Asymmetric Gaming Further Apart: Effects of World and Goal Sharing on Cooperative Play

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Fig. 1. Screenshots of Grim's (left) and Plume's (right) views in the Shared level of our prototype, where they share both the world and goal: seeing each other and the same map elements (e.g., buildings) and having to complete five pedestals together.

Asymmetric game design can create rich social experiences and foster inclusion by assigning players distinct, interdependent roles that cater to different needs and preferences. However, as this approach intentionally introduces differences between individual gameplay experiences, it raises questions about how far asymmetry can go before undermining sociality. Prior work has emphasized shared spaces and goals as central to cooperative play, yet their impact in asymmetric contexts remains underexplored. We present a mixed-methods study with 88 participants who took part in pairs, investigating how world and goal sharing influence social behavior and perceived sociality in asymmetric cooperative games. Drawing on questionnaire data, gameplay metrics, and interviews, our findings show that, while distinct worlds and goals introduce friction, they also enable new 'flavors' of cooperation. We discuss how these asymmetries can be used to design engaging grounding challenges and moments of autonomy without sacrificing a sense of shared play. Finally, we contribute key design considerations (e.g., visible effort, tangible and playful intrusions) to support social connection in highly asymmetric experiences.

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1 Introduction

Digital games have become an important site of social interaction, connecting people across geographical and generational boundaries [21, 24, 35, 41, 55–57, 61, 74, 80]. Cooperative games, in particular, support connection through shared challenges, teamwork, and socioemotional exchange [52, 59, 64, 66]. Building on this understanding, prior research has explored how multiplayer games can be intentionally designed to foster meaningful social interaction, showing how specific design choices, such as degrees of interdependence [36] and shared control [26] shape players' social experiences and behaviors.

Asymmetric game design (i.e. designing intentional differences in players' individual experiences) is commonly used in research and industry to craft cooperative experiences in which players contribute complementary actions and perspectives [23, 36, 37]. It has also been explored as a strategy for designing multiplayer games that cater to different player needs and preferences, including ability [33, 34], skill [12], time availability [58], and device use [40, 58]. In some cases, accommodating these differences requires asymmetry to be pushed to the point where players engage with games that barely resemble each other (differing in platform, play style, or demands) yet remain connected through cooperative mechanics and shared progression (e.g., a child playing a complex dungeon crawler on the computer while a parent contributes through short-session mobile play [58]).

Previous research identified shared worlds and shared goals as key contributors to the social aspect of gaming [24, 64, 66]. However, it is unclear how players behave and feel socially when in distinct worlds (i.e. not sharing the same virtual space) and pursuing distinct goals (i.e. under different win conditions). This question is especially relevant for heterogeneous groups, such as mixed-ability or intergenerational players, where impactful asymmetries may offer more accessible or personalized gameplay [33, 34, 58]: placing players in different worlds or with distinct goals could allow each individual to play in ways that better align with their abilities and motivations, while still contributing to a broader cooperative context. At the same time, such differences may diminish mutual awareness and interaction [9, 51, 75], calling into question if and how player connection can be sustained under these conditions.

In this work, we present an experimental mixed-methods study with 88 experienced players (in pairs) who play together at least occasionally, investigating how sharing (or not sharing) a game world—defined by space and location—and goal—defined by win condition—affects social experiences in asymmetric cooperative play. We evaluate their effects independently by comparing each factor against a baseline, focusing on perceived cooperative social presence, in-game interaction, and communication. We address the following research questions:

- **RQ1:** How does world sharing affect the sense of sociality and social behavior in asymmetric cooperative games?
- **RQ2:** How does goal sharing affect these same outcomes?

To answer these questions, we developed an asymmetric cooperative game supporting three different conditions: 1) shared goal and world (baseline), 2) shared goal and distinct world, and 3) shared world and distinct goal. Starting from an already asymmetric baseline (e.g., players view the same world from different perspectives and assume different responsibilities), we investigate whether further separating players' worlds or goals affects their sense of social connection. In remote sessions, pairs of participants played two of these conditions (baseline plus one other), completed questionnaires measuring player experience and social presence, and participated together in an interview exploring their perspectives on the game's sociality across conditions. The analysis includes a mixed-methods approach combining quantitative analysis of self-reported and behavioral metrics with qualitative thematic analysis of interview data.

Our findings suggest that distinct worlds create friction in achieving a shared understanding, while distinct goals shift the focus on teamwork to increased autonomy, posing challenges to cooperative play. Yet, participants' perspectives also reveal that these aspects are not necessarily detrimental to social feelings and could be leveraged to create new 'flavors' of asymmetric cooperation, with dynamics that flow across different degrees of awareness and interdependence. Our work contributes design considerations and strategies to navigate these asymmetries, such as reinforcing tangible, unintentional intrusions across worlds, and emphasizing moments of personal sacrifice to signal commitment when players pursue distinct goals.

2 Related Work

In this section, we first introduce gaming as a social activity, focusing on cooperative interactions, communication, and social presence. We then introduce asymmetric game design, focused specifically on its presence in cooperative games, along with research that conceptualizes and operationalizes it. Finally, we present research around the concept of world and goal in games and other digital environments.

2.1 Social Gaming

The advent of digital gaming brought new possibilities and spaces for people to get together, becoming an important part of social life for many [24, 61, 74]. Past research portrays gaming as a way to initiate, maintain, and strengthen relationships, having positive links with quality of relationships [69, 77], social support, and psychosocial well-being [27, 69, 83]. Apart from that, social exchange is shown to be a central motivation to play games [18, 45, 79].

Multiplayer games typically pose challenges that promote competition and/or cooperation among players, offering various ways to interact, both through game actions (e.g., combat) and communication (e.g., chat, voice call) [22, 52]. Research has identified unique social affordances for specific genres [19, 24], and has explored specific mechanics to foster interaction—in particular, cooperative challenges where players are required to work together [6, 66]. Previous work [59, 64, 66] formalizes cooperative structures, highlighting that cooperation is shaped by the underlying mechanics that define how players interact, share information, and coordinate their actions. Common design patterns in cooperative games include task, spatial, and temporal dependencies, space sharing, asymmetries and synergies between players [59].

Drawing from organizational theory [39], interdependence acts as a core concept behind cooperation and is conceptualized as spanning two dimensions: task interdependence (where someone's actions require cooperation with others) and outcome interdependence (where groups succeed or fail collectively) [71]. Many works [23, 26, 36] apply this concept in games research, sometimes referring to the level of *'coupling'*, where *'closely-coupled'* games require a higher degree of interaction between players and ensure players are aware of each other's actions and state [51].

To assess the level of sociality a game or specific mechanics promote, previous studies have combined self-reported and observational measures. For example, Emmerich and Masuch [26] examine the effects of interdependence, shared control, and time pressure on player experience and social interaction using validated questionnaires and annotated gameplay recordings. Some research is focused on exploring how specific design choices impact communication frequency and quality—for instance, Depping and Mandryk [23] use the number of conversational turns to indicate communication frequency while Eklund and Johansson [25] measure instrumental (meant to coordinate and complete a task) and sociable (meant to simply socialize) communication.

While past work [35] shows there is a lack of self-reported data metrics that can capture the social dimension of a gaming experience, one key construct is social presence, which assesses the feeling of being *'there'* with other players and the degree of interpersonal connection [7]. While conceptions of presence are usually focused on the spatial and immersive side of inhabiting a virtual environment, the concept of social presence encapsulates key concepts of shared play, such as team identification, social action, and team value [38, 46].

2.2 Asymmetric Game Design

Asymmetry, in the context of game design, means that players are not bound to the same set of rules or goals [37]. There are several types of asymmetry, including asymmetry of information, ability, interface, challenge and goals [37]. Harris et al. [37] proposed a conceptual framework addressing asymmetries at the mechanical level and how these shape gameplay dynamics and aesthetics. Building upon this work, Rogers et al. [65] presented an expanded framework that includes patterns of shared control, asymmetries in shared space, age, and abilities. Recently, Neto et al. [53] proposed an updated framework with the *'bricks'* of asymmetry, which include the vehicle of the asymmetry (what leads to players being asymmetric e.g., being on different locations) and the type of asymmetry (e.g., having different abilities). In this work, we focus on asymmetry of goals, as defined by Rogers et al. [65] and asymmetry of environment, identified by Neto et al. [53].

To maintain social connection, asymmetric roles are often intertwined and designed to be mutually dependent, where one player's success relies on the other [23, 30, 36, 50]. For instance, in *Keep Talking and Nobody Explodes* [30], one player acts as the Defuser who can see the bomb but does not know how to disarm it, while the other acts as the Expert who has the manual but cannot see the bomb. Past research [6, 23, 36] shows that asymmetry, when coupled with this form of interdependence, has a positive influence on perceived connectedness and engagement. In particular, findings from Harris and Hancock [36] suggest that tightly-coupled interdependencies make players feel more connected.

Beyond the potential to create social experiences, asymmetric design has been used to create multiplayer games that cater to different individual needs and preferences [33, 34, 40]. Gonçalves et al. [34], for instance, developed two asymmetric games to be played by pairs of sighted-blind players. By having one role based on auditory challenges (e.g., manning the sonar of a submarine) and another relying on visual ability (e.g., piloting the submarine through obstacles), the games ensured appealing and challenging gameplay for both players. While in these games, players control a single vehicle (submarine or airplane), the ways they perceive and act are radically different. Similarly, Pais et al. [58] developed a cross-device asymmetric game for parent-child pairs, where a child ventures through complex dungeons, based on dexterity challenges, while parents support their progress by running a shop through a mobile clicker game. In this example, players never share the virtual environment and have individual goals aligned with their unique experiences. Supporting shared experiences in these contexts may require designing for entirely different gameplay loops within the same game, raising the challenge of how to maintain a sense of connection in such scenarios.

Prior work [9, 51, 75] suggests that asymmetric design, especially when players have distinct views or play through different devices, can reduce common frames of reference and harm social connection. For instance, Bortolaso et al. [9] demonstrate that simply playing through different devices (VR headset versus tablet) may bring communicative barriers, requiring explicit mechanics to support player interaction and awareness. This can be especially exacerbated when players are playing in different worlds or pursuing different goals. Previous studies on asymmetric game design [23, 36, 40, 51] and most asymmetric games assume worlds and goals are shared by players—the space in which all players act is the same (even though they may have different perspectives of it) and, while varying levels of task interdependence are explored [36], games assume outcome interdependence, with players having a single overarching goal to which they contribute, losing or winning the game together.

2.3 World and Goal in Games

Defining a 'virtual world' is complex, as the term has evolved to encapsulate a vast array of digital technologies ranging from digital games to social media platforms and even shared workspaces like Google Docs [54]. Fundamentally, virtual worlds are simulated environments characterized by a sense of space and time, in which users can be in, interact with, and affect the environment [3, 54]. A virtual world is considered shared when multiple users can perceive and interact with that same environment [3]. In the context of cooperative games, shared spatiality has traditionally been viewed and leveraged as a cornerstone of interaction. Many games make cooperation constrained in space and time, to force players to coordinate their actions and communicate [14, 23, 36, 52]. Similarly, Ducheneaut and Moore [24] highlights the value of shared spaces to provide a shared understanding and invite both planned and spontaneous social interaction.

Yet, some designs present different views and environments to players to foster interaction based on information asymmetry. In these, players hold different, necessary information and must communicate their unique perspectives to succeed [63]. According to collaboration theory, bridging these perspectives relies on grounding processes [16, 32] through which communicating parties establish mutual knowledge and understanding. Popular titles like We Were Here [31] embrace this asymmetry of spaces and information to drive social interaction, where one player typically acts as the "eyes" and the other as "the hands". Yet, these games typically balance moments of separation with moments of shared visibility or symmetric mechanics, which help preserve mutual awareness and connection. Recent findings suggest that interacting in separated VR environments does not necessarily diminish social presence [76]. Our work seeks to push this boundary further, investigating its impact in gaming, where players play in totally distinct worlds in a highly asymmetric context.

Just as shared worlds anchor players physically, shared goals anchor them motivationally. A goal or objective in a game gives players something (typically challenging) to accomplish within its rules and mechanics [28]. Pais et al. [59] provide a comprehensive taxonomy of goal structures in games, identifying five distinct categories, from which two are especially relevant for this study: 1) shared goals, where players seek to succeed in one particular challenge, winning or losing together and 2) intertwined goals, where players have different success conditions that are somehow dependent on one another. Multiple works [64, 66] emphasize that shared goals are a defining feature of cooperative games.

Introducing distinct or individual objectives can fundamentally shift the social dynamic. Previous research [82] suggests that, when players work together but have different payoffs or outcomes, it may alter how they cooperate, introducing elements of tension and unique interactions (e.g., free riding, backstabbing). Similarly, Depping et al. [23] discuss how introducing individual goals may weaken cooperation, calling for future research to investigate cooperation when goals are not fully shared. Our work addresses this gap, by exploring the nuance of intertwined yet distinct goals—by assigning players different win conditions, we aim to understand how it affects the sense of sociality compared to the traditional shared goal structure in cooperative games.

3 Experimental Testbed Game

We designed and developed a game prototype—Grim and Plume [Figure 1]—with three different levels serving as experimental conditions: Shared, in which players pursued a shared goal while playing in a shared world; Distinct-World, in which players pursued a shared goal but acted in distinct game worlds; and Distinct-Goal, in which players were in the same game world but pursued distinct goals [Figure 3]. Below, we describe the design decisions behind the prototype. We also provide a showcasing video[1] and a more detailed explanation of the game[2] as supplementary material. The game is available to download[3] and free to play.

3.1 Overview

In Grim and Plume, one person plays as Grim, a warrior searching for ancient treasures, featuring a hack-and-slash gameplay. A second person plays as Plume, a spirit with magical building powers, relying on crafting and resource management. The game includes cooperative mechanics for players to help each other in achieving their goals. Both roles are played with keyboard and mouse, with Grim's challenge relying mostly on combat through keyboard dexterity and Plume's challenge relying on resource management through mouse clicks.

According to established frameworks on asymmetric design [37, 53, 65], players have asymmetric abilities, challenges, feedback, interfaces, information, outcomes, and responsibilities. These asymmetries are similar to games used in previous research [23, 36]—additionally, in Distinct-World the game features entirely asymmetric environments [53] and in Distinct-Goal it features asymmetric goals [65].

3.2 Conditions

Each level (condition) has a time limit of 15 minutes. If players complete their goals in that time, they succeed. At the end of a level, a screen shows whether they won and offers performance stats for each player. In the Shared condition, Grim and Plume play in the same shared world (desert), having the common interdependent goal of completing five pedestals. To complete a pedestal, Plume has to gather and spend resources, and Grim to pick up and place a relic on it. In Distinct-World, Plume is in the desert world while Grim is in the forest world. They have the same shared goal as Shared: to complete a pedestal at a distance, Plume awakens an obelisk in the desert and Grim places a relic on the corresponding pedestal. In Distinct-Goal, both players play in the same shared world (desert), but they pursue different independent goals (they can win or lose independently). Grim needs to place the relics on five already-awakened pedestals, while Plume needs to awaken five obelisks (in this level, obelisks and pedestals are not tied).

In Shared and Distinct-Goal, **the world is shared** as players navigate the exact same virtual space, seeing and interacting with the same elements in the same positions (mountains, totems, ruins, buildings built by Plume, etc.). While the world is shared, they have distinct views of it [59]—beyond different aesthetics (isometric art for Plume, pixel art for Grim), Plume has a wider view of the world and can traverse it faster, while Grim sees some elements that are invisible to Plume (enemies and crates). Given Plume's wider field of view, Grim is represented as an icon indicating his position and direction, while the enemies and crates are omitted to avoid visual clutter. Conversely, in Grim's narrower view, Plume is represented as a full-body avatar, while buildings, mountains, and stones are visible and act as navigation obstacles—no elements are omitted from Grim's view, as none introduced visual clutter. In Distinct-World, **the world is entirely distinct**

[1] Prototype Showcasing Video. https://osf.io/w6rs8/overview?view_only=ada9f541e0e340b1b51033439bb361ee
[2] Protototype Detailed Description. https://osf.io/8c4sq/overview?view_only=3ddeb8a5d84f45958a0ef84f8468e9b4
[3] Grim and Plume Download Page. https://techpeople.itch.io/grim-and-plume

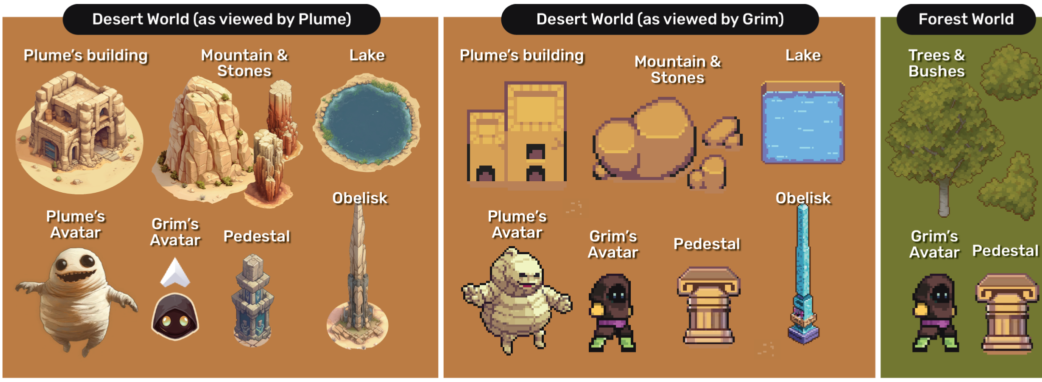

Fig. 2. Game elements in the desert and forest worlds as viewed by Plume and Grim.

as players do not see or interact with common elements nor each other (Grim is in a forest and Plume is in the desert).

The world sharing in Shared and Distinct-Goal is grounded in the notion of shared space and location, where players navigate the same bounded environment and all elements (except Grim's enemies and crates) occupy the same spatial positions in both players' views. However, it is important to note that no condition featured an entirely shared world, as some elements were visible to only one player and shared elements were represented differently across perspectives (similar to other asymmetric games [1, 36]). Figure 2 depicts the visual representation of game elements for both Plume and Grim when in the desert and forest worlds.[4].

In Shared and Distinct-World, **the goal is shared** and fully interdependent as players' actions are both needed to complete the pedestals and one cannot win alone. While the goal is shared, players have different responsibilities to contribute to its success (similar to previous studies [23, 36])—Plume has to gather enough resources to awaken the pedestals while Grim has to find, recover, and safely move the relics to them. In Distinct-Goal, **the goal is distinct** as players are not dependent on each other to win the game—the game is significantly more difficult if they do not cooperate, but they do not contribute directly to their individual goals.

The design of our baseline condition, Shared, was informed by the prototype presented and evaluated by Harris and Hancock [36]. While the game world and overarching goal are shared, the experience remains highly asymmetric. Mirroring their prototype, our game features distinct views of the same world, players have access to different elements and take on different responsibilities (one engaging in combat and traversal, the other manipulating the map). This asymmetric configuration is also present in commercial games, like *Silica* [50] and *Clandestine* [1].

3.3 Gameplay

Grim is constantly facing hordes of monsters (increasingly more difficult), while leveling up and becoming more powerful. By defeating enemies, Grim finds a map that indicates the location of a relic. In all three conditions, Grim needs to recover five relics and deliver them to the five pedestals in the center of the map. **Plume** gets basic resources from stones to then build and fuel buildings on the map, which provide additional resources and buffs (e.g., increased collection speed, potions). Buildings gradually deteriorate due to sandstorms, so Plume needs to repair them frequently to

[4]We note that, although the shared elements are represented through different visual assets for each player, in the study (Section 4), participants could not see each other's screens. Their perception of sharing the same elements was driven by the same spatial position, behavior, and mutual understanding of their meaning and function.

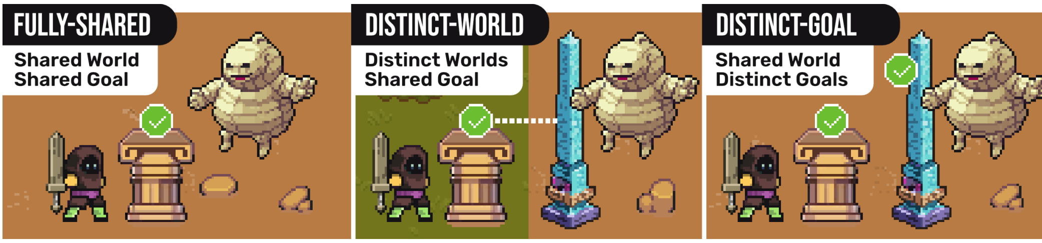

Fig. 3. Illustrative scheme of the three conditions/levels in our game prototype: Shared, Distinct-World, and Distinct-Goal.

maintain their functionality. In all three conditions, Plume needs to collect enough materials to awaken five structures (obelisks or pedestals), which become increasingly more difficult (requiring rarer materials and/or larger quantities).

3.4 Cooperation Mechanics

The game includes five tasks that require players to cooperate (Figure 4).

3.4.1 Trading. Players can **trade** when standing on the trading platform in the center of the map at the same time. Plume can give potions to Grim, and Grim can give materials to Plume. Through trade, players gain unique abilities (e.g., attack potions, building reinforcement).

3.4.2 Mushroom and Ruin. Players can help each other overcome negative effects. Periodically, an **infested mushroom** appears, spawning stronger enemies for Grim. Plume needs to first remove the infestation, after which Grim can destroy it. Conversely, the map starts with five **cursed ruins** inflicting various debuffs on Plume (e.g., reduced speed) and blocking building in that area. Grim first attacks a ruin to lift the curse, allowing Plume to excavate and destroy it. In a shared world, players see and interact with mushrooms and ruins in the same location, while in distinct worlds, they do not (e.g., Plume removes the infested roots in the desert while Grim destroys the mushroom in the forest).

3.4.3 Cannon and Totem. Players can grant each other powerful abilities. Plume can build and load a **cannon** (spending resources) for Grim to use, which instantly kills enemies in a large area. Conversely, Grim can cast a **totem** which Plume uses to protect nearby buildings from sandstorms. To cast a totem, Grim has to become vulnerable to enemies (no access to the sword) and sacrifice experience. These mechanics were designed to emphasize altruistic actions [59]. Because cooperation is often tied to shared space (e.g., placing a bomb at a specific location), we made these mechanics require spatial coordination in the shared world but not in distinct worlds. In the shared world, the totem is positioned by Grim and the cannon must be used nearby, requiring players to discuss and coordinate where to place them. In distinct worlds, the totem is sent to Plume, who can place it anywhere, and Grim can fire the cannon remotely from anywhere on the map.

All cooperative mechanics were designed to emphasize impact (strongly help the partner), intention (being conscious when initiating and resolving an interaction), and visibility (having a clear effect and explicit feedback for players). All mechanics create a bidirectional dependence, with the trading having expectant timing and the rest being sequential [37]. We grounded their design on previous research and playtested them to ensure they could provide a strong sense of connection between players. In particular, we designed the mechanics to achieve interdependence equivalent to the tight coupling described by Harris and Hancock [36], which participants in their study perceived as the preferred degree of connectedness.

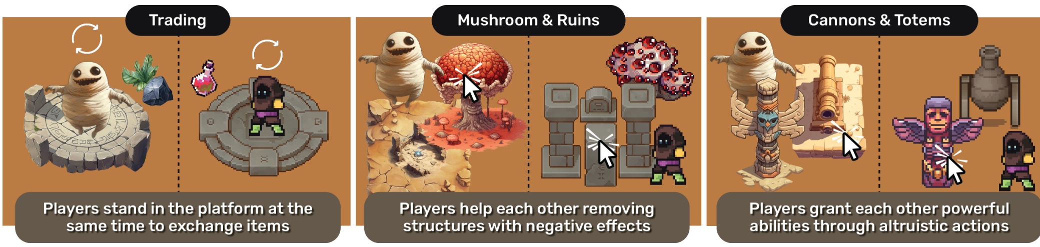

Fig. 4. Illustrative scheme of the five cooperative mechanics.

3.5 Development

We used Godot to develop the game[5]. No third-party content was used, except open-source pixel art and sound effects. All art used in Plume's gameplay was generated by Midjourney[6].

4 Evaluating the Impact of World and Goal Sharing

Using the prototype as our research instrument, we conducted an experimental mixed-methods study to evaluate the effect of world sharing (i.e., being in the same virtual space) and goal sharing (i.e., working toward the same win condition) on the sociality of a gaming experience, specifically on players' sense of social presence, in-game interaction, and communication. Our study design focuses on how these aspects foster connection and interaction among players with pre-existing relationships. We chose to evaluate world sharing and goal sharing independently to account for the possibility that they impact metrics differently (e.g., one dimension could negatively affect metrics while the other does not, or vice versa).

The study involved 88 participants who played as pairs in a total of 44 remote sessions, engaging with Shared (baseline condition) and either Distinct-World or Distinct-Goal. Our data includes questionnaire responses, gameplay recordings, and interview audios from these sessions. The study was approved by the ethics committee of our institution.

4.1 Recruitment and Participants

We recruited participants through word-of-mouth and by sharing a recruitment call on forums related to gaming and our institution. In total, we recruited 88 individuals, applied as pairs. Although the first session served as pilot, we included its interview data, as subsequent changes were minor adjustments to the prototype's cooperative mechanics and overall difficulty. Due to network issues (e.g., participants disconnecting), we excluded gameplay recordings and questionnaire data from three of the sessions but retained their interview data. Overall, we used interview data from 88 participants and questionnaire plus gameplay data from 80. All participants were compensated with a gift voucher.

Our sample comprises 88 individuals (64 male, 22 female, 2 Non-binary), aged 18-37 (M=23.2, SD=4), who play digital games either less than once a month (n=2), once a month (n=5), once a week (n=24) or daily (n=57). All participants have experience playing with their study partner, at the time playing together less than once a month (n=15), once a month (n=24), once a week (n=30)

[5]A repository with the developed game's source code is available at https://github.com/davidslycooper/grim-and-plume
[6]Midjourney. https://www.midjourney.com/

or daily (n=19). Most participants (n=80) had past experiences playing asymmetric games. Pairs were either friends (26 pairs), romantic partners (16 pairs) or family (2 pairs). Participants reported high closeness with their study partner—on a 5-point scale ranging from 1 (stranger) to 5 (intimate), ratings ranged from 3 to 5 (M=4.6, SD=0.6). Participants who played as Grim are referred to as G1–G44, and those who played as Plume as P1–P44.

4.2 Procedure

All sessions were conducted via Discord call, with a pair of participants and one to two researchers. Each session consisted of: 1) participant briefing; 2) demographics questionnaire; 3) game tutorial; 4) two consecutive play sessions, each followed by a set of questionnaires; and 5) a group interview. Throughout the session, participants had to keep their microphones enabled (webcams were not used) and share their screen while playing. Participants were instructed to minimize the Discord window and not watch each other's screen sharing. Researchers responded to any participants' questions or doubts, including during gameplay. Each session lasted between 60 and 90 minutes.

4.2.1 First Contact and Game Tutorial. Players freely chose their role, being introduced to the game through a landing page containing a short description and short video clips showcasing each role. This provided basic awareness of the other role's gameplay. Participants did not switch roles during the study. They first played a short tutorial (different for each player) that introduced individual mechanics and cooperative interactions, requiring players to learn through play.

4.2.2 Play Sessions. All pairs experienced the baseline condition (Shared) and a second assigned condition (Distinct-World or Distinct-Goal). Conditions were assigned to ensure even representation of the non-baseline conditions and order was counterbalanced. Before each, the game presented two screens—the first introduced the goal(s), while the second reminded the cooperative mechanics. Between conditions, the changes in the gameplay and aesthetic were introduced by researcher(s) (e.g., "*Now Plume will stay in the city, but Grim will explore the forest*") to ensure participants understood what changed. We explained that players were free to communicate before, during, and after play sessions. All play sessions were recorded and we took notes throughout.

4.2.3 Questionnaires. After each play session, participants completed the same set of validated questionnaires: the Basic Needs in Games Scale (BANGS) [2], a 7-point Likert scale with 18 items that assess satisfaction and frustration of each basic psychological need in gaming contexts: autonomy, competence and relatedness; and the Competitive and Cooperative Presence in Gaming (CCPIG) questionnaire [38], composed of 39 items scored on a 5-point Likert scale, that measure social presence across two sub-scales: cooperative and competitive. Although CCPIG was originally developed for team-based games, we used only the cooperative subscale, as done in prior work [76]. We used BANGS scores to characterize participants' experiences and confirm they enjoyed the game, and CCPIG scores to evaluate perceived social presence in line with one of our hypotheses.

4.2.4 Group Interview. Participants took part in a semi-structured group interview guided by a seven-question interview script[7]. The interview focused on participants' overall experiences of sociality, perceived differences in sociality across conditions, specific moments that fostered social connection, and comparisons with other games they play together. Interviews lasted between three and twenty minutes. We also included subsequent messages sent to the researchers (with participants' consent), describing additional experiences they had with the game after the study.

[7]Interview Script. https://osf.io/hjcts/overview?view_only=6406afc95d1f424aa4b876d09b41ec7a

4.3 Measures

We grounded our measures in prior work [23, 26], assessing the social dimension of play sessions using both self-reported and behavioral metrics.

4.3.1 Cooperative Social Presence. We used the CCPIG global score, calculated as the average of all items. While CCPIG includes four components (Team Identification, Social Action, Motivation, and Team Value), validation studies did not support a reliable four-component structure [38]; therefore, we report only the global score. The internal consistency of CCPIG was evaluated using Cronbach's alpha, demonstrating excellent reliability (α=.94).

4.3.2 Communication Frequency. We analyzed gameplay recordings to code the number of conversational turns taken by the pair per condition. Following conversation analysis principles [81], we counted a new turn every time the speaker changed, including backchannels (like "*yeah*" or "*hm-hm*"). We treated consecutive speech by the same person as separate turns only if they were divided by an "attributable silence" (a pause where an answer was clearly expected but did not come) or a gap of more than three seconds. Additionally, we treated responsive in-game actions as turns—for example, if Grim asked for an item, Plume moved their character to the trading platform, and Grim then said "*thanks*", we counted this as two sequential turns taken by Grim. We counted overlapping speech as two turns and excluded reactions to the game (e.g., "*Wow!*") and speech not intended to communicate (e.g., thinking aloud). Additionally, we coded each turn as **instrumental** (asking, providing information or coordinating to understand or complete a task in the game), **sociable** (greetings, jokes, tension relief, laughing, banter), **neutral** (e.g., giving an opinion about the game), or unintelligible. Because a turn may contain multiple turn-constructional units, multiple codes were applied when appropriate. We also coded for the specific cooperative mechanic that prompted each (e.g., instrumental turns to coordinate totem placement).

4.3.3 In-game Interactions. We coded gameplay recordings to capture in-game interactions per condition. Each type of cooperative mechanic (trade, mushroom, ruin, cannon, or totem) was coded for initiation (e.g., Grim placing a totem) and completion (e.g., Plume using the totem to protect at least one building). From these codes, we calculated, for each pair, the number of completed interactions and the number of incomplete interactions (i.e., initiated but never completed).

4.4 Hypotheses

Based on related work (see Section 2), we anticipated that making worlds and goals entirely distinct would negatively impact sociality and cooperative behavior, albeit potentially in different ways across our specific metrics. Thus, aligned with our research questions, we developed separate hypotheses to evaluate their impacts independently:

- **H1a:** Perceived cooperative social presence is significantly lower in the <u>Distinct-World</u> condition compared to the <u>Shared</u> baseline.
- **H1b:** Perceived cooperative social presence is significantly lower in the <u>Distinct-Goal</u> condition compared to the <u>Shared</u> baseline.
- **H2a:** The frequency of communication (conversational turns) is significantly lower in the <u>Distinct-World</u> condition compared to the <u>Shared</u> baseline.
- **H2b:** The frequency of communication (conversational turns) is significantly lower in the <u>Distinct-Goal</u> condition compared to the <u>Shared</u> baseline.
- **H3a:** The frequency of in-game interactions is significantly lower in the <u>Distinct-World</u> condition compared to the <u>Shared</u> baseline.
- **H3b:** The frequency of in-game interactions is significantly lower in the <u>Distinct-Goal</u> condition compared to the <u>Shared</u> baseline.

4.5 Quantitative Analysis

We computed descriptive results for all metrics, including the different types of conversational turns and in-game interactions. To test our hypotheses, we employed a multilevel modeling framework. This approach was necessary because our data violates the independence assumption of standard pairwise comparisons; since participants played in pairs, their responses are subject to dyadic interdependence (e.g., if Player A is highly talkative, it may directly influence how much Player B talks). Following statistical recommendations for nested data [20, 43] and past studies in games research [68, 72], we employed a multilevel analysis approach to appropriately model this variance. We also considered a potential order effect, specifically a practice effect, suggested by participants in the interviews (reporting that the condition experienced second felt "more social" as they gained individual competence and a better understanding of the cooperative dynamics). Consequently, for our models, we used Condition and Order as fixed factors, with a random-effects structure optimized for each metric. We ran diagnostics on all final models to verify that assumptions regarding multicollinearity, homoscedasticity, normality of residuals, and variance structure were met.

Finally, to further explore specific qualitative insights, we used the same multilevel framework for three post-hoc tests examining specific types of communication and in-game interaction. As these were not formulated *a priori*, we integrate their results directly into our qualitative findings. Quantitative data, scripts used[8], and a detailed document presenting analysis (including model selection and assumption checks)[9] are provided as supplementary material.

4.5.1 Cooperative Social Presence. Due to detected non-normality of residuals (p=.014), we employed a robust linear mixed model (RLMM) for all analyses of this metric. To identify the most appropriate model, we compared additive (Condition + Order) and interaction (Condition × Order) structures. The Likelihood Ratio Test revealed the interaction model to result in a significantly better fit ($\chi^2(2)$=9.34, p=.009) and was therefore selected for the final analysis. Regarding random effects, a nested structure (Participant within Pair) was initially considered, but Pair-level variance was estimated at zero (singularity)—as such, only Participant was used as a random intercept. This random effect accounted for a substantial proportion of the variance (ICC = 0.599). Further tests indicated that adding Role as a fixed factor did not significantly improve the model.

$$\texttt{CCPIG Score} = \texttt{Condition} + \texttt{Order} + (\texttt{Condition} \times \texttt{Order}) + \texttt{Participant}_{\text{Random}}$$

4.5.2 Conversational Turns. Given that the dependent variable consisted of count data with a Negative Binomial distribution, a Generalized Linear Mixed Model (GLMM) was employed. We again compared additive and interaction models. The additive model was selected over the interaction model based on a lower AIC (ΔAIC=3.6) and a non-significant Likelihood Ratio Test ($\chi^2(2)$=0.40,p=.819). We specified a random intercept for Pair, which accounted for a very high proportion of the variance (Adjusted ICC = 0.794).

$$\texttt{Conversational Turns} \sim \texttt{Condition} + \texttt{Order} + \texttt{Pair}_{\text{Random}}$$

4.5.3 In-game Interactions. The frequency of in-game interactions was also analyzed using a Negative Binomial GLMM. Again, we compared additive and interaction models—while the Likelihood Ratio Test yielded marginal results ($\chi^2(2)$=5.62, p=.060), the interaction model was retained as it provided the best overall fit (AIC=590.08) compared to the additive model (AIC=591.70). We

[8]Quantitative Data and Analysis Scripts. https://osf.io/963xz/overview?view_only=ab5647cbf455417d8401aea7f5a23178
[9]Quantitative Analysis Detailed Explanation. https://osf.io/n3th5/overview?view_only=4cc2e02a94c3446b8b769ada8e50cdf9

specified a random intercept for Pair, which accounted for a substantial proportion of the variance (Adjusted ICC=0.741).

$$\texttt{In-Game Interactions} = \texttt{Condition} + \texttt{Order} + (\texttt{Condition} \times \texttt{Order}) + \texttt{Pair}_{\texttt{Random}}$$

4.6 Qualitative Analysis

All interviews were transcribed verbatim using speech-to-text tools and revised. We analyzed the transcripts using a codebook thematic analysis [11], combining Braun and Clarke's six-step framework [10] with the structured codebook approach of template analysis [44]. The first and second authors familiarized themselves with the data and independently coded an initial subset of five interviews, then met to consolidate an initial codebook. The first author applied this codebook to the remaining data, iteratively refining it by adding, merging, and revising codes. Observational notes were also annotated. The coders later met to review the final codebook and discuss relationships between codes, leading to an initial outline of themes that was iterated with the team. The analysis was both inductive and deductive (guided by our research questions e.g., world effect). The final prose of the qualitative findings was written after the quantitative analysis, allowing us to reflect on those results. Both the final codebook[10] and the outline of themes[11] are available as supplementary material.

The authors who led the qualitative analysis are individuals who play digital games regularly, have played several asymmetric games, and have experience in game design and development, especially within a research context.

5 Findings

In the following sections, we organize participants' perspectives into quantitative results and qualitative themes.

5.1 Quantitative Results

We first present results on player experience and performance to characterize participants' experiences with the game. We then report the results of the statistical analyses used to evaluate our hypotheses.

5.1.1 Player Experience and Performance. In terms of player experience, responses to the BANGS (scale: 1–7) suggest that most players had a positive experience as suggested by above-average need satisfaction scores (M=5.2, SD=1.1) and below-average levels of need frustration (M=2.8, SD=1.0). Regarding individual player performance (number of relics delivered or pedestals awakened; range 0–5), average scores were 2.7 (SD=1.4) for the condition experienced first and 3.9 (SD=1.2) for the condition experienced second. Average performance was similar across roles—Plume (M=3.4, SD=1.3); Grim (M=3.1, SD=1.5)—and conditions: Shared (M=3.3, SD=1.5); Distinct-World (M=3.3, SD=1.4); Distinct-Goal (M=3.2, SD=1.4). These results suggest that the difficulty level was generally appropriate across conditions and roles.

5.1.2 Cooperative Social Presence. As for cooperative social presence, CCPIG scores (scale: 1–5) were above-average (M=4.1, SD=0.6). Our model identified a significant main effect for Distinct-World (β=-0.424, SE=0.14, t=-2.95, p=.003) and Order (β=0.336, SE=0.125, t=2.69, p=.007). When players played in distinct worlds, social presence scores were significantly lower than the baseline, decreasing by approximately 0.42 points. These results also confirm a practice effect, as scores were

[10] Codebook. https://osf.io/zwfjy/overview?view_only=01b024cc31bd4a5ba6be8f5961826af8
[11] Outline of Themes. https://osf.io/muh8j/overview?view_only=78ce14bc855146c3a203220cb495885e

significantly higher in the second session, increasing by roughly 0.34 points regardless of condition. The analysis showed a marginal trend for an interaction between Distinct-World and Order (β=0.449, SE=0.25, t=1.83, p=.071), suggesting that the negative impact of distinct worlds may have softened after familiarizing with the game. Distinct-Goal did not significantly impact social presence (β=-0.123, SE=0.14, t=-0.85, p=.398), and its effect did not change significantly across sessions (β=-0.166, SE=0.25, t=-0.68, p=.499). Post-hoc power analysis (1,000 simulations) indicated 84.70% power (95% CI [82.32, 86.88]) to detect the Distinct-World effect and 80.20% power (95% CI [77.59, 82.63]) to detect the Order effect.

Based on these results, H1a is supported—**perceived cooperative social presence was significantly lower in Distinct-World than in baseline**—whereas H1b is not supported.

5.1.3 Conversational Turns. The frequency of communication during a play session highly differed between pairs, from a minimum of 11 conversational turns to a maximum of 219 turns (M=118.7, SD=46.9). Most conversational turns were instrumental (82.3%, M=97.7, SD=42.9), while a small percentage were sociable (9.8%, M=11.6, SD=12.1) or neutral (6.7%, M=8.9, SD=4.9), with the remaining being unintelligible. The cooperative interactions that fostered more communication were trading (23.5%, M=27.9, SD=15), the totems (13.7%, M=16.2, SD=13.4) and cannons (13.5%, M=16, SD=13.2). As for the statistical analysis, our model revealed a significant main effect of Distinct-World (β=-0.266, SE=0.06, z=-4.16, p<.001), which resulted in a 23.4% decrease in total conversational turns compared to the baseline (IRR=0.766). A significant main effect of Order was also observed (β=0.234, SE=0.05, z=5.08, p<.001), with pairs increasing their communication frequency by 26.3% during their second session regardless of the condition (IRR=1.263). Distinct-Goal did not significantly influence communication frequency (β=-0.078, SE=0.06, z=-1.25, p=.211). Post-hoc power analysis (1,000 simulations) indicated 98.70% power (95% CI [97.79, 99.31]) to detect the Distinct-World effect and 99.90% power (95% CI [99.44, 100.00]) to detect the Order effect.

Based on these results, H2a is supported—**frequency of communication was significantly lower in Distinct-World than in baseline**—whereas H2b is not supported.

5.1.4 In-game Interactions. Again, there was a large variance in how many times pairs interacted during a play session (M=27.1, SD=12.2). Most interactions were complete (81.7%, M=22.1, SD=11), while the remaining percentage (18.3%, M=5, SD=3.4) were interactions initiated by one player but never resolved by the other (e.g., Plume builds a cannon but Grim never shoots it). The most used cooperative mechanics were trades (31.4%, M=8.5, SD=4.6) and cannons (27.7%, M=7.5, SD=8.1). The model revealed a significant main effect of Distinct-Goal (β=-0.303, SE=0.14, z=-2.20, p=.028), resulting in a 26% decrease in total in-game interactions compared to the baseline (IRR=0.74). Distinct-World did not significantly influence in-game interaction frequency as a main effect (β=-0.174, SE=0.14, z=-1.27, p=.204). While the main effect of Order was not significant in this model (β=0.19, SE=0.12, z=1.59, p=.112), there was a significant Distinct-World × Order interaction (β=0.468, SE=0.24, z=1.97, p=.048). This indicates a 60% increase in total in-game interactions (IRR=1.6) when the Distinct-World was played second. Post-hoc power analysis (1,000 simulations) indicated more moderate detection strength for these effects, with 59.60% power (95% CI [56.48, 62.66]) for the Distinct-Goal and 54.80% power (95% CI [51.66, 57.92]) for the Distinct-World interaction.

Based on these results, H2b is supported—**frequency of in-game interactions was significantly lower in Distinct-Goal than in baseline**—whereas H2a is not supported. Contrary to what was expected, there was even a positive effect when playing Distinct-World second. Yet, given the limited statistical power, these results should be interpreted with caution.

5.2 Qualitative Results

The following themes address: (1) awareness in shaping cooperation, (2) tangibility of interactions, (3) shared progress and achievement, (4) sense of effort and impact, (5) interaction continuity, and (6) team learning processes. Each theme highlights how world and goal sharing influenced players' experiences across these aspects. Many themes also capture additional factors that participants considered important for supporting sociality.

5.2.1 Awareness Level Shaping the Flavor of Cooperation. The level of shared awareness when playing in shared versus distinct worlds shaped the way participants communicated and cooperated. In shared worlds, teamwork was described as "*intuitive*" (G7), with visual access to a partner's avatar and environment allowing players to more easily build a mutual understanding of how they acted in the world and with each other: "*You could see what the other person was doing, it was easier to communicate what was needed and have a sense of what the other person was doing on the other side*" (G44). A shared world also made it easier to locate map elements and understand their relevance to the gameplay. This was observed in gameplay recordings, with participants drawing their partner's attention to mushrooms and ruins and talking to reach a shared understanding.

An increased shared awareness also facilitated implicit coordination. For instance, some participants mentioned that seeing their partner move toward the map's center provided valuable feedback that they were ready to trade, replacing the need for verbal exchange. Some participants also noted that knowing the other player's position also influenced when they chose to cooperate (e.g., Plume asking for help when seeing Grim approach a ruin). G23 described a similar realization with totems, explaining that seeing Plume's buildings in a shared world helped him understand their purpose and prompted cooperation: "*It was only when we saw each other that the penny dropped: 'ok, this protects the buildings'*" (G23).

When playing in distinct worlds, some participants reported a greater need for verbal communication. Because their partner's actions and needs could not be inferred through in-game feedback, they felt compelled to "narrate" what they were seeing and doing: "*When separated, we automatically have to force ourselves to say where things are, that there are curses that were defeated, that we are on the platform, that we need a totem to be sent, that we need cannons... I think it forces you to narrate what you are seeing to the other player and forces communication to reach objectives*" (G5). These perspectives stand in direct contrast to the quantitative findings, which revealed that the frequency of communication significantly decreased when players were in different worlds. To complement this perspective, and given that participants mentioned instrumental exchanges specifically, we examined whether the trend for instrumental conversational turns differed from that observed for overall communication. Using the same model structure, the results show that the frequency of instrumental turns followed the same negative trend in the Distinct-World condition (β=-0.289, SE=0.07, z=-4.00, p<.001, IRR=0.75). This further supports that, while participants reported a heightened feeling of needing to communicate, it did not translate into more frequent exchanges.

A few participants noted that this reliance on verbal communication raised the need for trust, as they did not have access to all information (e.g., if player was ready to trade). While these discussions often happened when comparing between Shared and Distinct-World, participants noted that even when sharing a world, players' unique perspectives created awareness gaps: "*From the description that [G24] was giving, I could tell it was difficult [...] but since I don't see enemies, for me, it's a bit hard to believe, just like that, automatically*" (P24). Some participants enjoyed the awareness gap created by distinct worlds and views, describing it as an engaging challenge to reach mutual awareness: "*It really makes you think, like, trying to figure out what the other person is doing without seeing it*" (G10).

Still, many valued the more intuitive cooperation enabled by shared visibility, preferring in-game cues over "*forced*" (P24) verbal explanation. These participants suggested increasing overlapping views even within a shared space. Some participants wanted this visibility for improving strategy (e.g., seeing enemies to better choose where to place a cannon) or entirely bypass the need for communication (e.g., seeing each other's inventory to know when to trade). Many participants wished for pings as a way to reduce verbal exchanges (e.g., marking an infested mushroom). Others noted that shared awareness may also enhance sociable interaction around common elements (e.g., G13 joking about the look of the mining building, G11 and P11 celebrating when completing a pedestal).

While some preferred in-game cues and others prioritized verbal communication, there were those who saw both as simply different 'flavors' of cooperation: "*[In one] you could see what the person was doing, and in the other, you needed to communicate. Honestly, I think it was the same, they were just different forms*" (G41).

5.2.2 Sense of Co-Location and Tangibility in Interactions. Sharing a world allowed for more than just increased awareness—it enabled interactions that were more visible and tangible for participants: "*Seeing her moving towards the center of the map, that feedback was very important to me, to feel that we were truly cooperating*" (P44). The shared space also encouraged more casual social moments, such as quick greetings when avatars passed by. Many participants who played as Grim appreciated that Plume could collide with them, fostering moments of collective laughter and leading players to bump into each other intentionally, purely for fun: "*The collider is the cherry on top. It's like: 'ok, we're in the same space. I'm physically pushing you' [...] I know it's a small detail that could probably be ignored, but it made a difference to my experience*" (P26).

Some participants suggested additional ways to enhance co-presence, such as creating opportunities to interact directly with the other avatar: to playfully "*troll*" (i.e. deliberately upset or disrupt) the partner (P27) or make avatars speak to each other. These ideas emphasize that, for some participants, interactions do not need to contribute to game objectives to have value: "*Even if it's not beneficial for the progression of the game, if it's for fun, it is still positive for the game*" (G27). Participants noticed that Grim and Plume avatars led to different levels of co-presence.

Some also noted that the sense of co-presence could be enhanced if they saw each other's avatars actually acting in the world (e.g., Grim defeating enemies, Plume interacting with buildings), rather than simply "*passing by*" (G29). Even if these actions, unique to each role, were not important for their partner's gameplay, their visibility was considered important for sociality: "*She seemed almost on another plane. I couldn't see what she was doing, and I don't know if she could see what I was doing. Since we were on different planes, in that sense it didn't feel very social*" (G2). This feeling was even more pronounced in distinct worlds. Some described how the lack of visible cues about the other player's activity made the experience feel solitary.

Participants highlighted specific moments when this sense of co-location felt stronger, particularly when trading (which required both players to be at the platform) and coordinating around a shared space: "*In the second one, I had to stick with [G19], to protect him and reload the cannons where he was. I think that made the sense of being a team a bit stronger*" (P19). Never being co-present in distinct worlds led to a more detached form of cooperation, where interactions became simple instructions at a distance: "*One thing that felt more social in the first one than in the second was the mushrooms. In the second, I would just say, 'go look for them.' In the first, I'd say, 'come here, I need you to destroy these ones'*" (G21).

In line with this desire for increased tangibility and co-presence, many participants suggested mechanics requiring players to be co-located and to directly interact with their partner's avatar and vicinity (e.g., requiring both players to be present when completing a pedestal, building a barrier for Grim). This lack of more direct manipulation in a shared world was also given as a reason why some participants preferred playing in distinct worlds: seeing the other player (or their buildings) without being able to interact with them directly felt "*unnatural*" (P25), making distinct worlds feel more coherent: "*Since I can see him, it would make sense for him to be able to interact more directly with me and with the world*" (G13).

Interestingly, some participants emphasized that shared goals helped reinforce feelings of co-presence and tangibility. In this condition, both players were required to interact with the pedestals at the center of the map (Plume awakening them and Grim placing relics) which led them to work together around the same space.

5.2.3 Progress, Dependency, and Achievement in Unison. Participants described how goal sharing impacted feelings of shared progress and achievement. Having a shared goal "*emphasized teamwork*" (P42), helped them feel "*more connected*" (G6) and forced them to play together (P6). In contrast, distinct goals made players feel disconnected: "*It felt like we were just sharing things. We weren't really playing together*" (P12). A few participants also noted that distinct goals could encourage more self-centered play: "*I could very well ignore [G6] completely, just play my own game*" (P6). These qualitative insights align with the statistical analysis, which showed a significant decrease in game interactions under the Distinct-Goal condition.

Participants reported a sense of shared achievement upon completing the pedestals, which made the results of their teamwork visible: "*We could directly see that what we were doing together was working, because the relics would light up, like: 'Ok! We did this! Let's go!'*" (G42). One participant also mentioned an increased sense of responsibility when playing for a shared goal, as their partner's success depended on his own performance: "*[When sharing a goal] I really felt like I failed [P28]. I had the moment to make us win, and I got cocky*" (P28).

Most participants expressed that goal sharing influenced their perception of difficulty and autonomy. When pursuing distinct goals, they felt they could focus on their own goal and be less concerned with each other. Again, these perspectives align with our quantitative findings. For players who showed a better performance than their partner, this sense of autonomy might have come from the fact that they could accomplish more when working on an individual goal: "*I was able to complete [the objectives] better... In the first level, I was placing the relics and then waiting. It gave the impression that I wasn't getting anything done...*" (G2).

Across conditions, participants wanted more shared progression and interdependence, suggesting mechanics where one player's progress reflected rewards for the other (e.g., unlocking buildings and weapons for each other). P29 highlighted that the shared world should also evolve to reflect their shared progress (e.g., unlocking new areas together). Some even assumed there was a sequential dependence for completing pedestals, where Grim could only place relics once Plume had awakened them. Without that dependence, completing pedestals was perceived as not so different from separately completing obelisks and relics in Distinct-Goal: "*The fact that I didn't need the base of the relic to be open in order to place it made it feel a bit the same*" (G8). While these "blocking mechanics" were seen as essential for many, other participants framed them as simply a different style of cooperation: "*In other games... you can't advance if she doesn't advance. Here, you can keep doing things... I'd say it's good, it's different. We're just not used to it*" (G22).

According to participants, having fully asymmetric responsibilities (e.g., Grim unable to awaken pedestals), even with a shared goal, may also reduce the feeling of truly working together: "*We have a common goal, but we don't have the same mechanisms to achieve it [...] you just ended up being a way to improve what I could do*" (G17). This feeling was particularly noticeable once participants had completed their own responsibilities: "*At the end, when there was only her part left, I felt like I* *was just waiting for her to do her part... If I had some way to help her get the remaining items more directly, it would have felt more cooperative*" (G2).

5.2.4 Investing Effort, Seeing the Impact, Building Connection. While participants differed in which cooperative mechanics they found most impactful, their usefulness was often cited as the main driver of social presence: "*Because the potions are really strong [Laughs]. They were a big part of my gameplay*" (G28); "*When I discovered the totem made such a huge difference, now I can't live without it [Laughs]*" (P20). However, the impact of cooperative actions was not always obvious. Some participants questioned whether their efforts were truly helping their partner—for instance, during play sessions, many Plume players would ask their partner if the cannon was actually useful. It was common for participants to feel they were not making that much of an impact, only to learn in the interview that their partner had found their help essential: "*I understand that my actions affected [G11]'s game, but I don't know if we actually felt the impact*" (P11).

Another frequently discussed aspect was the sense of effort and self-sacrifice involved in cooperative interactions. Totems and cannons were designed to emphasize altruism, and participants recognized this. For some, deliberately sacrificing time, attention, or gameplay resources was central to feeling strong cooperation: "*I often had to almost risk myself to place totems, and I think I did this more than once... it was a sacrifice, yes, but willingly. The more annoying it became, the more I felt I was cooperating*" (G12). Similarly, the coordination required to place totems and cannons in a shared world (being restricted in where they could be placed) enhanced the sense of effort and sociality for many: "*In the first level, how you placed the totems made me feel more interaction. In the second, I just asked for the totem, you gave it to me, and the interaction mostly ended there. The cannon was just me keeping it loaded, nothing else*" (P29). However, others found this coordination too inconvenient and frustrating, preferring these mechanics in Distinct-World: "*I preferred the second level, because I received them immediately. I didn't have to tell him where to put something I needed*" (P33).

Most participants recognized that coordinating in the shared world emphasized sociality but also made frequent cooperation more difficult, describing it as a double-edged sword. This tension was not limited to cannons and totems, with some participants suggesting ways to reduce concurrency, such as adding a "*chest*" to leave and collect items asynchronously (P21, P12) or building additional platforms to facilitate trading (P21). Preferences for these mechanics depended on each group's desired level of effort when cooperating: "*[Cannons in Distinct-World] isolate the co-op gameplay aspect a bit more rather than promoting it. Still, I genuinely enjoyed that experience... But that reflects individual preferences for gameplay independence*" (G5). G9, on the other hand, argued that the spatial coordination introduced unnecessary friction and felt less meaningful compared to other interactions: "*I don't think it has the same social value as other interactions in the game. The minutiae of: 'no, go a bit left, no, a bit right', isn't as important*" (G9). Given the lower coordination required for using cannons and totems in Distinct-World, it seemed a likely driver for in-game interactions being significantly more frequent when this condition was experienced second. Yet, additional statistical analyses using the same model structure revealed no significant differences in the frequency of totem-related interactions (β=-0.172, SE=0.24, z=-0.71, p=.473, IRR=0.84) or cannon-related interactions (β=-0.020, SE=0.37, z=-0.05, p=.957, IRR=0.98) across these conditions. In short, while spatial coordination did not significantly influence how much players used these mechanics, it changed how the cooperation felt, from a tightly coordinated (for some, inconvenient) team effort to an effortless (for some, distant) interaction.

During play sessions, participants often tried to assess the cost-value of cooperative actions by discussing with their partners: "*The cannon... I had to use my own resources... but then it's like: 'I don't know if I want to spend these resources on the cannon'*" (P10). This tension between autonomy and altruism varied across groups and was particularly noticeable when one player was less skilled. In some play sessions, a player would dedicate substantial effort and time to help their partner complete their tasks (e.g., loading cannons one after the other).

Across participants, a consistent theme was the importance of cooperative mechanics having a strong helpful impact and requiring effort. Participants also emphasized that these aspects need to be explicit and observable, as cooperation was sometimes perceived as "*implicit*" (G35), especially in Distinct-World. This includes clearly showing where help comes from and how much effort is involved, rather than just a "*counter increasing*" (P21) or a "*notification saying: 'I need cannons'*" (P17), as some described cannons and totems in Distinct-World.

5.2.5 Task Overload Disrupting Interaction Continuity. Many participants felt that interactions only occurred during "*key moments*" (G13), and that the sense of shared play was not "*continuous*" (G1). Participants explained this happened because individual tasks (e.g., Grim fighting enemies) took up most of their attention and came with time pressures. Participants described periods of time when they were not even thinking about their partner: "*The hack-and-slash part got so difficult that I had to focus a lot to survive, so I couldn't pay much attention to [P20]*" (G20). Moreover, all mechanics were inherently limited either by time (e.g., mushroom) or resources (e.g., cannons), making continuous interaction nearly impossible. As a result of these factors, some participants felt like they were playing mostly separate games that only intersected during key moments: "*We're playing different games, and then every now and then they cross paths, and it's like: 'Oh, do you want to work together now, for 10 seconds?', 'Sure, why not'*" (G33).

Some participants suggested adding more relaxed moments to allow space for communication. Ideas included a between-level market phase where they could "*buy stuff together*" (P26), or moments where the gameplay paused or became easier, allowing them to discuss strategies: "*A place where he would be invulnerable and could pause with me... I think I would interact more there*" (P41).

For some pairs, a sense of ongoing connection was maintained through constant communication or requests for help: "*I was always reminded: 'oh, the potions, give me!' I was always reminded that I was not alone there [Laughs]*" (P16). The additional cues afforded by a shared world (e.g., buildings) acted as continuous reminders of a player's presence. Yet, even in distinct worlds, some of the mechanics promoted a more continuous cooperation, namely trading (requiring regular and concurrent interaction) and cannons (Plume needed to reload whenever Grim used it): "*When [G44] used the cannon and I heard the audio that it had been fired, I often was doing something else and thought, 'ok, my work here is done', but then hearing the cannon fire made me think: 'ok, I'm helping her, I'm not just doing my own thing' [...] it was just audio and the cannon firing, and I loved it*" (P44). In contrast, mechanics that were sequential or 'one-and-done' were seen as promoting fragmented cooperation: "*When I clear a ruin and say, 'look, there's something you need to do,' I don't see when they go or when it's done*" (P33).

5.2.6 Learning and Growing as a Team. The learning effect was prominent in our study—most participants reported playing more socially and communicating more in the condition experienced second, which was also reflected in the quantitative results. All participants completed the tutorial, revisited cooperative mechanics before each condition, and could ask the researchers for clarification. Many, however, said that in the condition experienced first they were still discovering the mechanics and learning how to play as a team: "*Especially in the first level, trying to understand exactly how to play, not knowing what was happening... it made it, as I said, difficult to play with another person*" (G18). Some participants noted that having a clearer strategy helped them be more communicative and helpful. Several suggested a tutorial where they could already play together and affect each other's actions, since the existing tutorial only demonstrated interactions without requiring coordination: "*We had the tutorial, that's true, but we hadn't yet, so to speak, played together and didn't have a* *sense of how it would be to act as a team*" (P32). Additionally, after playing a level, it was clear that progressing alone was very difficult, encouraging players to cooperate more.

Interestingly, some participants experienced the opposite effect. P30 felt the condition experienced first was more social because it required more communication to reach mutual understanding, while in the second, communication became shorter and more focused: "*In the second, since we already knew what to do, we didn't need as much communication. Communication was more efficient: 'ah, here are mushrooms', and that's it*". Distinct-World was often seen as a challenge to smooth learning and understanding cooperative dynamics: "*I don't know why you made us play the second level right away, where we couldn't see each other's actions and were still learning the game. It helped me a lot to see what [P11] was doing*" (G11).

6 Discussion

We begin by answering our research questions and outline how world and goal sharing affected the sense of sociality and social behavior in our study. Then, we discuss strategies for acknowledging, leveraging, and mitigating these effects in future designs (summarized in Table 1).

6.1 RQ1: How does world sharing affect the sense of sociality and social behavior in asymmetric cooperative games?

As expected, playing in distinct worlds reduced mutual understanding and awareness. For many participants, this had a clear negative impact on sociality, especially when playing for the first time. It was more difficult to reach common ground, coordinate actions, and made interactions feel less tangible. Sharing a world also enabled emergent social interactions around common elements (e.g., greetings, jokes about Plume's buildings) that were absent in distinct worlds. These aspects likely contributed to the significant decrease in cooperative social presence in Distinct-World, compared to the baseline. Although participants expressed a greater need for verbal communication in Distinct-World, communication frequency was significantly lower. While verbal reliance was crucial for mutual understanding, the spatial coordination required to place cannons and totems in the shared world was largely absent in Distinct-World. Some participants preferred this lower-friction interaction, whereas others felt that spatial coordination reinforced social connection. **Thus, to account for distinct worlds, games need to offer strategies that sustain awareness, tangibility, and coordination despite the absence of spatial co-presence.**

6.2 RQ2: How does goal sharing affect these same outcomes?

Having a shared goal enhanced participants' sense of 'being in this together'. Many perspectives highlighted that pursuing independent goals increased autonomy and reduced concern for their partner. This goes in line with our quantitative results, which show that in-game interactions significantly decreased compared to the baseline. Shared goals shifted focus from individual performance to collective achievement, increasing responsibility and perceived difficulty. Yet, we found no significant effect on cooperative social presence or communication frequency. Many participants noted little difference, as they were already motivated to cooperate and could support each other through the game's mechanics. **Our results suggest that cooperative mechanics emphasizing usefulness, commitment, and altruism can sustain social connection even without outcome interdependence.**

6.3 Carefully Crafting Interdependence: From Playing in Separation to Sharing a Journey

Organizational theory [71] highlights that perceived interdependence derives from multiple factors, including how abilities and resources are distributed, tasks assigned, goals defined, and team

Table 1. Summary of design considerations and implications derived from our results.

To mitigate feelings of isolation when playing in distinct worlds, future designs should emphasize mechanics where one player's actions **physically intrude upon or visibly alter the partner's world** (e.g., enemies escaping to a co-player's world). Even when invisible to one another, players must feel the tangible weight of their partner's influence.
When goals are distinct, players may be unsure of their contribution to the co-players' success. Future designs must **reinforce and explicitly show the impact of a player's help** to cultivate vicarious agency and ensure players feel tied to the success of others.
Distinct worlds introduce grounding challenges that can be too difficult or frustrating for some groups. Future designs should provide **optional shared reference points** (e.g., pings, auditory cues, temporary peeks) to support those who struggle with or prefer to avoid heavy verbal communication.
The effort of building shared understanding in distinct worlds can itself be engaging for groups that enjoy communication challenges. Future designs can frame this as a playable challenge, where players **actively verify and construct a shared reality** (e.g., cross-referencing clues), turning the awareness gap into a cooperative puzzle.
Distinct goals can create a motivational distance between players, as players naturally prioritize their own objectives. Future designs should include cooperative mechanics that allow players to **signal their commitment by requiring them to sacrifice personal resources, time, or comfort to help co-players**.
Players value the autonomy of having distinct goals while still wanting to feel accountable for each other. Future designs should consider **customizable levels of interdependence and explore mixed outcomes** where cooperation is required to unlock specific content or rewards, but overall success still reflects individual performance.
Even with shared goals, strictly asymmetric responsibilities can cause frustration if one player struggles. Future designs can explore **costly substitution, allowing players to help with co-players' unique tasks at higher cost or lower efficiency**.
High-intensity gameplay can limit the processing of social cues and communication. To maintain social connection, designers should balance intense cooperation with low-pressure **"campfire moments" where players can debrief and bond without performance pressure**.

performance rewarded. By assigning shared or distinct goals, we directly manipulated outcome interdependence, which prior work [4, 5] shows can improve coordination and mutual support in organizational settings. Although we did not find a strong effect of goal sharing, our results point to several nuances that shape how players cooperate and to what extent they feel they share the experience. Games research already captures some of these nuances, such as the degree and direction of interdependence [36, 37, 76], synchronicity [37, 59], and task distribution [59]. Beyond these, insights from outside games research may be critical to advance this understanding, highlighting cooperation factors rarely explored in games, such as relative power, information certainty, and future interdependence [39, 42].

Although less common, cooperative games do not always have fully shared outcomes. In many cases, players group up to face a difficult challenge together (e.g., a boss fight), yet their intentions and rewards may differ (e.g., complete the fight versus collecting a specific item drop), and outcomes can also vary (e.g., some obtain valuable items while others gain none) [62]. Similarly, players do not always win or lose together (e.g., in Left 4 Dead [70], some players may fail to reach the rescue vehicle, missing out on achievements). These examples highlight how outcome and success may be interpreted differently by players and goal sharing can emerge in multiple ways depending on how success is defined and how outcomes depend on others.

Participants in our study highlighted this complexity. Many emphasized that interdependencies that block progress for others can reinforce the feeling of cooperation. At the same time, some appreciated not being fully dependent on their partner to succeed. **This suggests value in mixed outcome interdependence, where cooperation is required to unlock specific content and rewards, while overall success still reflects individual performance.** Such structures are also discussed in organizational research as balancing autonomy and collective accountability [39], and may help explain why players can feel socially connected even when outcomes are only partially shared.

Across conditions, two recurring drivers of cooperation were feelings of usefulness and commitment. The valuable impact cooperation had on their gameplay was often referred to as the main reason for the game feeling social. This not only encouraged players to cooperate, but made them feel more tied to each other's gameplay. Importantly, they also valued interactions that required effort. This parallels the work of Harris and Hancock [36], in which cooperative actions were best received when framed as "*thoughtful contributions*" that require players to overcome their own challenges to help each other.

Evolutionary psychology [49] establishes that costly signals (i.e., behaviors demanding significant resources, risk or effort) are important to indicate an individual's quality and intentions within a group, as well as to assess cooperative intent [47] and honesty in communication [13]. Our findings align with this perspective: when players sacrificed effort, they signaled investment in the partnership, which in turn gave weight to cooperation. Many games, including our prototype, foster costly signals through spatial or temporal coordination [15]. However, this raises an open design question: how can games convey commitment when players are separated across worlds or timelines (asynchronous play)?

While most participants felt strongly helped by their partner, many were uncertain of how useful they were to their partner. **For this commitment to feel rewarding, both the effort and the impact must be visible**. Future asymmetric designs should consider including feedback to create a sense of vicarious agency (feelings of authorship for the actions of others) [78], where a player's effort is directly seen causing a significant impact (e.g., the cannon exploding an entire horde of enemies). Existing games, especially those that include assisting or supporting roles, already implement such mechanisms (e.g., cues for when a player performs an assist [29]). Enhancing these types of cues in highly asymmetric games can make cooperation more tangible and reinforce the feeling of shared achievement.

Our results also highlight the role of substitutability, a concept from social interdependence theory [39] describing the extent to which one player's actions can replace another's. In our design, roles were strictly non-substitutable, and some participants expressed a desire to 'cover' for partners when they struggled with their responsibilities. Future research in cooperative gaming should explore this space between complementarity and redundancy—for instance, allowing a player to perform their partner's tasks at a higher cost or lower efficiency, preserving role uniqueness while mitigating imbalance. By intentionally tuning factors such as accountability, commitment, and substitutability, designers can support a spectrum of cooperative experiences, from transactional help to strong group entitativity, where players perceive themselves as a unified, cohesive team [39].

6.4 Preparing and Maintaining Extreme Asymmetry: The Importance of Grounding and Shared Awareness

When cooperating, individuals must establish what Clark and Brennan [16] describe as “grounding”: a shared set of mutual knowledge, beliefs, and assumptions. In gaming, grounding becomes increasingly difficult as asymmetries between players grow, since they no longer begin from common perspectives or interaction patterns. In our study, awareness gaps appeared across all conditions: substantially more pronounced in distinct worlds but also in the shared world, where players had distinct views. **For players who struggle with or prefer to limit verbal communication, such gaps can weaken the social dimension of play**, particularly in the first play sessions. Allowing players to switch roles or see each other’s gameplay (e.g., split screen) can help mitigate this, but this may not be feasible or desirable for all games or player groups. Also, as the game evolves and new challenges arise, this barrier may reappear.

Collaboration theory [17, 32] establishes that groups seek to reduce the total effort spent on grounding over time, adjusting their grounding behavior to exploit additional channels (e.g., using deictic expressions and gestures, relying on visual confirmation) and reducing verbal exchange [32]. We observed this reliance on visual cues in the shared world and many participants felt they decreased the need for verbal exchange. Yet, most pairs increased communication frequency on the level played second, regardless of condition, suggesting that they did not reach a point where they were able to reduce effort. For participants who found common ground earlier, the communication challenges shifted from a focus on grounding to routine, procedural exchanges to complete the cooperative mechanics. Our study emphasizes that, while intuitive grounding streamlines cooperation, making it an ongoing part of the challenge can lead to meaningful interaction, requiring players to constantly check in and verify their shared reality.

Our results also show that, while one game or mechanic might lead to more communication, it does not necessarily translate into more positive interaction, as many preferred the intuitiveness of in-game cues and reduced need for spatial coordination. Consistent with prior work [36], group preferences may vary, where some prefer explicit situational cues while others appreciate the need for tight verbal communication. In certain contexts (competitive gaming), verbal communication might even be undesirable or reduced to a minimum in favor of in-game cues, ping, and emotes [8, 48]. These present distinct flavors of cooperation and designers should consider that grounding challenges require efficient verbal communication and a certain level of trust. Importantly, our results suggest that placing players in distinct worlds can introduce grounding challenges that some players find engaging, but designers must carefully support those who rely less on verbal communication.

6.5 Rhythms of Interaction: Pacing Instrumental and Sociable Exchange

Our findings illustrate how sociality in cooperative games extends beyond instrumental cooperation, with participants placing value on interactions performed for bonding rather than utility. In line with this, research indicates that for specific games and groups, communication is primarily social rather than task-focused [24, 52, 60]. In our study, sharing a space provided shared frames of reference that anchored these sociable moments (e.g., celebrating when completing a pedestal, joking about buildings). In distinct worlds, future designs should strive for mechanics that emphasize tangible causality, where one player’s actions intrude upon the other worlds even if unintentionally (e.g., an escaping enemy spilling over to the partner’s world). These types of interactions align with participants’ desire for playful interference as a vehicle for social connection. Having ambient cues to give more information about other players’ state can also be important for co-presence (e.g., darkening the sky in one’s world whenever a partner has low health or dies).

Social connection also relies on a carefully designed rhythm of interaction. Our participants reported feeling overloaded during intense gameplay segments, noting that their focus drifted entirely to individual tasks. When designing for social interaction, it is important to acknowledge that high cognitive load may suppress the processing of social cues [73]. Harris and Hancock [36] have previously highlighted the importance of varying interdependence over time to avoid fatigue and boredom. Our results show that designers should balance intense moments with relaxed ones, not just for player engagement, but to sustain social connection. According to our participants, introducing distinct goals can also help with pacing, providing moments of increased autonomy. Beyond pacing, **asymmetric games can benefit from 'campfire moments': low-pressure moments when the group can relax, reflect on their learning, and appreciate each other's company without the pressure to perform.** Future research should explore adjustments to difficulty [12] and pacing, recognizing that these not only affect player flow but also disrupt social connection.

6.6 Limitations

This study examined distinct worlds and goals independently. To preserve statistical power across our sample, we did not include a fourth condition that combined both. Additionally, to prevent participant fatigue, pairs only played two of the three available conditions. Because we evaluated these factors strictly independently, we acknowledge that combining distinct worlds and distinct goals would likely reveal additional tensions and design implications not captured here.

Further, our findings specifically capture the effects of separating worlds and goals when comparing against an already highly asymmetric baseline. Notably, although the world was shared in two of the conditions, it was not shared to the greatest extent possible, as some elements were not visible to both players and shared elements were represented differently across perspectives. As reflected in some participants' accounts, these decisions have introduced minor awareness gaps despite the shared environment (e.g., seeing Grim's enemies would have helped Plume players better judge when and where to help), which should be considered when interpreting the results. Overall, we acknowledge that the effects observed in this study might manifest differently if evaluated against a (more) symmetric baseline—for instance, one where players shared identical views (e.g., Plume also seeing enemies) or overlapping responsibilities (e.g., Grim also gathering resources to awaken pedestals).

We did not allow participants to switch roles or become familiar with each other's gameplay to emphasize first-contact experiences (critical for player retention [67]) and scenarios where role switching may be undesirable or impossible [33, 34]. Instead, participants only watched short clips of each role, mimicking how players rely on trailers when choosing what to play. Our findings center on social play among players who regularly play together, at a distance, with an open communication channel. Several design decisions (e.g., sequential cooperation, timer) limit the generalizability of our findings to other games and contexts. Moreover, participants were mostly younger, male gamers, which limit generalizability to other demographics.

7 Conclusion

This study investigated how sharing (or decoupling) game worlds and goals shapes social connection in asymmetric play. Our findings demonstrate that while shared spaces and objectives facilitate cooperation, they are not strictly required for a meaningful social experience. Instead, distinct worlds reframed communication as an engaging grounding challenge, while distinct goals shifted the focus to a sense of parallel play, increasing perceived autonomy. Ultimately, our work encourages a re-evaluation of extreme asymmetry not merely as a design challenge in itself, but as an important design strategy for inclusion and personalization. By understanding the impact of different asymmetries, future inclusive design can go beyond asymmetric roles to connect radically distinct experiences (e.g., bridging a high-fidelity sports simulation with a casual match-3 puzzle), tailoring gameplay to individual needs without breaking the social bond. To sustain this connection, future designs should focus on making a partner's effort and impact visible, reinforcing tangible intrusions across worlds, and protecting the rhythm and space for social interaction.

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LLMs were used to improve the phrasing of many paragraphs after a draft was achieved, in an iteration process that, with no exception, ended with the authors reviewing the text and ensuring that what is said was what they originally intended. LLMs were also used in writing code and generating images for the game. All ideas, analyses, and interpretations are original and work of the authors.

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