Player Experiences and Behaviors in a Multiplayer Game: designing game rules to change interdependent behavior

Niko Vegt[1], Valentijn Visch[1], Arnold Vermeeren[1], Huib de Ridder[1]
[1]*Delft University of Technology, faculty of Industrial Design Engineering*
{n.j.h.vegt, v.t.visch, a.p.o.s.vermeeren, h.deridder}@tudelft.nl

Abstract

Serious gaming is used as a means for improving organizational teamwork, yet little is known about the effect of individual game elements constituting serious games. This paper presents a game design experiment aimed at generating knowledge on designing game elements for teamwork. In previous work, we suggested that interaction- and goal-driven rules could guide interdependence and teamwork strategies. Based on this finding, for the present experiment we developed two versions of multiplayer Breakout, varying in rule-sets, designed to elicit player strategies of either dependent competition *or* dependent cooperation*. Results showed that the two rule-sets could generate distinct reported player experiences and observable distinct player behaviors that could be further discriminated into four patterns: expected patterns of* helping *and* ignoring, *and unexpected patterns of* agreeing *and* obstructing*. Classic game theory was applied to understand the four behavior patterns and made us conclude that goal-driven rules steered players towards competition and cooperation. Interaction rules, in contrast, mainly stimulated dependent competitive behavior, e.g. obstructing each other. Since different types of rules thus led to different player behavior, discriminating in game design between interaction- and goal-driven rules seems relevant. Moreover, our research showed that game theory proved to be useful for understanding goal-driven rules.*

Keywords: *Game Rules; Interdependence; Competition; Cooperation; User Research; Game Theory.*

1. Introduction

Teamwork in business organizations (such as a meeting) benefits from individually motivated members and flexible collaborative strategies. Teamwork strategies need to be flexible because teams can change over time in type of task, composition, hierarchy, etc. [1]. Yet teams often tend to choose for one approach and not adapt their strategy to the situation or task at hand [2].

In the last two decades various serious games have been developed to improve teamwork and to align individual and collective goals (c.f. [3]). Examples of serious games for organizational teamwork range from serious gamification of bricks (e.g. Serious Play by Lego [4]) to collective play in 3D environments [5,6]. However, although various serious games are developed for this organizational application domain and they seem to be valuable for the market, very little is known about the effects of separate game elements constituting the serious games [7,8]. For instance we do know that serious games can enhance collaboration but do not know why [9,10]. Nor do we know which game-element within a serious game is responsible for targeted player behavior and player experience - most serious games are still developed as black boxes. In the present work, we aim to provide fundamental ground to the player effect of distinct game elements. This knowledge can in our view be applied to understand found effects of existing games. The knowledge might as well be of value in developing precisely targeted serious games.

To start with, in previous work we explored theories in organizational psychology that overlap with game design theory [11]. Like in organizational psychology, game design theorists agree that goals and rules steer the behavior of players. Rules are seen as fundamental building blocks of games

[12,13,14,15]. According to Caillois [16], play in games is governed by rules and simultaneously serves the need for relaxation and purposeful use of one's knowledge and skills. Game designers can direct the behavior of players by defining the purpose of a game and the procedures and rules that govern the activities to reach it. However, still there is little empirical knowledge on what rules affect what player behavior.

For the present research, the aimed-for effect of serious games (i.e. transfer effect) is team performance. More specifically, the present experiment investigates how player behavior that relates to team performance can be affected by game rules. According to organizational psychology, conflict is one of its main drivers. Most games involve conflict by nature, either among players or between players and the system [17]. Hence conflict management theory could provide a useful perspective for the analysis and design of multiplayer games. Under specific conditions [18], conflict can be used to force teams to rethink their approach and switch towards more favorable strategies. The conflict management model describes possible strategies for dealing with conflict. Depending on the situation, teams can adopt *bargaining* or *problem solving* strategies, such as competing, collaborating, or compromising [19]. Such strategies are also frequently seen in games. According to social interdependence theory, competition or cooperation arises when people experience interdependence in relation to their goals or tasks [20]. People experience interdependence when a change in the state of one causes a change in the state of other(s) [21]. Thus, to design strong teamwork experiences in games, we need to look for game elements that increase the feeling of interdependence and direct teams towards bargaining or problem solving strategies.

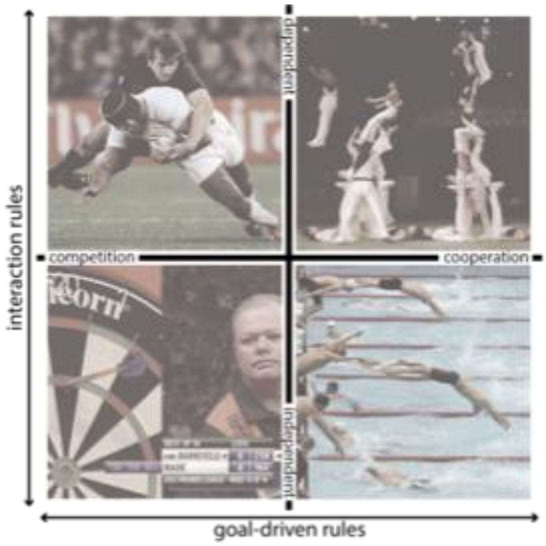

Figure 1. Evoking interdependent behaviors/experiences with goal-driven- and interaction rules (adapted from [11]).

Our framework for the gamification of teamwork situations describes how goals and rules can steer interdependent behaviors and experiences of users, depending on their skills, knowledge, and attitude [11]. It defines four types of interdependent game behaviors: *dependent competition*, *independent competition*, *dependent cooperation*, and *independent cooperation* (see Figure 1). Interaction rules define the interdependence between players. For example, in relay swimming or a darts game, the players take turns. They independently cooperate to swim fastest or independently compete for the highest amount of points. In other cases players directly interact with each other, such as in a rugby game or a group of acrobats. Goal-driven rules govern the actions to reach a goal. They can persuade players to compete or cooperate [22]. For example, in tennis, players gain a point if the other player hits the ball outside the court. The opposite would be to assign points to both players for keeping the ball in the court. The game may become rather boring, but the players will probably cooperate and play the ball such that the other player can hit it back. Think of 'camping badminton'.

Rules in games often relate to objects like coins or an hourglass. Thus embodying rules into game objects is what game design is often about. For example, by drawing lines game designers define the rules for the space of a rugby game. Yet players experience game rules differently. They generally perceive embodied rules, such as the lines of a rugby pitch or the placement of the goals, as game objects rather than rules. From a player perspective, rules are negotiable, "was the tackle allowed or not?" However, from the designer perspective, we are mostly interested in embodied rules, as they can be designed to steer the player behavior and experience. In computer games in particular, most rules are embedded into objects [23]. Negotiable rules may exist or arise, but generally a computer game consists of a fixed set of elements that players can play with. The rules are defined as algorithms or procedures in the game. Hence when we play computer games "*we explore the possibility space its rules afford by manipulating the game's controls*" [13]. Based on the given procedures in a computer game, players can decide on their strategy for reaching their goal (e.g. scoring more points than the opponent or reaching an end condition).

This paper investigates in a multiplayer computer game if and to what extent two fundamental types of game rules, i.e. goal-driven- and interaction rules, lead to specific interdependent player behavior and experiences.

2. Designing embodied rules for a multiplayer game

To investigate the effect of interaction and goal-driven rules, we developed multiplayer Breakout (see Figure 2). The above-described framework was used to design two variants. The interaction and goal-driven rules were defined such that one variant would stimulate *dependent competition* and the other variant *dependent cooperation*. More precisely, interaction rules were kept the same to generate a strong feeling of interdependence in both games, and goal-driven rules had to direct the players towards competition or cooperation.

Multiplayer Breakout is a simple computer game, in which two players move paddles within a confined space and cannot pass each other (nr. 1 in Figure 2). The players score points by breaking bricks (2) with a bouncing ball (3). The goal of the game is to achieve an as high as possible individual score (4) within a certain amount of time (5). A study on the motivational effect of the game elements of single player Breakout [24] demonstrated that, compared to the score and the bouncing ball, players mostly enjoyed to see the bricks break. Even though, compared to the game elements used in that study a paddle is added in multiplayer Breakout, we assumed that breaking bricks is still engaging and that the game motivates players to score as many points as possible.

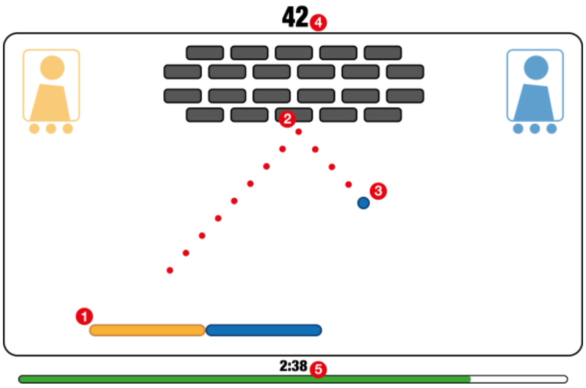

Figure 2. Game elements in multiplayer Breakout: 1) paddles, 2) bricks, 3) ball, 4) score, 5) time.

The game starts with a white ball in the middle of the area and 22 bricks at the top. After a countdown, the ball starts moving and bouncing on the objects in a straight angle. Meanwhile, the players can steer their paddles on the bottom of the screen using the arrow keys on a keyboard. By catching the ball on a particular location of the paddle, players can steer the bouncing angle of the ball and thereby hit the ball into a certain direction. When the ball is not white (i.e. has the color of one of the paddles), it will break the bricks when it hits them. For each broken brick one or both players receive points, depending on the goal-driven rule. Many bricks can be broken in one go when the ball bounces back and forth from one brick to the other. When all bricks are broken, a new level will start in which the speed of the ball increases and a new set of bricks is laid out. The ball can get lost at the bottom of the game area if the paddles do not catch it. Consequently, one or both players will loose a point, unless their score is zero. Every time a ball gets lost, a new white ball will pop up in the middle of the screen. In the original game, players are 'game over' when they have lost 3 balls. Yet in this case, each session takes 3 minutes.

The players only get to see their own score. In order to strengthen the players' focus on their individual score, a high-score list is displayed after each round. It shows one's own scores of all previous rounds and the score from the last round is highlighted. To evoke a strong feeling of interdependence, the paddles cannot cross each other. In a draft version of the game, the paddles were placed on opposite sides of the screen. Yet this resulted in a more independent type of interaction. Moreover, opposition induced a competitive experience, rather than a cooperative experience. In the final version, the interaction rules are defined such that the strength of bouncing each other away depends on the speed of the paddles. Players can take a leap in order to increase speed and thereby make a stronger impact on the other paddle.

The way in which the color of the ball changes embodies the goal-driven rules that should evoke competitive and cooperative behavior. To achieve dependent competition, the players are meant to battle for hitting the ball. The ball therefore adopts the color of the paddle that *has* hit it. Correspondingly, the player that has hit the ball will score points when bricks are broken and loose points if the ball gets lost. In the cooperative variant, the players are meant to alternately hit the ball. In order to achieve this, the color of the ball indicates the paddle that *should* hit it. If the yellow paddle hits the ball, it will turn blue (as shown in Figure 2) and vice versa. If the color of the ball matches the color of the paddle that hits it, the ball will switch color. Otherwise the ball turns white and cannot break bricks. When bricks are broken, both players receive points. If the ball gets lost, both players loose a point.

Consequently, if players are motivated by achieving an as high as possible individual score, the embodied goal-driven rules should direct them towards battling for the ball in the competitive game, and alternating in hitting the ball in the cooperative game. The players should experience competitive behavior as *dependent competition* and cooperative behavior as *dependent cooperation*.

3. Experimental design

We set up a within-subject experimental study to test to what extent the two game variants would actually lead to *dependent competition* and *dependent cooperation*. As explained above, the only difference between the variants were the goal-driven rules, embodied in the way the color of the ball changes. The interaction rules were kept the same. We wanted to measure how the goal-driven rules affected the behavior of players and the way they experienced the game in terms of interdependence, competition, and cooperation.

To capture experiential as well as behavioral effects, a mixed-methods approach was used in which quantitative and qualitative data are integrated [25]. In game analytic research, it is common to use an explanatory design, in which quantitative analysis is followed by qualitative analysis [26]. Yet from a designer perspective, player experiences generally serve as the starting point. Hence, we adopted an exploratory design [27], in which we first analyzed qualitative user experiences building to a quantitative behavioral data analysis.

Measures

In order to measure experienced *dependent competition* and experienced *dependent cooperation*, the players reported their experiences on interdependence, competition and cooperation by filling in a questionnaire after each game round. The questionnaire was partly derived from the Social Presence in Gaming Questionnaire [28]. In order to not influence the behavior of the players in successive game rounds, competition and cooperation were phrased as *obstructing* and *helping* (based on [22]). Players rated statements about interdependence, obstructing, and helping in two directions (e.g. “I depended on the other” and “the other depended on me”; scale 1-5). Moreover, players had to rate their own and the other’s performance, own satisfaction with the performance, and enjoyment during gameplay. At the end of the session, the players had to rate the games on competition and cooperation, on a scale from purely competitive (1) to purely cooperative (10). In a short structured interview, they were asked about the goals and rules they had focused on. We wanted to know if they had understood the game and what elements motivated them most, to determine what elements had mainly driven their behavior and experience.

For measuring behavioral *dependent competition* and *dependent cooperation*, real-time gameplay data and screen capturing captured the player behavior. Initially, it was unknown what behavioral data in the game would be most relevant for measuring interdependence and distinguishing competition from cooperation. Therefore, all gameplay data was stored that could possibly distinguish behavior patterns: location of the paddles, score progression, paddle collisions, and ball hits with coordinates. All game rounds were screen captured to determine behavioral variables that could distinguish interdependence, competition, and cooperation through observation afterwards.

Participants

Game sessions were conducted involving one pair of players at a time. The participants (*N*=30, 15 pairs, 19 female, age ranging from 19 to 34 with an average age of 25) were students and employees of the faculty of Industrial Design at Delft University of Technology. The composition of the pairs was random in terms of age and sex. As a result, we had 2 pairs of men, 6 pairs of women, and 7 mixed pairs. Most players were familiar with the original single player game of Breakout (22 out of 30), 18 participants had also played it before.

Procedure

Each session (30 minutes) started by welcoming two participants in separate, neutral rooms so they would not meet before and during game play. Playing the game in separate rooms ensured that players could not communicate in other ways than through the game. They were seated behind a PC screen with a keyboard and mouse (Figure 3). The game was programmed in Flash Actionscript 3.0 and played full screen on a Windows PC with a 17” screen. First, the participants had to sign a consent form. Next, on-screen textual instructions were shown about the goal of the game and the use of the arrow keys. The instructions did announce two types of the game, yet the embodied rules in the game were deliberately not explained.

The participants continued by filling in a nickname. To show them which paddle they would control, the nickname was visible on their paddle. The first two rounds were single player Breakout as a way of practicing the game and measuring the skills of each individual player. Next, they would play the competitive or cooperative version twice, after which they would play the other version twice. To avoid potential order effects, the order of presentation of game conditions varied. In sum, each participant played 6 rounds. Each round took 3 minutes because pilot tests showed that nearly all players had grasped the embodied interaction and goal-driven rules within that time. So the effect of learning the rules was expected to be significantly smaller during each second round. After each round they had to fill in questionnaire questions that would pop-up on the screen. In the final questionnaire, the players were also asked to rate the games on competition and cooperation, and pick the game they liked most. At the end of the session the players were introduced to each other and shortly interviewed together (10 minutes).

Figure 3. Pairs of players behind a PC in separate rooms.

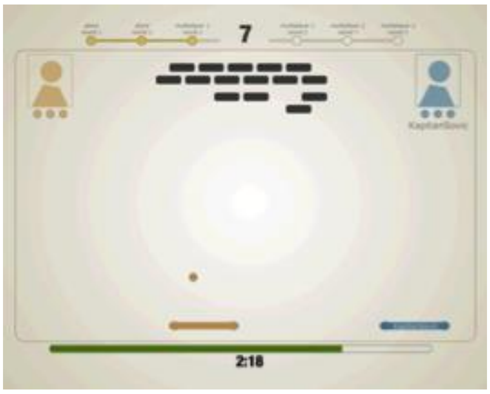

Figure 4. Screenshot of the actual game.

ISSN: 2384-8766 http://dx.doi.org 10.17083/ijsg.v3i4.150

4. Results

Player experience

First, we looked at the effect of the two game variants on the players' experiences. Each variable from the player reports was analyzed, using a 4-way mixed ANOVA, with the game variants and rounds as within-subject variables, and sex and order as between-subject variables. Before performing these analyses, overall interdependence, obstructing and helping were calculated by averaging ratings of self and other. As a result, we found that players felt a strong sense of interdependence in both game variants. In the cooperative game, players felt significantly more interdependent than in the competitive game $F(1,21) = 9.29$, $p = .01$, $\eta_p^2 = .31$; M_{coop}: 3.99, M_{comp}: 3.45. Moreover, there was an order effect $F(1,21) = 7.07$, $p = .02$, $\eta_p^2 = .26$, in which playing the competitive game first led to a stronger overall feeling of interdependence. As expected, obstruction was reported to be significantly stronger in the competitive game (M: 4.02) than in the cooperative game (M: 2.79) $F(1,21) = 30.23$, $p = .00$, $\eta_p^2 = .59$. The reverse holds for helping with a mean score of 3.58 for the cooperative game and 2.25 for the competitive game. In addition, a first order interaction effect between rounds and game variant was found for helping: in the second competitive round, players reported to help each other more. This effect was strongest when players had not yet played the cooperative game $F(1,21) = 10.80$, $p = .00$, $\eta_p^2 = .34$.

Players reported no significant difference in perceived performance and satisfaction between the game variants. We did find a weak first order interaction between order and variant for enjoyment $F(1,21) = 7.72$, $p = .01$, $\eta_p^2 = .27$. Players enjoyed the competitive game less when they first played the cooperative game (M: 3.21) compared to playing the competitive game first (M: 4.30), whereas the cooperative game was always rated approximately the same (M: 3.84). At the end of the session, half of the players reported to prefer single-player most. The competitive game was preferred by 37% of the participants, and 13% liked the cooperative game most.

By clustering the competition-cooperation rating (1-5 = competition; 6-10 = cooperation) that players filled in after the final round, analysis shows that 78% of the game rounds were correctly identified which according to a Fisher's exact test is significant at $p < 0.0001$. From the interviews, we know that most players understood the rules of the game immediately (64%), for others it took a few minutes (31%), and 3 players (5%) did not grasp the rules of the cooperative game at all. Fortunately, these players played the game with a peer that did understand the rules.

Player behavior

Next to subjective player reports, we wanted to investigate the behavioral effect of the different goal-driven rules. In order to find the most differentiating behavioral variables, the screen captures of all game rounds were observed to determine patterns in gameplay. The observed patterns served as guidance for selecting behavioral variables that could distinguish *dependent competition* and *dependent cooperation*. Next, the self-reports were used to check if the chosen behavioral variables correlated with the experiences of the players.

Figure 5 and Figure 6 show graphs of game data of two different game rounds of 3 minutes. The blue line depicts the location of the blue paddle and the yellow line the yellow paddle. Ball hits are visualized as dots; purple crosses depict collisions between the paddles. Figure 5 shows a game round with the cooperative rule. Before this round, the players played the competitive game. The opposite can be seen in Figure 6. These figures suggest that the game variants evoke distinctive behaviors. Initially, paddles move in a way similar to the previous round. In these extreme examples, after approximately a minute (average was 10s) they seem to discover that the rules have changed and adapt their behavior to it. Observations of the screen captures enabled us to describe the different behaviors in more detail.

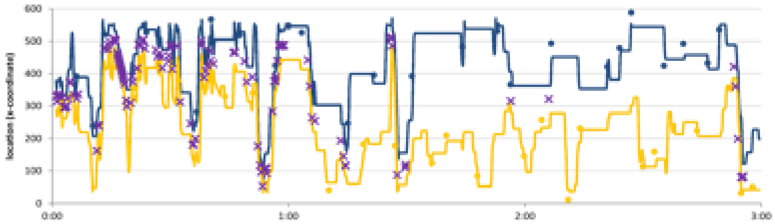

Figure 5. Gameplay data of a cooperative game round; example of players switching from competitive to cooperative behavior.

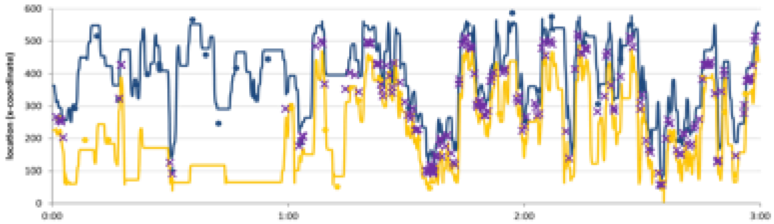

Figure 6. Gameplay data of a competitive game round; example of players switch from cooperative to competitive behavior.

Screen captures observations

In line with the intention behind the design, we mainly observed paddle movements that related to alternating between hitting and not hitting the ball in the screen captures of cooperative game rounds. If a paddle hit the ball, it would typically go to the side and the other paddle would move to hit it. In some cases the ball was hit in such a way that the ball would go towards the other paddle. We also frequently observed occasions in which both paddles stayed on different halves of the game area. They would hit the ball if it landed on their side. When the ball did not resemble the color of the paddle on that side, or when the ball would land in the center of the game area, it was not always clear which paddle went for the ball. If one paddle appeared passive, the other would generally try to catch the ball, irrespective if it was their ball color or not.

In the competitive game, we mainly observed paddle movements that did not seem to relate directly to the trajectory of the ball. The paddles mainly seemed to follow each other, rather than following the ball. For example, the players performed timed collisions by taking a leap to increase the speed for a powerful push. In other occasions, collisions were more constant. The paddles would continuously follow each other from one side of the game area to the other. As a result, collisions were observed frequently. We also observed movements in which both paddles tried to follow the trajectory of the ball. In order to do so, they sometimes needed to push away the other. If the ball landed in a corner that the paddle could not get to, it stayed passive, waiting for the moment to follow the trajectory of the ball again. In this behavior, collisions were observed frequently as well, because both paddles would typically try to follow the ball.

By clustering these observations, we derived four behavior patterns that were observed in both game variants and comprised nearly all gameplay: *help*, *agree*, *ignore*, and *obstruct*. When players were making room for the other to hit the ball, we refer to this as *helping* each other. On occasions when paddles stayed on one half, they seemed to *agree* on dividing the game area. When the paddles followed the trajectory of the ball, the other paddle was merely an annoying obstacle, rather than an opponent. The other seemed to be *ignored*. The pattern of *obstructing* was the opposite. Players seemed to ignore the ball and were mainly focused on colliding with the other paddle, rather than scoring points or catching the ball. We observed all four patterns in both game variants. Yet players mostly seemed to *obstruct* each other in the competitive game, and *help* each other in the cooperative game.

Patterns of behavior in the game data

In order to objectively measure the behavior patterns in the game data, we looked for behavioral variables that could distinguish them. When players *helped* each other (Figure 7), they made room for the other, which would lead to few collisions. When players *agreed* to divide halves (Figure 8), they generally stayed on different sides of the game area, leading to few collisions as well. When players *obstructed* each other (Figure 9), paddles obviously collided frequently. We also expected a large number of collisions when players *ignored* each other (Figure 10), because they would both follow the trajectory of the ball. Thus by counting number of collisions within a certain timeframe we expected to distinguish competitive patterns from cooperative patterns.

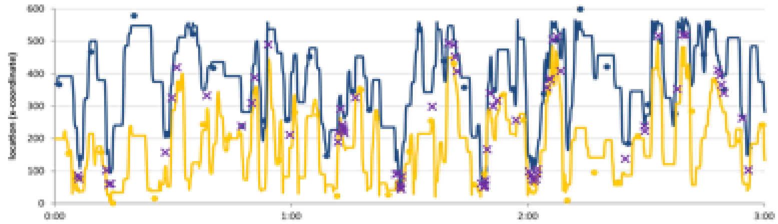

Figure 7. Game round where players predominantly help each other.

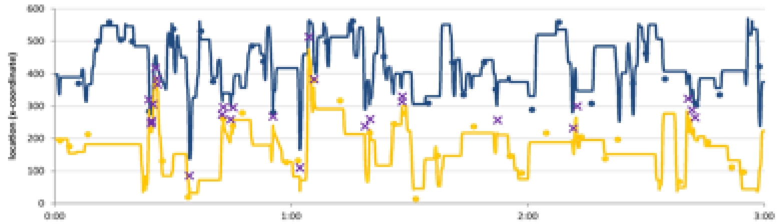

Figure 8. Game round where players predominantly agree to divide the space.

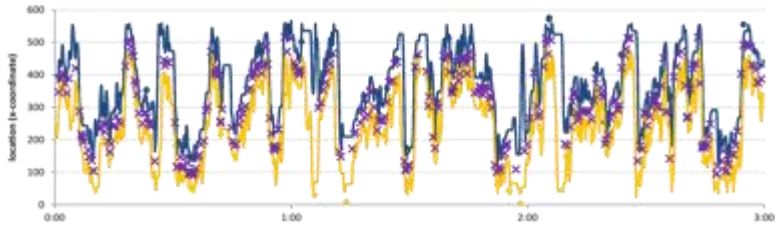

Figure 9. Game round were players predominantly obstruct each other.

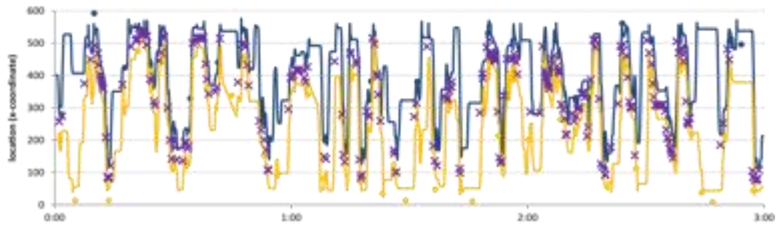

Figure 10. Game round where players predominantly ignore each other.

In the cooperative patterns (*help* and *agree*), players seemed to be focused on hitting the ball, and if possible, hit it alternately. As Figure 7 shows, while *helping* each other, they took turns in covering the full game area, whereas while *agreeing* (Figure 8), they divided the game area. These patterns seemed distinguishable by the distribution of the paddles over the game area: *helping* should lead to larger spatial distribution than *agreeing*. Unfortunately, *ignoring* and *obstructing* could not be distinguished by location distribution, as in both cases they cover the full area, either by following the ball or by following each other. When players followed each other, the paddles stayed close together continuously. When they followed the ball, paddles sometimes became passive when they realized it was not possible to hit the ball or take a leap to push the other paddle away. Hence distance between paddles could distinguish *ignoring* from *obstructing*, in which, on average, *ignoring* was expected to lead to a larger average distance than *obstructing*.

Next, the chosen behavioral variables were used to determine to what extent each pattern occurred in the game data of the competitive and cooperative game. They were measured in blocks of 10 seconds, which was the granularity necessary to measure a distinguishable number of collisions. Thresholds were determined such that measured patterns in the game data correlated with the patterns observed through screen capture observations. To distinguish competition from cooperation, 8 collisions per 10sec was found to be the threshold, nearly resembling the median of 7. For measuring the mutual location distribution of the two paddles we took the standard deviation of the average location of both paddles over 10sec (max: 49.7px, min: 0.4px). A deviation of 16px (32% of the maximum deviation) was found to distinguish *helping* (>16px) from *agreeing* (<=16px).

For average distance in 10sec, 140px (27% of the game area, median: 127px) was found to be the threshold, 140 pixels or less was labeled as *obstruct*, otherwise it would be *ignore*.

As a result (Table 1), we found that in competitive rounds, players *ignored* each other 16% of the time, they *agreed* on dividing the space in 21%, and *helped* each other in 8% of the time. Yet they mostly *obstructed* each other (55%). In the cooperative rounds, we mostly measured *helping* behavior (38% of the time) and *agreeing* behavior (36% of the time). *Ignoring* and *obstructing* were measured 18% and 8% of the time respectively. A chi-squared test finds that frequencies of behavior patterns in the competitive game differ significantly from the cooperative game, $\chi^2(3, N=954) = 281.60$, $p = .000$. *Help* and *agree* are associated with the cooperative game and *obstruct* with the competitive game. Moreover, we found an order effect for *agree*, in which the frequency that players *agree* doubled in the second game variant, irrespective which type.

Table 1. Measured behavior patterns per game variant (blue: competitive behavior, green: cooperative behavior)

	Competitive game	Cooperative game	χ^2 sig.
Help	35 [8%]	193 [38%]	.000
Agree	95 [21%]	180 [36%]	.000
Ignore	74 [16%]	90 [18%]	n.s.
Obstruct	246 [55%]	41 [8%]	.000

Player behavior and experience

Lastly, we investigated to what extent these behavior patterns relate to experienced interdependence, competition and cooperation by comparing the measured patterns with player reports. For each round we defined the dominant behavior pattern by determining the pattern that occurred most. *Help* only dominated in cooperative rounds and *obstruct* was only dominant in competitive rounds. Figure 11 shows the average player reports on interdependence, obstructing and helping, clustered by dominant measured behavior pattern per game round. After playing a round in which *ignore* or *obstruct* occurred most, players reported high obstruction (i.e. competition), whereas *agree* and *help* led to more reported helping (i.e. cooperation). Moreover, players reported to feel more interdependent when *obstructing* or *helping* each other, compared to *ignoring* and *agreeing*. *Ignore* led to the lowest feeling of interdependence.

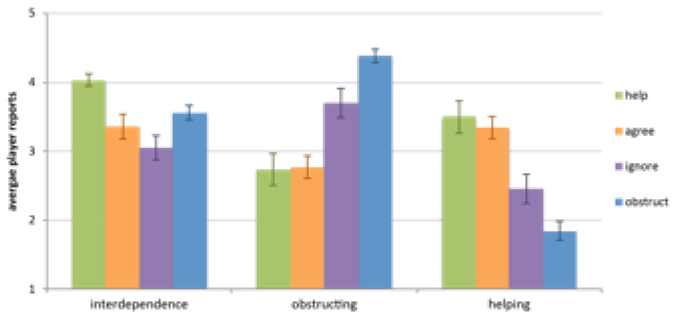

Figure 11. Average player reports per dominant behavior pattern.

The relation between dominant behavior patterns and player reports was analyzed by a one-way ANOVA with the dominant patterns as independent variable and reported interdependence, obstructing and helping as dependent variables. We found a main effect for all player reports (interdependence, $F(3,52) = 6.45$, $p = .001$ $\eta_p^2 = .28$; obstructing, $F(3,52) = 22.52$, $p = .000$, $\eta_p^2 = .58$; helping, $F(3,52) = 19.20$, $p = .000$, $\eta_p^2 = .54$). Post-hoc analysis revealed that *agree* and *help* significantly differ from *ignore* and *obstruct* with respect to reported obstructing and helping. Moreover, rounds in which *help* dominated led to significantly different reported interdependence compared to *agree* and *ignore*.

Effect of goal-driven rules on player behaviors and experiences

The measurements suggest that within the two goal-driven rule types, the competitive rule makes players exhibit behavior that is felt as dependent competition approximately half of the time (i.e.

55% *obstruct*) and the cooperative rule leads to 74% of dependent cooperative behavior (i.e. *help* and *agree*). Thus, the players adapted their behavior considerably to the goal-driven rules. *Helping* in the competitive game and *obstructing* in the cooperative game might be explained by not understanding the rules, but still a large part of unexplained behavioral variance remained.

In the cooperative game, players generally behaved as was intended. *Helping* was clearly aimed at alternating to hit the ball and when players *agreed* to divide the space they frequently alternated in hitting the ball as well. However, in the competitive game, the intended behavior was not frequently observed. Behavior that is aimed at maximizing individual ball hits corresponds with following the trajectory of the ball. This happens when players *ignore* each other. Yet players exhibited this behavior only 16% of the time. Instead, players mostly *obstructed* each other, which led to the intended dependent competitive experience. However, when players had behaved as intended, they might have experienced the competitive game as independent competition, because the player reports suggest that *ignoring* led to moderately interdependent competition.

This may partly be caused by the selection of behavioral variables, which we will get back to in the discussion. Still, we could conclude that the intended behavior did not correspond with the intended experience in the competitive game. Thus, in order to avoid this incoherence in future game designs, we need to better understand how the goal-driven rules led to player behaviors. Game theory provides methods to describe the rules of a game and make predictions on the resulting behavior of players [29]. Therefore, the following section describes an analysis of the goal-driven rules using game theoretical principles. First we describe the goal-driven rules using payoff matrices and deduce what would be logical player behavior. Next, a comparison between the predicted behavior and the measured behavior patterns could indicate in what way and to what extent the goal-driven rules have led to the measured player behavior.

5. Understanding the effect of goal-driven rules through game theory

Camerer [30] explains how game theory could be used to predict player behavior. In non-cooperative strategy games (i.e. players cannot negotiate), like multiplayer Breakout, payoff matrices are used to show the outcome (or *payoff*) of all possible strategy combinations. These matrices allow deducing what would be consistent behavior. To make predictions, the basic assumption is that people play games rationally. They are expected to behave as though maximizing the outcome. In this way, the payoff matrices enable us to describe strategies that players may adopt in relation to achieving an as high as possible score. If predicted strategies correspond with measured behavior patterns we may assume they are affected by the goal-driven rules.

Predicting strategies

In multiplayer Breakout, the color of the ball defines the payoff for each player with respect to the actions: *hit ball* and *not hit ball*. The payoff matrices in Table 2 and Table 3 show the payoff for each action. Two numbers, separated by a comma, represent the payoff: the left payoff is for the ‘row’ player (with the paddle that matches ball color, referred to as *player 1*) and the right payoff is for the ‘column’ player (that does not match ball color, i.e. *player 2*). The payoffs represent the maximum amount of points that players can win or loose within 10s, reflecting score progression instead of the score for each separate ball hit. Moreover, this allows for comparison with the measured payoffs in relation to the 10s interval of the behavioral measures, as explained in the next section. The highest score that was scored in the single player game (115) was taken as reference for the maximum possible score. A game round takes 3 minutes, so one could win approximately 6 points in 10s. When none of the players hits the ball in 10s, the speed of the ball dictates that it can get lost 4 times. Hence the minimum possible payoff is -4.

Table 2 displays the payoffs for the competitive game. If both the players do not hit the ball in 10s, player 1 will loose 4 points and player 2 does not win or loose any points (payoff: -4,0). If one of the players always hits the ball, he or she wins 6 points and the other 0. The players cannot hit the ball simultaneously, so if both players aim to hit it, they have 50% chance of doing so, resulting in a payoff of 3,3 after 10s. In the cooperative game, both players loose points for not hitting the ball. If player 1 hits it, both players win points, and if player 2 hits the ball, no points are scored. Moreover, if both players aim to hit the ball the average payoff would be 3,3.

Table 2. Payoff (i.e. maximum points in 10 seconds) matrix of the *competitive game*

Competitive game		Player$_{(2)}$ that does not match ball color	
		Not hit ball	Hit ball
Player$_{(1)}$ that does match ball color	Not hit ball	-4,0	0,6
	Hit ball	6,0	3,3

Table 3. Payoff (i.e. maximum points in 10 seconds) matrix of the *cooperative game*

Cooperative game		Player$_{(2)}$ that does not match ball color	
		Not hit ball	Hit ball
Player$_{(1)}$ that does match ball color	Not hit ball	-4,-4	0,0
	Hit ball	6,6	3,3

With the payoff matrices of both games we can derive the strategies that players could adopt to reach the optimal score. In game theory, typically the first thing to consider is *dominance*. A strategy is dominant if it is the strict best response to any strategy that the other might play. In the competitive game, hitting the ball is the dominant strategy for both players. For player 1, not hitting the ball leads to a payoff of -4 or 0, whereas hitting the ball makes 6 or 3 points. For player 2, hitting the ball leads to 6 or 3 as well, instead of scoring 0 points when not hitting it. In the cooperative game, hitting the ball is dominant for player 1 as well. Player 2 needs to assume that player 1 will respond with the dominant strategy. Then not hitting the ball dominates for player 2.

Other possible strategies would be to maximize one's minimum possible payoff (i.e. maximin) or minimize the other player's maximum possible payoff (i.e. minimax). In the competitive game, only the minimax strategy for player 2 differs from the dominant strategy to always hit the ball. If player 2 wants to minimize the maximum possible payoff of player 1, he or she should not hit the ball; thereby maximizing the chance that player 1 looses points. In the cooperative game a minimax strategy makes no sense. However, player 2 could adopt a maximin strategy by deciding to hit the ball in order to avoid losing any points.

Comparing predicted strategies with behavior patterns

If the four measured behavior patterns correspond with dominant, minimax, or maximin strategies we may assume that they are driven by the goal-driven rules. Thus, similar to the above-described prediction of game theoretical strategies, we made a hypothetical mapping of the behavior patterns to the payoff matrix (see Table 4). *Help* seems to relate to the dominant strategy in the cooperative game, in which players hit the ball when matching ball color and the other player makes room to allow it. *Agree* corresponds with the maximin strategy in the cooperative game, i.e. players make sure that one of them always hits the ball, irrespective of its color. *Ignore* relates to the dominant strategy in the competitive game, in which both players aim to hit the ball irrespective of the other player's actions. *Obstruct* seems to partly relate to a minimax strategy in the competitive game, in which player 2 tries to block player 1 from hitting the ball. However, observations suggest that *obstruct* alternately leads to both hitting and not hitting the ball, which does not correspond with any of the predicted game theoretical strategies.

Table 4. Mapping patterns of mutual player behavior to the payoff matrix.

<table>
<tr><td colspan="2" rowspan="2"></td><td colspan="2">Player(2) that does not match ball color</td></tr>
<tr><td>Not hit ball</td><td>Hit ball</td></tr>
<tr><td rowspan="2">Player(1) that does match ball color</td><td>Not hit ball</td><td>Obstruct</td><td>Agree</td></tr>
<tr><td>Hit ball</td><td>Agree
Help</td><td>Obstruct
Ignore</td></tr>
</table>

The mapping was verified by comparing measured scores per pattern with predicted scores per pattern (see Table 5). The predicted score per pattern was determined using the mapping in Table 4 and the payoffs in Table 2 and Table 3. As a result, *help* leads to a predicted payoff of 6,6 in the cooperative game and 6,0 in the competitive game, because player 1 will always hit the ball. If players *agree* and the ball lands as frequent on one side of the game area as the other, the players alternately hit the ball. In the cooperative game this would either lead to 6,6 or 0,0 and in the competitive game to 6,0 or 0,6. Hence on average, we expect 3,3 in both variants. Moreover, we expect that *ignore* leads to 3,3 in both variants. If players *obstruct* each other, we expect a payoff of 0,1½, assuming that both players will not hit the ball half of the time (-2,0) and alternately score points the other half (1½,1½). In the cooperative game, *obstructing* leads to 0,0 because the players loose more points than they win.

To determine the measured score per pattern, the average score of all 10 sec instances of a pattern was calculated. In order to avoid analyzing the effect of variation in skills, the scores were corrected in relation to the average single player game score. In order to compare the payoff differences between the paddle matching ball color and the paddle not matching ball color in the competitive game we used number of ball hits. The player with the most ball hits in a 10 sec block resembled the paddle matching ball color. Hence the measured payoff left of the comma in Table 5 represents points scored by the player with the most ball hits and the payoff of the player with the least ball hits is given on the right of the comma.

Table 5. Average predicted and measured scores within 10 sec per behavior pattern.

	Competitive game		Cooperative game	
	Predicted	Measured	Predicted	Measured
Help	6,0	4,1	6,6	3,3
Agree	3,3	3,2	3,3	3½,3½
Ignore	3,3	3,1	3,3	1½,1½
Obstruct	0,1½	2,1	0,0	1½,1½

When comparing predicted and measured scores, we see that players tend not to score as many points as expected. Only when they *agree* in the cooperative game, they reach a larger payoff than predicted. In the competitive game, the actual scores correlate quite well with the predicted scores. *Help* leads to the highest score for the player that matches ball color. *Agree* leads to a more or less equal distribution of points, and *obstructing* results in the lowest scores. The score of player 2 for *ignore* does not correspond with the prediction. Moreover, player 1 scored more points than predicted when players *obstruct* each other.

Understanding behavior patterns through game theory

In general, we conclude that the predicted scores correlate to a large extent with the measured scores. This suggests that the mapping as shown in Table 4 may indeed be used to determine to what extent maximum score drove players to exhibit behavior patterns. In the cooperative game, *help* and *agree* were mostly observed (38%, 36%) and this is most likely caused by goal-driven rules, because players do indeed score most points when *agreeing* or *helping*. In theory, *helping* leads to the maximum score. In practice however, cooperating optimally seems to be difficult, as the measured scores demonstrate. In fact, it seems more efficient to divide the space, thereby minimizing maximal loss. Nonetheless, players adopt *helping* behavior as much as *agreeing*, even when it does not pay off. Hence goal-driven rules could largely account for the measured behavior in the cooperative game.

However, in the competitive game, players seem less driven by the score. When players *obstruct* each other (observed 54% of the time), this does not result in a high payoff. Moreover, the measured score possibly rejects the assumption that *obstruct* could partly be explained by a minimax strategy, because the score of player 1 is not lower than the score of player 2. On the other hand, one could argue that player 1's score is lowest compared to the other patterns. Interestingly, *agree* approximates the predicted score more than *ignore*. Thus, if players wanted to play safe, they could cooperate to score an optimal amount of points. This might explain why players adopt *agree* more than *ignore*, although *ignore* corresponds with the dominant strategy as explained in the previous section.

6. Conclusion

The above-described experiment was aimed at examining to what extent interaction- and goal-driven rules steer interdependent behavior in a multiplayer computer game. Interaction rules were expected to evoke a strong feeling of interdependence. Goal-driven rules were expected to evoke competition in one game variant, and cooperation in the other. The results show that players indeed experienced competition as a result of competitive goal-driven rules and cooperation due to cooperative goal-driven rules. Unexpectedly, further analysis of the player reports demonstrated that the cooperative game led to a stronger feeling of interdependence than the competitive game. An explanation for this was found in the behavioral measurements. The results suggest that players exhibited significantly more behavior that was experienced as *dependent cooperative* in the cooperative game (74%) than *dependent competitive* behavior in the competitive game (55%).

Game theory was used to understand the lack of dependent competitive behavior in the competitive game. Game theoretical strategies predicted that the competitive goal-driven rule would lead to actions that are aimed at a maximum of individual ball hits. This corresponded with behavior patterns *agree* and *ignore*, that players perceived as moderately interdependent (see Fig. 11). Thus the competitive goal-driven rules accidentally induced strategies in which players competed or cooperated relatively independently, even though the intention behind the competitive variant was to evoke dependent competition.

Nonetheless, we mostly observed behavior that evoked a dependent competitive experience in the competitive game (i.e. *obstruct* each other). Yet the game theoretical analysis predicted that the competitive goal-driven rules would induce *agree* and *ignore*, thus we conclude that players either were not driven by scoring points or had other goals in mind. In the interviews, some players indeed expressed they just wanted to obstruct the other player for fun. Others said they wanted to make the other loose the ball or win more points than the other player.

The fact that players mostly exhibited dependent competitive behavior in the competitive game even though it was not the optimal strategy, suggests that the interaction rules may have overruled the effect of goal-driven rules in the competitive game. Players seemed more engaged with interacting with the other paddle than with scoring points. The distracting effect of the interaction rules seemed to diminish over time, as players generally *agreed* more in the final rounds which is likely to be driven by scoring points.

7. Discussion

Limitations

An increase in *agreement* in the final game rounds could, however, also be explained by passivity of players, because *agree* was measured by few collisions and a low location distribution. The measured scores do not suggest passivity however. Instead, measured scores suggest that the behavioral variables for *ignore* (i.e. many collisions and a large distance between the paddles) may have partly captured passivity of one of the players. This could explain why it was observed as much in the competitive game as in the cooperative game and why it was experienced as moderately interdependent. In the present experiment, passivity was not included in the behavioral analysis, because it would probably not significantly impact the relative occurrences of patterns. In more complex contexts, such as a serious game, passivity of players may become a more important factor to take into account.

As [11] explains, the variation between intended and observed behavior patterns could also be explained by user characteristics (i.e. skills, knowledge and attitude). Among other things, learning time seemed to influence player behavior, as some players understood the rules immediately, whereas for others it took a while. Yet a transition phase as shown in Fig. 5 and 6 was rare. On average, players needed 10s to switch to a behavior pattern that related to the game variant. Still, particularly in the cooperative game, not fully understanding the rules or mastering the controls was probably one of the main causes for behavior patterns other than *helping*.

Next to skills and knowledge, the players' playful attitude may have influenced their behavior, because people that are more playful generally pay less attention to goal-driven rules [31]. Moreover, they would probably react differently on the presence of another player. Some players stayed focused on their individual task, thereby *ignoring* the other player. Yet most players seemed to be significantly distracted by the presence of the other paddle. And finally, players may have had predetermined preferences for certain strategies. Some prefer to approach conflicts cooperatively, whereas others prefer to compete.

To address effects of player characteristics, the sample size (number of player sets) in this study is too limited. Regarding the effect of the rules on player behavior and experiences the results seem convincing, as effect sizes are relatively high. Moreover behavioral measures, player reports, and player comments in interviews are consistent.

Recommendations for designing game rules

Overall, the findings suggest that by designing interaction- and goal-driven rule-sets, we can persuade players to compete or cooperate in games. Application of these rule types is expected to be of value especially in the design and understanding of serious games aimed at increasing team performance, i.e. interdependent player behavior. Yet defining the rules of a game for particular interdependent behaviors and experiences is proven to be difficult. This paper demonstrated that although we designed a game for a particular type of behavior, players tend to exhibit a broader spectrum of behaviors. Therefore, a framework such as Figure 1 or game theoretical principles are useful tools for defining the right set of game elements to stimulate intended behaviors and possibly avoid unwanted ones. For example, game-like workshops often bog down in pure gameplay, where participants loose the serious purpose out of sight. By strengthening goal-driven rules, such as introducing competing groups, this may be avoided.

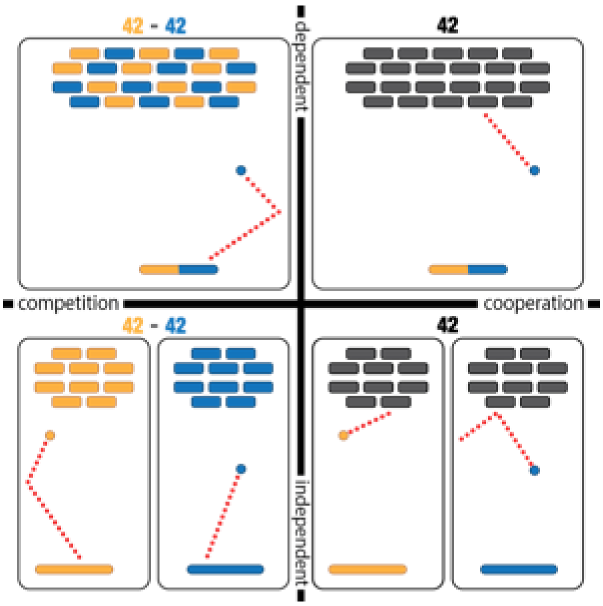

Figure 12. Alternative designs of multiplayer Breakout, inspired by the framework.

The game theoretical analysis showed that, when designing multiplayer Breakout, we only had dominant strategies in mind. By predicting strategies from the goal-driven rules, game theory added to a more precise prediction of the resulting player experience. Moreover, game theoretical principles, such as payoff matrices, could be used to design player experiences. For example, by adapting the payoff distribution towards a zero-sum game, in which one player looses points when the other wins them, thereby intensifying competitive experiences.

The framework for the gamification of teamwork situations (Figure 1) aided the game design process by identifying behavioral/experiential variations as a result of interaction- and goal-driven rules. Figure 12 schematically shows alternatives for the embodiment of interaction- and goal-driven rules in multiplayer Breakout. For example, by adapting the interaction rules such that both players control one paddle, *agreement* would not be possible, as shown in the upper variants. Conversely, by giving each paddle its own game area, players are forced to *agree* or *ignore* each other. By clearly showing an individual or collective score, competition or cooperation could be stimulated. In this way we could develop games that elicit more distinctive experiences.

In a simple game like Breakout, with simple goals and interactions, developing alternative designs for distinctive experiences seems relatively straightforward. Yet in serious games with its more complex scenarios and decision-making processes, developing such designs is expected to be more difficult. A possible strategy to resolve this gap is to dissect a serious game into its "*goal atoms"* [11] for disentangling the effects of individual interaction- and goal-driven rules. For example, in a leadership assessment game, teams compete for winning the challenge, while at the same time teammates cooperate to develop a good product and compete for the best individual assessment. All three goals may be adapted differently using the framework to diversify player experiences or to make them more coherent.

Future work

More distinctive experiences might lead to games that are more engaging over a longer period of time and thus increase gameplay retention. Investigating the effect of varying sets of experiences as a result of interaction- and goal-driven rules on retention rate would be an interesting follow-up question. Next to game design research, our findings could inspire non-game or serious game research, as the findings are based on theory that is not restricted to entertainment games. A direct way of using this paper's outcomes could be to deploy the two variants of multiplayer Breakout as assessment tool in non-game contexts, such as a personality test. As explained above, players seemed to react differently on the game depending on their attitude, knowledge, and skills. Hence, switches in interdependent behavior as shown in Figure 5 and 6 might say something about a players' characteristics.

Moreover, if game elements can steer players towards particular strategies in entertainment games, we may be able to use the same principles in organizational serious games to influence non-game teamwork situations as explained above. Yet the difficulty of predicting the effects of rules and user characteristics on player behavior possibly complicates the use of interaction- and goal-driven rules in non-game teamwork contexts as they are more complex than multiplayer Breakout. On the other hand, entertainment games generally make players behave more playful. Thus stepping outside the *magic circle* [32] might positively affect the extent to which people act goal-oriented and consequently the extent to which they can be persuaded by goal-driven rules. Hence investigating the effect of interaction- and goal-driven rules in non-game teamwork contexts remains an interesting direction for future research. Additionally, it would be worthwhile to examine the effect of these rule types in serious games that elicit player behaviors other than the behavior patterns found in the present experiment, such as trading or communication.

Regarding measuring the effect of such interventions, this paper presented a successful account of combining user research with game analytics. Currently, game design research is in need of mixed-methods approaches [33], as they seem crucial to address the complexity of serious game design. By thoroughly describing our method and including organizational psychology and game theory, we hope this paper contributes to the methodological discussion as well as to adhere to the still limited knowledge of behavioral effects of rule-sets in games.

References

[1] Salas, E., Cooke, N.J., Rosen, M.A., On Teams, Teamwork, and Team Performance: Discoveries and Developments. Human Factors. 2008 June;50(3):540-547.

[2] Hackman, R.J., The design of work teams. In: Lorsch J, editor. Handbook of organizational behavior. Englewood Cliffs, NJ: Prentice-Hall; 1987.

[3] Stoppelenburg, A., de Caluwe, L., Geurts, J., Gaming: organisatieverandering met spelsimulaties. Deventer: Kluwer; 2012.

[4] Kristiansen, P., Rasmussen, R., Building a better business using the Lego Serious Play method. John Wiley & Sons; 2014.

[5] Bozanta, A., Kutlu, B., Nowlan, N., Shirmohammadi, S., Multi user virtual environments and serious games for team building. Procedia Computer Science. 2012;15:301-302.

[6] Wendel, V., Gutjahr, M., Göbel, S., Steinmetz, R., Designing collaborative multiplayer serious games. Education and Information Technologies. 2013;18(2):287-308.

[7] Deterding, S., Dixon, D., Khaled, R., Nacke, L.. From Game Design Elements to Gamefulness: Defining "Gamification". In: MindTrek’11; 2011; Tampere, Finland.

[8] Hamari, J., Koivisto, J., Sarsa, H., Does Gamification Work? - A Literature Review of Empirical Studies on Gamification. In: System Sciences (HICSS), 47th Hawaii International Conference on; 2014. p. 3025-3034.

[9] Mayer, I.S., van Bueren, E.M., Bots, P.W.G., van der Voort, H., Collaborative decisionmaking for sustainable urban renewal projects: a simulation - gaming approach. Environment and Planning B: Planning and Design. 2005;32:403-423.

[10] Apostolakis, K.C,, Psaltis, A., Stefanidis, K., Kaza, K., Thermos, S., Dimitropoulos, K., Dimaraki, E., Daras, P., Exploring the prosociality domains of trust and cooperation, through single and cooperative digital gameplay in Path of Trust. International Journal of Serious Games. 2016;3(3):39-57.

[11] Vegt, N., Visch, V., de Ridder, H., Vermeeren, A., Designing Gamification to Guide Competitive and Cooperative Behavior in Teamwork. In: Reiners T, Wood LC. Gamification in Education and Business. Cham: Springer International Publishing AG; 2014. p. 513-533.

[12] Avedon, E.M., The Structural Elements of Games. In: Avedon EM, Sutton-Smith B. The Study of Games. New York: Wiley; 1971. p. 419-426.

[13] Bogost, I., Persuasive games: the expressive power of videogames. Cambridge: MIT Press; 2007.

[14] Juul, J., Half-real:video games between real rules and fictional worlds. Cambridge: MIT Press; 2005.

[15] McGonigal, J., Reality is broken. London: Jonathan Cape; 2011.

[16] Caillois, R., Man, play, and games. University of Illinois Press; 1961.

[17] Salen, K., Zimmerman, E., Rules of Play: Game Design Fundamentals. Massachusetts: MIT Press; 2004.

[18] de Dreu, C.K.W., When too little or too much hurts: evidence for a curvilinear relationship between task conflict and innovation in teams. Journal of Management. 2006;32(1):83-107.

[19] Rahim, M.A., Toward a theory of managing organizational conflict. The international journal of conflict management. 2002;13(3):206-235.

[20] Wageman, R., Interdependence and Group Effectiveness. Administrative Science Quarterly. 1995;40:145-180.

[21] Johnson, D.W., Johnson, R.T., New Developments in Social Interdependence Theory. Genetic, Social, and General Psychology Monographs. 2006;131(4):285-358.

[22] Deutsch, M., Cooperation and Competition. In: Deutsch M, Coleman PT, Marcus EC. The Handbook of Conflict Resolution: Theory and practice. San Francisco: Jossey-Bass; 2006. p. 23-42.

[23] Järvinen, A., Games without Frontiers: Theories and Methods for Game Studies and Design. Tampere: University of Tampere; 2008.

[24] Malone, T.W., Toward a theory of intrinsically motivating instruction. Coginitive science. 1981 333-369.

[25] Tashakkori, A., Teddlie, C., Sage Handbook of Mixed Methods in Social & Behavioral Research. Thousand Oaks: Sage; 2010.

[26] El-Nasr, M.S., Drachen, A., Canossa A., Game Analytics: Maximizing the Value of Player Data. Springer; 2013.

[27] Creswell, J., Plano Clark, V., Designing and Conducting Mixed Methods Research. Thousand Oaks: Sage; 2007.

[28] de Kort, Y.A.W., Ijsselsteijn, W.A., Poels, K., Digital games a social presence technology: Development of the social presence in gaming questionnaire (SPGQ). In: PRESENCE 2007 Proceedings; 2007; Barcelona. p. 195-203.

[29] Binmore, K., Game Theory: a very short introduction. Oxford: Oxford University Press; 2007.

[30] Camerer, C.F., Behavioral Game Theory: Experiments in strategic interaction. Princeton University Press; 2003.

[31] Apter, M.J., Understanding reversal theory: a programmed tutorial. 2008.

[32] Huizinga, J., Homo ludens: proeve eener bepaling van het spel-element der cultuur. 2008th ed. Amsterdam: Amsterdam University Press; 1950.

[33] El-Nasr, M.S., Desurvire, H., Aghabeigi, B., Drachen, A., Game analytics for game user research, part 1: a workshop review and case study. IEEE Computer Graphics and Applications. 2013 Mar-Apr;2:6-11.