GardenQuest: Using Hexad Player Types to Design a Step-Based Multiplayer Persuasive Game for Motivating Physical Activity

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Abstract. Exergames have the potential to reduce sedentary behavior and motivate physical activity. However, they suffer from retention problems mainly because the level of interest declines over time. In this paper, we report on the results of a social exergame prototype called Garden Quest. The game implements gamification elements based on the Hexad player type framework that have been shown to motivate players. Before the development of a full game, we designed wireframes of the game interface, followed by an interactive prototype, and conducted a usability test and heuristic evaluation with six experts. We present initial results showing that the user interface is usable and simple, and the overall system is persuasive. Based on the collected results, we plan to revise the prototype and perform a second round of evaluation before moving on to the development and field evaluation of the game with a large sample.

Keywords: exergames · gamification · persuasive design · personalization · player type

1 Introduction

Due to the COVID-19 pandemic, a sedentary lifestyle has become a concern more than ever as obesity rates continue to rise [1]. One way to address the problem is to keep an active lifestyle and participate in physical activity. Living an active lifestyle by engaging in regular exercise is associated with many health benefits [2]. However common complaints associated with physical activity are lack of time, lack of motivation and perceived feelings of exhaustion [3]. Since the release of Nintendo Wii and Microsoft Kinect, video games that require players' active body motions are considered effective tools for participating in physical activity. These video games are commonly referred to as *active video games* or *exergames* [4]. Exergames can induce behavior change by encouraging physical activity by playing games [5]. Research shows that playing exergames can enhance social wellbeing by reducing loneliness and has the potential to affect players' attitudes toward other groups of people [6].

Exergames motivate exercise by making it a more enjoyable activity [7]. In general, there are two forms of exergames: asynchronous (players exercise at different times and

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collect reward) or synchronous (players exercise while in-game), which may also separate physical activity from gameplay elements (e.g., collecting points through exercise to use later in the game). Although studies show that exergames are successful at capturing initial interest, the level of interest drops over time [8–10]. Existing research suggests that meaningful social interactions can increase the level of motivation [11, 12]. As such, we designed an exergame prototype as a testbed to evaluate the plausibility of matching players using personal characteristics for promoting physical activity. This is based on theory in the interpersonal relations domain from the similarity-attraction perspective [13, 14]. We believe that the better players are grouped (e.g., compatible interests and personal characteristics) the more likely they would enjoy their interactions and increase the likelihood of exercise adherence.

Many researchers have investigated the value of games for promoting exercise [7, 15, 16], and have identified guidelines for designing exergames [17–19]. Different methods have also been proposed and studied on how to increase the level of motivation and maintain exercise interest. These methods include personalizing the game experience using player-type models [20], tailoring game elements to the players' personalities [21, 22], and offering a variety of game elements [23, 24]. Gamification, the application of game mechanics in non-game contexts [25], has been heavily researched as a way to motivate exercise [23, 26, 27]. Previous studies suggest that a combination of gamification elements such as badges, social interaction, points, and leaderboards can increase feelings of intrinsic motivation [28], which has been shown as one of the strongest predictors of exercise adherence because of inherent satisfaction and enjoyment [29]. Although there is some research comparing the effectiveness of single player vs. multiplayer exergames for motivating physical activity [30], there is very little research that has explored the effects of cultivating social connectedness, the number of quality interactions shared between players [31], for increasing exergame adherence.

Social exergames are gaining research attention because players can motivate each other to keep playing and provide a platform for engaging in meaningful social interactions [32, 33] satisfying people's need to feel a sense of belongingness [34]. In the present research, we build on previous works that have studied social exergames for motivating continued play [35–37] and the idea of player matching using personal characteristics for increasing physical activity [38]. We aim to examine how well social gamification elements affect users in a realistic game environment. Our target audience are gamer designers who can implement social elements and persuasive strategies into a game for anyone interested in starting an exercise routine. The personal characteristic of interest in this research is player type as defined in the Hexad model [39].

Our contribution to the field of persuasive technology, HCI, and gamification, is twofold: (1) we designed a social persuasive game prototype to promote physical activity by applying elements that have been shown to increase enjoyment in player groups, and (2) based on the evaluation, we offer insights for designing multiplayer experiences that can strengthen the relationship (enhance social connectedness) between players interactions by tailoring persuasive game elements based on player type.

2 Theoretical Background and Related Work

2.1 The Benefits of Social Play and Group Exercise

Exergames can encourage social play in computer-mediated environments, which is vital for experiencing enjoyment [40, 41] and is made possible through social interactions. Research shows that social presence [42], social benefits [32], and the experience of social relatedness [43, 44] are common motivations for video game play. Playing in multiplayer mode can also elicit higher levels of energy expenditure compared to single-player mode [45] and playing with friends is more enjoyable than with strangers [46]. However, there is some research suggesting that even pre-existing social relationships and a variety of gameplay actions are insufficient for sustaining long-term motivation for physical activity beyond four weeks [10]. In two recent reviews on existing gamified fitness tracker apps, the authors reported that social elements were paramount in nearly every app they reviewed, particularly plot-based collaborative games, and proposed that a potential direction for future research is to perform a qualitative examination of collaborative games [47, 48]. We aim to address this gap by using the findings of this present study as a basis for the development of a fully functional exergame.

Exercising in a group can be motivating as supportive peer relationships can encourage adherence [49]. From a social psychology perspective, people are drawn to the exercise habits of those around them [50]. Research shows that social support can motivate individuals to adopt healthier habits, such as better medication compliance and a higher propensity to seek out medical care [51]. Exercising with others can help people keep an exercise program and enhance mood, and psychological functioning because social support promotes healthy behaviors. The Social Comparison Theory (SCT) [52] is a useful framework for comprehending the outcomes of group exercise. The theory argues that "humans have the drive to assess how they are doing and to assess how they are doing; they seek standards against which to compare themselves. When objective standards are not available, people look to their social environments and engage in comparison with available others" [53]. Our design applies SCT by displaying the performance of all players in the game using a leaderboard as a source of motivation.

2.2 Player Matching and Player Modeling

Despite the many benefits of social (multiplayer) exergames for helping people achieve a variety of positive physiological and psychosocial outcomes [36], existing studies show that current player-matching services are ineffective at fostering social connectedness [54]. Numerous academics and game designers are also customizing the exergame experience to improve retention [55, 56]. To create games that can accommodate a variety of playing styles, game designers can use player modelling, which is defined as "the study of computational means for the modelling of player cognitive, behavioral, and affective states which are based on data (or theories) derived from the interaction of a human player with a game" [57]. This involves identifying players' playing patterns and modifying the game content and elements generated in real-time.

Research on personalized gamification is gaining much research attention [58–61], and one of the most promising methods for personalizing gamified systems is the use of the Hexad player type model [62]. The model has been developed for understanding and explaining player preferences and behaviors in gamified systems [63, 64]. The model suggests six different types of players: (1) Philanthropists are altruistic, wanting to give to other people and enrich the lives of others in some way with no expectation of reward, (2) Socialisers want to interact with others and create social connections, (3) Free Spirits strive for exploration and act independently, (4) Achievers seek to advance within a system, (5) Disruptors are driven by the need to bring about change, and (6) Players are motivated by extrinsic rewards and winning. Individual preferences for various design elements are connected with their player types [65].

To date, the influence of groups composed of similar player types on exergame play experience and adherence has only received limited investigation. Previous research in multiplayer online games [66, 67] and exergames [68] has demonstrated the potential of matching players to promote physical activity. This research is part of larger ongoing work on player matching using personal characteristics. In this study, we examine player type as the personal characteristic [69] and preferred social behavioral elements as the motivational affordance [70] for increasing exercise motivation.

3 Game Prototype Design: GardenQuest

To investigate the effects of matching players using player type for promoting physical activity, we applied social behavioral principles based on existing work [71–73] that appeal to specific player types. This section explains the rationale for the inclusion of gamification and principles in our design and components in the game interface.

3.1 Game Concept

For this research, we needed a multiplayer group experience that allows players to make choices based on their player type and induces light to moderate levels of exercise intensity. Thus, we devised the following six requirements for our design: (1) asynchronous exergame to elicit light- to moderate-intensity exercise that is not confined to a game console or indoors, (2) exercise points as the main score item to earn in-game tokens, (3) multiplayer design to offer competitive and cooperative playing options, (4) social behavioral game elements that have been shown to be persuasive, engaging and motivating future exercise intention, (5) small individual incentives and large group rewards to encourage joint effort, and (6) a choice board for player groups to decide on the element they would like to engage in and progress in the game.

3.2 Gamification Elements

The main elements include a points system, a selection of different challenges to progress in the game and building a garden. Our proposed design is grounded in the Hexad player type model which discusses gamification elements that appeal to player types. Our study offers a new application of the Hexad Model in general group functions with the aim of better understanding how an asynchronous multiplayer exergame can motivate continued play and exercise adherence. The Hexad model has been used repeatedly as a popular tool for capturing player preferences and perceptions of gameful design aspects in various contexts [58, 74, 75] and is a reliable measure of player preferences [76]. To achieve our goal, we designed an exergame prototype called "GardenQuest", that promotes group-based physical activity. The prototype implements social gamification elements that are tailored to player types defined by the Hexad model. These elements were selected based on the results of prior studies showing that elements such as leaderboard, supporting different roles, customization, knowledge sharing and exchanging supportive updates are correlated with each Hexad type [72]. We selected five gamification elements (Table 1). We used five Persuasive Strategies, one of them is customization which is commonly employed in persuasive health applications [77, 78] and the other four were from the Persuasive System Design model adapted from Oinas-Kukkonen et al. [79]. Principles that encourage social behaviors [80] were considered such that there is at least one element that appeals to each player type.

Table 1. Gamification elements, persuasive strategies, and supporting literature.

Gamification elements	Persuasive strategies	Description	Justification and supporting literature	Target type
Customization	Customization	Set the next goal of the team	Interventions suggest health goals that are tailored based on end users' current and desired capabilities are more engaging than interventions with generic goals [81]	Philanthropist and Socialiser
Rewards	Reward/ Incentives	Collect special elements and prizes	Displaying virtual trophies or medals are common ways of implementing a reward strategy in many game user studies such as GeoFit [82] and GoalPost [83]	Achiever and Player

(*continued*)

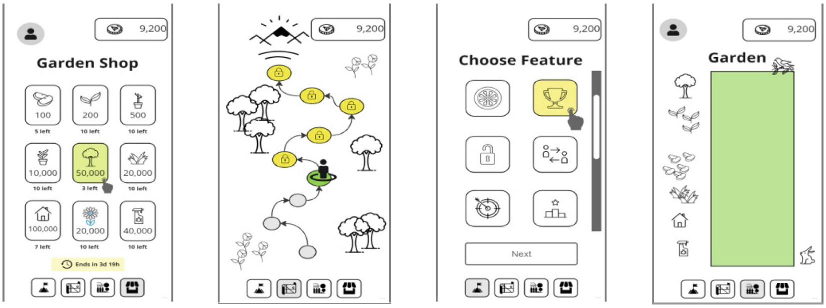
Table 1. (*continued*)

Gamification elements	Persuasive strategies	Description	Justification and supporting literature	Target type
Different Roles	Cooperation and Social comparison	Intra-subgroup interaction design. Players can take turns to be the leader	In group cycling, cyclists often take turns to be the leader of a paceline to distribute the burden imposed on the leader due to air resistance [84]	All
Leaderboard	Competition	Change team order on the leaderboard and see rankings	Many mobile games that aim to persuade people to participate in physical activity use leaderboards as a source of motivation such as PhoneRow [85] and iGO [86]. Leaderboards display the performance of other players and allow them to compare against each other [52] can be motivational	All
Lottery	Reward/ Incentives	Random reward	Highly agreeable individuals are motivated by lottery elements [87]	All

3.3 Prototype Design

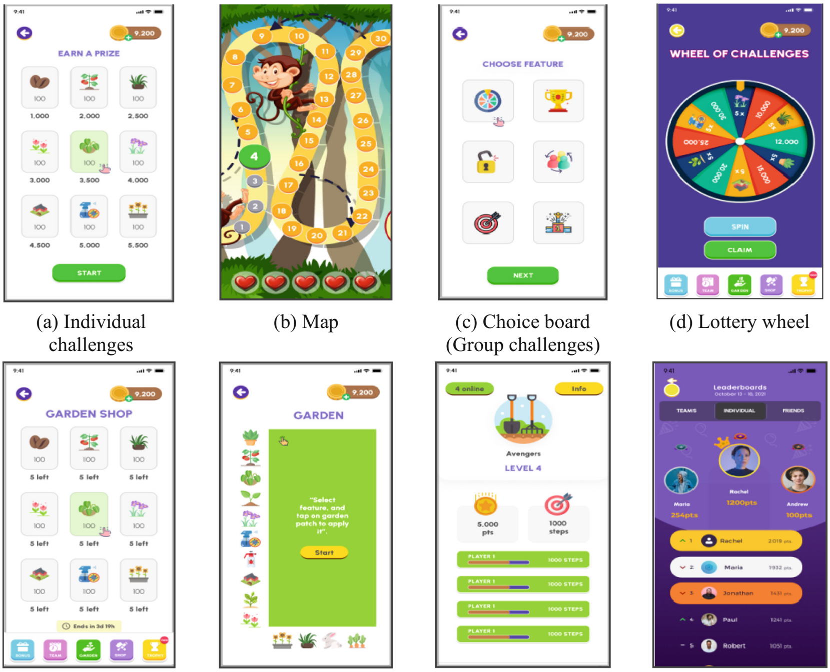
First, we sketched wireframes using Miro[1] (Fig. 1) to design the layout of the game interface elements. Once the basic foundations of all the screens were drawn, we created an interactive prototype using Figma[2] (Fig. 2).

[1] https://miro.com/
[2] https://www.figma.com/



(a) Garden Shop (b) Map (c) Choice board (d) Garden

Fig. 1. Initial wireframe sketches of GardenQuest game interface elements



(a) Individual challenges (b) Map (c) Choice board (Group challenges) (d) Lottery wheel

(e) Garden shop (f) Garden (g) Performance (h) Leaderboard

Fig. 2. Interactive medium-fidelity prototype of GardenQuest

3.4 GardenQuest Gameplay

GardenQuest is a step-based multiplayer exergame where players form groups and participate in step challenges. Physical activity and gameplay occur separately but are connected via a points system. As players are performing physical activity (steps are tracked by their smartphone using GoogleFit [88]) in the real world, they are collecting points to use in the game to build a garden.

The player begins by creating a new group or joining an existing group. Once the player is part of a group, they can begin taking on step challenges. There are two types of challenges: (1) individual challenges and (2) group challenges. To participate in an individual challenge, players select the prize (e.g., 100 plants require 3,500 steps – Fig. 2a) they wish to achieve and clicks "start" to begin the challenge. When the challenge is complete, the player is rewarded with a prize they can use to decorate the garden.

The map (Fig. 2b) is used to facilitate group effort in the game. To make progress, and move from one checkpoint to the next, players can participate in group challenges by engaging in a voting process using the choice board (Fig. 2c). This aims to connect players for social interaction to decide on a group challenge. There are six choices for players to determine a step challenge for the group: (1) a "lottery wheel" where the number of steps is determined by chance, (2) "win a trophy" where the number of steps is determined by the trophy they wish to win, (3) "unlock a prize" where the number of steps is determined by the prize the group wishes to unlock, (4) "rotating leadership" where the group decides on who the leader is in the next challenge, (5) "custom goal" where the group decides to set a custom step goal, and (6) "leaderboard" where the group decides to climb up the leaderboard and overtake the current group in the lead. The six choices were selected from previous literature showing positive correlations between gamification elements and player type [72]. The group can decide on spinning the lottery wheel (Fig. 2d) to determine the number of steps to be pursued by the group in the current challenge. The challenge ends when the group reaches the number of steps dictated by the wheel. The end of a challenge is followed by rewarding the group by converting steps to points. Player groups can then use the points earned to purchase items from the garden shop (Fig. 2e) to decorate the garden (Fig. 2f). Players can also view their group performance (Fig. 2g) and ranking on the leaderboard (Fig. 2h). As we are interested in evaluating the long-term effectiveness of the game for promoting physical activity, we did not define an end to the game. Players can continue to participate in challenges and grow their gardens for as long as they wish.

Based on the similarity-attraction perspective [89, 90], we expect that groups composed of similar player types are more likely to select the same choices. For example, a group composed of mostly Player-oriented traits is more likely to prefer spinning the lottery wheel and climbing up the leaderboard.

4 Study Design

To evaluate the prototype, we used a mixed-methods (qualitative and quantitative) user study approach. The evaluation was divided into three separate parts: (1) a usability test, (2) a heuristic evaluation, and (3) completing a post-study questionnaire.

4.1 Participants

Participants were recruited by email. Six (6) experts agreed and completed the evaluation. This number is informed by previous research that recommends using three to five evaluators because the amount of new problems found does not increase significantly by using larger numbers [91]. Experts were all males and ranged in age from 18–35 years old. Two experts hold Bachelor's degrees and four hold Master's degrees in Computer Science specializing in Human-Computer Interaction and Game Design.

4.2 Recruitment and Procedures

After receiving approval from our university ethics, we began recruiting participants. To participate in the study, participants had to be over 18, understand English, and have extensive experience in HCI, game design and technology. Participants who pass the inclusion criteria were asked to proceed with the following three-part procedure:

- **Part 1**: After reading the consent form and accepting it, experts completed 7 tasks (Table 3) using the prototype. After each task, experts were asked to rate the level of the task's difficulty on a 5-point Likert scale (1 = very hard to 5 = very easy via a "Single-Ease Question" (SEQ) [92] and explain why they provided that rating. Experts were also asked to think aloud [93]. The think-aloud technique is widely used in HCI research and usability studies to better understand the choices and motivations that invite users to perform specific actions.
- **Part 2**: After completing part 1, experts were invited to evaluate *GardenQuest* using the 10 usability heuristics developed by Nielsen [94]. Experts identified the heuristic violated along with their severity ranking (0 = not a problem, 1 = cosmetic issue, 2 = minor usability problem, 3 = major usability problem, and 4 = usability catastrophe), a description of the problem, and proposed a solution.
- **Part 3**: Experts completed a questionnaire about their experience with the app. The questionnaire statements were composed of measurement instruments commonly used in HCI research to evaluate user preferences. In particular, usability [95], perceived persuasiveness [96], and simplicity [97] were all evaluated using a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree).

4.3 Data Analysis

Results were analyzed using both quantitative and qualitative data analysis techniques. Quantitative data collected in the questionnaire were analyzed using descriptive statistics to first explore the data, followed by a one-sample t-test to determine whether the subjective ratings are above the mid-point (neutral score), and significant.

5 Results

5.1 Usability Test Results

The results of the usability test are summarized in Table 2. The SEQ scores revealed that the average easiness for each of the tasks that experts were asked to perform was above 3.00 except for Task 4 (Vote on an element) with an average score of 2.50 (SD = 0.55) and Task 8 (Move to the next checkpoint) with an average score of 3.00 (SD = 0.63). Looking more closely at the think-aloud comments, we observed that experts provided a low rating for two main reasons: (1) there was confusion about the meaning of some of the icons as one expert said, "*What do these icons mean? I don't understand them!",* particularly in the choice board (Fig. 2c) and (2) they expected more direction as this was a novel game when one expert said, "*I think a tutorial at the beginning would help*". Overall, these results show that the prototype offers decent usability, as most tasks were highly rated. Nevertheless, we found some minor issues through the think-aloud approach that some experts expected to find some functions in certain areas of the app but were not offered (e.g., a back button was missing), some labels/terminologies were misinterpreted (e.g., choose a "feature"), and some of the navigations were slightly confusing (e.g., moving from the garden to the garden shop).

Table 2. Summary of usability test results.

Tasks	*M*	*SD*	Key Comments and Issues from think-aloud data
1. Register and sign in	5.00	0.00	All experts were able to accomplish this task with ease
2. Join a group	4.50	0.55	All experts were able to accomplish this task with ease
3. Create a new group	4.67	0.52	All experts were able to accomplish this task with ease
4.Vote on an element	2.50	0.55	"*There is a lack of instruction and I feel like there needs to be more direction on what these icons mean.*" "*What do these icons mean? I don't understand them*!" "*This page is not intuitive, and I don't know what I should do.*"
5. Purchase an item in the garden shop	3.83	0.75	"*What is the currency here? Do I use coins or steps?"* "*I think there needs to be a price tag attached to the item*"
6. Add purchased items to the garden	3.83	0.75	"*This is hard, I am not sure if the items on the side are purchased or unpurchased."*
7. View progress/performance	4.50	0.55	"*Is the performance my coins or can I see my activity performance? I'm not sure.*"
8. Move to the next checkpoint	3.00	0.63	"*I think the colours should be the opposite – completed should be a dark colour, and uncompleted should be a light colour."* "*I think a tutorial at the beginning would help."*

5.2 Heuristic Evaluation Results

The heuristic evaluation identified a total of eight problem areas. Table 3 summarizes the identified issues and proposed solutions. In general, the issues that were rated as a "major usability problem" (score = 3) related to help and documentation, visibility and system status, and user control and freedom. Suggestions to rectify these issues include offering help, tooltips and tutorials, better labels, and identification of icons, as well as allowing the user to revert their actions. Other issues that were rated as a "minor usability problem" (score = 2) were associated with helping users recover from errors, and recognition rather than recall. To address these problems, experts recommended adding tooltips and animated popups to help users understand and recover from errors. "Cosmetics issues" (score = 1) included problems with the aesthetics and minimalist design and the match between the system and the real world. Experts recommended the use of a simpler color pallet and more appropriate terminology.

Table 3. Summary of heuristic evaluation results.

Issue/Problem	Severity Ranking	Heuristic Violated	Potential Solution
Some screens lack descriptions to help the player understand the actions they need to take	3	Visibility of system status	Use animated texts/icons or pop-ups where necessary (e.g., the foot of the monkey could be placed at the level number the player is currently at)
Very few terminologies can be rephrased to make more sense to the player	1	Match between system and real world	Use "Accept" and not "Claim" for the wheel challenge
Some screens have no clear point of exit or revert a player action	3	User control and freedom	Make the point of exit clear and ensure that there is a revert functionality for every action. If the feature is not reversible, inform the player that their next action will be irreversible
I felt lost in some screens and don't know how to recover	2	Help users with errors	Animate pop-ups or text

(*continued*)

Table 3. (*continued*)

Issue/Problem	Severity Ranking	Heuristic Violated	Potential Solution
There is no help page	3	Help and documentation	A help page is critical in such an app to guide players when they are lost
There is no help page	3	Help and documentation	A help page is critical in such an app to guide players when they are lost
Need to remember features	2	Recognition rather than recall	Offer tooltip or hint text should be implemented
Too many color gradients	1	Aesthetic and minimalist design	Blend colors more
No tutorial and no tooltips	3	Help and documentation	Add tutorial and tool tips

5.3 Questionnaire Results

The System Usability Scale (SUS) scores and item means were reported to provide a high-level view of *GardenQuest's* usability. The SUS revealed an average score of 70.00 ($SD = 11.62$), which indicates that the overall usability of the app is "above average" [98]. One sample t-tests were conducted to compare perceived persuasiveness [96] and simplicity [97] scores to the mid-point of 3. Results showed that the game was perceived to be persuasive (t (5) = 2.549, $p = .026$) and the interface was simple ($t(5) = 3.722$, $p = .014$). Furthermore, 100% stacked bar charts were generated to visualize each item in the perceived persuasiveness scale (Fig. 3) and the different facets in the simplicity scale (Fig. 4). Figure 3 shows that the scores leaned toward the positive end of the scale in which 83% of experts selected agree/strongly agree for items that evaluated the relevance of the game and the degree to which the game would persuade them to reconsider their exercise habits. Figure 4 shows that the game interface was simple as over 70% of experts rated agree/strongly agree across all facets of simplicity, except for Reduction and Dynamic Complexity suggesting that the number of steps to achieve a task and the complexity of interface elements still needs more work.

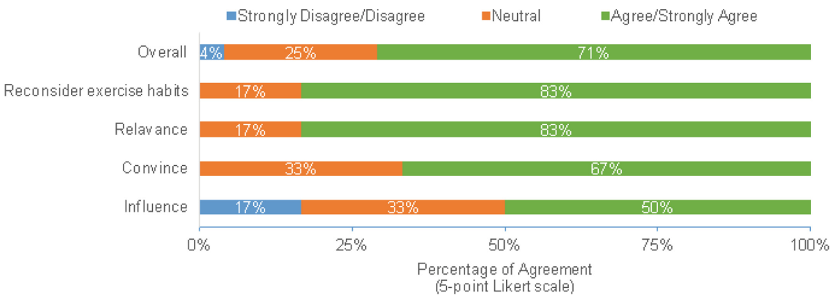


Fig. 3. Perceived persuasiveness ratings ($N = 6$).

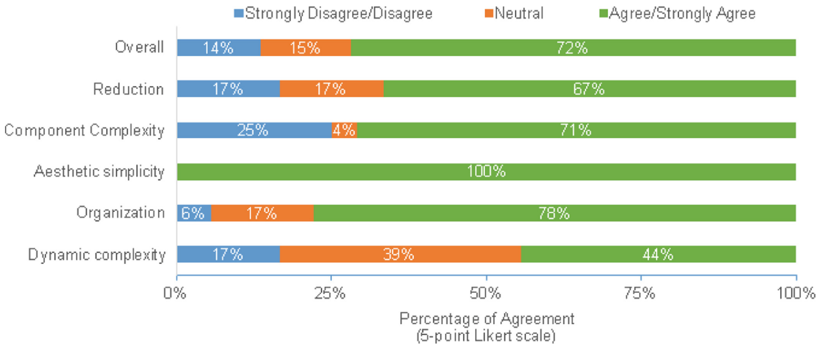


Fig. 4. Facets of simplicity ratings ($N = 6$).

6 Discussion and Future Work

Our results show that the overall game interface is usable, persuasive, and simple. Yet the game experience is still unknown and thus, the next step is to evaluate the game experience. In this study, we found that the game elements presented in the prototype were perceived to be persuasive which suggests that the game (soon-to-be developed) is likely to provoke users to reconsider their current exercise habits and promote physical activity. Experts also rated the organization and aesthetics of the interface to be rather simple, which suggests that the content and functions are consistent and systematic, and the screen design is neat and modern. Yet components related to "dynamic complexity" were rated rather poorly suggesting that the interface can be improved on the predictability of subsequent screens and taking the user to the expected desired action. This is further supported by the results in the think-aloud and heuristic evaluation sessions where experts noted that some actions were irreversible (Fig. 2b, 2g, and 2h – no back button) and there was a lack of instructions making them feel lost, particularly on the choice board (Fig. 2c). As suggested, we plan to add labels and tooltips to better guide the user with the navigation and understanding of the icons. Also, a participant suggested adding a time limit to complete group challenges and if a group is unable to complete the challenge within that time frame, the reward will not be granted, and points collected will be used towards the next challenge.

Despite the interesting results, one limitation is the use of a prototype for evaluating the user experience and persuasiveness of the design. Thus, the implementation of a game that can be evaluated in a real-world setting will be necessary to further validate the components and the concept of matching based on player qualities. We plan to address the issues found in the interface and perform a second round of testing with another group of experts before moving on to the development of a fully functional game. We also plan to conduct a long-term, in-the-wild study with a larger sample which will help us to gather quantitative, objective (e.g., the number of times an element is selected as an indication of preference) and subjective (e.g., enjoyment, engagement, social presence, intrinsic motivation, and intention for future exercise) measures, as well as qualitative interviews to gain further insights on how the game can be improved to answer our future overarching question: "Can matching players using personal characteristics in exergames promote physical activity?" The sample will include our target audience as expert-based assessments cannot replace end users' points of view.

7 Conclusion

The goal of this research is to evaluate the usability of a persuasive game prototype for promoting physical activity. This intermediate step was necessary to verify that the proposed interactions, aesthetics, functionality, and navigation flow are clear to the user before moving forward with the development of a fully functional game. Overall, participants rated the game interface to be usable and simple and perceived the game concept to be persuasive for promoting physical activity, as well as motivating repeated use (retention). An evaluation of the long-term effectiveness of the game is on the research agenda.

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