on reputation dynamics. This approach follows standard practice in experimental economics when the goal is to study intrinsic motivation or the effect of design elements without confounding social learning or trust-building (Andreoni and Croson, 2008).

Each stage involve resource allocation, optional upgrades, and cooperative combat, with the ultimate goal of maximizing players' own financial gains.

Each participant began the game with an initial endowment of 200 coins, with 1 coin equivalent to 0.01€. In each stage, players chose how much of their balance to invest in their character by purchasing upgrades in a shop phase, and how much to retain in their personal account. Investments were irreversible but cumulative, carrying over from stage to stage.

Upgrades increased a player's strength, which determined their contribution to the group's collective damage during the combat phase. At the end of each stage, the group's total damage was multiplied by a fixed factor of 1.5 (1 strength adds 1.5 coins to the pool), and the resulting sum was distributed equally among all group members, regardless of individual contribution. This introduced the classic public goods dilemma: players had to weigh personal investment against free-riding on others' contributions.

Therefore, the payoff function[1] is given as:

$$\pi_i^t = (B_i^t - c_i^t) + \frac{1.5 \cdot \sum_{j=1}^{n} \sigma_j^t}{n}$$

where π_i^t is the payoff of player i in stage t, B_i^t is the budget of player i at the start of stage t, c_i^t is the amount invested in upgrades during stage t, σ_j^t is the cumulative strength of player j

[1] Inspired by Aumann (1981).

at stage t and n is the total number of players in the group.

The first term, $B_i^t - c_i^t$, corresponds to the money kept by player i, while the second term represents their equal share of the group reward, which depends on the total group strength multiplied by a factor of 1.5. Strength investments are irreversible but persist across stages, thus influencing future returns.

Upgrades do not necessarily have the same price or provide the same amount of strength. Each upgrade offers a distinct cost-benefit ratio, requiring players to make strategic choices about how best to allocate their limited resources. This variability introduces an additional layer of decision-making, simulating realistic trade-offs that we can find in video games and further testing the influence of nudges on cooperative investment behavior.

Unspent coins remained in a player's account for future stages. The game unfolded in a loop of four phases:

1. **Preparation Phase**: Players reviewed their balance and decided whether to enter the shop or proceed directly to combat.

2. **Shop Phase**: Players could purchase upgrades that increased their strength.

3. **Combat Phase**: A visual boss fight played out, representing the group's effort. This phase had no impact on the distribution of rewards beyond visualization.

4. **Results Phase**: Players viewed the group's total damage, individual contributions, and the earnings allocated to each player.

Each decision point offered trade-offs between individual and collective benefits, making the game an effective experimental environment to test the impact of visual nudges on cooperation and prosocial investment. The game continues into a post-experiment questionnaire.

2.1.3 Post-experiment questionnaire

The post-experiment questionnaire available at https://kevin-jeu.click/stages/questionnaire.php is comprised of 21 questions that have 6 distinct functions:

1. To assess participants' demographic background (Questions 1–6), including prior experience with economic experiments and video games, age, gender, education level, and field of study.

2. To evaluate basic cognitive reflection (Questions 7–9), using three classic logic questions from the cognitive reflection test (Frederick, 2005), which measure intuitive versus analytical thinking.

3. To gauge their gaming experience (Questions 10–13), including enjoyment, immersion, clarity, difficulty.

4. To understand participants' in-game decision-making and strategy (Questions 14–17), via open-ended and Likert-style items about saving, cooperation, and competitive behavior.

5. To capture their perception of the game (Questions 18-20), via questions about the influence of the game's presentation on their choices.

6. To measure their risk aversion (Question 21), via the Bomb Risk Elicitation Task (Crosetto and Filippin, 2013). This will allow for a control to see wether loot boxes and slot machines purchases are associated with

Bomb Risk Elicitation Task

A method developed by Crosetto and Filippin (2013) to measure risk preferences is the Bomb Risk Elicitation Task (BRET). In this task, participants choose how many boxes k to collect out of 100. Each box yields a reward x, except for one randomly placed bomb. If the bomb is collected, the payoff is zero.

There are two possible outcomes:

- **A**: The bomb is collected, with probability $\frac{k}{100}$, and the payoff is 0.
- **B**: The bomb is avoided, with probability $\frac{100-k}{100}$, and the payoff is xk.

Assuming a constant relative risk aversion (CRRA) utility function, the expected utility is:

$$EU(x) = \frac{k}{N} \cdot 0^{\theta} + \frac{N-k}{N} \cdot (xk)^{\theta}$$

Maximizing this utility with respect to k yields:

$$\frac{k}{N} = \frac{\theta}{1+\theta} \quad \Rightarrow \quad \theta = \frac{k}{N-k}$$

Thus, by observing the number of boxes collected, we can estimate the participant's risk aversion:

- $k < 50$ implies risk aversion ($\theta < 1$),
- $k > 50$ implies risk seeking ($\theta > 1$).

In our experiment, participants chose which boxes to open from a grid of 64, rather than specifying a number (c.f. appendix 3.9). This interactive format simplified the task and increased engagement. To incentivize completion of the questionnaire, participants were told before starting the experiment that they would play a short mini-game at the end, with potential earnings of up to $3.20.

2.2 Visual nudges implemented

Leaderboard

In the first phase of a stage – the preparation phase – nudged players will see the top 3 contributors of the room. This visual prompt is designed to leverage social comparison as a behavioral nudge, encouraging prosocial behavior by highlighting cooperative norms. Research in behavioral economics has shown that making contributions visible, especially by showcasing high performers, can significantly increase cooperation in public goods settings.

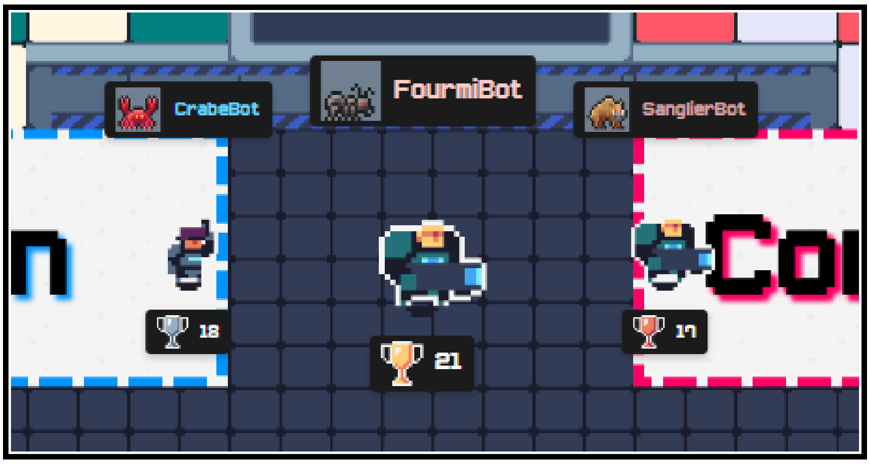

Figure 2.1: Display of the top 3 contributors in the room. "FourmiBot" is the first contributor with 21 strength, "CrabeBot" is second with 18 strength and "SanglierBot" is third with 17 strength.

For instance, Yoeli et al. (2013) demonstrate that publicizing individual contributions in a communal energy-saving program led to significantly higher participation rates. Similarly, this strategy is effective in increasing the frequency of blood donation (Lacetera and Macis, 2010) as well as college charity donation (Karlan and McConnell, 2014). Fehr and Gächter (2000b) show that conditional cooperation is strengthened when individual contributions are observable.

In a video game context however, the results of Pedersen et al. (2017) question the use of leaderboards. Indeed – by analysing the data of the citizen science game Quantum Moves, where some players could see the leaderboard while some couldn't – they found that leaderboards make no difference in terms of retention and performance. Zichermann and Linder (2013) explains that, depending on the context and design of the leaderboard, there can be a polarization in terms of motivation, where some players gain motivation while others are demotivated.

Therefore, it's unsure wether the leaderboard implemented in our experiment has a positive effect[2]. Further investigation from video game experts would be needed to understand its potential. Nonetheless, we retained it in the experiment, as it offers additional content for participants who were nudged and may help increase overall engagement.

Formated currency

To test the effect of the formated currency on spending behavior, the presentation of player balances was manipulated (c.f. figure 2.2). This design draws on findings from behavioral economics and consumer psychology, particularly the concept of "money illusion" (Gourville, 1998; Raghubir and Srivastava, 2002; Shafir et al., 1997) – the idea that individuals perceive and respond to nominal rather than real values.

[2]To try to understand wether leaderboards have a positive effect, I programmed a similar experiment than the one in this memoir, in a more traditional format (non-gamified). It includes 4 groups: a control group, a group that sees a leaderboard of players who invested the most, a group that sees the players in their team with their respective investments, and a group that sees both (a leaderboard and the players in their team). I haven't had the time to run the experiment though.

Figure 2.2: The nudged player's balance container displays 200 and a coin image next to it, whereas the control player's balance container displays 2.00€.

Toccafondi et al. (2023) show that virtual currencies can significantly influence user spending behavior through the mechanism of money illusion. In their randomized controlled trial, they found that participants were more likely to spend when using virtual currencies with fixed exchange rates, as opposed to real-world currency.

This supports the idea that abstracting monetary value through in-game currencies can reduce the perceived cost of purchases, encouraging users to spend more. Additionally, the authors note that higher nominal values of virtual currency (e.g., "200 coins" instead of "2.00€") may amplify this effect by distancing the player's perception from the actual economic cost, especially under conditions of risk and ambiguity.
This is hardly surprising, as it aligns with well-established behavioral insights and the theory of "money illusion". Raghubir and Srivastava (2008) demonstrates that less transparent payment forms, like gift certificates or stored value scrip, are treated more like "play money" and lead to higher spending.

This has direct implications for game design, as it suggests that the use of stylized or inflated virtual currencies can act as a subtle yet effective nudge, increasing investment in upgrades or items within the game environment.

Rarity system

This nudge consists of visually coding by rarity the items in the shop, which is designed to leverage the psychological mechanism known as the fear of missing out (Przybylski et al., 2013). FOMO taps into players' aversion to loss and their desire to acquire exclusive or scarce rewards, even when those rewards have no objective performance difference. This type of nudge exploits scarcity heuristics – the tendency to assign higher value to items perceived as rare or limited.

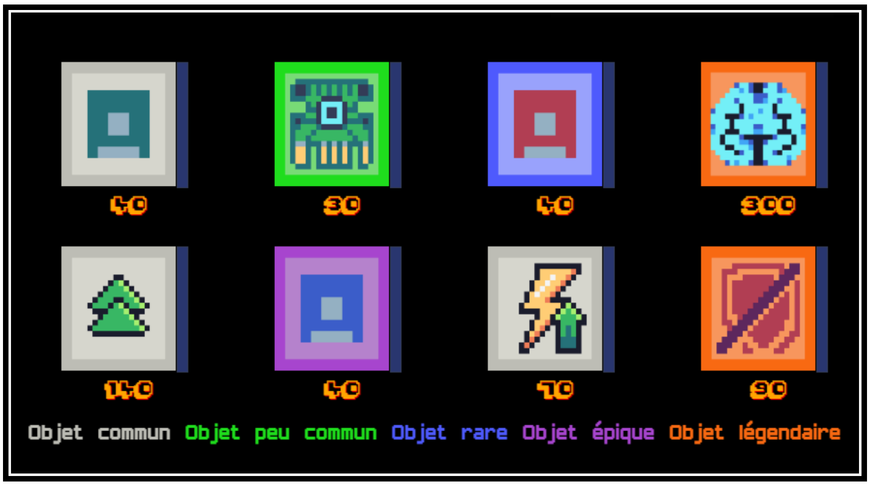

Figure 2.3: Items shop of the game. We observe that some have a gray background (common), green (uncommon), blue (rare), purple (epic) and orange (legendary).

The intuition behind that nudge is that rarity systems are a well-established design strategy in video games, especially in games with loot boxes, gacha mechanics, or collectible items. Games such as *Fortnite*, *CS2* or *Clash Royale* use color-coded rarity tiers (e.g., common, uncommon, rare, epic, legendary) to drive user engagement and purchasing behavior.

As discussed in King and Delfabbro (2019) and Zagal et al. (2013), the illusion of scarcity contributes to increased desire and urgency, often prompting players to spend more to avoid missing out on perceived high-value opportunities.
Toccafondi et al. (2023) show that this type of presentation can distort perceived utility and increase willingness to spend, particularly when tied to visual signals of exclusivity in the case of loot boxes. In behavioral terms, it can trigger mechanisms like anticipated regret and social signaling, motivating players to acquire rare items not just for gameplay advantages, but also for status and psychological reward.

This is the reason why we also included loot boxes, slot machines and skins in our game as they tend to have a more important response to this type of presentation.

Progression bar

Progress bars are a classic game design element used to provide players with a visual representation of their advancement toward a goal. In our game, nudged players were shown a level indicator (Figure 2.4) in order to link visual feedback directly to in-game behavior.

Figure 2.4: Level indicator for nudged players. It shows the level of the player and how far they are from leveling up. One level equals to 8 damage.

This nudge is grounded in the behavioral principle of the goal-gradient hypothesis (Hull, 1932; Kivetz et al., 2006), which suggests that individuals increase their efforts as they perceive themselves to be closer to a goal. In gaming, this is often done through experience points, level-ups, or achievement systems that visually track and reward progression.

Progress indicators exploit both intrinsic and extrinsic motivational factors. Visually approaching a goal provides a sense of accomplishment and mastery, which are key drivers in self-determination theory (Ryan and Deci, 2000; Rigby and Ryan, 2011). Furthermore, progression bars can nudge players into performing more actions (inflicting damage) simply to see the bar fill up.

Self-reflection prompt

This nudge takes the form of a pop-up message (Figure 2.5) that appears when a player attempts to enter battle without visiting the shop. The prompt encourages the player to pause and reconsider their decision.

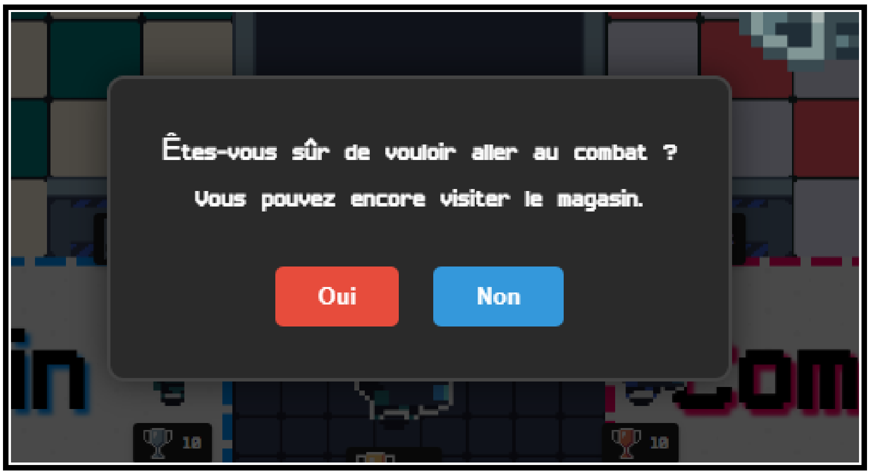

Figure 2.5: Prompt that appears as a pop-up when the player tries to go to battle without visiting the shop. It reads: "Are you sure you want to go to battle? You can still visit the shop.".

Such interventions are a form of self-reflection prompt designed to interrupt automatic behavior and elicit more deliberate, goal-consistent choices (Thaler and Sunstein, 2008; Bovens, 2009). In behavioral terms, it is a system 2 activation cue, pushing users to move from fast, intuitive thinking to slower, more reflective reasoning (Kahneman, 2011).

These prompts have been shown to reduce impulsive or default choices in digital contexts (e.g., purchasing, app usage), especially when phrased to imply missed opportunities or pending actions (Schneider et al., 2018; Caraban et al., 2019).

In our context, the prompt serves a dual purpose:

1. It acts as a gentle reminder of the available in-game resources (shop items).
2. It encourages players to reflect on their readiness, potentially reinforcing more strategic and cooperative behavior.

2.3 Player sample

The player sample is composed of 44 participants. They were divided into 2 groups: a control group (24 participants) and a treatment group (20 participants). Unfortunately, due to a bug in the game, only 37 participants could answer the post-experiment questionnaire. The demographics data is self-reported from the post-experiment questionnaire.

2.3.1 Demographics

The sample is predominantly composed of young individuals, with 17 participants under the age of 18 and 15 between 18 and 24 years old. This skew toward younger age groups can be explained by the recruitment method, where participants were drawn from a video game. As noted by Wittek et al. (2016), video game players are typically younger, with the majority falling within adolescence or early adulthood.

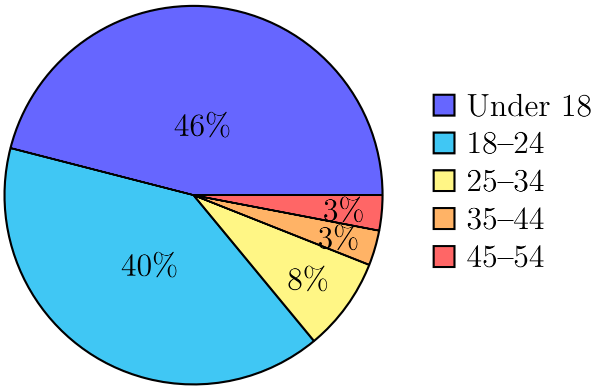

Figure 2.6: Age distribution of participants.

Participants reported a diverse range of preferred game genres (c.f. figure 2.7), reflecting a broad spectrum of gaming interests. Similar findings were observed by Kim et al. (2022) who noted comparable diversity in player genre preferences.

Regarding gender distribution (figure 2.8), our sample is skewed toward male participants. While a male-dominated sample is expected given the general demographics of video game players, the imbalance in our study is more pronounced than in comparable research. For instance, Wittek et al. (2016) report a sample consisting of 62.7% male participants. This discrepancy may reflect the specific game environment used for recruitment or the design of the study, which may have attracted more male players.

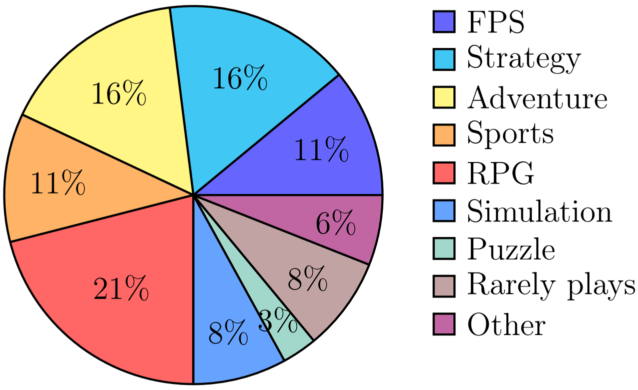

Figure 2.7: Most played game genre distribution.

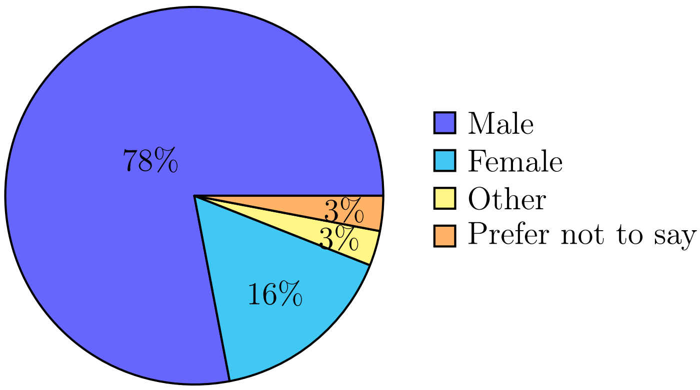

Figure 2.8: Gender distribution of participants.

The education level of participants (figure 2.9) is fairly diverse but skewed toward lower levels of formal education. A majority reported having either no diploma (7), middle school (7), or high school education (12), which together represent nearly two-thirds of the sample. This distribution likely reflects the young age of participants, many of whom are still in school and have not yet pursued higher education.

Participants come from a wide range of academic and professional backgrounds. The most common fields are “Other” (11 participants), “Unemployed” (7), and “Computer Science” and “Sciences” (5 each). The high number in the “Unemployed” and “Other” categories again suggests a young and potentially still-studying population. The noticeable representation in technical fields such as Computer Science and Health also aligns with general gaming demographics, which often show higher interest from STEM fields.

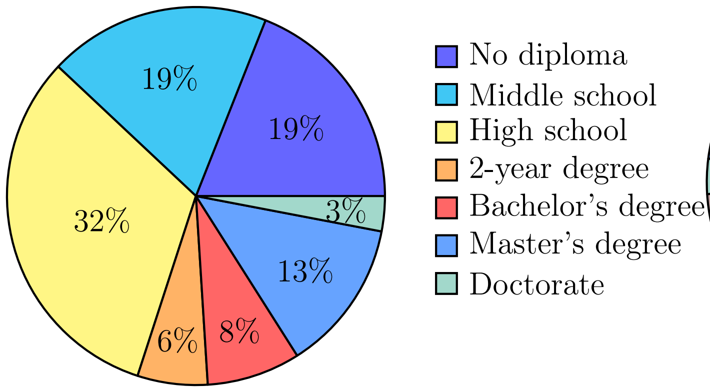

Figure 2.9: Education level of the participants.

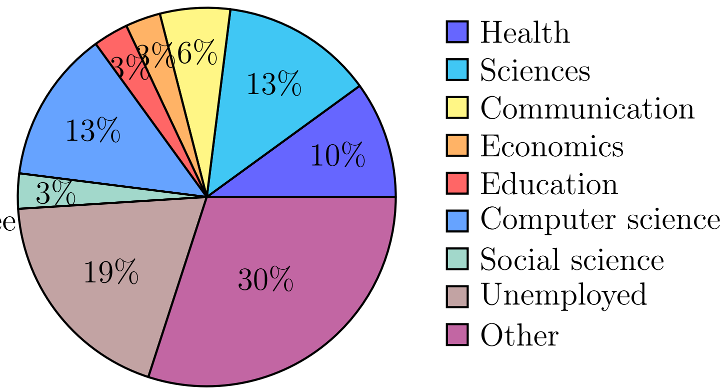

Figure 2.10: Field of study or work of the participants.

All in all, the data suggest that the sample is relatively young and still in education, with a concentration in technical or scientific fields. This demographic profile aligns well with the intended audience of the experiment, which was designed as a video game.

Therefore, the sample's familiarity with gaming environments likely enhanced their engagement and understanding of the game mechanics, making them particularly suited for this type of study.

2.3.2 Recruitment process

The recruitment process started from June 1st 2025 to June 5th 2025. The participants were recruited directly from the mobile and PC video game *Cubic Castles*[3]. This recruitment method was used for multiple reasons:

1. To recruit participants familiar with video games and their monetization methods (e.g., the rarity system).

2. For its high degree of flexibility, allowing us to embed recruitment messages with links in a way that integrates naturally with the gameplay experience.

3. For its in-game currency.

To find participants, we used one of the game's feature called "Hollawarps" (c.f. appendix 3.10). It allows for players to teleport directly to the experimenter for easier communication[4].

The instructions to join the experiment were given inside Cubic Castles via a Non-Playable Character (NPC) and informational panels (c.f. appendix 3.11). The link of the website wasn't given right away as a way to control the flow of the players joining the experiment.

Difficulties encountered

After the 7th game, it was getting harder to find participants. *Hollawarps* became insufficient to attract new participants. As a result, I resorted to actively teleporting to other players and pitching my experiment in a manner reminiscent of a car salesperson.

Recruiting a fourth player to start a game session was often challenging. Some players desisted at the last minute, which made the recruitment process even more challenging.

[3] https://play.google.com/store/apps/details?id=com.cosmiccow.cubiccastles

[4] If you prefer, they can be considered as a Short Message Service (SMS) with a link in the end that physically brings you to the sender when you click it.

Another difficulty encountered was having to answer multiple players at the same time, while some others are impatient to start. This made giving instructions to join the experiment harder than anticipated.

Finally, it was hard to retain participants after the game bugged, as I had no way to not only see the screens of the players to try and understand the issues, but also couldn't communicate with players who had to leave Cubic Castles in order to participate to our experiment.

2.3.3 Incentives

The participants were compensated from participating in the experiment with the in-game currency of Cubic Castles called "Cubits". The conversion rate from dollars to cubits was taken from the first offer proposed by the game (c.f. appendix 3.12), $1 = 500 cubits.

At the end of the experiment, participants were given a unique code (c.f. appendix 3.13). Participants had to privately message the experimenter the code in order to receive their rewards.

In total, 53530 cubits ($107.06) were awarded to the participants. More cubits (around 30000) were rewarded as a marketing stunt and to compensate from the video game's bugs.

On average, players were rewarded 1530 cubits ($3.06) with a minimum of 155 cubits ($0.31) and a maximum of 6325 cubits ($12.65).

While the reward structure was sufficient to attract some engagement, it felt relatively low compared to traditional experimental incentives. This is consistent with findings from Amir et al. (2012), who show that small stakes can reduce task seriousness and may not generate the same level of cognitive engagement or incentive effects as more substantial monetary rewards. Moreover, Gneezy and Rustichini (2000) highlight the "low-pay, low-effort" phenomenon, where lower incentives can sometimes produce counterintuitive behavioral responses.

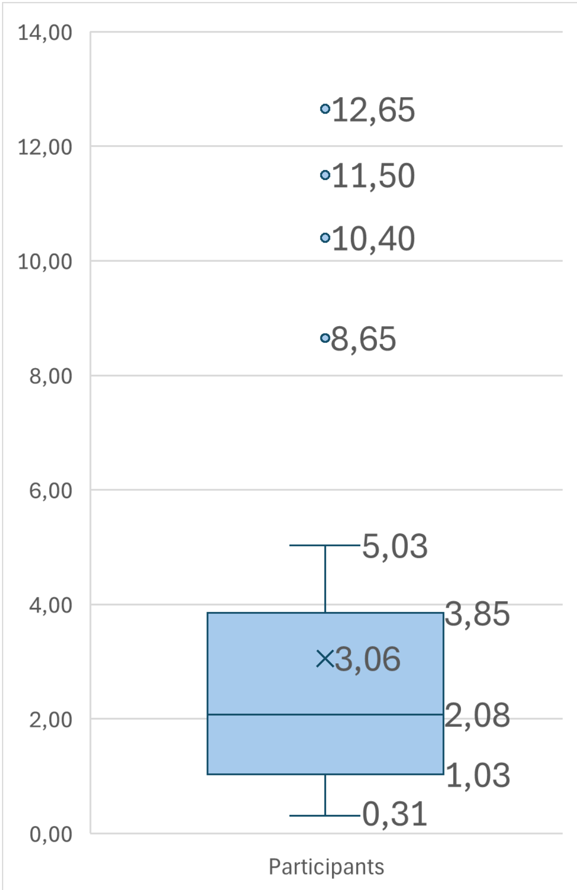

Figure 2.11: Final gains rewarded to the players, in USD.

In this case, the relatively modest payouts may have limited motivation for full engagement among some participants, despite the virtual currency's contextual value.

The modest participant compensation was not the result of limited financial resources, but rather was due a miscalculation in the reward structure. Specifically, the reward estimates were based on idealized conditions (assuming perfect play and a free-rider strategy) to cap the maximum earnings per participant. However, this conservative design unintentionally reduced the average payouts more than anticipated, as real player behavior did not align with the optimal scenarios assumed in the calculations.

2.4 Hypotheses

Recent research in behavioral economics shows that nudges can significantly influence decision-making, often leading individuals to act in ways that align with long-term or collective goals, even at a short-term personal cost (Thaler and Sunstein, 2008). In economic games, interventions such as default options or social framing have been shown to increase contributions to public goods (Madrian and Shea, 2001). When individuals are nudged toward cooperation or investment-like behavior, they may spend more resources in the process, resulting in a lower personal payoff despite helping the group.

Therefore, H1: Nudged individuals will end up with a lower final payoff than the control group because they invested more.

In digital environments, game design can act as a powerful mechanism for shaping social behavior. Small design tweaks such as highlighting others' cooperative actions or introducing progress cues have been shown to encourage teamwork and reciprocal behaviors (Tomasello, 2009; McEvily et al., 2006). If the game was designed to subtly prompt collaborative strategies among nudged participants, we expect greater alignment and shared effort in gameplay.

Therefore, H2: The game design improves cooperation for nudged individuals.

Additionally, nudges often increase engagement by reducing friction or increasing the salience of certain actions (Benartzi et al., 2017). In consumer behavior, this translates to more frequent purchases or interactions with highlighted features. In the context of a game, nudged players might be more likely to buy in-game content like loot boxes or skins simply because these options are made more visible or compelling through the nudge design.

Therefore, H3: Nudged individuals purchased more loot boxes and skins than the control group.

Finally, nudges can also enhance the subjective user experience. If the game guides players toward more rewarding or fluid behaviors such as achieving small goals (level up bar), feeling included in group success (leaderboard), or interacting more with the environment (framing), it could increase overall satisfaction. Johnson et al. (2012) show that user-centered design nudges improve both engagement and enjoyment in digital applications.

Therefore, H4: Nudged individuals enjoyed the game more than the control group.

Chapter 3

Results

The results can be found at: https://kevin-jeu.click/adminpanel123.php. The cleansed and analyzed data can be found at: Google Drive.

The reason only a subset of rooms was selected is that the others were either affected by bugs or abandoned due to players not joining the correct room, requiring a restart of the game.

3.1 Cooperation metrics

Hypothesis 1

H1: Nudged individuals will end up with a lower final payoff because they invested more.

We observe on figure 3.1 that, on average, nudged individuals ended up with \$1.92 less than the control group, which is an important difference.

We formally test this difference in final payoff using a linear regression where the dependent variable is the final balance (in USD) and the independent variable is a dummy indicating whether the participant was in the nudged group.

We find that this effect is statistically significant at the 5% level (p-value $= 0.0278 < 0.05$), suggesting that the difference in earnings is unlikely due to chance.

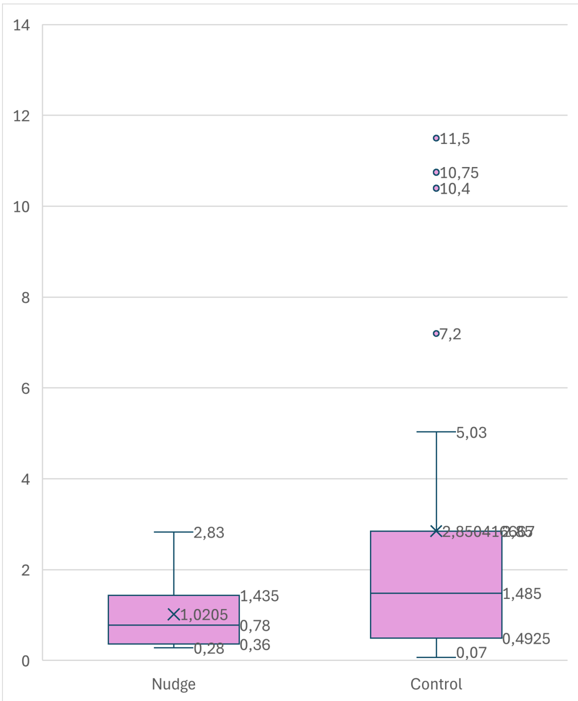

Figure 3.1: Final balance (in \$) of nudged individuals vs. the control group.

The model's $R^2 = 0.0889$ indicates that about 9% of the variance in final payoff is explained by the nudging condition, which is small but non-negligible in behavioral experiments.

Taken together, these results support H1: nudged individuals earned significantly less than those in the control group, likely due to investing more during the game. While \$1.92 might seem small, it represents over 60% of the average total earnings (\$3.06), which is a substantial behavioral shift. This suggests that nudging mechanisms effectively encouraged investment behaviors, even at the cost of final monetary payoff. This highlights their potential power in shaping in-game economic decisions.

Hypothesis 2

H2: The game design improves cooperation for nudged individuals.

Cooperation in our game is defined by the amount of strength of the players, as each point of strength adds 1.5 tokens to the pool.

We observe in figure 3.2 that the average strength of nudged players consistently exceeds that of the control group at every stage. This difference becomes more pronounced in the later stages of the game. However, only a few games reached late stages, so we cannot draw conclusions too early.

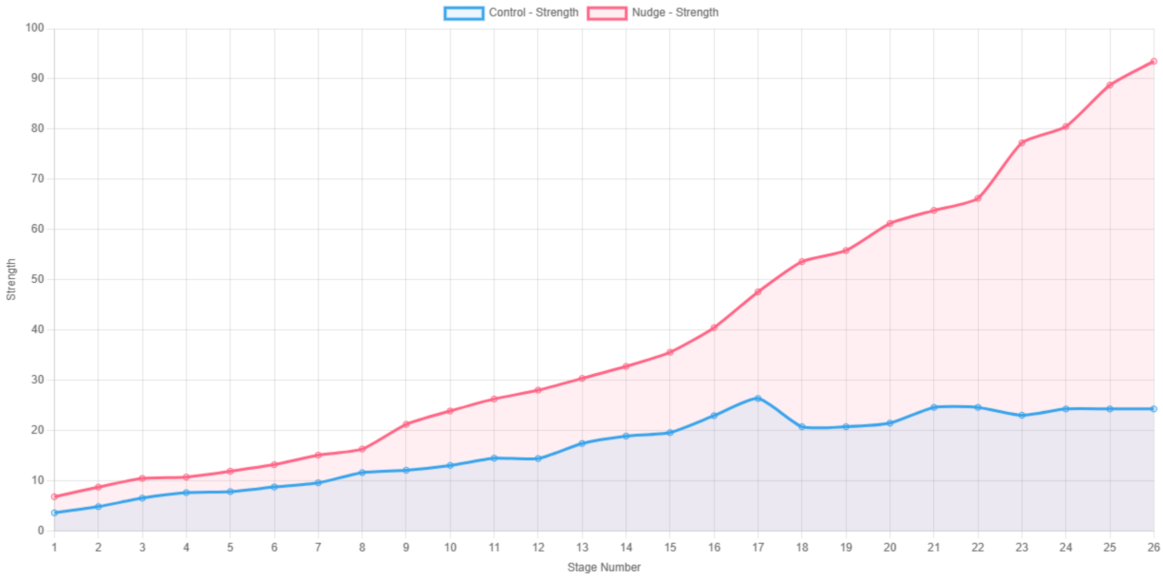

Figure 3.2: Average strength overtime of the control group vs. nudged players.

The results from the linear regression analysis using player strength as the predictor indicate a significant positive relationship between strength and the nudged condition (p-value = 0.0153, $R^2 = 0.13$).

However, given the limited number of completed games, our analysis should focus on a stage that was reached by all sessions. Stage 6 represents the latest common point across all games and will therefore serve as the primary focus of our analysis.

Therefore, another linear regression was conducted for stage 6. The results reveal a stronger and statistically significant positive effect of strength on player performance (p-value = 0.0034). The model explains a larger portion of the variance ($R^2 = 0.19$), indicating a more robust relationship at this critical stage.

Two additional linear regressions were conducted to evaluate the relationship between player strength and performance across different game stages.

The first regression, limited to stages 1 through 6 ($n = 301$), reveals a significant positive effect of strength (p-value < 0.001) on performance. The model explains approximately 13.4% of the variance in outcomes ($R^2 = 0.13$) and indicates that nudged players tend to have more strength early. This supports the idea that the impact of nudging on behavior is measurable relatively early in the gameplay.

The second regression, which includes all available stages, yields similar but slightly stronger results. The strength coefficient remains positive and significant (p-value < 0.001), and the explained variance increases slightly to 13.9% ($R^2 = 0.14$). Despite a smaller coefficient, the much larger sample size ($n = 675$) makes the estimate more robust, indicating that the relationship between strength and performance persists throughout the entire game duration.

Together, these regressions confirm a consistent and statistically significant relationship between strength and player performance. The results suggest that nudging likely influenced players to cooperate more, not only early on but across the full game experience. H2 is confirmed.

Self-reported metrics

In the post-experiment questionnaire, two questions were inquiring on the self-reported cooperation of the participants (question 16 and 17).

> Question 16: "Did you feel encouraged to cooperate with other players?"

A linear regression on responses to this question reveals a significant effect of the treatment (p-value = 0.006; $R^2 = 0.19$). Participants who were nudged reported higher encouragement to cooperate compared to those in the control group. This supports the hypothesis that the game design influenced social behavior by fostering stronger cooperative intent in nudged individuals.

> Question 17: "Did you ever consider taking advantage of others (letting others contribute while saving your own money)?"

The linear regression results show a significant negative relationship between the treatment and the tendency to consider free-riding (p-value = 0.002; $R^2 = 0.24$). Participants in the nudged condition were less likely to consider exploiting their teammates, suggesting that the nudge not only promoted cooperation (as seen in Question 16) but also discouraged strategic selfishness (free-riding).

This finding adds further support to H2, confirming that the game design enhanced cooperative behavior among nudged individuals.

3.2 Player behavior patterns

Hypothesis 3

H3: Nudged individuals purchased more loot boxes and skins than the control group.

We can see on figure 3.3 that, overall, nudged players purchased more items including skins, loot boxes and slot machines, except for the green skin. The question is wether they purchased these types of items more than the others.

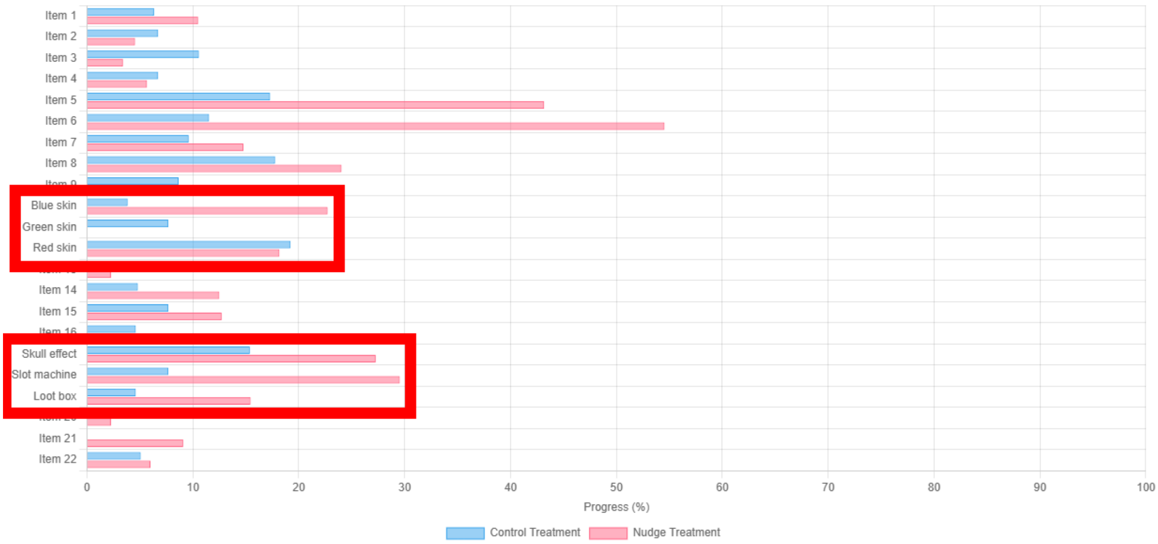

Figure 3.3: Items purchased by the players, depending on their treatment group. The red rectangles contain skins and loot boxes.

To investigate this, we calculated the proportion of skins, loot boxes, and slot machines purchased relative to the total number of items bought by each player. We then conducted linear regressions to test whether the treatment (nudge vs. control) predicted a higher ratio of these "temptation" items.

Three separate regressions were run:

1. The ratio of all temptation items (skins + loot boxes + slot machines) to total purchases.
2. The ratio of skins to total purchases.
3. The ratio of loot boxes and slot machines to total purchases.

The results show that none of the regressions revealed a statistically significant effect of the nudging treatment on the proportion of these items:

1. For the overall temptation item ratio, the effect was negligible (p-value = 0.76).
2. For skins alone, the treatment had no meaningful impact (p-value = 0.82).
3. For loot boxes and slot machines combined, the negative trend was slightly stronger but still non-significant (p-value = 0.27).

These findings suggest that, while nudged players may have bought more items overall, they did not disproportionately favor temptation items such as skins, loot boxes, or slot machines when compared to the control group. H3 is rejected.

Hypothesis 4

H4: Nudged individuals enjoyed the game more, were more immersed and the game was clearer.

We can visibly see on figure 3.4 that nudged players reported to enjoy the game more, find it more clear and we more immersed. To test these impressions statistically, we conducted a series of linear regressions using treatment group (nudge vs. control) as the independent variable and participants' self-reported scores on enjoyment, clarity, difficulty, and immersion as dependent variables.

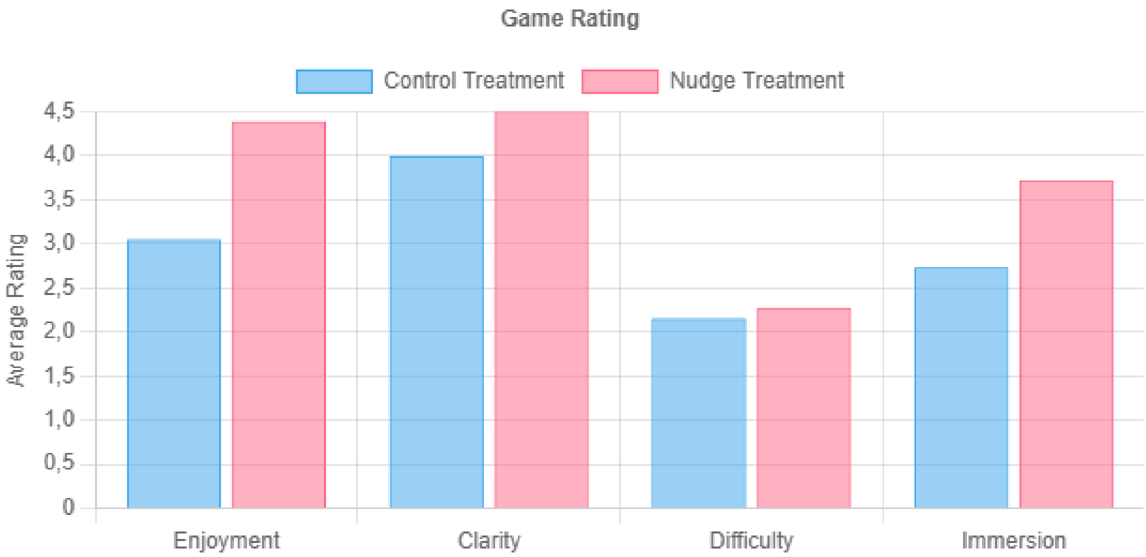

Figure 3.4: Players feedback comparison (control vs. nudge).

- The regression on game enjoyment reveals a statistically significant effect of the treatment (p-value = 0.004; R^2 = 0.21). This suggests that nudged participants enjoyed the game significantly more than the control group.
- In contrast, the regression for game clarity does not reach statistical significance (p-value = 0.314; R^2 = 0.029). This implies that although nudged players subjectively reported slightly greater clarity, this difference is not robust enough to be statistically confirmed.
- Regarding perceived difficulty, the regression result is also not statistically significant (p-value = 0.421; R^2 = 0.019). Nudging did not affect how difficult participants found the game.
- The regression for immersion shows a statistically significant effect (p-value = 0.033; R^2 = 0.12). This suggests that nudged participants felt more immersed in the game.

Overall, these results provide partial support for H4: nudged participants reported significantly higher enjoyment and immersion, but no statistically significant differences were found in clarity or perceived difficulty. These findings suggest that the nudging condition may have made the experience more engaging and rewarding, but not necessarily easier or clearer from a cognitive standpoint.

Game metrics

Another way to measure enjoyment is to look in the database the 2 following metrics: the mini-game's highscore in the waiting room (a higher score would mean the player skipped the shop quickly because he is not interested in the experiment) and if the player skipped the battle animation.

Contrary to our initial expectations, nudged participants had higher mini-game scores on average. Although this effect was only marginally significant (p-value = 0.083), it challenges the assumption that a high mini-game score reflects disengagement or a desire to skip through the shop. Instead, this result may suggest that nudged players were more motivated or attentive overall, thus weakening the validity of this behavioral proxy for enjoyment.

Regarding the decision to skip battle animations, no significant effect of the treatment was observed (p-value = 0.27). Nudged players were slightly less likely to skip, which could be consistent with increased immersion, but the evidence is inconclusive.

These results highlight the complexity of interpreting behavioral metrics, which may be influenced by multiple factors beyond the scope of the intended experimental manipulation.

3.3 Effectiveness of nudges

Although several nudges were implemented simultaneously in the treatment condition, it is important to acknowledge that we cannot isolate the effect of each individual nudge. The design does not permit attributing changes in behavior to specific interventions (e.g., the self-reflection prompt vs. visual enhancements), since one nudge may influence multiple behaviors or interact with the effects of others.

For example, a self-reflection nudge meant to encourage thoughtful decision-making could indirectly increase time spent in the shop, which might in turn increase item purchases, rerolling, or exploration of other features. Therefore, the results should be interpreted as reflecting the overall effect of the nudge package.

Nonetheless, several behavioral differences between the control and treatment groups are consistent with greater engagement among nudged participants. First, participants in the treatment group rerolled the shop more often than those in the control group, suggesting a heightened interest in the available items (p-value = 0.0038; $R^2 = 0.18$). This behavior may reflect a more deliberate or motivated approach to in-game purchasing decisions.

Second, nudged players skipped the shop interface less frequently, likely due to the self-reflection prompt that appeared when they attempted to go directly to battle (p-value = 0.0084; $R^2 = 0.15$). This finding suggests that the prompt was effective at encouraging players to at least briefly consider the shopping phase.

However, there was no significant effect of the treatment on the purchase of higher-rarity items, such as epic or legendary gear (p-value = 0.46; $R^2 = 0.01$). This indicates that while the nudges increased exploration and interaction with the shop, they did not necessarily lead players to prefer or invest in rarer (and typically more expensive) items.

Taken together, these results suggest that the nudge package was successful in promoting greater attentiveness and exploratory behavior during the shopping phase, even if it did not significantly influence specific purchasing patterns such as a preference for rare items.

3.4 Interpretation and limits

This study demonstrates that a combination of behavioral nudges embedded within a game environment can measurably influence cooperation, engagement, and decision-making patterns. Across multiple hypotheses, we observe consistent behavioral shifts in the treatment group, including increased cooperative investment, higher self-reported prosocial intent, greater in-game activity (e.g., rerolling and reduced skipping of the shop), and enhanced enjoyment and immersion.

However, the experimental design introduces several important limitations that should guide the interpretation of these findings:

1. Absence of randomization in certain game elements

One important design limitation is the lack of randomization in the visual and perceived value of items. For example, while their positioning was random, some shop items may have had more attractive thumbnails that unintentionally skewed player preferences. This could have confounded efforts to assess whether nudges genuinely influenced behavior, or whether visual appeal or design artifacts did so instead. In future iterations, randomizing visual elements in the shop would help reduce systematic bias and strengthen internal validity.

2. Sample size and stage progression

Several findings rely on regressions with limited sample sizes, particularly when analyzing advanced stages of the game. Although results for strength and cooperation effects are consistent across stages, the later stages had fewer observations, reducing statistical power. This limits our ability to make strong claims about long-term effects or late-game behavior. For more robust generalization, further testing with larger samples and more completed sessions would be beneficial.

3. Limits of behavioral proxies

While behavioral proxies such as mini-game scores and battle skipping provide useful indirect measures of engagement, they are also open to multiple interpretations. For instance, a higher mini-game score could suggest boredom with the shop, or alternatively, increased motivation and focus. Similarly, skipping battle animations may reflect impatience or efficiency rather than a lack of immersion. These nuances highlight the challenge of interpreting behavior without triangulating with more direct measures (e.g., interviews or detailed time-tracking).

4. Generalizability of findings

Finally, while the experiment was well-suited to detecting in-game behavioral shifts, the extent to which these results generalize beyond the experimental environment remains uncertain. The game was specifically designed for the study, and players' behavior might differ in more complex or higher-stakes contexts. Additionally, the participant pool and setting could shape cooperation and engagement in ways not fully representative of broader player populations.

Despite these limitations, the results provide compelling evidence that well-designed nudges can influence prosocial behavior, engagement, and enjoyment in game-based environments. The study demonstrates that even subtle interventions can produce meaningful effects across multiple behavioral dimensions, including cooperation. However, to deepen our understanding and optimize future designs, it will be essential to disentangle the effects of individual nudges, improve experimental control, and explore longer-term dynamics with more diverse player groups.

Conclusion

This study set out to examine how subtle game design features, specifically visual nudges, affect cooperative behavior, spending, and user experience in video games. The results confirm that design choices, even when minimal and seemingly aesthetic, have real behavioral consequences. Nudged players were more cooperative, spent more on cosmetic features, and reported higher enjoyment, yet often at the cost of personal payoff. This supports previous findings on how design elements like reward systems or visual stimuli can unconsciously shape player decisions (Hamari and Lehdonvirta, 2010; Geslin et al., 2016; Hamari and Koivisto, 2015).

These findings carry important implications for digital policy and consumer protection. If game mechanics can nudge users into spending more or contributing more than is optimal for them, this raises red flags around informed consent, autonomy, and potential exploitation – concerns that echo earlier critiques of predatory monetization in games (King and Delfabbro, 2018; Zendle et al., 2019).

Three major policy implications emerge from this research:

1. Transparency in Game Design

Game developers should be required to disclose the behavioral mechanisms embedded in their systems, especially when those mechanisms are designed to influence spending or decision-making. This includes the use of artificial scarcity, social comparison tools (e.g., leaderboards), and psychologically potent reward systems like level-ups or loot boxes (Shah et al., 2015; Landers and Landers, 2014; Raghubir and Srivastava, 2008).

2. Design Standards for Responsible Play

Regulators should encourage or mandate ethical design standards, similar to those in finance or advertising. Games should offer players clear, cognitively digestible information about the consequences of their choices and avoid manipulative mechanics, especially in games accessible to children (Karlsen, 2022).

3. Experimental Testing and Certification

Just as pharmaceuticals require clinical trials, highly monetized or gamified systems could be subject to third-party behavioral testing. The experimental framework developed in this study (combining game environments with economic decision-making) offers a replicable tool to evaluate the ethical impact of design features before they are deployed at scale.

Another idea would be to provide auditing tools (powered by AI) that can systematically scan and evaluate games for potentially manipulative design patterns. These tools could analyze in-game features such as pricing structures and the presence of social pressure mechanisms like time-limited offers, flagging elements that exploit cognitive biases or emotional vulnerabilities (Renner et al., 2016; Samak and Sheremeta, 2013).

In conclusion, nudges, when deployed thoughtfully, can encourage prosocial behavior. When weaponized, they can exploit impulsivity and erode informed consent. The line between engagement and exploitation is thin, and often invisible to players.

Future research should deepen this inquiry, testing nudges in more complex or commercial gaming environments and with more diverse player populations. For now, this study provides both a framework and a cautionary tale for how we build the games of tomorrow. Because in the end, the cost of play should never be human agency.

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Appendix

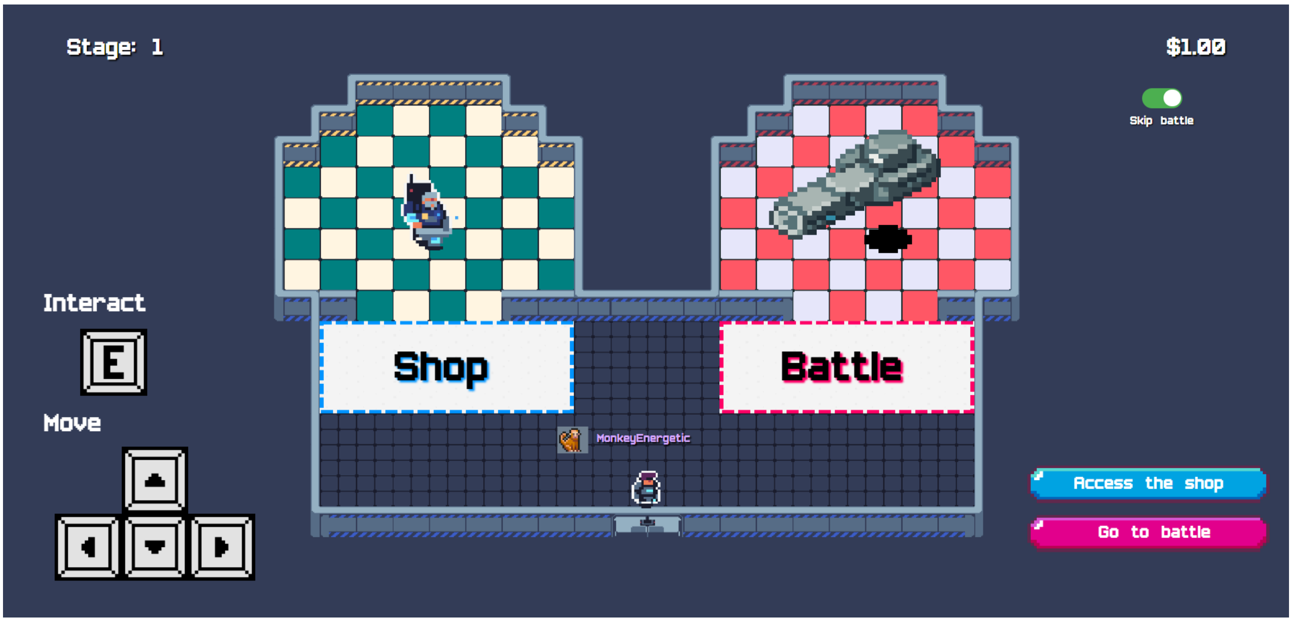

Figure 3.5: **Appendix 1:** Preparation phase in Nudge Wars.

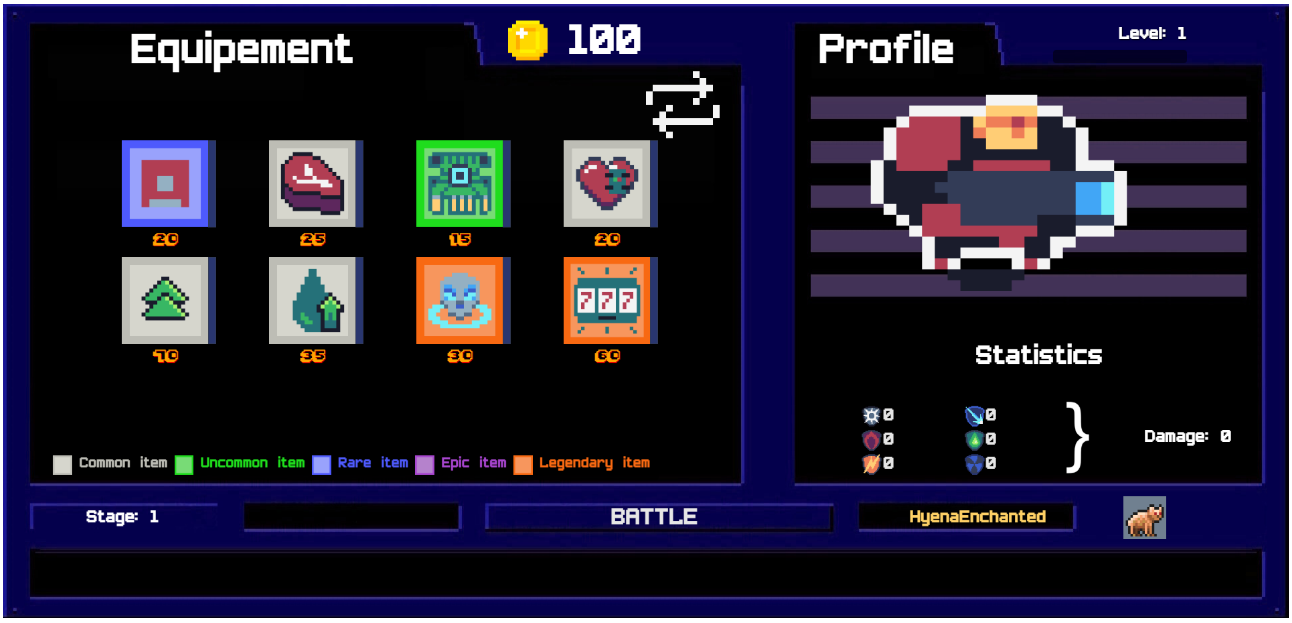

Figure 3.6: **Appendix 2:** Shop phase in Nudge Wars.

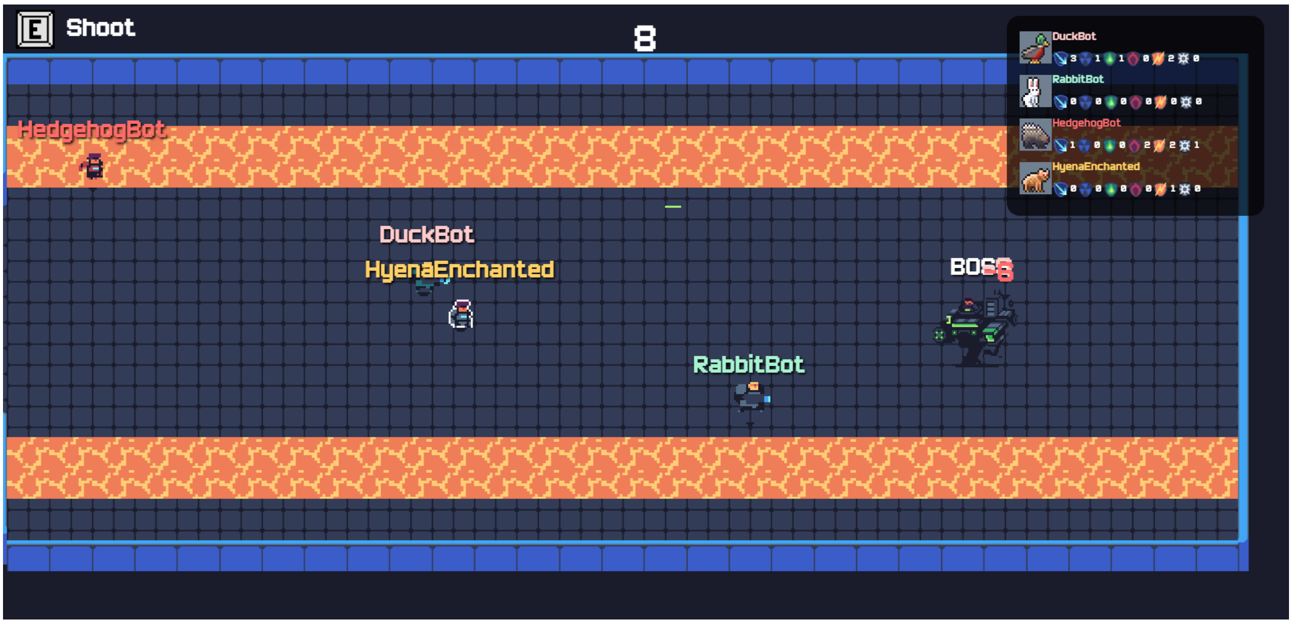

Figure 3.7: **Appendix 3:** Battle phase in Nudge Wars.

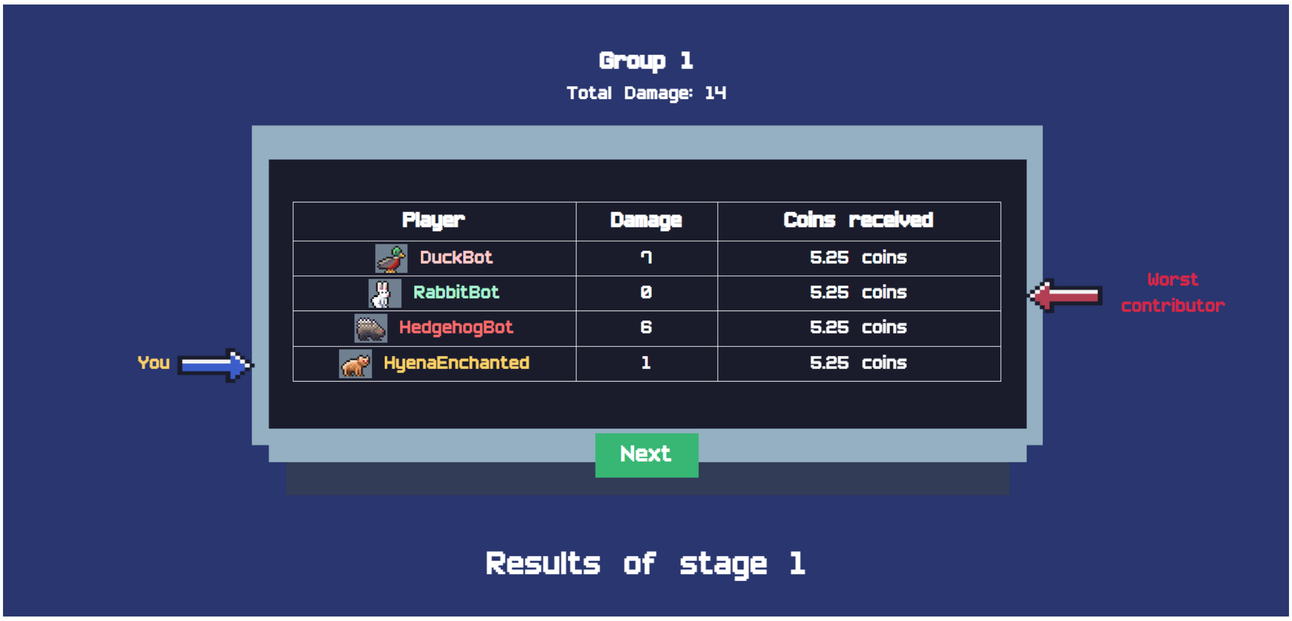

Figure 3.8: **Appendix 4:** Results phase in Nudge Wars.

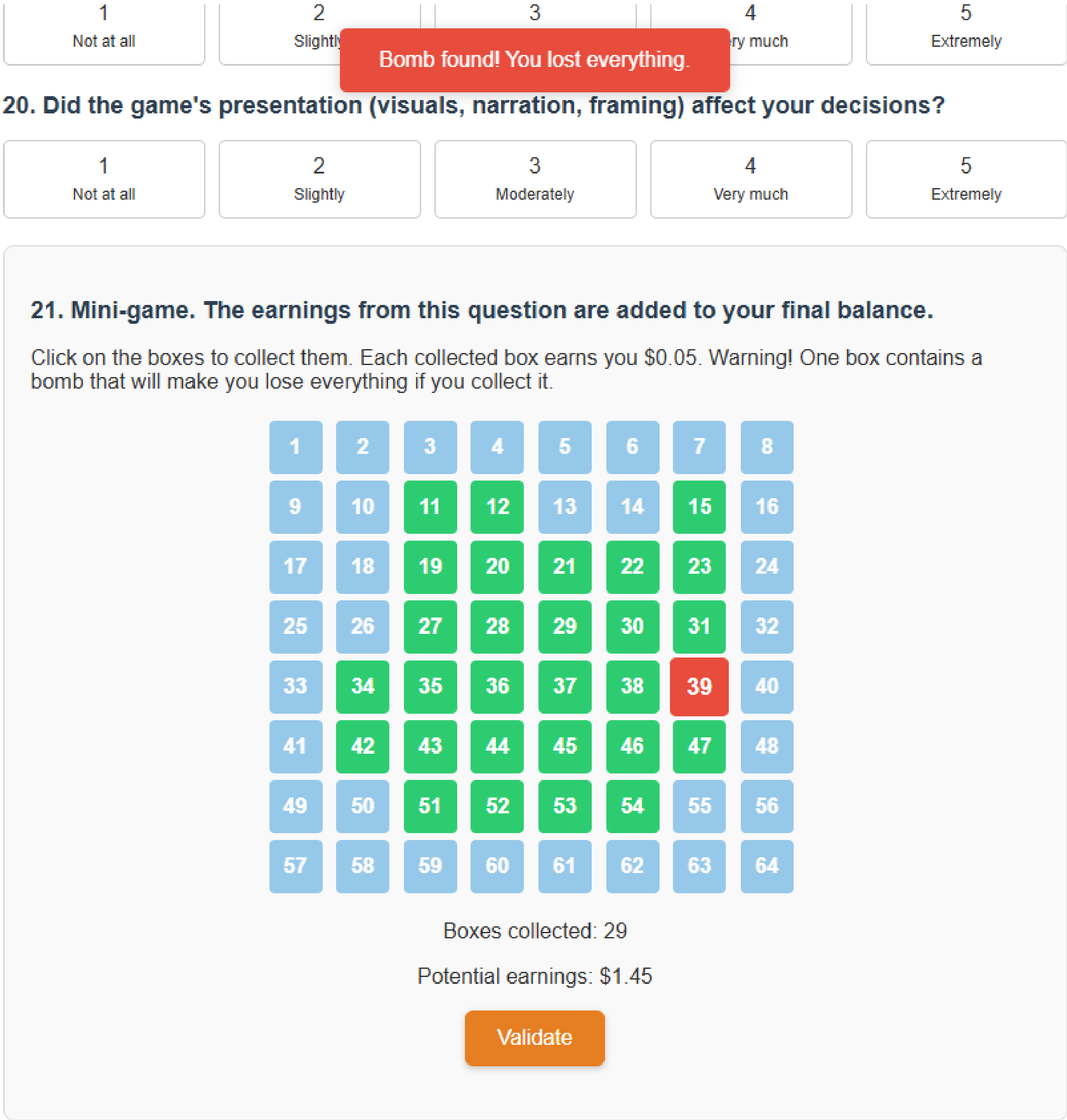

Figure 3.9: **Appendix 5:** Bomb Risk Elicitation Task.

Figure 3.10: **Appendix 6:** Hollawarps in the video game Cubic Castles. The hollawarp is the text in yellow sent by the experimenter. It allows for other players to click a link that teleport them to the experimenter for better communication. The red text is a player joining. Players' username are censored for privacy reasons.

Figure 3.11: **Appendix 7:** The instructions to join the experiment are given inside Cubic Castles via a Non-Playable-Character (NPC) and informational signs.

Figure 3.12: **Appendix 8:** The Cubit Store. It allows players to purchase the in-game virtual currency "Cubits" in exchange of real currency in the video game Cubic Castles.

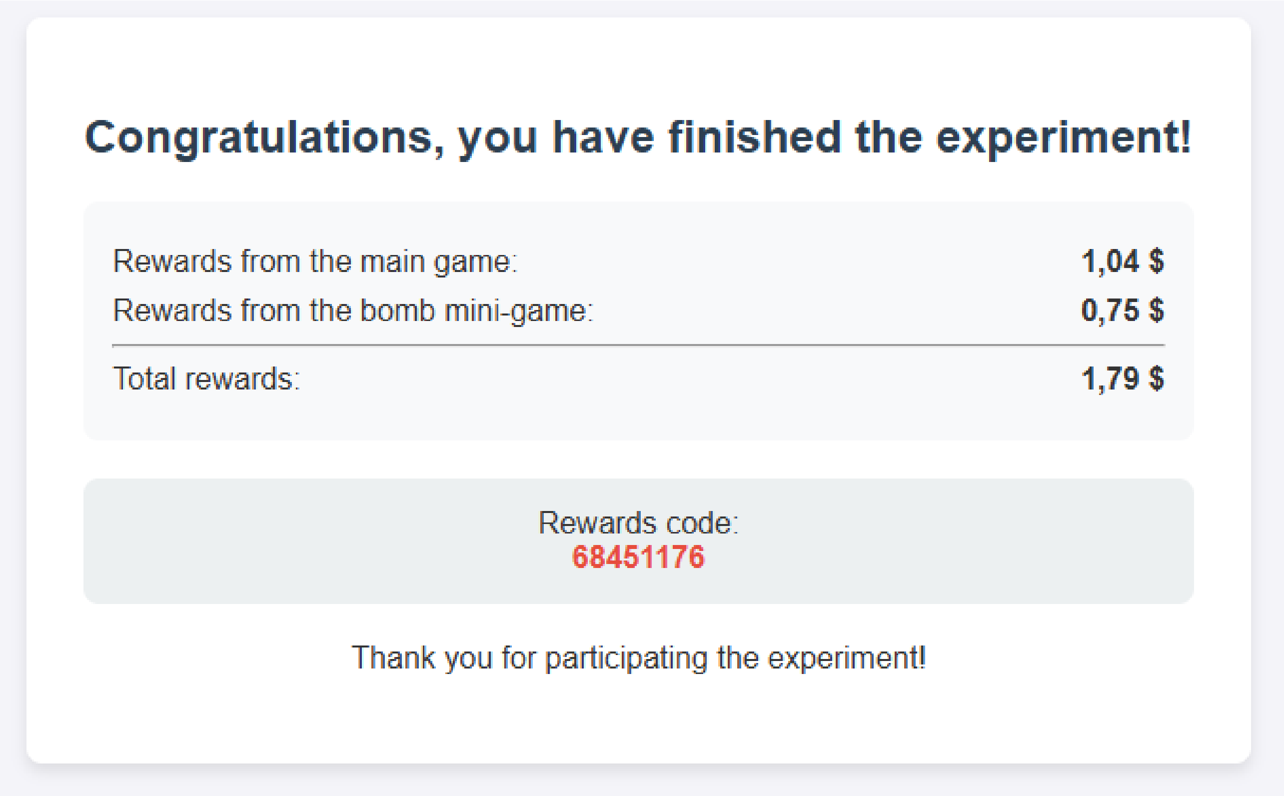

Figure 3.13: **Appendix 9:** Rewards panel at the end of the experiment.