

# Cooperation and Interdependence: How Multiplayer Games Increase Social Closeness

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## ABSTRACT

Games have long been used as a bonding activity; however, research on establishing and maintaining social closeness through games uses different terms, different mechanics and controls, and different contexts of use. As a result, designers have little guidance on which multiplayer game mechanics are most effective. We summarize literature on game design for social closeness into a framework with two collaborative mechanics: cooperation and interdependence. We then created four versions of an online game to independently test the effects of these game mechanics on relationship formation between paired online strangers, showing that cooperation and interdependence are two distinct factors that both can be used to improve play experience and increase social bonds. Additionally, we unpack the effect of interdependence, showing that the improved social closeness can be explained by the increase in conversational turns.

## Author Keywords

Social Play, Cooperation, Interdependence, Collaboration

## ACM Classification Keywords

K.8.0 [Personal Computing]: General - Games.

## INTRODUCTION

Games have long been used to support social interaction: family board game nights, tabletop gaming in board game stores, and weekly poker games among friends can help us satisfy our need for relatedness [42,43] and create shared experiences that draw us closer together. Digital games are increasingly being employed to help form and maintain social relationships, with the additional advantage of assisting distributed friends and families to maintain social connections – for example, people enhance their friendship through playing social network games [51], seniors play online poker together to stay connected [47], and kids with mobility disabilities connect through online multiplayer games [17]. The Entertainment Software Association (ESA) reports that in 2016,

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the majority of gamers played in multiplayer mode at least weekly because they felt that video games help them connect with friends [12]. Multiplayer co-op modes are becoming increasingly common in games [34,37] and people are playing games online with both friends and strangers [12].

Research on facilitating social closeness through games suggests that multiplayer game mechanics can be used to build or strengthen relationships in various contexts. For example, in the context of supporting people with different game preferences and abilities (e.g., grandparents playing with grandchildren), Harris et al. [16] explore asymmetric games that embrace and cater to differences between players, but maintain tightly-coupled social interactions. Investigating the context of supporting distributed work teams, Depping et al. [9] show that playing a cooperative interdependent digital game can facilitate trust formation between two strangers online. And in the context of family members with caring responsibilities, Gerling et al. [14] show that playing a motion-based game with cooperative, closely-coupled game mechanics can help caregivers bond with an older adult who has motor impairments.

Although these examples all demonstrate the benefits of multiplayer game mechanics for establishing or reinforcing social closeness, we cannot compare or contrast the advantages of the different approaches taken by the different research teams. Each project uses different terms for the multiplayer aspects (e.g., asymmetry vs. complementarity), different game mechanics and controls (e.g., a shooting mechanic in a motion-controlled game vs. a puzzle mechanic in a mouse-based game), and different contexts of use (e.g., supporting existing familial relationships vs. building new work relationships). These differences mean that game designers or researchers who wish to leverage multiplayer game mechanics to facilitate social relationships have little guidance on which mechanics or approaches to choose to implement for optimizing social closeness.

In this paper, we systematically explore how multiplayer game mechanics facilitate social closeness among dyads of strangers. First, based on a literature review of multiplayer game mechanics for relationship formation and maintenance, we establish cooperation and interdependence as two distinct multiplayer game mechanics that have been successfully employed. Second, we designed a game to investigate the efficacy of these two mechanics separately and in combination, but with all other structural elements of the game remaining

consistent. Third, we conducted an experiment with dyads of strangers to determine how the mechanics affect the social relationship that results from playing together. Our results show the following:

- Collaboration and interdependence are two distinct mechanics that separately influence *game enjoyment and experienced relatedness* during play.
- Similarly, collaboration and interdependence are two distinct mechanics that separately and significantly influence the *experienced social closeness* as a result of play. Furthermore, they do not interact with each other.
- We additionally determine a primary mechanism through which interdependence works – the number of conversational turns between players fully mediated the prediction of interdependence on resulting social closeness.

Fourth, we explain our results and turn to theories of interpersonal interaction to describe why these two mechanics facilitate social closeness. And finally, we discuss the implications of our results for the design of games to establish and facilitate social closeness.

Social games have the potential to help form new relationships and strengthen existing ones. We contribute to the growing body of literature that aims to understand the potential of games to strengthen the bonds between people.

#### RELATED LITERATURE

We reviewed literature on the benefits of multiplayer game mechanics for establishing or reinforcing social closeness.

##### Scope of Literature Review

To scope the review, we were specifically interested in including previous work that satisfied three conditions:

First, the primary goal of the research should be promoting or understanding social closeness, rather than it being a secondary benefit that “came for free” along with the main goal of interest. For example, we do not include multiplayer exergames in which the goal was to leverage social pressure to improve exercise adherence (e.g., [38]), or papers in which communication is more productive when using game interfaces that support simultaneous interaction (e.g., [46]).

Second, the research should be focused on games as a tool of intervention, rather than an ethnographic study of how playing games can bring people closer together. For example, we do not include work that examines how playing online games, such as World of Warcraft, helps people make friends (e.g., [7,49]) and build social capital (e.g., [55]).

Third, the research should have either built and evaluated, or analyzed collaborative games, as opposed to other forms of technology that promote social closeness. For example, we do not include in our review work on how domestic video technologies can be used to bring families together (e.g., [26,27]), how adolescents can engage in playful activities over videochat interfaces (e.g., [53]), or how grandparents can read to their kids over a distance (e.g., [2]).

Although there are important results that we draw from each of these out-of-scope areas, our intent in the systematic review was to synthesize the literature on collaborative game mechanics that facilitate social closeness.

##### Goal of Literature Review

As noted in the introduction, researchers that investigate the effects of collaborative play on social closeness have implemented different mechanics with different goals and have used different terminologies. For example, Harris et al. investigated “asymmetric” game mechanics in the context of intergenerational play in the game *Beam Me ‘Round, Scotty!* [15,16]. Beznosyk et al. investigate “closely-coupled” play in the context of six casual games using six different mechanics [4]. Rocha et al. identify collaborative design patterns like “complementarity” and “synergies between abilities” in an analysis of existing collaborative games [40].

Our primary goal was therefore to identify the commonalities between all of these implementations so that we could identify the abstract overarching patterns that connect the existing approaches. The three aforementioned examples might use very different mechanics in very different contexts; however, what they have in common is the goal of inducing a dependency between players. Based on our review of the literature on collaborative game mechanics and their potential to facilitate social bonds, we identified two overarching mechanics: cooperation and interdependence. In the next sections, we use these two dimensions to review existing literature on social closeness through play.

##### Cooperation

The most prevalent idea in the literature on collaborative play is the notion of players working towards the same goal. This stands in contrast to competitive play in which players have separate or in its most extreme, opposing goals. Rocha et al. [40] identify “shared goals” and “synergy between goals” as essential design pattern in collaborative play. The “synergy between goals” pattern acknowledges that collaboration does not necessarily mean complete cooperation. It is possible for players to simultaneously pursue individual goals (leveling up one’s own character) and group goals (making sure the group wins). Zagal et al. [54] describe this phenomenon as the tension between ‘individual utility’ and ‘group utility’. Another way of thinking about cooperation is by examining conflict. Definitions of ‘games’, as well as design guidelines, emphasize the important of conflict [13]. Competitive and cooperative games differ in where conflict originates. Competitive games pitch players against each other and the conflict lies between the players. In cooperative games, players team up to overcome obstacles and challenges (e.g., limited time or resources) and the conflict originates between the players and the system or other groups.

The virtue of cooperation in the context of facilitating social bonds seems obvious and a matter of common sense and is often included in design frameworks [3,19]. It is therefore not surprising that every study we reviewed implicitly assumes cooperation to be the superior mechanic for facilitat-

ing social bonds. Seif El-Nasr et al. [45] investigated cooperative games like *Little Big Planet* or *Rock Band 2* to identify cooperative performance metrics. Depping et al. [9] investigated the trust facilitating properties of a cooperative puzzle game in the context of distributed teams. A number of cooperative 3D environment puzzle games have been found to effectively promote team building [6,11,30]. In the game *Operation Sting*, players share the goal of successfully performing a heist together [35,36]. Researchers found the game to have a positive effect on the social fabric of the group [35,36]. Only one study investigating the effect of a collaborative game on the players' perception of each other actually built a competitive version of the game [8]. Unfortunately, a direct comparison between cooperation and competition was not reported. The authors do, however, suggest that competition diminishes the extent to which players relate game outcomes to liking for their partner in a game [8].

The idea that games should be cooperative if they are to facilitate social closeness appears to be an assumption made by researchers and designers. Unfortunately, there has not been a direct comparison between cooperation and competition regarding their individual effects on the social bonds formed through play. Furthermore, cooperation has almost always been implemented in combination with interdependence. Without an investigation of cooperation separately from interdependence, we can only make assumptions about the effectiveness of either mechanic.

### Interdependence

The second theme that emerges in the literature on collaborative play is focused on the level of dependence between players. Interdependence is a term from psychological frameworks on social and group interactions and is commonly defined as the 'degree to which group members must rely on one another to perform their task effectively' [44]. In the context of games, the 'task' can be viewed as the goal players want to achieve within the game. Rocha et al. [40] identify six design patterns in their analysis of popular collaborative games. As already discussed, 'shared goals' and 'synergies between goals' are mechanics emphasizing cooperation. The other four design patterns are: 'complementarity' (specific to roles in the game), 'synergies between abilities', 'abilities that can only be used on another player' and 'special rules for players of the same team.' All of these patterns describe game mechanics that induce dependency, i.e., a need to rely on and interact with the other players [40]. Similarly, in their analysis of the collaborative board game *Lord of the Rings*, Zagal et al. [54] suggest that 'a collaborative game should bestow different abilities or responsibilities upon the players', emphasizing the importance of interdependent play. Beznosyk et al. [4] distinguish 'closely-coupled' from 'loosely-coupled' casual games and find that closely-coupled games rated higher overall in engagement. Unfortunately, they compare different games with each other, making it hard to distinguish what effects are due to the game and what effects are due to interdependence. Their

results suggest however, that interdependence has a positive effect on player experience.

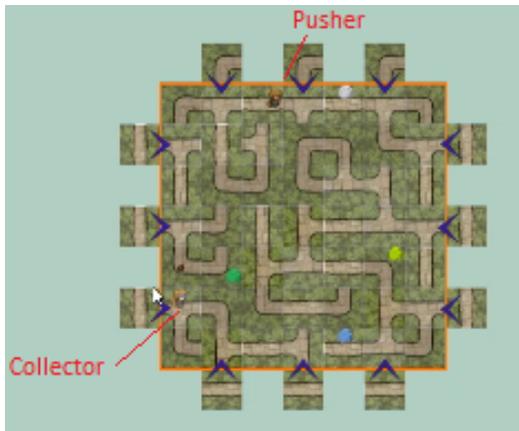
In the game *Zoom* [6], each player received one picture they had to describe to the others; the group then had to arrange the order to create a coherent story. The game utilized complementary knowledge to induce dependence between the players. Findings suggested that the game was a viable tool for team building [6]. Similarly, Ellis et al. [11] designed the games *Castle Builder* and the *Tower of Babble*, which each utilized complementary knowledge in a different way. In *Castle Builder*, only a few players were familiar with the blueprint of the castle that was supposed to be built. In the *Tower of Babble*, players were required to utilize perspectives of different viewpoints to ensure the tower was being built straight. In all of these games players were bound to interact because each member had a piece of information that was required to complete the task. All of these games appeared to have positive effects on the social fabric between the players. Nasir et al. [35,36] created a game called *Operation Sting* to facilitate team building. Players each had the same knowledge, however, the actions they were able to perform were different for each player, giving them complementary roles (e.g., thief, hacker). Also utilizing complementary roles, Harris et al. [15] created the game *Beam Me 'Round, Scotty!*, a game utilizing "asymmetric" game mechanics inducing interdependence between players. The experimental design does not compare high interdependence to low interdependence; however, the participants' quotes suggest a positive impact of the interdependence that was experienced. Gerling et al. built two interdependent games to explore social play as an opportunity to connect caregiving dyads [14]. They found that dependence between players appeared to foster communication between the players.

Each of these studies used different games, mechanics and contexts to implement interdependence. The findings suggest, however, that a dependence between players and a necessity to interact and communicate could potentially facilitate social closeness. While these results seem promising, we do not know how high interdependence compares to low interdependence or how it affects social closeness when it is not confounded with cooperation.

### Summary of Systematic Review

Although these examples suggest that cooperation and interdependence can promote social closeness, we cannot compare or contrast the advantages of both mechanics. While we have a rich understanding of different methods and contexts in which playing together facilitates social bonds, we have little guidance on the effects of the underlying mechanics. If we want our academic knowledge of collaborative games to effectively inform game design, we need to understand the different elements that make games so effective at reinforcing relationships. In previous studies, cooperation and interdependence have been implemented together. How the two mechanics affect relationships individually is yet unclear. Previous studies have also not systematically evaluated how the mechanics affect social bonds. Are the relationships

formed through cooperation different from the relationships formed through competition? Finally, we have no knowledge about how the two mechanics interact. Common wisdom might suggest that both mechanics have to occur together in order to facilitate social closeness. Psychological theories on group work would even suggest that interdependence in combination with competition would elicit hostilities and distrust [23,24]. For game designers to be able to make informed design choices based on research, we need to look beyond the blanket term ‘collaboration’ and systematically disentangle and evaluate the underlying forces of collaborative play.



**Figure 1. Labyrinth game board (cooperative, interdependent)**

## EXPERIMENT

We conducted an experiment to evaluate how cooperation (vs. competition) and interdependence (vs. independence) affect how players perceive the game and each other.

### Game Design

We created a game in which both collaborative factors, i.e. cooperation and interdependence, could be varied independently. This resulted in a two-by-two matrix: crossing competition or cooperation with independence or interdependence resulted in four different games. In our design process, we ensured that all other structural elements of the game were identical, and that only the two game mechanics were manipulated. In the following sections, we will first describe the general design of the game, and then describe the implementation of the four versions.

#### *Labyrinth Game*

We created the game called *Labyrinth*: a networked, 2-player puzzle game implemented with the Unity Game Engine, based on a German board game of the same name. The game is a top-down 2D board-style game. The game board is comprised of tiles and the configuration of the tiles creates paths through the maze. The players control 2D avatar sprites that they can move along the paths using the arrow keys. The goal is to reach and collect gems that are positioned on the paths of the maze. The game is structured in individual puzzle ‘sets’. A set starts with both players and one gem spawning in specific locations. A set lasts for a fixed period of time

during which the players have to collect the gem (the set duration is different between the four versions for balancing purposes). Once the set time is up, a new set is loaded with new starting positions. If a gem is not reachable with the current configuration of the maze, the players can push rows and columns to reconfigure the maze and open new paths. Players change the maze by pressing the spacebar and walking against the wall they want to push. After a wall is pushed, the players have to wait until the wall automatically moves back to its original position before they can push another wall.

Before the multiplayer game, players completed an interactive single-player tutorial that took approximately three minutes. The tutorial used written instructions to present the rules of movement and wall pushing. Players could only progress to the multi-player experiment versions once they completed the tutorial.

#### *Interdependence*

In order to operationalize dependency or lack thereof between the players, we used two strategies: complementary roles and separate board games. Complementary roles meant that one player was only able to move walls but not collect (the ‘*pusher*’) while the other player was only able to collect gems but not push (the ‘*collector*’), leading to a high level of dependency in the interdependent versions of the game. In the independent game version, each player could use both abilities. To further avoid any effect one player might have on the other player’s game experience we had them play on two separate game boards in the independent games.

#### *Cooperation*

We induced cooperation by manipulating the goal of players. In the cooperative conditions, players were instructed to work together to maximize the gems they collected as a team. To reinforce this, we presented the final team score. Depending on their score, they received a crown (bronze, silver, gold, or diamond), emphasizing the struggle of the players against the game system. In the competitive conditions, players were informed that they were rivals and were to compete for the gems. To reinforce this, their scores were presented individually and the winner received a golden crown after the game, emphasizing comparison.

#### **Game Versions**

These variations resulted in four versions of the game (see video figure for audio-visual explanation):

#### *Cooperative and Interdependent*

Both players were positioned on the same game board. One was the pusher and the other was the collector. Together, they had to try to collect as many gems as possible. Each set consisted of a gem that was not reachable without pushing at least one wall; the most difficult sets required three wall pushes to reach the gem. The difficulty of the sets increased over time. The final score was the number of gems collected.

#### *Competitive and Interdependent*

Both players were positioned on the same game board. One was the pusher and the other was the collector. The collector was instructed to collect as many gems as possible. The

pusher was instructed to prevent the collector from doing so. The gems were positioned in a way that made them reachable for the collector without any wall pushes. The pusher was spawned in a position that made it possible for them to rearrange the maze so that the collector's path was blocked. The collector's score was based on the number of gems they collected. The pusher's score was based on the number of gems they prevented the collector from reaching before the set timed out and a new set was loaded. A winner was declared at the end.

#### *Cooperative and Independent*

Both players solved the same maze configuration; however, they were positioned on individual game boards. Both players were capable of pushing and collecting. Players were instructed to collect as many gems as possible as a team. The final score was the sum of both players' scores.

#### *Competitive and Independent*

Both players solved the same maze configurations; however, they were positioned on individual game boards. Both players were capable of pushing and collecting. Players were instructed to collect more gems than their rival. Their final scores were compared to declare a winner.

In all versions, participants played two rounds of 5 minutes each (10 total minutes of gameplay). In the conditions with asymmetric roles, they switched roles in the second round to ensure that both players had experience with both roles. During gameplay, partners were connected over voice chat.

#### **Measures**

All responses were measured on a 7-point-Likert scale.

**Interpersonal trust:** Social closeness or the quality of a relationship has been measured in a variety of different ways. In the context of computer-mediated relationships, some research measures 'liking' [8,23] to describe the depth and quality of the relationship. However, the predominant construct that has reliably and authentically characterized social relationships in this context has been interpersonal trust [9,22,25,28,39,41]. To measure trust, we adopted a scale that was previously used in the context of brief initial encounters [9]. The scale consisted of 11 items that were derived from the Rempel trust scale [39] (e.g., "*I could count on my partner to be concerned about my welfare.*"), the Dyadic Trust scale [28] (e.g., "*I feel that my partner can be counted on to help me.*"), and the Specific Interpersonal Trust Scale [25] (e.g., "*I could expect my partner to tell the truth.*"). As with previous research [9], the scale was an internally consistent measurement of trust (Cronbach's  $\alpha=.922$ ,  $M=5.46$ ,  $SD=.93$ ).

**Intrinsic Motivation Inventory (IMI):** To quantify the play experience, we measure interest/enjoyment, invested effort and pressure/tension using the IMI [32].

**Player Experience of Needs Satisfaction (PENS):** We used the PENS scale, which measures need satisfaction of competence, autonomy and relatedness in-game. We also measured intuitiveness of controls [43].

**Conversational turns:** We quantified how responsive or involved the participants were with each other by calculating the number of conversational turns in the speech signal based on the audio that we recorded during play ( $M=28.69$ ,  $SD=19.35$ ). Each change in who is talking is considered a turn in the conversation.

**Propensity to trust:** We measured general propensity to trust (trait) as proposed by Yamaguchi [52]. The 6-item questionnaire asks participants to rate statements such as "*Most people are basically honest.*"

#### **Participants**

The study was deployed on Amazon's Mechanical Turk (MTurk) crowdsourcing platform. MTurk connects paid workers to *Human Intelligence Tasks* (HITs) and has been shown to be a reliable research tool [31]. We recruited 138 participants, who received \$3 for the 20 min study. Ethical approval was obtained from the behavioral research ethics board of our university, and participants were asked to give informed consent. To comply with ethical guidelines, the task was only made available to workers older than 18.

#### **Procedure**

We first presented participants with information about what was expected of them (a working microphone and the willingness to interact with another person for 10 uninterrupted minutes). They then completed the consent form and demographics and propensity to trust. Subsequently they performed the tutorial in which they learned the basic gameplay. Once they completed the tutorial, they progressed to match-making in which they were assigned a partner and then randomly assigned to a condition. They were connected over voice chat to their partner for the duration of the game. After 10 minutes of gameplay, they completed the PENS, IMI, and trust scales. Finally, there was a debriefing and an opportunity to leave comments.

#### **Data Analyses**

All analyses were performed with SPSS 24. We identified noncompliant participants based on two criteria and removed them from subsequent analysis. First we went through the comments in the debrief and the audio recordings to check if they actually had a working microphone and removed the ones who did not ( $N=14$ ). Second, we checked for careless responses in the questionnaires using a response-time threshold. We removed participants who completed three or more questionnaires with an average time per item of less than 1.5 seconds ( $N=19$ ). Our final dataset consisted of 105 participants. Our phonetic analysis of conversational turns required high sound quality. Despite microphone checks and careful instruction, in some cases the sound quality was not high enough to be accurately analyzed. For the analysis including conversational turns, we excluded an additional 39 participants due to poor sound; this left 66 participants for analyses involving conversational turns.

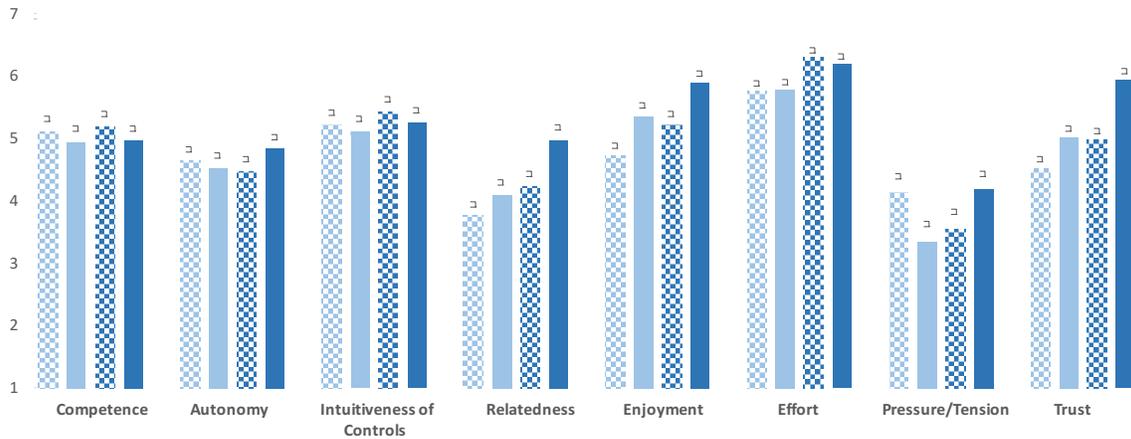


Figure 2. Means and standard errors for outcome variables. ■ (light blue)=competition, ■ (dark blue)=cooperation; ▨ (pattern)=independent, ■ (solid)=interdependent (e.g., ▨ = Cooperative and Independent).

**Group vs. Individual Variables**

Although our survey items were completed by individual participants, their individual ratings are subject to the experience of being in a dyad with another participant. For statistical analyses, it is important to determine whether the participants can be treated as independent cases. We conducted an inter-rater agreement (IRA) analysis [29]. The IRA was assessed using the  $r_{WG}$  index, which defines agreement in terms of the proportional reduction in error variance. It compares the observed variance on a variable over the group members to the variance drawn from a theoretical null distribution that represents complete lack of agreement [29]. We computed the multi-item  $r_{WG}$  index over all relevant constructs. Our  $r_{WG}$  index ( $M = .60$ ,  $se = .06$ ) was below the recommended threshold for group aggregation ( $.72$ ). We therefore proceeded treating our psychometric measurements (i.e., surveys) as individual variables. Excluded from this analysis were conversational turns, which were inherently measured on a group level.

**Propensity to Trust**

Literature on trust formation has long acknowledged that a large factor in trust formation is someone’s general propensity to trust [41,52]. To control for this, we used the participants’ propensity to trust as a covariate in all subsequent models that use trust as an outcome.

**RESULTS**

We explore the independent and joint effects of cooperation and interdependence by answering two questions: First, do the two mechanics affect how players experience the game? Second, how do the two mechanics affect the relationship between players outside of the game?

A two-way analysis of variance with two between-subjects factors (cooperation/competition and independence/interdependence) was conducted to investigate the main effects and interaction of cooperation and interdependence on the dependent measures (see Figure 2). This analysis allowed us to investigate the distinct main effects of cooperation and interdependence as well as their interaction.

**Player Experience**

*Are the games structurally similar?*

The different versions of the labyrinth game employed different mechanics that changed the gameplay significantly. The changes were designed to manipulate the multi-player experience; however, we intended our manipulation to be as equal as possible to avoid confounding factors. To ensure our manipulations did not systematically vary in overall difficulty or the difficulty of the control scheme, we investigated the effect of our manipulations on the perceived competence and autonomy of players and on the intuitiveness of controls.

For perceived competence, we did not observe any significant main effects of cooperation ( $F_{1,101} = .05$ ,  $p = ns$ ,  $\eta^2 = .00$ ) or interdependence ( $F_{1,101} = .58$ ,  $p = ns$ ,  $\eta^2 = .00$ ). Neither was the interaction of the two mechanics significant ( $F_{1,101} = .00$ ,  $p = ns$ ,  $\eta^2 = .00$ ). Similarly, autonomy was not affected by cooperation ( $F_{1,101} = .08$ ,  $p = ns$ ,  $\eta^2 = .00$ ), interdependence ( $F_{1,101} = .32$ ,  $p = ns$ ,  $\eta^2 = .00$ ), or the interaction of the two mechanics ( $F_{1,101} = 1.05$ ,  $p = ns$ ,  $\eta^2 = .01$ ). Finally, intuitiveness of control was also not affected by cooperation ( $F_{1,101} = .56$ ,  $p = ns$ ,  $\eta^2 = .01$ ), interdependence ( $F_{1,101} = .34$ ,  $p = ns$ ,  $\eta^2 = .00$ ), or the interaction of both mechanics ( $F_{1,101} = .01$ ,  $p = ns$ ,  $\eta^2 = .00$ ).

Based on these results, we can assume that there were no inadvertent differences in the perceived competence, autonomy, or the difficulty of the control scheme.

*How were the remaining aspects of player experience affected by cooperation and interdependence?*

First we investigated differences in how related the players felt during the game. The ANOVA revealed significant main effects for cooperation ( $F_{1,101} = 7.08$ ,  $p = .01$ ,  $\eta^2 = .07$ ) and interdependence ( $F_{1,101} = 4.19$ ,  $p = .04$ ,  $\eta^2 = .04$ ) on experienced in-game relatedness. Both mechanics increase scores in relatedness but do not interact ( $F_{1,101} = 1.19$ ,  $p = ns$ ,  $\eta^2 = .01$ ).

We also investigated the effect the two mechanics have on enjoyment. Similar to relatedness, there are significant main effects for cooperation ( $F_{1,101} = 4.92$ ,  $p = .03$ ,  $\eta^2 = .05$ ) and interdependence ( $F_{1,101} = 8.19$ ,  $p < .01$ ,  $\eta^2 = .08$ ) on enjoyment. Both cooperation and interdependence increase the enjoyment of

the game. The two mechanics do not interact in their effect on enjoyment ( $F_{1,101}=1.10$ ,  $p=ns$ ,  $\eta^2=.00$ ).

The significant main effects and the lack of interactions indicate that cooperation and interdependence are two distinct mechanics. Both appear to increase experienced relatedness and enjoyment.

We observe a significant main effect on invested effort for cooperation ( $F_{1,101}=4.33$ ,  $p=.01$ ,  $\eta^2=.06$ ); however, there was no main effect of interdependence ( $F_{1,101}=.28$ ,  $p=ns$ ,  $\eta^2=.00$ ). Cooperation increased invested effort over competition. The interaction of the two mechanics is also not significant ( $F_{1,101}=.68$ ,  $p=ns$ ,  $\eta^2=.01$ ).

There were no main effects of cooperation ( $F_{1,101}=.16$ ,  $p=ns$ ,  $\eta^2=.00$ ) or interdependence ( $F_{1,101}=.46$ ,  $p=ns$ ,  $\eta^2=.00$ ) on experienced tension. The interaction term, however, is significant ( $F_{1,101}=5.21$ ,  $p=.02$ ,  $\eta^2=.05$ ); the effect of interdependence on tension appears to depend on whether the players are competing or cooperating. When competing, interdependence decreases perceived tension. When cooperating, interdependence increases perceived tension.

### Relationship between Players

We were most interested in how the two mechanics affect the feelings of closeness and rapport that developed between the players as a result of gameplay.

Similar to enjoyment and relatedness, we can observe two distinct main effects of cooperation ( $F_{1,101}=12.00$ ,  $p<.01$ ,  $\eta^2=.11$ ) and interdependence ( $F_{1,101}=13.47$ ,  $p<.01$ ,  $\eta^2=.12$ ) on interpersonal trust after gameplay. Cooperation facilitated trust development better than competition and interdependence facilitated trust better than independence. Furthermore, there was no significant interaction between cooperation and interdependence ( $F_{1,101}=2.32$ ,  $p=ns$ ,  $\eta^2=.02$ ).

These findings further suggest that cooperation and interdependence are two distinct game mechanics that both influence the relationship individually and do not interact.

### Unpacking the Effect of Interdependence

As explained previously, interdependence is likely to affect social bonds due to the increase in interaction and communication between the agents involved. Our ANOVA results support the idea that interdependence increases trust development between the players. Theory suggests that this relationship facilitation can be explained by the degree of interaction between the players during the game.

To explore this idea, we performed a mediated regression analysis using the Process macro [18] in which we investigated whether the prediction of interdependence on trust is mediated by the number of conversational turns (controlling for an individual's propensity to trust). The regression revealed that interdependence significantly predicted the number of conversational turns ( $b=25.75$ ,  $SE=3.005$ ,  $p<.001$ ), explaining 52% of the variance and also directly predicted trust ( $b=.544$ ,  $SE=.227$ ,  $p=.020$ ). Conversational turns also di-

rectly predicted trust ( $b=.021$ ,  $SE=.010$ ,  $p=.038$ ). Furthermore, when conversational turns were included in the model, interdependence was no longer a predictor of trust ( $b=-.017$ ,  $SE=.353$ ,  $p=.961$ ), consistent with a full mediation. The indirect effect was tested using the bootstrap estimation approach with 10000 samples [18], revealing that conversational turns significantly mediated the prediction of interdependence on trust ( $b=.561$ ,  $SE=.274$ , 95% CI=.1043, 1.1439). Approximately 20% of the variance in trust was explained by all predictors ( $R\text{-sq}=.20$ , including general propensity to trust).

There is no theoretical reason to assume that the number of conversational turns would mediate the effect of cooperation on trust as the theoretical underpinnings of cooperation as an effective game mechanic relate to shared goals and establishing an in-group effect (i.e., us against the game). A mediated regression supports this. Cooperation predicts trust ( $b=.697$ ,  $SE=.231$ ,  $p=.004$ ), but not conversational turns ( $b=4.44$ ,  $SE=4.48$ ,  $p=.325$ ). Furthermore, when the number of conversational turns is included in the model, the effect of cooperation on trust is still significant ( $b=.612$ ,  $SE=.210$ ,  $p=.005$ , 95% CI=.1915, 1.03).

### DISCUSSION

In this section, we summarize our results, provide some theoretical background for our findings, and discuss design implications, limitations and future directions.

### Summary of Results

Our results demonstrate that cooperation and interdependence each affect the relationship between players. First we established comparability between the four versions of the game. The four different versions of our game were identical in terms of the dramatic elements and visual design; we further established that the players' perceived competence, autonomy, and intuitiveness of controls did not differ between versions. Ensuring these similarities between the game versions allows us to more confidently attribute our results to the manipulations of cooperation and interdependence. Second, we reveal how cooperation and interdependence affect different aspects of player experience. As expected, both collaborative mechanics appear to increase the relatedness that players experience during the game. Similarly, both cooperating and interdependence increase game enjoyment. When considering the invested effort and the perceived tension, the two mechanics appear to have different effects. The effort players invest into the game increased when they were cooperating compared to competing. Sharing a goal with another player appears to be a key motivator to engage with the game. Interdependence between players seems to have no effect on the effort invested by players. Cooperation can also induce tension and pressure; however, only when the game is also interdependent. When players' actions do not affect each other (low interdependence), cooperating decreases the perceived tension. Third we confirm that cooperation (vs. competition) and interdependence (vs. independence) affect the relationship between players outside of the game. Similar to relatedness and enjoyment, we observe both mechanics

separately affecting the interpersonal trust that developed between players. Informed by theory, we further offer a model as to how interdependence facilitates the relationship between players. As proposed by previous work, interdependent tasks increase the need for communication [10,9,23,24] and previous work in psychology has hypothesized that this increase in interaction between group members would be responsible for stronger social bonds between the group [5,21,22,24,41]. Our results confirm this hypothesis. The influence that interdependence has on interpersonal trust is fully explained by the increased number of conversational turns between the players.

#### *Disentangling Collaborative Mechanics*

Previous research has only implemented cooperation and interdependence together. This approach was enough to illustrate the potential of games to enhance social relationships. For game developers to make informed design choices, however, we need a more detailed understanding of how these different parts make collaborative games effective at establishing and reinforcing relationships. We need to look underneath the broad category of “collaboration” and start teasing out the underlying mechanics of social play. Our study is the first to disentangle two major mechanics and investigate them as separate properties of a collaborative game. We successfully demonstrate that cooperation and interdependence are in fact two separate forces shaping the players’ perception of the game as well as the relationship that develops with their fellow players.

#### *A Systematic Comparison*

Looking back at existing literature, it becomes evident how much we already know about collaborative play. We have an understanding of which mechanics successful multiplayer games utilize [40,54]. Findings suggest that collaborative games can reinforce relationships between work colleagues [6,11,30], caregiver and caretakers [14], or family members of different generations [16]. What we still lack are systematic evaluations of the mechanisms that we believe are driving the beneficial effects of games on relationships. Our study systematically compares cooperation with competition as well as interdependence with independence within an otherwise identical game. This allowed us to make assertions about how strongly each mechanic influences different outcomes. What we observe is that both mechanics have medium-sized effects on the perceived relatedness, enjoyment and tension. The invested effort in the game is only affected by shared goals, but also with a medium effect size. Regarding the relationship between the players, we observe that both mechanics exhibit large effects on interpersonal trust.

#### *The Additive Model of Collaborative Play*

Our experimental approach allowed us to also investigate how the two mechanics interact with each other. As cooperative and interdependent play have so far only been implemented together, we had no knowledge about if and how the two mechanics influence each other. One reason why these two mechanics are always used together might be the idea that a dependence between players is only conducive to their

relationship if they are on the same team, working towards the same goal. Social interdependence theory [24], for example, proposes that interdependence in combination with competition would lead to oppositional, negative interaction resulting in conflict and distrust. Or perhaps researchers have only used the two mechanics in tandem because they thought that the two mechanics would amplify each other’s effect on social bonds if they occurred together. These models of thinking about the inner workings of collaborative play represent ideas of interactions between the two mechanics. These models, however, have never been investigated in the context of games. Our study addresses this lack of knowledge by giving evidence in support of an additive model. Our findings support the notion that cooperating and being dependent on the other player are two separate mechanics that do not interact, but instead each provide their own influence on how players experience the game and each other. Our results indicate that both individual effects are additive, leaving the cooperation plus interdependence condition to be the most effective at facilitating social closeness. Only the effect on the perceived tension/ pressure appears to adhere to a conditional model.

#### **Theories of Interpersonal Interaction**

In the following section, we look to psychological theories offering explanations as to why cooperation and interdependence in games facilitate social closeness.

*Cooperation in Theory:* The argument that working towards the same goal will facilitate social bonds is most commonly justified using Social Identity Theory (e.g., [11]), which argues that a large part of a person’s self-concept is based on group membership [48]. As an individual can potentially identify with many different groups, an important concept within Social Identity Theory is *group saliency* [19]. When a group membership is more salient to the individual, they will likely identify more strongly with that group. Findings suggest that group saliency can be induced by a minimal set of identifiers—even randomly assigning people to a group can elicit group identification [19]. A game that pits the players together against another team or the system could therefore already be enough to create a sense of group membership reinforced by conflict, i.e., ‘us vs. them’. Greater identification with a group has been linked to greater trust and cohesion among group members [1], greater individual contribution to the goals of the group [1], and increased group productivity [19].

*Interdependence in Theory:* The concept of task interdependence comes from psychological frameworks on group work and is usually described as the ‘degree to which group members must rely on one another to perform their task effectively’ [44]. Regarding the formation of trust in relationships, psychological research supports the idea that task interdependence is a requirement. Trust towards another person is only required if that person’s actions affect the trustor. A person is only vulnerable to a partner if they can be potentially hurt or helped by that person. Therefore, a context of interdependence is helpful, and perhaps even necessary for two

people to build a trusting relationship [41,23]. According to Social Interdependence Theory [24], if a group or dyad performs a task that is high in interdependence, their need to interact and engage with each other increases. This increased interaction and communication between group members is believed to reinforce the formation and maintenance of social relationships. Interestingly the assumption that interdependence in competitive settings would diminish social closeness was not confirmed in our study. Our results suggest that even in competition, interdependence increases relatedness, enjoyment, and interpersonal trust.

### Implications for Design

Given what we have learned from our results, and the psychological theory that explains the findings, we can derive some design implications for social games with the goal to facilitate relatedness, enjoyment, and the relationship between players.

#### Maximizing Cooperation

Our results show that sharing a goal with the other players affects the game positively. Building on social identity theory, we can further recommend that cooperative game mechanics should be designed with group identification in mind. Designs could maximize group saliency by emphasizing group identity. In-group identification can be enhanced by pitting the in-group against an outside force, such as a challenging system or another group. Many multiplayer games have been successfully using group membership as a tool to emphasize cooperation as a game mechanic. *World of Warcraft* (WoW) introduced two factions, creating strong in-group identification (e.g. “For the Horde!”) and a clear enemy faction that players are pitched against in PvP games and ranking systems within WoW. A similar faction system was used in *Pokémon Go*. While there is little interdependence between fellow players in the same team (e.g. team Mystic), game designers used team colors, symbols, and unique Pokémon to create a sense of belonging to one particular group.

So far we have only discussed fully assured cooperation in which goals were pre-set as fully shared. In some games, however, players pursue multiple goals that might conflict. A support character in a MOBA game like *League of Legends* for example, is pursuing the individual goal to level up their own character. Their group goal, however, is to support other characters, which can result in fewer resources for them. As mentioned previously, Zagal et al. [54] describes this as the tension between individual utility and group utility. These scenarios add a level of uncertainty as the players cannot know whether the other players will act in their own best interest or what is best for the group. This uncertainty could hurt the social facilitation through the game or it could form even stronger bonds as cooperation is now a choice and thereby perceived as more meaningful. Our study has only investigated the effect of full cooperation. How conflicting goals affect the relationship between players remains to be investigated.

#### Maximizing Interdependence

Based on our results, we can conclude that a high level of dependency is a desirable property of a game if the goal is to strengthen the social bonds between players. We can furthermore suggest that any mechanic implemented to induce dependency between players (e.g., synergies between abilities, complementary knowledge) should be in service of increasing interaction between players. In this study, we used voice chat as a communication channel and operationalized ‘interaction’ through conversational turns. While our system configuration yielded very positive results, many games might not offer that communication channel to their players. Other games offer different means of interaction such as text chat or low bandwidth signals that signify simple messages like, for example, ‘help’, ‘danger’ or ‘missing enemy’ (as is implemented in *League of Legends*). Research has even suggested that in-game actions can be interpreted as conversational turns [33]. Any mechanic that induces interdependence challenges the players to effectively coordinate and communicate. As a design guideline, we can recommend that any implementation of interdependence should be accompanied by a way for players to successfully send, receive and adequately interpret other players’ signals. The communication channel has to allow for signals that are rich enough in information that players can effectively overcome the coordination challenges that the game poses.

Frameworks from literature on work and organizational psychology distinguish different kinds of interdependence [23,44,50] – specifically, task interdependence and outcome interdependence [50]. Johnson and Johnson [23] define *task interdependence* as the necessity for each member to take action for other members to do any part of their work. In contrast, *outcome interdependence* is defined as the degree to which the outcomes an individual receives depend on the performance of others [23]. As outcome interdependence does not actually require interaction during the task, we would recommend implementing task interdependence. In games, this means that the dependence between players should not be an addition of scores or damage or any other resource in the game, but be derived from a need to coordinate and interact during play.

#### Working with Restrictions

Ideally a game should employ both mechanics in pursuit of strengthening the social bonds between players. However, some games have core mechanics that are incompatible with some of our recommendations. Some games might be inherently competitive and shared goals as a design option is unavailable. Online chess, for example, or multiplayer tower defense games are inherently zero sum paradigms that pit players against each other. Our results suggest that even competitive games can still reinforce relationships through interdependence. Other games might be entirely optimized for individual play independent of other people’s influence or cooperation. *Clash of Clans* for example, is an interesting example of an inherently single player game that still successfully generates strong bonds between their players. The core game elements of building your village and raiding

other villages are competitive and independent in nature. Game designers implemented clan membership, and clan-specific success metrics and leaderboards to induce group identification and an “us vs them” mentality. Game designers also created interesting ways to induce interdependence. Because the core game elements were asynchronous and optimized for a single-player experience, game designers opted for outcome interdependence. In ‘Clan Wars’ (battles between two clans), individual performances were added up to clan-specific performance metrics. Clan wars also induced a need for coordination, as attack strategies have to be discussed. Another mechanic they introduced was a reinforcement system. Other clan members can send reinforcements that support the single players in their raids. These design choices are all peripheral additions that do not fundamentally change the game. They rather leverage the psychological mechanics that underlie the benefits of cooperation and interdependence (group identification, increased interaction), without actually requiring the development of a fully cooperative and interdependent game.

#### Limitations and Future Work

Although our findings provide insights into multiplayer game mechanics for facilitating social closeness, we acknowledge the limitations of this work.

First, we only tested our results using one specific puzzle game. Comparing our conditions in an otherwise identical game was necessary for our research questions. How well our findings translate into game genres like platformers, first-person shooters, or even board games remains unclear. The psychological frameworks would suggest that dynamics like group identification and increased interaction would have similar effects regardless of genre; however, future research should investigate if our findings hold in different genres.

Second, we only tested with a specific set of mechanics. While we believe that these mechanics are valid representations of cooperation and interdependence, we cannot exclude the possibility that other mechanics inducing cooperation and interdependence might have led to different results.

Third, we focused on establishing a new relationship between two strangers in a brief game interaction. How the results extend to relationship maintenance or to establishing relationships that are intended to be deeper (e.g., longer term) or of a different nature (e.g., romantic) is still speculative.

Fourth, we examined dyads. Extending the findings to groups would provide value for the field.

Fifth, it is important to acknowledge that cooperation and interdependence are most likely not the only game elements that facilitate social closeness. Based on theory and the predominant themes discussed in the game literature, however, we found them to be the most prevalent. Future research should further identify mechanics that can bring players closer together.

Finally, our experimental setup did not anticipate the difficulties of sound quality we encountered. While we still found effects using phonetic analysis despite our reduced sample size, future research can draw a lesson from this and instruct participants to reduce background noise (e.g. radio, TV) and use headphones to avoid echo.

#### CONCLUSIONS

The motivational draw of video games comes from different needs they satisfy. While games can make players feel powerful, autonomous, and explorative, they can also make players feel socially connected to other players. In 2016, 54% of the most frequent gamers played socially, to bond with friends, family, or strangers through play [12]. This need is already being acknowledged by game researchers who investigate the social potential of games, as well as by the video game industry who continue to implement more multiplayer mechanics into their games. How do we design games that effectively promote social closeness between the players? We previously had a very narrow understanding of what social play should look like. The work on social play predominantly assumed that games need to be cooperative and interdependent to facilitate social closeness. Our results demonstrate that both factors do in fact positively influence the relationship between the players. Our findings additionally widen the perception of what collaborative play can entail. The effects of cooperation and interdependence are not co-dependent, but are additive and can therefore be leveraged separately. A competitive game high in interdependence can still help two players form a connection. Similarly, shared goals and group identification alone could help players form communal bonds. The disentanglement of concepts previously only used in tandem broadens the design space that we can explore to innovate and further the use of social games. Our findings also help us better understand these mechanics. Interdependent play may only ever be as effective as the communication channels of the game allow it to be.

Forming and maintaining positive relationships between grandparents and grandchildren, caregivers and elderly caretakers, work colleagues, parents and their kids, or distributed friends can be difficult. Social games can be a powerful tool to help strengthen these bonds. The more we understand the underlying elements of social play, the more we can use games to bring people closer together.

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