Promoting Family Play through Asymmetric Game Design

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For families, where abilities, motivations, and availability vary widely, opportunities for intergenerational play are limited. Designing games that cater to these differences remains an open challenge. In this paper, we first identify barriers related with time and expertise. Next, we propose asymmetric game design and asynchronous play to reconcile children's and adults' requirements; and interdependent gameplay mechanics to foster real-world interactions. Following this approach, we designed a testbed game and conducted a mixed-methods remote study with six pairs of adult-child family members. Our results showcase how asymmetric, asynchronous experiences can be leveraged to create novel gaming experiences that meet the requirements of family play. We discuss how interdependent progress can be designed to promote real-world interactions, creating pervasive conversational topics that permeate the family routine.

CCS Concepts: • **Applied computing → Computer games**; • **Human-centered computing → Interaction design**.

Additional Key Words and Phrases: Games Research, HCI, Asymmetry, Family Play, Intergenerational Gaming

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1 INTRODUCTION

Digital games have become a widely accepted form of entertainment and an important part of the social life of different generations. Young people are playing with friends, both in person and online, talking about games, and expanding their social circles through gaming [28, 38, 44]. Within families, shared play can reinforce bonds, provide conversational topics, and offer shared experiences [20, 32, 45, 52, 60, 64, 66].

However, seldom are games designed to consider highly disparate needs and preferences of players at the same time, leading to limited room for multiplayer experiences among heterogeneous

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groups. For families, where people can have vastly different availability, motivations and skills [32], opportunities for playing together can be scarce. For example, while children regularly play games, many parents or older siblings find it difficult to make time to participate [60, 61], with both parties missing out on a shared experience that could bring them together.

Digital games have been explored as a space for intergenerational family play [36, 50, 54] but the various constraints make it a design challenge to foster meaningful shared experiences that are accessible and engaging for adults and children alike. In a symmetrical gaming experience—where all players are ruled by the same mechanics, goals, and skill demands [23]—this may mean that someone has to conform to a less engaging style of play.

We believe asymmetric game design can be leveraged to tackle this challenge, simultaneously meeting the diverse constraints and preferences of different players. Its potential was demonstrated before as a design strategy to provide inclusive experiences, bringing together players with differing abilities [25, 26], and players accessing different devices [34].

In this sense, we first conducted a survey with 376 participants to further understand the challenges to family play. Next, we designed a collaborative game, targeted at adult-child pairs (e.g., siblings, child and parent, or grandchild and grandparent) with an age gap of at least 10 years, where the child is aged between 7 and 14 years old, that leverages asymmetric gameplay (i.e., offering different rules and/or mechanics for different players or playing at different times) to address these issues, by creating roles specifically catered to each player that allowed for asynchronous play. However, playing asymmetric and asynchronously (i.e. asymmetry of time) could lead to an experience more akin of a single player game if not designed to foster interaction. We carefully designed a set of collaborative and interdependent mechanics to create a sense of shared play, and more importantly, to prompt real-world interactions between family members. Our work aims to contribute to the design of family-inclusive games by addressing the following research questions (RQ):

- **RQ1:** How can asymmetric game design create gaming experiences that simultaneously meet the requirements of different adult-child family members?
- **RQ2:** How to best leverage asymmetric game mechanics to promote family interaction?

Based on previous research and the aforementioned survey, we chose to design a game that would tackle the challenges family members have with: 1) difficulty to play synchronously due to different schedules and responsibilities; 2) disparate available time (e.g. adults not able to have longer play sessions), and 3) differences in expertise and/or preference between players.

We conducted a user study where six adult-child pairs were asked to play the developed game, daily, for a week. Our results illustrate how asymmetric and asynchronous gameplay can create a shared space that promotes and extends family interactions, supports different contexts of play, and integrates players' routines and preferences. In line with previous research [15, 16, 29, 32, 62], the design of interdependent tasks, augmented with asymmetric information and the need to communicate in the real-world to overcome challenges, was successful in promoting new interactions within pairs. The asymmetric nature of the gameplay was essential to promote these interactions, with players sharing information and learning how to play their roles together. Based on these results, we discuss design considerations and opportunities leveraging asymmetry and asynchrony to tailor digital play and promote interaction for family members with heterogeneous requirements. We expect our findings will inform the design of future family-inclusive games and how to create gameplay mechanics that promote real-world interactions.

2 RELATED WORK

In this section, we discuss relevant related work. We focus on shared play, gaming in intergenerational and family settings, and asymmetry in game design.

2.1 Shared Play

Digital gaming can provide a shared social space to enhance interaction and communication. The high-level benefits of gaming together include increased prosocial behavior [24], co-play strengthening ties between players [14–16, 28, 29, 32, 45, 60, 64, 66], mixed-ability gaming empowering gamers with disabilities [25, 26], as well as a range of cognitive, motivational, and emotional benefits for players [13, 28]. Similarly, works on Joint Media Engagement [22], in which shared gaming can be included, have reported a positive impact of co-located play, for example, in strengthening relationships between parents and children playing Pokemon Go together [52]. Shared play has the potential to foster interpersonal trust, also among heterogeneous groups [15, 17].

However, there is limited work seeking to understand which aspects of games contribute to a positive social experience. Given the immense diversity of games and contexts of play [21], we are far from understanding this precisely. Notably, Emmerich and Masuch [21] propose a research model that encapsulates social player interaction in three determinants: the *composition of the player group*, which comprises players' individual traits, relationship and history; the various *attributes that characterize the game*, including mechanics, rules and gameplay elements; and *environmental variables*, such as the presence of an audience or the privacy of the context. These are the deciding factors that frame player interaction, which can occur within the game—usually limited to the range of actions allowed by the game, but also outside, with interactions that might be as complex as in other real life situations (e.g., verbal communication) [13, 21].

Previous work suggests that solitary play is preferable for a more immersive and relaxing experience, while shared play mainly provides challenge and competence when playing with strangers, and social connectedness when playing with known others [61]. Voida et al. [62] observed both intra- and intergenerational groups, and identified elements in console gaming that emphasized the group as a whole (e.g., interdependence and self-sacrifice among players) and elements that emphasized the gamer as individual (e.g., trash talk). Interdependence, in particular, is recognized to have a positive influence on the feeling of connectedness [15, 16, 29, 32, 62]. For example, Depping et al. [16] results suggest that, in both cooperative and competitive settings, interdependence increases feelings of connectedness between players, provided that players can communicate effectively.

When designing games for shared play, one must consider the impact of the selected design elements, and carefully manipulate them to promote the desired outcome (e.g. interdependence to promote connectedness) [21, 27].

2.2 Family and Intergenerational Gaming

While digital gaming is still a relatively new medium, with a more prominent footprint in younger age groups, there is an opportunity to explore games as a meeting place for different generations. Benefits of family play include reinforcing relationships [14, 32, 45, 52, 59, 60, 64, 66], increasing reciprocal learning and mutual understanding of other generations, and decreasing social anxiousness [32]. Previous works focus on understanding and designing for mixed-age experiences [12, 46, 50], in some cases focusing on the specific context of family play [36, 42, 52, 54, 59, 60, 64, 66]. Kow et al. [37] investigated family play around a social network game, outlining design features that encourage these interactions, including low entry barriers, minimized time restrictions, and appealing themes that mirror real-life relationships. Wang et al. [64] also outlined desired features in family play, including cooperation, teaching, and thinking. Further recommendations include

prioritizing physical and multimodal interaction, collaboration, and providing simple interfaces and adaptable game controllers [12].

Rice et al. [50] aimed to derive design ideas for intergenerational games, by conducting co-design workshops with mixed-age groups. Game concepts resulting from the study shared a set of common characteristics, such as short, easy to master gameplay and knowledge exchange between players. In particular, the study highlights the various asymmetries that characterize intergenerational relationships and group play, but also how these are reflected on game ideas that include asymmetrical roles closely related with everyday life (e.g., the older player as the taller mentoring character that provide new abilities to the younger more agile and adventurous character). A recent study [40] reveals modern parent-child interaction dynamics emerging through gaming as a "democratized" space, with parents and children collaborating in selecting games to play and fluidly switching leadership positions during gameplay. The study also highlights how families show a preference for co-located experiences, valuing the sense of co-presence, and how interactions rooted in the gameplay extend to real life, as these topics can transition into meaningful conversations. The authors provide design recommendations anchored on encouraging conversations (both during and post-gameplay) through direct prompts in the game and conversation guides, as well as ensuring ways in which spectators can take part in the game, affecting it in other ways.

Parents particularly value digital games that allow for creativity and problem solving [39]. In previous studies [52, 59], the mobile location-based game Pokémon Go was depicted by parents as a means to spend quality time with their children, stimulating conversations, reinforcing common interests, and bonding. Although, in this case, the game is not centered on a traditional multiplayer experience, the social aspect that exists around and outside the game is reflected in the daily lives of these families [52, 59]. Examples range from parents accompanying their child on the walks the game promotes, or playing separately and sharing their individual achievements with joy [52]. Different studies [14, 41, 48] have highlighted how family play experiences can often be vicarious, in other words, someone helping out a player, without actually using a game controller (e.g., giving advice, solving a puzzle).

Voida et al. [63] examined generational roles in gaming, importantly how younger gamers end up taking more leadership roles in gameplay, while older players come about as models of prosocial behavior. In digital gaming, the traditional roles of the adult as a teacher and the child as a learner might end up reversed [1, 52, 63] and reflected on a knowledge trade between generations—while, in many households, young players have the gaming know-how, older players have the social know-how, moderating social interactions [63].

Ulicsak et al. [60] raised important concerns such as the roles that different generations take in family play, how cost can be an issue for accessing this medium, and how parents report lack of time to play video games with their children. While previous work identified constraints and benefits for intergenerational and family play, it is important to explore new designs that support these constraints to reap the benefits.

2.3 Asymmetry in Game Design

Asymmetry, in the context of game design, means that players are not bound to the same set of rules or goals [23]. There are several types of asymmetry, including asymmetry of information, ability, interface, challenge and goals [23, 51]. Some games offer collaboration with asymmetry in controls, allowing the second player to join with a simpler role. For instance, in Super Mario Galaxy 1 [56] and 2 [57], a second player participates by aiming a controller at the screen to freeze enemies and collect items. This is an example of how asymmetry can be used to welcome players with different skill levels.

Harris et al. [30] have proposed a conceptual framework addressing asymmetries at the mechanical level and how these shape gameplay dynamics and aesthetics. The work introduces concepts such as directional dependence and synchronicity, and how these can be manipulated to potentiate shared play, leading to higher social presence and connectedness [30]. In a subsequent study [29], Harris and Hancock show that asymmetry and interdependence have a positive influence on perceived connectedness and engagement. Drawing on this work and game research theory, Rogers et al. [51] present an extended framework that captures additional dimensions, such as patterns of shared control and asymmetries in shared space, age, and abilities.

Previous work leveraged asymmetry to cater to gamers with differing abilities [25, 26] In Last Tank Rolling [25], a two player game with one able bodied player and one motor-impaired player, the wheelchair is embraced by design, metaphorically linked with the movement of a tank. Similarly, in Gonçalves et al. [26] one role was based on auditory challenges (i.e for blind players) and the other on visual challenges (i.e. sighted player).

Asymmetric game design has been shown to be flexible to cater to different players needs regardless if they stem from preferences or abilities. We believe there is untapped potential to leverage it in promoting family bonding through gaming.

3 SURVEY: GRASPING FAMILY PLAY PERSPECTIVES

Previous research gives insight into how preferences, needs, and motivations change throughout aging [6, 7, 31, 50], and how these affect gaming habits among families [1, 42, 60, 64, 66]. In a first formative study, we sought to extend existing knowledge on the topic, by surveying families in Portugal, aiming to characterize how they are playing together, and to identify the requirements of different adult-child family members to be tackled in RQ1.

3.1 Procedure

We launched an online questionnaire[1], and published a call on social networks and forums, mostly related to gaming communities, apart from sharing it through personal platforms and word of mouth. The survey had 376 respondents (146 female, 229 male, 1 preferred not to say), ages 12-69 (M=28.7; SD=12.25). All participants answered general demographic questions, a set of both multiple-choice and open-ended questions about their gaming habits, with a focus on family play experiences (including non-digital games) and factors that limit or hamper such experiences. Multiple-choice questions were designed based on barriers and outcomes of family play previously identified by the literature [14, 32, 45, 52, 59, 60, 64, 66] and open-ended questions were included in each section to allow participants to develop their answers and share positive and negative family play experiences. We collected responses during one month. Ten respondents, randomly selected from the sample, were rewarded with a 20€ voucher.

3.2 Data Analysis

Answers to multiple-choice questions were subject to a descriptive statistical analysis. Written responses were interpreted following an inductive thematic analysis (TA), as proposed by Braun and Clarke [8]. Two researchers were mainly involved in this process, first repeatedly reading and annotating low-level concepts that were recurring and/or relevant. Following initial discussions, the first author started a more formal coding process, eventually reaching a first set of codes, which were then discussed with the team and iterated (e.g., added, grouped, merged). We proceeded to search for relationships between codes and coded segments, resulting in a set of themes. These

[1]Survey Questionnaire - https://osf.io/zq62b

were discussed among the authors in various sessions, defined and named accordingly. Documents with the final code book[2] and outline of the themes[3] are available.

We conducted a mixed method analysis embracing the benefits of TA on making sense of collective shared experiences [9], and situating the analysis within the quantitative results from the survey multiple-choice questions. All the statistical analysis presented below pertains to multiple-choice questions within the survey that characterize respondents and not coding frequencies. The analysis of the data was predominantly carried out by the first author who is a man in his 20s, with no children and with a background in Computer Science. He was assisted by two male members of the research team with previous experience in thematic analysis. The three researchers play both digital and board games regularly, play with their family members and come from relatively structured families, educated by their biological parents.

3.3 Limitations

In the call for participation, we highlighted that we sought to understand the reasons why families play or don't play together in order to seek solutions and opportunities for shared play. In conjunction the choice of dissemination through gaming forums leads to our sample being primarily of gamers (i.e. 85%), of which about 44% do not play with their families. The survey therefore, primarily represents the perspectives of gamers who want to play with their families and the challenges they face when they do, or why it is not possible, informed by 15% of non-digital-gamers.

3.4 Results

The majority of respondents in our sample were playing digital games, at least occasionally (N=319, 85%) (we will refer to this group as 'gamers'), and '*family gamers*', playing digital games with their families, at least occasionally (N=178, 56%). We consider as '*non-gamers*' participants who reported not playing digital games at all (N=57, 15%). Playing with the family is expectedly less frequent, as most were doing it "Once or twice a week" (N=29, 23.6%), "Once or twice a month" (N=44, 35.8%) or even "Less than once a month" (N=45, 36.6%), with session length averaging "1 to 2 hours" (N=71, 57.7%). Quantitative results derived from multiple-choice questions are available in full[4]. Below we present the results of the mixed-method analysis grouped by the themes crafted and situated within the quantitative results of the survey.

3.4.1 Family bonding. Games enable families to bond over shared experiences. Family gamers report feeling more engaged (N=52, 42.3%), challenged (N=44, 35.8%) and connected (N=63, 51.2%) with their families when playing with them. "*I feel it's an incredibly bonding experience*" (R32, age 17); "*We always laugh a lot and she [sister] feels like she spends quality time with me*" (R341, age 21). Respondents mentioned gaming in family provides a space to interact and communicate: "*A greater ease to talk about other subjects comes up while we play*" (R140, age 33). Furthermore, during the recent COVID-19 pandemic, games provided a shared place for families to be together "*In pandemic times, even though we are not together, when playing online together, it was like we were*" (R176, age 33).

3.4.2 Time demands. For some families, gaming together is not possible due to the current demands of synchronous and often co-located play. The majority of non-gamers chose "*lack of time*" (N=33, 58.9% of non-gamers) as the primary motive for not playing games. "*Lack of time*" was also

[2]Final Code Book - https://osf.io/gvs9k
[3]Themes Outline - https://osf.io/mvehf
[4]Survey Quantitative Data - https://osf.io/ajv7t

considered a prominent barrier to family play (N=48, 24.4% of non-family-gamers). Respondents who do not play with their families highlighted how they would need "*more time together*" (R252, age 42); "*compatible schedules among everyone*" (R43, age 19). Alternatively, others suggested short play sessions: "*a game that is easy to set up [...] and has short rounds*" (R98, age 38).

3.4.3 No game for everyone. Games are not typically designed to cater to a diverse set of individuals at once, making it a challenge to find a game that would captivate the whole family. For gamers, the main reason for not playing games with their family is that "family does not want to play digital games" (N=80, 40.61%). Respondents highlighted that "*finding the right game*" (R37, age 21) is difficult and that it is important to select one that is able to cater to all "*a game that would interest several generations, with a friendly look to attract people who are not interested in playing*" (R257, age 28).

3.4.4 Unbalanced experiences. Games that provide symmetric experiences to players result in unbalanced experiences when there are significant differences between its players. In intergenerational scenarios, some players cannot competitively keep up with others: "*Younger kids get angry if they are losing, and then there is someone older [...] complaining we should not have played so seriously with the younger ones*" (R163, age 20). In collaborative experiences, players can feel like a burden: "*My mother becomes sad as she thinks she has nothing to contribute because I have been playing for longer*" (R94, age 27).

3.5 Discussion

We were able to assert that the main barriers felt by our respondents were the differences in **available time**, which are reflected in **limited opportunities for shared play**. Additionally, the **differing expertise and preferences** limited the choices available, even when time and place was not an issue. Below we describe the main identified issues for family play.

3.5.1 Time Investment. Families often do not have time to play together [60]. Generally, younger generations are shown to play more, which may mainly be due to professional and family responsibilities related to adulthood [6, 37]. A possible solution would be to offer games that can be started and completed in short sessions, or longer games that can be played in successive short bursts [37, 60]. Still, for individuals who can and want to dedicate more time to these experiences, this might not be enough. From a design standpoint, this unbalance might be relieved if there is an asymmetry of investment [30, 51] within the multiplayer interaction. While this can happen naturally with some multiplayer games, it can also be embraced and inspire the design process.

3.5.2 Synchronous Play. For families, it can still be a challenge to find compatible schedules to play together. Asynchronous interaction is very common in social network games (e.g., *FarmVille* [68]), where players do not need to be online at the same time to engage socially [11, 37, 47]. These can be an asset for families to communicate and keep track of each other's routines, even asynchronously [66]. However, this type of gameplay may neglect actual player-to-player interaction, getting closer to a single-player experience with limited opportunities for social engagement [11, 47]. While mere instant messaging can lead people to feel connected [33], digital gaming can certainly go beyond that.

3.5.3 The Expertise Conundrum. The heterogeneity of skills and abilities within a family may jeopardize a balanced multiplayer experience. Participants shared experiences where players (usually younger or less-experienced) felt frustrated for not being able to play on par with others. Previous work [10, 18] explores player balancing strategies where in-game advantages (e.g., aim assistance)

are leveraged to compensate for skill differences. Their results suggest there is an opportunity for these strategies to be incorporated in game design, without harming player experience. As aforementioned, the design of asymmetric roles is also a recognized balancing strategy [18, 25, 26]. For intergenerational contexts with potential novice gamers, it might be important to ensure a game is able to efficiently introduce the tasks involved, rules, and mechanics. This implies not only concerns about the game design itself (e.g., tutorials, interfaces), but also about the means used to access (e.g., platforms, devices). Additionally, simple controls and a soft learning curve could be essential to avoid discouraging novice players [50].

4 DESIGNING ASYMMETRIC ROLES FOR FAMILY INTERACTION

We designed and developed a proof-of-concept digital game, conceived from the ground up to address the identified barriers and promote family interactions. The game, "*Koala Boutique*", was developed for Windows[5] and Android[6] smartphones. It was developed in Unity[7] leveraging the Top-Down Engine assets[8]. We relied on Google's Firebase Realtime Database[9] for data synchronization and logging. All graphics were either designed from scratch or adapted from free-licensed assets. Sound effects were collected from various free-licensed sound libraries and post-edited. Below, we describe the design process and provide an overview of gameplay. A detailed description of every mechanism is available[10].

4.1 Design Process

Inspired by the literature [60] and the previous survey, we defined a set of constraints in adult-child gaming experiences that we sought to tackle: 1) differences in **available time** to play and **differing expertise and preferences**. We set out to design a game that would enable adult-child pairs with these constraints to play together. To address the different time constraints, we designed a game with two asymmetric roles that, despite being interdependent (i.e players cannot progress certain conditions without each other's actions), could be played autonomously and asynchronously. In order to promote family interaction, we opted for a collaborative game because interdependence between players in collaborative games has been successfully leveraged to foster feelings of closeness and connectedness in the past (e.g., [15, 29]). Following a framework proposed by Harris et al. [30], we designed player interdependencies, where one player performs an action that allows the other to progress, but the specifics of 'when' are irrelevant. Players do not need to play at the same time or in the same place. We leveraged asymmetry of information and the interdependence between roles to foster communication in an attempt to reap the benefits of co-play, and appeal to families who value co-presence [15, 16, 32, 62] by having required interactions in the real-world. We designed *collaborative tasks* that required pairs to communicate outside of the game in order to complete them.

The adult's role provides the opportunity to play whenever they are willing and available to. As such, this role was designed to be played on a smartphone, which is readily available to be played on the go and in short bursts. The child's role is played on a computer and its gameplay supports longer play sessions. Gaming expertise differences between adult and child can happen both ways. For this work, we followed what has been previously found in the literature [60] and our own survey where children often have greater expertise.

[5]Koala Boutique Windows version - https://techpeople.itch.io/koala-boutique
[6]Koala Boutique Android version - https://play.google.com/store/apps/details?id=com.techpeople.familyPlay
[7]Unity Real-Time Development Platform - https://unity.com/
[8]TopDown Engine Documentation - https://topdown-engine-docs.moremountains.com/
[9]Firebase Realtime Database - https://firebase.google.com/products/realtime-database
[10]Game Description - https://osf.io/y5h74

We designed the game in line with the requirements to fulfill the E (Everyone) rating from Entertainment Software Rating Board. With the content suitable for persons ages 6 and older, and with minimal cartoon, fantasy, or mild violence and/or infrequent use of mild language, such as avoiding violent terminology (e.g., "defeat" instead of "kill") and not include any gore animations (e.g. blood). We additionally sought to ensure playability for children by implementing adjustable difficulty and simplistic interfaces

We collected preliminary feedback through informal playtesting with convenient users, including two industry game developers and one research engineer. The prototype was tested and iterated over with two children 6 and 11 years old.

4.2 Game Overview: Koala Boutique

The game happens in the Koala Kingdom where the players are the owners of a shop closing in on bankruptcy and they have to work together in order to save its future. Each player has their specific role in this game. The Adventurer (child) plays a top-down roguelike dungeon-crawler games, akin to *The Binding of Isaac* [19], and the Trader (adult) plays an idle game [2] (i.e., games where the players do not have to invest much time to play), akin to *AdVenture Capitalist* [49].

4.2.1 Gameplay. The core gameplay encompassing both roles consists of 1) the Adventurer delving into the dungeon, slaying monsters, avoiding traps, gathering loot from monster drops, collecting mushrooms, and successfully finding the exit door; and 2) the Trader receives the loot, processes and sells the items, and buys unlocks that upgrade the shop, change what can be found in the dungeon, and what powers and classes are available to the Adventurer. The Adventurer is able to repeat their gameplay loop as much as they like, independently of the Trader. The Trader requires items from the dungeon in order to progress. We made significant efforts to ensure the game could withstand longer play times than traditional game research prototypes meant for laboratorial studies. Below we provide an overview of the game developed.

The **Adventurer** [Figure 1], designed to be controlled by the child (aged 7 or older), plays from a top-down perspective and is able to move it freely and attack with their weapon. The Adventurer starts as a 'Ranger' (using a bow), but can unlock two more classes (with different weapons) during the game.

Fig. 1. Screenshot depicting the Adventurer's gameplay.

Players move through a randomly generated map, consisting of multiple rooms, created with adaptive difficulty to both lower the barrier of entry for less proficient players and to keep high performing ones engaged. Each designed room had an associated difficulty level which was used in the map generation. Each time a player successfully completed a dungeon, the next generation

would include more difficult rooms, while losing meant the opposite. In the dungeons it is possible to find a wide variety of power-ups (which are unlocked by the Trader[11]).

The **Trader** [Figure 2], designed to be controlled by the adult, manages the shop inventory which consists of items gathered by the Adventurer (i.e. raw materials), and processed items. Traders are able to process raw material (e.g., turning Iron Ore into Iron Ingots) and sell any item type in the Market (i.e. granting them gold).

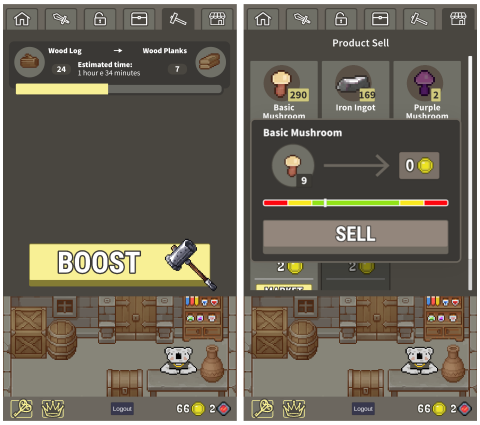

Fig. 2. Screenshots depicting the Trader's gameplay. To the left, the Processing menu and the boosting minigame; to the right, the Market menu and the selling minigame

Players can process items faster and sell items for higher prices by playing two different simple tapping timing games. To engage players, and to promote short play sessions, the Market prices for every item vary every 3 hours providing the opportunity for players to optimize their profits, if they so desire. To buy unlocks, players have to pay a combination of gold and items and in some cases have another unlock as a prerequisite. The Trader role is less demanding in terms of dexterity and time commitment, lowering the entry barrier. The Trader also has the ability to override the current difficulty of the Adventurer dungeon and control which of the mushroom types become abundant in the dungeon, which can be necessary to have new unlocks or to make gold faster.

4.2.2 Collaborative Tasks. The Adventurer and Trader have intertwining game loops and are interdependent to unlock new content. While none of the core mechanics require the users to communicate to progress, some content is locked without it. Communicating allows them to share their experiences and be more efficient (and considerate) in what the other role demands.

In addition to the core game loop, we designed six optional collaborative tasks that could reward players with gold or new unlocks but would not be possible to complete without players communicating outside the game [Table 1], promoting a shared sense of exploration. The main goal of the tasks was to **foster family interaction outside of the game**.

5 USER STUDY: FAMILY PLAY THROUGH ASYMMETRIC GAME DESIGN

We conducted a remote user study with adult-child pairs. Our goal was to understand the potential of the approach in creating a meaningful gaming experience, one that simultaneously meets the requirements of adult and child family members (RQ1), creates opportunities for real-world interactions (RQ2), and has players engaged. The study was approved by the Ethics Committee of our school.

[11]Unlocks List - https://osf.io/7w2cy

Table 1. A summary of the six collaborative tasks.

Name	Description	Adventurer	Trader
Trading Daily Quest	The Trader has to sell a specific combination of items (changes daily), giving the Adventurer more attack damage if they do	The Adventurer **sees** the combination at the end of a successful mission and needs to **share** it with the Trader	The Trader has to **sell** the **combination** of items
Gathering Daily Quest	The Adventurer has to gather a specific combination of items (changes daily), unlocking a new type of mushroom if they do	The Adventurer has to **gather** the exact amount of mushrooms in the combination	The Trader **sees** the combination after selling an item and needs to **share** it with the Adventurer
Oracle	A character in the dungeon tells the Adventurer when an item is sold at a higher price	The Adventurer **interacts** with the character, **sees** the time and should **tell** the Trader	The Trader can choose to **sell** the items at this time for higher profit
Secret Door	Inserting the correct code in the Secret Door lets the Adventurer enter a room with more loot (code resets every 2 days)	The Adventurer **interacts** with a door they cannot enter and gets **prompted** for a code. They have to **insert** the correct code to enter.	The Trader has to **process** the key, **tap** the secret code button to see the code and **share** it with the Adventurer
King's Offering	Players lose money if they fail to offer a randomly generated combination of mushrooms in time or offer the wrong combination (new offering every 2 days)	The Adventurer **sees** the combination at the end of a successful mission and needs to **share** it with the Trader	The Trader **sees** a button he has to **interact** with to **give the offering**
Diseased Mushroom	If the Adventurer brings a diseased mushroom to the shop, they lose gold for each (changes every 8 hours)	The Adventurer must **not bring to the shop** the diseased mushrooms	The Trader **sees** in the Mission tab which mushroom is diseased and **shares** this information with the Adventurer

5.1 Participants

We recruited 12 participants, 6 adult-child pairs (with at least a 10 year gap) from the same family, 4 parent-child, one sister-brother and one brother-brother pairs. Adults (A1-A6) were aged 25-48, while children (C1-C6) were aged 9-14 [Table 2]. We accepted pairs who had an adult (aged 25 or older) who participated with a child (ages between 7 and 14). The participants filled in a demographic and gaming habits questionnaire, which included the Inclusion of Other in Self scale [3] to assess their familial relationship (Q1). Three adults played video games on a daily basis and often with their child pair. The other three adults played occasionally. Only one child played occasionally with all others reporting playing frequently. All participants except A6 reported high scores of closeness [Table 2].

5.2 Procedure

To recruit participants, we shared a call on social networks, and relied on word of mouth. We provided a game trailer on the call[12]. In the trailer we told players the overarching objective of the game was to unlock additional classes to give them a sense of direction, but unlocking the classes

[12]Game Trailer - https://youtu.be/WsmSIDktfag

Table 2. Participants summary of gender, age, gaming frequency and how close they felt to their study partner, according to the IOS scale [3]. M - Male; F - Female. R - Rarely; O - Occasionally; Fr - Frequently

	A1	C1	A2	C2	A3	C3	A4	C4	A5	C5	A6	C6
Gender	M	F	M	F	F	M	F	F	F	M	M	M
Age	44	11	45	13	48	10	31	9	25	13	25	14
Gaming	R	Fr	Fr	O	R	Fr	Fr	Fr	R	Fr	Fr	Fr
Closeness	7	7	6	6	7	7	7	7	6	7	4	6

had no impact on the overall experience other than allowing the Adventurer to use a different weapon in the dungeon.

After filling in the first questionnaire (Q1) and consent form, pairs were contacted with instructions to download and install the games. Participants were asked to make an effort to play the game daily for one week or until they unlocked the two classes available. We encouraged pairs to share their experiences and/or problems whenever they wished through a shared Google Form that acted as a diary[13]. Mid-week, we contacted the adult participant to ensure there were no issues or questions. There were no strict time requirements and the online form was entirely optional to not overburden pairs, as we knew that time was already a barrier to gaming.

At the end of the week, pairs were sent an online questionnaire (Q2) with the Ubisoft Perceived Experience Questionnaire (UPEQ) [4], a validated questionnaire that allows to quantitatively measure player's subjective experience based on needs satisfaction of autonomy, competence, and relatedness. Finally, participants were contacted to schedule a semi-structured interview (script available[14]).

The interviews were conducted remotely by one researcher with each pair through Zoom. We asked about their thoughts on the game, theirs and their partner's role, perceived benefits (e.g., changes in the relationship), comparison with other family activities, to reflect on the game demands (i.e. time and communication) and specifically about the collaborative tasks. We ensured the minor was always addressed first, to avoid influence from the adult's answers. The session was recorded and consent was obtained. Interviews lasted on average 45 minutes.

Gaming sessions of each pair were logged in a database, which was useful to contextualize their perceptions. We recorded participants starting or closing the game, collaborative tasks (e.g. completing a daily task), player actions (e.g. performing an attack), and progression (e.g. unlocking a new power-up). A full list of the log types is available [15].

We compensated all pairs with a €20 gift card.

5.3 Data Analysis

We performed an inductive thematic analysis [55] over interview transcriptions and perspectives given through the diary forms. The coding scheme was developed iteratively. Two researchers started by repeatedly reading the data, annotating recurring ideas and concepts relevant to our approach. The coding scheme was iterated across multiple meetings (with other team members for review), adding new codes for relevant ideas that were not yet captured, merging and removing the ones that were redundant or irrelevant, and grouping them to account for hierarchical relationships. The analysis of the data was predominantly carried out by the first and second authors assisted by

[13]Diary Form - https://osf.io/xmn59
[14]Interview Script - https://osf.io/fzqau
[15]List of Log Types - https://osf.io/42mx9

a member of the research team with previous experience in thematic analysis. The code book[16] was used to annotate all data. Finally, the team met in order to identify relationships between codes, and rationalize the overarching themes[17] we present below. Throughout the following sections we will refer to each pair by their participation number (e.g. P4), and use either A or C when mentioning an adult or child respectively (e.g. A3).

Quantitative data resulting from the administration of UPEQ, IOS, and logs was summarized by calculating descriptive statistics (mean and standard deviation). We quantitatively measured participants engagement through UPEQ scores, as the questionnaire was shown before to be a reliable predictor of player's engagement [4, 35]). One pair (P3) did not answer the UPEQ.

5.4 Limitations

Our approach tries to create games that enable people to play together that could not before due to several restrictions. Since such games do not exist, it is particularly hard to recruit participants who struggle with these constraints, given what they have come to expect from mainstream games. Additionally, given that the main barrier we are addressing is the lack of time from the adult, it becomes especially difficult to recruit pairs that are willing not only to play, but to accommodate the protocol requirements in their daily lives. Because of the limitations, we were only able to recruit 12 participants (6 pairs), however we saw a wide variety of age gaps (between 11 and 38 years) and gaming frequency within the pairs (Table 2). The six pairs experienced the game very differently providing us with key insights for future research which we discuss below.

Table 3. Summary of participants' play time (days, sessions per day and minutes per session), unlocks obtained and engagement average (and standard deviation).

	A1	C1	A2	C2	A3	C3	A4	C4	A5	C5	A6	C6
Days played	7	5	5	6	4	2	5	5	3	3	1	1
Sessions/day	3.4	2.2	1.6	2.2	1.8	1.0	6.0	2.2	8.0	9.0	6.0	9.0
Minutes/session	6.7	18.2	9.7	13.4	5.5	18.7	3.4	31.3	8.0	13.5	18.3	11.6
Total unlocks	41		36		22		48		29		48	
Class unlocks	Warrior		Rogue		None		Both		None		Both	
Engagement	4.86 (0.36)	3.9 (1.09)	4.14 (0.65)	4.52 (1.21)			4.29 (0.64)	4.57 (0.93)	4.24 (1.09)	4.38 (0.5)	4.05 (1.56)	4.29 (1.06)

5.5 Findings

In this section, we first contextualize the gameplay experience of the pairs quantitatively, followed by a discussion anchored on the themes established.

Adventurers (children) played an average of 2.1 sessions per day, each session averaging 17.7 minutes. The Traders (adults) played more regularly, averaging 3.0 sessions per day, but with a shorter average session duration of 8.5 minutes (Table 3).

All players reported enjoying the experience. Regarding overall engagement, participants reported an average UPEQ score of 4.32, SD=.99 (adults M=4.31, SD=.98 and children M=4.33, SD=1) [Table 3]. Some participants highlighted the feeling of novelty: "*never even heard of a game like this*" (C2); "*the first time I played something like this*" (A2); "*a different experience*" (A4).

[16]Code Book - https://osf.io/rqysv
[17]Themes Outline - https://osf.io/9nfdg

Table 4. Summary of findings, organized into the resulting themes.

Asymmetry Supporting Family Play. Adults appreciated the opportunity to meaningfully participate despite their time restrictions. The game design enabled participants to integrate it has part of their daily routines and family dynamics.
Creating Pervasive Conversational Topics. The game encouraged pairs to interact outside the game (e.g., strategizing what to unlock next) leading to pervasive shared topics of interest. For some, part of the interaction occurred co-located, facilitating the learning process and collaboration.
Promoting Real-world Interactions Through Gameplay. While the core mechanics naturally fostered collaboration, participants had difficulties identifying gameplay that demanded for real-world interaction. Conversely, the purposeful design of inconspicuous collaboration opportunities promoted a high sense of exploration and satisfaction when successfully identified.
Asymmetric Roles Reduced Player Awareness of Co-player's Role. Some participants reported being mostly unaware of how their partner's role worked, while others opted to openly share their individual experience.
Interdependent Progress Strengthened the Sense of Shared Experience. The gameplay was perceived as a collective and balanced experience. Both players felt important and valuable contributors to the gameplay (e.g., often prompting each other to play).

Two pairs unlocked all classes, two only one, and two, despite unlocking 20+ powers, did not unlock any class—which was established as the goal of the experience. Pairs 4 and 6 were able to obtain every unlock available and pair 6 completed the game in one sitting. All pairs engaged with all collaborative tasks with different levels of success. Five of the six collaborative tasks were completed and understood by at least one pair (Table 5).

Each following subsection corresponds to one of the themes [Table 4] resulting from the thematic analysis. We relied on a mixed-method analysis and thus further contextualize the themes with the quantitative results, and discuss participants' perceptions more in-depth.

5.5.1 Asymmetry supporting family play. The **different roles allowed adult-child pairs to play together, separately, despite their different constraints**. With the exception of P4 and P6, pairs rarely played digital games together or with their families "*I cannot play much with my father some types of games I play*" (C5).

Throughout the interviews, participants recognized that the game was designed in a way that catered and could cater to different family members' requirements: "*I think it's especially interesting [asymmetric roles] to be able to reach different ages*" (A6). For P5, the role division meant that, despite not being particularly interested in gaming, A5 enjoyed the experience of playing together with her brother.

> "*I could play [...] this game with people who don't really like to play. [A5] doesn't really like to play games, she doesn't like always being on her smartphone and I think she had a good experience.*" – C5

> "*I liked it very much. I think it is a good idea, because if... for example, if the roles were the same, C5 would find mine boring and I would not be as invested playing his role*" – A5

The **game successfully accommodated participants' daily responsibilities and family dynamics**. Both child and adult participants explained they were able to play in short sessions, avoiding the need for weighty time commitments. Adults highlighted how they could play on their

smartphones for a few minutes during lunch hours, short work breaks and even just before going to sleep. In total, adults had 88 sessions accounting for 565 minutes. While children played longer sessions, with 47 sessions for a total of 816 minutes.

Some pairs shared how they chose to integrate the game in their daily routine: "*When I got home. [...] a little bit before dinner or after dinner. I also happened to play one day at work, during my lunch*" (A2); "*For example, break after lunch, in between work.*" (A5); "*I could play the game at breakfast, I could play the game at lunch [...] it doesn't take up a lot of time [...]*" (A6).

For adult participants, **the asynchronous nature of the game was essential for it to adapt to their routines**. The choice of having their role played on a smartphone enabled play on the go, anywhere, and on small chunks of time. Three adults (A2-A4) recognized these aspects can be essential to families, where it is often a challenge to schedule play sessions, given the different responsibilities of each generation.

> "*Since nowadays it is almost impossible to have parents and children with time, on the same day and at the same time, to play together, the game allows both to play the same game in their own time*" – A4

Some were able to imagine themselves playing our game (or a similar one) with other members of their families. C5 imagined playing with his father to create new conversations, while A6 mentioned if their brother had participated with their mom instead, it could have improved the relationship between them:

> " *[...] If he had [participated in the study], for example with mom who, maybe... sometimes he's more distant, because he's usually playing and mother is doing her stuff... maybe it would force them to communicate a bit and I think that, inevitably that will strengthen... anything that promotes teamwork will strengthen a relationship.*" – A6

5.5.2 Creating Pervasive Conversational Topics. The game fostered persisting interaction outside of its environment. As players needed to communicate to together learn the interaction flow and objectives of the game, it **created new moments in the family dynamic for shared conversations**. For A2 and C2, this interaction mainly occurred during dinner time, when they were both home. This was reflected in the pair exchanging information on a daily basis, with the child telling the adult what they collected during the day and the adult requesting specific resources to unlock new abilities.

> "*In the afternoon, she came home from school and I was working. When I arrived: "So, did you play today?" [...] and she was studying or doing something and I would take the smartphone, and start looking. [referring to her daughter] 'Look, I've got you this, and this, and this'*" – A2

The **exchanges between adults and children were mainly promoted by the interdependence existing in the core mechanics**, as adults required their child partner to gather resources to unlock new content. Yet, while the Trader had the responsibility of unlocking new content for the Adventurer to enjoy, some adults described how they would discuss together what would be preferable to unlock. Two pairs in particular (P4 and P6) mentioned how they would come up with a thought process, depending on the best unlocks to assist the child on next missions.

> "*Initially, it was about what was obtainable. Then, we started to see there was this... there were items that could help the game progress. [...] The spikes not affecting us and others. There was a strategy. Trying to understand what was better for her, so she could progress in the game.*" – A4

For P4, P5, and P6, part of the interaction occurred when playing in the same space, at the same time. These moments provided opportunities for participants to learn more about each other's roles and exchange information more effectively.

> "*I tried to understand, when she was playing, if something appeared that would explain what he [the King] wanted*" – A4

Similarly, C3 described how, one day, when his mother was cooking dinner, he ended up taking her smartphone and started to explore her part of the game, trying to get a better understanding of how the collaboration worked:

> "*I was seeing how mom's things worked and I saw some things there… I was looking at the things to sell and all that, and I also found the codes*" – C3

We realized this moment was less of an interaction between participants (in contrast with A4 and C4, where they purposefully opted to share the experience and learn together), but a way to circumvent the communication needed, presumably in face of the difficulties A3 had in understanding their part of the game. Yet, even circumventing the challenge led to a conversation topic between the pair. Participants vividly described moments of interaction, and highlighted the potential of the game to bring families closer together, by motivating conversations. Curiously, A4 discussed how these interactions persisted during the week, making a comparison with other multiplayer games, where, typically, communication only spans over a match:

> "*There are very few games where there is this interaction where the person actually has to talk. In other words, we play Fortnite but that is in the moment and.. [...] Basically there is a goal which is to kill and win, that is it. And in this case, there is also a goal, but it is something that lasts over time and people can keep talking.*" – A4

5.5.3 Promoting Real-World Interactions Through Gameplay. There are sparse examples of digital games that spill into the real-world, requiring interactions outside the game environment. The collaboration tasks were designed to require exploration and communication with no clear indications of when the partner was required, nor when the information provided was meant for the other. Coupled with the novelty associated with the interaction flow, while participants understood the concept in principle, they also found it particularly **difficult to identify and act on them**, with some pairs only figuring out the mechanics (on their own) during the interview discussions. Pairs **attributed the difficulties to the lack of communication between them**, suggesting that if users become aware (or are reminded) of these hidden opportunities it may positively affect their number of interactions.

> "*I think we lacked, to be honest, a bit of more communication between the two for the game to have evolved further. For instance, in the King's Offering, as I said before, I was never able to do one. She [the child] never told me 'look, in the end it shows me what is needed to offer the king'. [child mumbles something indiscernible] Ah! Right, I'm telepathic [laughter]*" – A2

A1, A2, and A4 mentioned they tried more than once to complete the *King's Offering* but they were never able to get the correct combination, only realizing during the interview that they had to communicate with their child to succeed. The way this mechanic was presented to both roles was not sufficient to prompt players to communicate about it. On the other hand, all pairs understood how the *Secret Door* worked during the experience. In this case, the way the task appeared to players was more explicit and prominent, as it partially blocked the child's progress on the dungeons and the adult had to act with intent to gather the information, by processing an item (secret key). The resulting four digit code was clearly meant to be used somewhere else since no other inputs in

Table 5. Participants collaboration data summary. **Daily Quests (DQ)** – Quests generated (Quests completed); **Oracle** – Interacted with the Oracle; **Secret Door** – Codes generated (Correct code inserted); **King's Offering** – King's requests (Correct offering); **Diseased Mushrooms** – Mushrooms collected (Diseased Mushrooms collected);

	A1-C1	**A2-C2**	**A3-C3**	**A4-C4**	**A5-C5**	**A6-C6**
Trading DQ	5 (2)	5 (0)	1 (1)	5 (1)	3 (0)	1 (1)
Gather DQ	6 (0)	5 (0)	2 (0)	5 (0)	2 (0)	1 (1)
Oracle	8	8	2	15	11	16
Secret Door	9 (3)	6 (0)	5 (0)	9 (2)	11 (2)	2 (1)
King's Offering	3 (0)	3 (0)	1 (0)	3 (0)	2 (0)	1 (1)
Diseased Mushrooms	473 (52)	322 (38)	111 (0)	459 (83)	309 (8)	387 (48)

the Trader shop allowed to insert numbers. A2 shared the moment where they understood the mechanic:

> "*We were talking about the game and... there was a moment when [remembering a past conversation] 'there are some keys with some numbers... don't you need some numbers?' and she 'ah, you also have numbers and keys, you could have told me longer ago!'*" – A2

The *King's Offering*, in comparison, appeared at the end screen after completing a dungeon which could be easily confounded with session statistics, and the Trader could keep trying to make an offering with nothing blocking their attempts. In the same sense, the *Daily Quests*, while relying on the players to communicate, never prompted the players to do so. This contributed to the small number of completed quests.

In the case of a particular collaborative task, the *Diseased Mushrooms*, participants were aware that some of the collected mushrooms would be diseased, causing the shop to lose coins, but most did not know what could be done to avoid this (i.e. warning the Adventurer which mushrooms were diseased and not to collect them). The mechanic created the intended effect of promoting a shared exploration of the game, however, the unfortunate choice of naming it "diseased mushroom" caused it to be more confusing than it should be, for example changing to "spoiled mushroom" might have prevented it.

When asked for suggestions to improve communication, multiple participants mentioned that notifications about other player's actions and explicit prompts telling the players to share information would have helped. Curiously, A2 stated that more explicit prompts could subtract from the experience, as, in essence, it relies on players exploring the game together and sharing their part to reach a common understanding: "*that takes away from the essence of the game, which is for us to know how to communicate and share the things with the other, without the game having to tell us, right*" (A2).

5.5.4 Asymmetric Roles Reduced Player Awareness of Co-Player's Role. The trailer sent to all pairs gave a brief introduction to the game's objectives and showcased both roles' gameplay and purpose. However, the strong asymmetry, coupled with the asynchronous and potentially remote nature of the gameplay, meant that **players were not led to fully comprehend the other role's mechanics**, only purpose. For pairs who communicated less, this made it harder to grasp their

impact on each others' gameplay and complicated decisions on how to progress. Notably, A3 shared with us that seeing their child's game could have helped understand what she had to do:

> "*Because I did not see how he [the child] plays yet, not even seen his layout, or anything. I only know mine, on the phone, we did not have that interaction so I could see... 'let me see what you do so I can try to understand what I need to do'*" – A3

In this way, some collaborative tasks were not fully understood. A notable example is the *Oracle*, which required users to know the market had fluctuating prices. This information was only complementary and did not block access to any gameplay element, nor did it provide a clear benefit which led to it to be ineffective in creating social interactions. For collaborative mechanics to be enticing to be explored by players, our results suggest they need to be designed with stronger interdependence and significant gameplay effects.

5.5.5 Interdependent progress shaped the sense of shared experience. Despite playing two very different roles with no gameplay overlap, nor having any requirement for synchronous co-located play, players never talked about the individual roles as different games. **The experience was felt as one**. Participants highlighted how the roles were balanced in a way that **each player was essential to progress** in the game.

> "*She has to do her part and I have to do mine. It has to be a game in communion. It is not possible... I do not think anyone stood out more than the other [...] if someone wants to progress more or wants to do more, it reaches a point that is limited, they are unable to.* – A2

This pair highlighted how the collaboration was mostly balanced during the experience, with **players often prompting each other to complete their tasks to progress**. For A1, A2 and A5, it were the adults which prompted progress since they depended completely on the child to collect resources: "*When I no longer had coins and resources to spend, to unlock the items, I would say 'Shoot, go play, [name of the child]!' and she did not want to [laughter]*" (A2); '

By design, adults were more dependent on their child pair, as they were not able to complete their main tasks (i.e. selling and processing materials, unlocking new abilities) without the resources that were gathered by the Adventurer. In contrast, children were able to play freely and complete as many missions as they were willing to. Some participants echoed this: "*I can't progress on the store if he doesn't give me... if he doesn't put anything in there [...] so I think his role is more... it's more important*" (A5). This was an intended design option, given we assumed children would have more free time to play. However, for the Adventurer, the missions would not present new power-ups or loot, only different rooms depending on the difficulty.

6 DISCUSSION

In this paper we explored asymmetric game design to tackle barriers to inclusive family gaming while promoting real-world interactions. The developed game was positively received by the participants, who saw the opportunity as a way to enjoy a playful and engaging experience with a family member, at their own pace, allowing for different time requirements. Participants highlighted the novelty of the idea, mentioning the lack of games like this in the market. Below we reflect on *how asymmetric game design can meet the requirements of adult-child pairs (RQ1)* by completely decoupling the game experience, with **different time demands**, **enabling autonomous play** and creating gameplay loops that are **adaptable to families daily routines**. We also discuss *how to promote family interaction* (RQ2) through **interdependent progression** and **asymmetric information**.

6.1 Games Can Adapt to the Player

While roles were interdependent, they did not require synchronous play. This feature was essential for our study participants who repeatedly pointed out how the game was adaptable to their daily lives.

The adults were only provided with simple mechanics and gameplay which met the requirement to cater to adult gamers with less available time and less expertise, following the time constraints of adults reported on previous work [60], but neglected the ones who wanted more demanding mechanics. For adults with more playing time available, the autonomy and gameplay mechanics provided were not enough as they wished for the same freedom to keep playing.

Participants pointed out the potential of the approach to expand and add more people in the family to the experience. We explored the design and integration of two radically asymmetrical roles, focusing on a very specific problem that families face regarding digital play. For a game to be truly "*communal*" (A2) in this context, it would have to be adaptable to a wide range of needs, potentially requiring the design of additional or even overlapping asymmetric roles.

Many games today offer a variety of mechanics and tasks within their gameplay, leaving to the players the decision to focus on those they prefer, and pursue their individual motivations and playstyles [5, 53, 65, 67] (i.e. massive online games). Another example is Animal Crossing [43] which provides a wide range of activities and flexible game tasks allowing players to do what they are more interested in, at their own pace [58]. One can say these games promote emerging asymmetries, but often the core gameplay is shared between all players. Our results highlight there is potential to design highly disparate experiences while still conveying to different players a sense of shared play. Furthermore, we showcase how to integrate roles and tasks in multiplayer games that consider players unable to dedicate much time or effort to the experience, by alleviating time investment and compatibility restrictions by design, while maintaining their autonomy.

6.2 Context of Play

At a first glance, it might seem that having a clear separation between roles, with no synchronous interaction between the two different gameplay loops, would limit the interactions and contexts of play. However, our results suggest the opposite. We designed the game to not expect synchronous collaboration and have small time requirements–particularly on the adult's role–to meet the constraints that we found in our survey and that previous work points out [60]. Because of this, participants were able to adapt the experience to their needs, playing the game at the same time if they wanted to, sometimes playing the other role, in place of their partner. We were able to see the expected asynchronous gameplay but also co-located experiences with each player playing their own part, sometimes commenting on each other's gameplay. This kind of freedom of when and where to play is also mentioned in studies with games featuring geo-location [52] and should be investigated further, specifically how we can design games that support and/or adapt to different contexts of play.

6.3 Interdependence and spilling interactions into the real-world

Although players were interdependent by design to progress, each role gave players the ability to engage in meaningful challenges autonomously. For the adult, as long as resources were available in the shop, there was always something to do. Participants reacted positively to this and understood the context of interdependence, drawing attention to the interactions generated by it. The game promoted different types of interaction, as categorized in a Joint Media Engagement systematic review by Ewin et al. [22]: technical (e.g., asking each other for help with the gameplay), cognitive (e.g., Sharing information about the collaborative tasks or requesting specific unlocks), physical

(e.g., discussing the game over dinner) and limited (e.g., watching the other's screen to learn about their role). Interestingly, unlike the majority of studies reported in Ewin et. al [22], the interactions created were bi-directional, with children and adults switching between active and supportive roles accordingly. This continues to support the results of previous work, which point out how games, and interdependence in particular, can be used to generate conversational topics and facilitate social interaction, particularly when rooted in uneven information or in how players negotiate their roles [1, 16, 29, 32, 52].

Following along the lines of previous work, where games were found to support a fluid leadership dynamic between parents and children [1, 40, 52], the asymmetry of our game's design coupled with the autonomy of the child player and the roles' interdependence led to shifting leadership roles that challenge the traditional power dynamics in family dyads, with both having the ability to lead the experience, but equally limited to have to rely on and be led by the other. While the child could play autonomously, novel content was only introduced when the adult played their part which could have become a problem. However, while some pairs mentioned asking each other to play, it was always mentioned in a positive tone. Still, depending on the adult's availability, this could become a burden for both players. We believe there is space to explore how we tighten the requirements for interdependence and collaboration when we are able to perceive availability and, in turn, loosen the requirements/effort or even introduce novel content when engagement declines. This should be carefully designed to not completely substitute the adult (or child) at any point of the experience but still keep the sense of progression going.

For some participants, it was important that the experience and the interactions brought up through play did not end when the game did. Our results suggest that interdependence coupled with asymmetry of information and asynchrony create an experience that can create pervasive conversation topics that can spawn regular social interactions between family members potentially fostering family bonding.

6.4 Balancing asymmetry of information

We purposefully designed each role to have access to different information in order to promote a sense of discovery and a need for communication in the real world. However, we did not explicitly point out what information each role needed. This led to some players never figuring out how to solve some of the challenges that required communication (e.g. *King's Offering*).

Providing no information to the player can promote a sense of discovery (e.g. secret levels or collectibles) but should be done with care, as it can also leave the player feeling lost. On the other hand, the player can receive guidance from the game by having their progress blocked, signaling something is needed to be able to progress, or by being prompted to share the information with their co-player. This is a fine balance that should be carefully considered when designing asymmetry of information in a game.

Mechanics relying on asymmetry of information can be designed in different ways. We used a specific type of asymmetry of information where one player had all the information (but did not explicitly know they had it) and the other knew its purpose. Different combinations of feedback (i.e. explicit or implicit), and different divisions of information (e.g. both players have partial information) may yield different results and are potential avenues for future investigation.

Lastly, since the players play at different times they do not necessarily know the impact of each other actions within the game world. This led to players suggesting additional features such as prompts and notifications about other players' actions. This could be part of the solution but, ideally, feedback mechanisms are embedded within the gameplay from the game design process. Future asymmetric games should also strive to include a variety of feedback mechanisms that ensure each player's actions and impact are visible to the other despite the asymmetry of play.

7 CONCLUSION

While gaming has become a mainstream medium of entertainment, due to the differences between family members it is still hard to find an experience that they can equally enjoy together.

Embracing the differences between the players, we designed a game with two very distinct roles, seeking to create a space where both players play in their own way and are still able to meaningfully affect the game without compromising on the sense of shared play. The strong distinction of the roles, with little gameplay intersection, did not constrict the context of play. Instead, participants were able to adapt the experience to their needs. In the same sense, asymmetry of information combined with asynchrony and interdependence allowed for the game to pervade the participants' daily lives, generating opportunities for new interactions outside of gameplay, which may lead to other conversational topics.

As videogames are such a diverse space, it is important to understand what factors and design spaces better foster family interaction. We argue that, instead of trying to find ways to create an experience that pleases everyone equally, these games should embrace the differences between family members, and create experiences specifically catered to them. Additionally, games can take advantage of gameplay elements that invisibly compel players to interact and reap the benefits of social play.

8 FUTURE WORK

We hope to inspire future work in creating experiences for a wider variety and/or for an undetermined number of family members. More work is required to understand how to craft collaboration mechanics and the impact that they can have on player experience. We explored the case where one player had the information the other required, but what if both had part of the information? Or if both needed the information for some shared task? We focused on collaboration, however, competitive games can potentially generate other types of interactions and are worth further exploration.

Finally, while we advocate supporting multiple play contexts (e.g. co-located play, asynchronous and remote), it is worth pursuing games that are sensitive and potentially designed around the changes to play context. How could a game be designed to have mixed moments of asynchrony and synchrony, sometimes requiring players to play together at the same time?

We believe these explorations will eventually lead to creating gaming experiences that are adaptable to a variety of family environments promoting shared experiences that have the ability to reinforce family bonds.

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