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COMPETITIVE, NEUTRAL, OR COOPERATIVE OUTCOME INTERDEPENDENCE?
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CONSEQUENCES ON THE BEHAVIORAL AND PERCEPTIONAL LEVEL

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GENERAL INTRODUCTION

How to Reward Individual Performance

Monetary rewards are omnipresent in today's working life. It is the ultimate goal of every organization to motivate and satisfy its employees through the implementation of a variety of payment plans to heighten the individual work performance and thus organizational outcomes. Various studies about the motivational (Rynes, Gerhart, & Minette, 2004) and job-satisfactory (Judge, Piccolo, Podsakoff, Shaw, & Rich, 2010) aspects of monetary rewards have been conducted over the last decades. On the one hand, Deci, Koestner, and Ryan (1999, p. 657) advise to the possibly detrimental effects of monetary rewards linked to performance contingent on intrinsic motivation. On the other hand, Judge et al. (2010) allude to the linear positive connection between raising payments and job satisfaction. Overall, monetary rewards may not be the most perfect solution to motivate and satisfy workers, but they definitely are the most widespread solution in our western materialistic society nowadays (Kasser, 2002).

Research strongly focuses on at least two different levels to implement monetary rewards: individual and group. More precisely, what are the consequences of rewards which are paid on an individual level (individual-based rewards) vs. on a group level (group-based rewards; Durham & Bartol, 2000, "team-based" rewards)? Questions arise in terms of the interdependence of rewards and individual behavioral reactions to, and perceptions of different interdependences: What are perceptional and behavioral consequences of paying one employee better than others, because of his/her performance compared to others (the individuals "market value"; Lawler, 2000)? Is it problematic when all members of a group/department are paid the same, independently from their individual contributions? Does a competitive reward structure facilitate more reward-maximizing behavior, and does it coevally cause negative long-term consequences on perceived job satisfaction?

Individual-based Compared to Group-based Rewards

Individual-based rewards can ease each individual's appraisal of the proximate connection between individual performance (or individual attributes) and payment: When a set monetary reward is given for a pre-defined performance unit on the individual level (Durham & Bartol, 2000; Gagné & Forest, 2008), individual motivation can be affected positively because a raise in individual performance proximately and comprehensibly leads to a higher reward (Fang & Gerhart, 2012). So, when individual performance is identifiable and individuals are attending their tasks discretely it seems likely to implement such reward systems. Whereas pay-for-performance plans provide a proximate linearity between individual performance and the monetary reward (e.g., piece-rate plans), it is also possible to define cut-off values between specific amounts of performance and payment (bonus pay) or a pre-defined salary independently from individual performance (base pay; see Table 1 for an overview). In the long run, all individual-based rewards will depend on the individual's performance. Bad performances coevally result in a low reward when pay-for-performance plans are implemented.

Organizations often delegate group tasks to their employees because these tasks exceed the abilities of one individual alone (e.g., Hackman & Morris, 1974). Within group tasks individual performance can become less identifiable - group-based rewards are then the most appropriate reward system (DeMatteo, Eby, & Sundtrom, 1998; Nickel & O'Neal, 1990). A group-based reward can be distributed within a group by different strategies. Commonly, two strategies are distinguished (Bartol & Hagman, 1992; Gagné & Forest, 2008): First, equality strategy, which provides equal shares of the reward for each group member, independently from personal attributes or performance; second, equity strategy, which allocates unequal shares to the group members. When equity strategy shares are based on contributions of each individual to the group task (Bartol & Hagman, 1992), some relatedness to individual-based rewards becomes apparent: Although a group-based reward depending on the whole group's performance is allocated, e.g., a pay-for-performance plan can be realized *within* the group: The distribution of the reward then proximately depends on individual performance.

Furthermore, the term "gainsharing" is often named in touch with group- (Gagné & Forest, 2008; Wageman, 1995) vs. organizational-based rewards (Durham & Bartol, 2000). Here, gainsharing is classified as group-based reward: If each employee's reward is completely linked to the performance of his/her department or work group, the

criterion for group-based rewards is met: The reward is variable and depends on the performance of a group of employees (DeMatteo et al., 1998, p. 143). Thus, in Table 1, it is differed between individual- and group-based rewards:

Table 1: Individual- and Group-based Rewards

Individual-based rewards	*Definition*
Pay-for-performance	The monetary reward depends on a pre-defined performance unit (e.g, specific piece-rate at assembly lines).
Bonus pay	One or more cut-off values in terms of individual achievement of performance units are defined, which lead to pre-defined monetary rewards (e.g., as of 100 sold insurances, a specific monetary reward is paid by the employer).
Base pay	The monetary reward does not depend on pre-defined performance units, but on occupying a position in a group/an organization (e.g., monthly payment as employee *without* target-setting in terms of piece-rates). Base pay can be extended based on yearly performance appraisals ("merit pay") or based on knowledge competencies of employees ("Skill based pay").
Group-based rewards	*Definition*
(Gainsharing) Equality distribution	The monetary reward, depending on the whole group's performance, is equally distributed amongst group members (e.g., performance of a whole department within a company).
(Gainsharing) Equity distribution	The monetary reward, depending on the whole group's performance, is distributed equitably amongst group members. This distribution of uneven shares of the group-based reward within the group can be pre-defined by several criteria (e.g., status, contribution to the group's task).

Note. Selection and classification of individual- and group-based rewards according to Gagné and Forest (2008), Wageman (1995), Wageman and Baker (1997). Here, organizational-based rewards are not included into the scheme (see Gagné and Forest, 2008: "Profit sharing", "Stocks and options"), because they can also be described as group-based rewards by defining the organizational level as group level and implementing equality or equity distribution strategies. Furthermore, so called "mixed pay plans" are not named separately because they consist of single components of the listed individual- and/or group-based rewards and are thus merely combinations of the described reward systems above. *Merit pay*, which means raising the pay of an individual according to "past work behaviors and outcomes" (Durham & Bartol, 2000, p. 151) is not listed separately due to its relatedness to *Base pay*.

Neither individual- nor group-based rewards have been identified as the superior system to raise performance or job satisfaction over the past years in the literature: Evidence was found that individual-based rewards facilitate performance better than group-based rewards (McGee, Dickinson, Huitema, & Culig, 2006; Williams & Karau, 1991).

Evidence was also found that there is no difference between both reward systems (Honeywell, Dickinson, & Poling, 1997; 1999; London & Oldham, 1977). There is also some evidence that higher performance/motivation is caused by group-based rewards (Condly, Clark, & Stolovitch, 2003; Honeywell-Johnson & Dickinson, 1999; Lawler, 2002; Taylor, 2006; Wageman, 1995).

General differences between individual-based vs. group-based rewards on performance or performance-related measures are not focused in the empirical studies of this thesis. Nevertheless, both levels of rewards (see Table 1) have to be implemented to allow for all different forms of interdependence between each individual's rewards which are defined in the following. Effects of outcome interdependence on behavioral and perceptional variables are the main focus of this thesis, and different forms of outcome interdependence partly presume individual- or group-based rewards or can be varied differentially within group-based rewards.

Outcome Interdependence

Individual-based rewards as listed in Table 1 do not necessarily declare any form of dependence between individual outcomes. However, group-based rewards are always assuming at least a minimal level of interpersonal dependence between group members concerning their outcomes: When group members show a poor performance, they lower the level of monetary reward not only for themselves, but also for their colleagues. To classify dependence of monetary rewards between individuals for individual-based as well as group-based rewards, three different levels of outcome interdependence are used: cooperative outcome interdependence vs. no/neutral outcome interdependence vs. competitive outcome interdependence (Table 2):

Table 2: Forms of Outcome Interdependence

Outcome interdependence	Definition
Neutral outcome interdependence (only individual-based rewards)	Monetary rewards of multiple individuals are independent from each other. Thus, the performance of one individual can not affect the reward of another individual in a positive or negative way. All examples for individual-based rewards listed in Table 1 can be implemented with neutral outcome interdependence.
Cooperative outcome interdependence (only group-based rewards)	Monetary rewards of multiple individuals are promotively interdependent from each other. The performance of a whole group is rewarded, and then distributed throughout group members via equality strategy. A good performance of one individual equally raises the reward for all group members.
Competitive outcome interdependence (both individual- and group-based rewards)	Monetary rewards of multiple individuals are contriently interdependent from each other. A good performance of one individual lowers the reward for other individuals/group members. This competitive outcome interdependence can be both implemented as individual-based reward (only a limited overall-reward is available for all separately performing individuals) or as group-based reward leading to within-group competition (the group-based reward which depends on the whole group's performance is equitably distributed within the group, e.g., depending on individual contributions).

Note. Three different forms of outcome interdependence, integrating the definitions of Deutsch (1949a, 1949b), Vegt, Emans, and Vliert, (1998); Wageman (1995); Wageman and Baker (1997).

Outcome Interdependence and Individual- vs. Group-based Rewards

Neutral outcome interdependence can only be implemented on the level of individual-based rewards as it is described as "individual rewards" by Wageman and Baker (1997): Those rewards "[…] are earned by members based on individual performance" (p. 142). Pay-for-performance plans, as described in Table 1, are commonly implemented with neutral outcome interdependence and provide a linear, comprehensible connection between individual performance and the paid reward (Gagné & Forest, 2008; Wageman, 1995), and no dependence between individual rewards and the performance of others.

Cooperative outcome interdependence, on the contrary, can only be implemented as group-based reward. Here, individual rewards are promotively interdependent (Deutsch, 1949b): A whole group or department (gainsharing) is rewarded for its performance, and this reward is distributed within the group hereafter. At this point, it is important to allude to the distribution strategy of the reward, because only equally distributed rewards within a group fulfill the definition of promotive interdependence by Deutsch and thus, lead to "real" cooperative outcome interdependence: Only when each

group member will receive the same share of the group's reward, competition *within* the group is impossible. In line with this definition, Bartol and Hagman (1992) define the equal distribution of rewards within a group to "[…] support and reinforce cooperation among team members." (p. 28).[1]

Unlike neutral and cooperative outcome interdependence, competitive outcome interdependence can be implemented both as individual- and group-based reward. When only a limited overall reward is available, pay-for-performance plans as individual-based rewards become contriently interdependent (Deutsch, 1949b): Individuals are set in relation to each other, and only high performing individuals get high rewards. These contriently interdependent individual-based rewards presuppose that there is no rewarding of a whole group (e.g., Taylor, 2006). On the other hand, if group-based rewards are implemented, they can also be competitively interdependent, regulated by the distribution strategy of the reward *within* the group: If a group-based reward is implemented, rising performance of the group heightens each group members reward. But if the distribution of the group-based reward is non-equal between the group members - described as "equity" by Bartol and Hagman (1992) - competitive outcome interdependence occurs within each group. Thus, if one individual's performance is inferior compared to his/her group members, the reward can be extremely low/zero, even in a high performing group.

Consequences of Outcome Interdependence

There is strong evidence that cooperative outcome interdependence does facilitate a cooperative work climate - it is associated with higher perceptions of interpersonal trust, constructiveness, and psychological safety, (DeDreu, 2007). Furthermore, a positive effect of cooperative outcome interdependence on behavior - e.g., group's effort, achievement, helpfulness, or productivity - has been found (for overviews see the meta-analyses of Johnson & Johnson 2005, 2009). One major concern with these findings is that cooperative outcome interdependence, implemented as group-based reward with equality distribution strategy, could just cause proself motivation to achieve higher

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[1] Cooperative outcome interdependence within a group can also facilitate exploiting behavior like social loafing, because a good team members' performance can balance the substandard input of single individuals (e.g., see Karau & Williams, 1993 for an overview). This problem can rise linearly with the size and thus more anonymity within the group (e.g., Wageman & Baker, 1997).

rewards (DeDreu, Nijstad, & van Knippenberg, 2008; q.v. Judge et al., 2010; monetary rewards as extrinsic motivator): It pays out to help group members and to thus generate a cooperative climate, when a group-based reward is cooperatively linked between the group members (Deutsch, 1949b: promotive interdependence). In other words, cooperative outcome interdependence causes reward-maximizing, cooperative behavior with a high probability. This cooperative behavior is then perceived by all group members leading to the perceptional findings described above (DeDreu, 2007).

From this point of view, outcome interdependence should always facilitate reward-maximizing behavior, but this behavior differs between competitive and cooperative outcome interdependence. When individual rewards are competitively linked (Deutsch, 1949b: contrient interdependence), individuals show a reward-maximizing behavior which fully adapts the competitive scenario and drives them to disadvantage peers; e.g., to withhold information which could be useful for others and raise their chances for a higher reward (Taylor, 2006). It would not be surprising to find that competitive outcome interdependence leads to perceptions of a competitive climate between the individuals - e.g. less interpersonal trust, constructiveness, and psychological safety (DeDreu, 2007).

Here, perceptional variables are chosen which are crucial to appraise the expedient implementability of different outcome interdependences for organizations: pay satisfaction, stress level, and fairness. First, effects of competitive vs. cooperative outcome interdependence on pay satisfaction are rather important because of the long-term consequences on job satisfaction and organizational outcomes (e.g, Whitman, van Rooy, & Viswesvaran, 2010). On the long run, competitive outcome interdependence can lead to the systematic discrimination of multiple individuals, lowering their reward and pay satisfaction (Daniels, 2000). Second, a competitive climate can also raise the individual stress level (Fletcher, Major, & Davis, 2008), leading to psychological (e.g., depression, see Dragano et al., 2008) or physiological reactions (e.g., tinnitus; see Scheuch, 2008 for an overview). Third, competitive outcome interdependence can lead to perceptions of unfairness when individual efforts and payouts do not match efforts and payout ratios of group members (Adams, 1965) - this happens e.g., when criteria for different payouts within groups are not comprehensibly reasonable for single persons. Matching to the antecedent thoughts, Bettencourt and Brown (1997) found that the

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perceived (un-)fairness of employees' payment is proximately linked to less job satisfaction.

Contents of the Thesis

The aim of this thesis is to assess effects of competitive, neutral, and cooperative outcome interdependence in monetary individual- as well as group-based rewards on multiple dependent variables, and to draw conclusions about their implementability in today's work life. The general goal is to assess which consequences different forms of outcome interdependence have on (a) reward-maximizing behavior; (b) the individual work experience with those rewards. Thus, one aim of this thesis is to extend the psychological view on payment strategies by behavioral monitoring and to question if competitive, neutral, or cooperative outcome interdependence effect reward-maximizing strategies and perceived pay satisfaction, stress or fairness differentially between the conditions. It is thus differentiated between the triggering of reward-maximizing behavior (and related success) and perceptions of the reward structure - these perceptions should be affected by the type of outcome interdependence. An overall of three empirical studies are conducted, which are described in detail in **Chapter 1** (study 1, study 2) and **Chapter 2** (study 3) and below.
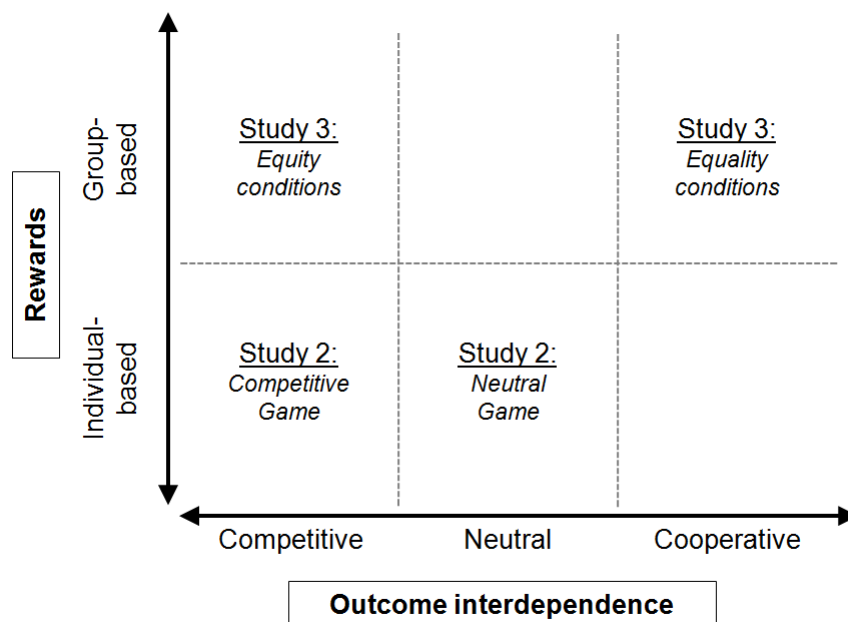

Figure 1. Note. Overview of the studies 2 and 3.

Study 1 is conducted to assess if the experimental setting (HoneyComb; Boos et al., in prep.; Pritz, 2011) can be handled by the participants without implementing any reward and is therefore not included in Figure 1. Neutral outcome interdependence (study 2), e.g., defined as "individual reward" by Wageman and Baker (1997) exclusively rewards individual performance and can thus not be implemented as group-based reward. Cooperative outcome interdependence (study 3) bases on the collective performance of a group (e.g., Wageman, 1995), and can thus not be implemented as individual-based reward.

Chapter 1 (study 1 and study 2)

In Chapter 1, the computer-based multi-client game HoneyComb (Boos et al., in prep.; Pritz, 2011) is used in two experimental studies. Study 1 focuses on the implicit tendency of humans to approach their proximate neighbors, described as "flocking behavior" (Vine, 1971), without any form of reward. In study 2, the effects of individual-based rewards under competitive and neutral outcome interdependence on reward-maximizing behavior, pay satisfaction and perceived stress are assessed.

Study 1

In study 1, effects of the visual presence of group members on a virtual 97-hexagons playfield in 10-person groups are assessed (HoneyComb, Boos et al., in prep.; Pritz, 2011). Two games are implemented: (a) a *Single Game*, which only represents one pertinent player on the playfield as black dot, other players are set invisible; (b) a *Joint Game*, where group members are also visible as smaller black dots on each screen. No rewards or goals are implemented in both games, but the demand is for each player to do at least 10 moves.

The HoneyComb game allows assessing multiple behavioral variables: movement speed, time each group needed to complete a game, and each group's dispersion rate on the playfield.

Expectations in study 1 are about a very implicit human behavior: the tendency to flock. It can be deduced from features of group living and related costs and benefits (Sumpter, 2010): Cohesion, which is most beneficial for the majority of group members, can only be achieved in groups which are dependent on flocking behavior as automatic

mechanism of self-organized collective behavior (Conradt & Roper, 2005; Conradt & List, 2009; Conradt & Roper, 2009; Boos, Kolbe, & Strack, 2011; Fichtel, Pyritz, & Kappeler, 2011). Pertinent models which contain this mechanism as basic assumption (Couzin, Krause, Franks, & Levin, 2005; Ichiro, 1982; Reynolds, 1987) assume the inherent tendency to approach neighbors without explicit goal or reason. Therefore, human players are expected to actively reduce the distance to their proximate neighbors in the Joint Game, compared to the Single Game. Furthermore, faster movements in the Joint Game compared to the Single Game are expected based on the generalized drive hypothesis (Zajonc, 1965), pleading for a higher activation level when group members are visible. In addition, effects of game sequences are assessed.

Study 2

In study 2, effects of outcome interdependence within an individual-based reward (pay-for-performance; see Table 1) on reward-maximizing behavior, pay satisfaction and perceived stress levels in two games, played via HoneyComb (Boos et al., in prep.; Pritz, 2011) in 10-person groups are assessed. Two conditions of achievable rewards - six virtual 0.50 Euro coins which can be found on the 97-hexagons playfield and are paid out after the experiment - are implemented: In the *Neutral Game*, outcome interdependence is set neutral (Wageman, 1995; Wageman & Baker, 1997: "individual outcome interdependence"): a coin cannot be taken away by group members. In the *Competitive Game*, outcome interdependence is competitive (Vegt et al., 1998): Coins can only be found once at all, so each individual actively reduces the achievable reward for his/her group members if he/she finds a coin.

Cooperative outcome interdependence, which is not implemented in study 2, is related to a number of positive effects like interpersonal trust, groups' effort, helpfulness, or productivity (Johnson & Johnson, 2005, 2009). For study 2, it is argued that proself motivation to achieve the highest possible reward influences these variables, making helpfulness under competitive outcome interdependence less attractive. In the Competitive Game compared to the Neutral Game, a reward-maximizing behavior which is adapted to the experimental setting is expected: Neighbors should (1) be avoided and (2) movement speed should be faster to raise the probability of a higher individual reward. Regarding pay satisfaction, which is lowered if individuals are consistently outperformed by group members (Daniels, 1989; 2000), competitive outcome

interdependence which disadvantages the majority of the whole group, should be significantly lower in the Competitive Game compared to the Neutral Game. Differences between high- and low performers in the Competitive Game are also assessed.

Chapter 2 (study 3)

In Chapter 2, effects of a group-based reward (see Table 1) on individual perception of fairness and individual knowledge sharing behavior in an online knowledge pooling task (cf. Hollingshead, 1998) in three-person groups are assessed. In study 3, two different distribution strategies of the achievable rewards are implemented (Bartol & Hagman, 1992): equality strategy, which divides a possible group reward into equal shares, and equity strategy, which builds a ranking order of all group members and allocates the reward to the group members according to their contribution to the knowledge pooling task within each group: 2nd (33%) and 3rd place (17%). The 1st place (50% of the reward) is not allocated through contribution, but through high status: One randomly chosen high status member is implemented in each group, who receives the highest reward in the equity conditions without his or her real contribution to the group task being considered. This high status member is either (allegedly) chosen by a specific characteristic which is connected to their potential value for the group task - score on a pre-test - or by a diffuse characteristic which is unrelated to the group task - age (Anderson & Kilduff, 2009; Berger, Rosenholtz, & Zelditch, 1980; Greenberg & Leventhal, 1976).

The design of study 3 allows assessing the effects of group-level competitive outcome interdependence on perceived fairness, contribution rate, and knowledge sharing behavior. Cooperative outcome interdependence can easily be implemented as group-based reward: in the equality conditions, good performance of group members raises the chance for the group to be higher rewarded than other groups, and thus each individual's reward. In the equity conditions, good performances of group members raises the probability of the whole group to be rewarded higher than other groups, but detains lower performing individuals to get a higher reward than their group members. The status manipulation makes it possible to check if there are different effects for high- and low-status members between cooperative and competitive outcome interdependence.

Compared to study 2, this within-group competition and different types of status assignments lead to more specific expectations of effects on each individual's perception

and behavior. Based on equity theory (Adams, 1965), perceived fairness is expected to be lowest in the equity conditions, when the high status is based on age: internal dissonance will occur when group members realize that their reward is not linearly connected to their within group effort, and partially bases on a diffuse characteristic. This effect is not expected in the equality conditions, because high- and low status do not affect each individual's rewards. Based on system justification theory, it is expected that high- as well as low status members are motivated to perceive the rewarding as fair and just (Jost, Banaji, & Nosek, 2004), and will adjust their contribution to the group task depending on the expected reward. Thus, low status members will share more knowledge in the equality conditions, and high status members will share more knowledge in the equity conditions. Furthermore, high status members are expected to justify their high status by contributing when their status bases on their age, compared to their pre-test score. Additionally, effects of distribution strategies and status assignment on contribution rate and task performance are assessed.

CHAPTER 1 INDIVIDUAL-BASED REWARDS

STUDY 1: FLOCKING BEHAVIOR IN HUMAN GROUPS

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Abstract

Flocking behavior, as one type of self-organized collective behavior, is described as the formation of groups without global control and explicit recruitment signals, which can be observed in many group-living animals, such as bird flocks, shoals or herds of ungulates. Flocking behavior has been simulated in a number of seminal models but it has not been detected experimentally in human groups thus far. We therefore created a computer-based, multi-client game where human players, represented as identical black dots, moved on a virtual playground, deprived of all information sources about their group members except for their positions over time. The participants played two games: (1) Single Game, where other group members were invisible, and (2) Joint Game, where group members in a local radius around each player were visible. We found that individuals approached their neighbors automatically if they were visible, leading to less spatial dispersion of the whole group compared to moving alone. We also found that this flocking behavior was consistent over the entire time the group moved around. We discuss these findings regarding the evolutionary causes of flocking behavior, its relevance for modern life, and its consequences for the simulation of self-organized collective behavior in human- and non-human species.

Keywords

collective movement; human group; flocking behavior; self-organizing behavior

Introduction

Group living is a universal feature throughout the animal kingdom and its costs and benefits have been investigated for decades (e.g., Alexander, 1974; Krause & Ruxton, 2002; Sumpter, 2010). Costs include intra-group competition over mating opportunities and resources as well as facilitated transmission of parasites and pathogens (Altizer et al. 2003; Bertram, 1978; van Schaik, 1989). However, the benefits of sociality seem to prevail, including predator confusion (Hamilton, 1971; Quinn & Cresswell, 2006), shared vigilance (Ward, Herbert-Read, Sumpter, & Krause, 2011), superior knowledge of both resource distribution and predation risk due to experienced members (Reebs, 2000), collective foraging (Pitcher, Magurran, & Winfield, 1982), cooperative hunting (Benoit-Bird & Au, 2009), joint territory defense (Williams, Oehlert, Carlis, & Pusey, 2004), offspring socialization (Pearson, 2011), cooperative breeding (Meade, Nam, Beckerman, & Hatchwell, 2010), and enhanced thermoregulation (Scantlebury, Bennett, Speakman, Pillay, & Schradin, 2006).

Group members can benefit from sociality only if they maintain cohesion and coordinate individual and often divergent behavioral preferences (Conradt & Roper, 2005; Rands, Cowlishaw, Pettifor, Rowcliffe, & Johnstone, 2003). In human and other primate groups, coordination of behavioral preferences is usually achieved via information transfer, which can involve a majority of group members or be initiated by a single individual or a small subset of the group (Boos, Kolbe, & Strack, 2011; Conradt & List, 2009; Conradt & Roper, 2005, 2009; Fichtel, Pyritz, & Kappeler, 2011). How behavioral information is transferred depends on group size: In small groups, members are usually able to process information about other's behavior globally, i.e. one individual reaches all other group members at the same time (Conradt & Roper, 2005). In large groups of animals such as fish shoals, flocks of birds or herds of ungulates, behavioral coordination is achieved by self-organization based on local information transfer. That means individuals follow simple behavioral rules and interact with their local environment without the need for global social control, explicit mutual recruitment or signals by a specific individual (honey bees, *Apis mellifera*: Seeley & Buhrmann, 2001; overview on vertebrates: Conradt, Krause, Couzin, & Roper, 2009; Couzin & Krause, 2003; Parrish, Viscido, & Grünbaum, 2002).

A simple behavioral regulator to maintain group cohesion based on local information is to reduce the distance to other individuals that is not undercut to avoid

collisions (Couzin, 2009; Vine, 1971). This "flocking rule" is part of several computer simulation models of self-organized collective behavior like group movement (Couzin, Krause, Franks, & Levin, 2005; Ichiro, 1982; Reynolds, 1987). The question addressed in this study is whether flocking is a universal behavioral mechanism that also applies to human groups. If this mechanism was also found in human groups, this would yield practical implications for crowd management and evacuation scenarios (Aubé & Shield, 2004). External motivators like attraction points (Helbing 2001, p. 373: e.g., posters within a pedestrian zone) or the strength of relationships between individuals in terms of social affiliation (King, Sueur, Huchard, & Cowlishaw, 2011) can also facilitate flocking behavior. Approaches and models have been conducted to describe and understand specific behavior of, for instance, pedestrians in terms of fluid-dynamic equations (Helbing, 2001), or to generally describe alignment behavior with models of self-driven particles to predict coherent motion of groups/subgroups in multiple species (e.g., Vicsek, 1995). Here, it is our goal to assess the general tendency of humans to flock without any external motivators.

Dyer et al. (2008, 2009) and Faria et al. (2009, 2010a) empirically tested various spatial coordination scenarios within human groups. Their goal was to assess the success of individuals with spatial preferences to lead the whole group. The studies revealed that human groups are able to reach a spatial goal cohesively without explicit signalling. These experiments addressed each component of the often discussed model of collective movement by Couzin et al. (2005) - except for flocking behavior. Participants were briefed to 'remain together as a group' (e.g., Dyer et al., 2008, p. 463), i.e. behavior was instructed explicitly and therefore the element of "natural" flocking was, via this explicit instruction, eliminated. Furthermore, the studies did not control for physical attributes that can influence leadership and recruitment success of specific individuals, e.g., size, mimics, and individual movement characteristics that could be observed by group members (inadvertent social cues: Faria et al., 2010a). This underlines the importance of our approach: to our knowledge, before our study an empirical result showing flocking behavior occurring without instruction or spatial attraction points (Helbing, 2001) and with strict control for social cues did not exist.

We created the computer-based multi-client game HoneyComb (Pritz, 2011) on a virtual 97-hexagons playfield in which human players are deprived of all information

sources about group members other than movement behavior (Boos, Pritz, & Belz, in prep.). Participants, visually represented on the playfield as black dots, played two games in randomized order: Single Game, in which other players were invisible, and Joint Game where other players could be seen. Participants were instructed on how to move on the playfield but were not given any (spatial or other) goal to reach. Due to (i) our experimental reduction of movement behavior as the only possible information source for players and (ii) the implementation of a limited perception radius, we expected that the players group into locally communicating (Conradt & Roper, 2005), self-organizing systems (Camazine, 2003). We predicted that the spatial distance between the players of the Single Game, in which they could not see each other, would be higher than in the Joint Game throughout the experiment. Furthermore, we investigated each groups' overall playing time and movement speed to test whether the visibility of other players had a stimulating effect in terms of the generalized drive hypothesis (Zajonc, 1965): In well-learned tasks, the pure presence of others can lead to a higher activation level within each individual, causing better performance (e.g., humans: Matlin & Zajonc, 1968; capuchin monkeys: Dindo, Whiten, & de Waal, 2009). Thus, we expected faster movements in the Joint Game, independently of flocking behavior.

Methods

Experimental Procedure

We conducted two computer games to test flocking in humans. Experiments took place in a lecture building of a German university in June and July 2010 and in May 2011. A total of 400 primarily undergraduate students participated in the study and were assigned to 40 groups each comprising 10 individuals. The groups were composed of students of 40 different fields between the ages of 18 to 44 ($M = 24.24$, $SD = 3.16$). Of the total sample, 43.6% were female. All participants were naive as to the purpose of the study. All participants received payment for their participation which could be achieved in three additional games with a monetary incentive structure which were played after this experiment.

Three assistants randomly recruited participants, providing standardized information about the experiment: (1) duration about 25 min; (2) maximum payment of 13 (2010) or 8 (2011) Euros, depending on their performance; (3) multiplayer game played on laptops. As soon as 10 participants were gathered, they were led into a separate

area with individual workstations, each equipped with an identical size laptop (screen size 13.3 in., 1366*768 pixels), a mouse, and a pair of earplugs. All participants were then instructed to wear earplugs. The workstations were encased by separation walls, making it impossible to watch other players during the experiment. Participants could navigate through self-explanatory instructions on the screens via 'forward' and 'backward' buttons, and click on a 'ready' button when they had finished reading. Once the computer games were finished, participants individually filled out a questionnaire to provide demographic data (age, gender, field of study, semester). Participants were anonymously paid via neutral envelopes after the experiment according to their performance summed up over all five games.
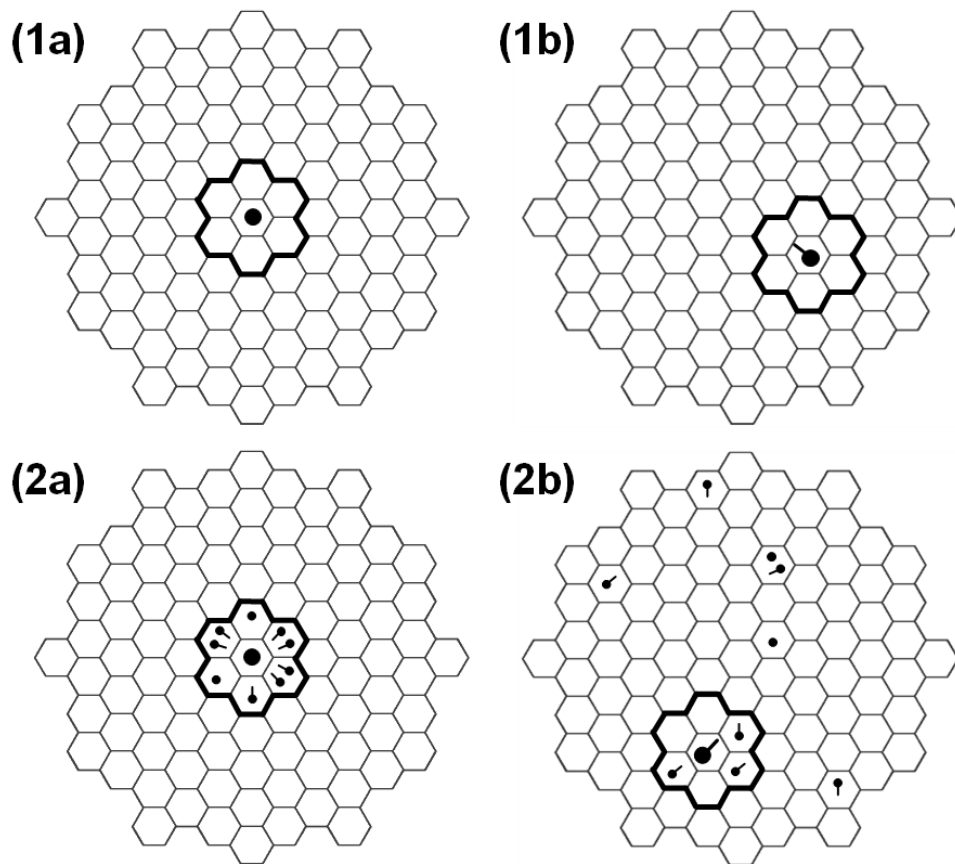
Figure 1. Note. Two exemplary situations in the Single Game (1a and 1b, other players are invisible) and the Joint Game (2a and 2b, other players within the individual perception radius are visible) from the perspective of one player. In the Single Game, the player starts in the centre of the virtual 97-hexagons playfield (1a). In 1b, the player has already made two moves from the centre. In 2a, all other players have already moved whereas the focused player still remains in the centre. In 2b, three other players are visible from the perspective of the focused player, whereas 6 other players stay out of the focus player's visual range. Original shades of grey have been removed to increase clearness of display.

Single Game

Each participant controlled a black point on a virtual hexagon playfield with his/her mouse. In the Single Game variation, there was only their black dot visible on the playfield; even though they were aware there were other game participants. Players always started in the centre of the playfield (Figure 1, (1a)). The black point could be moved to each of six neighboring fields by left-clicking into the respective small hexagon. Jumping over fields was impossible. When participants moved their cursor to a hexagon, a framework appeared during mouse rollover to indicate which fields could be chosen by left-clicking. To prevent experienced computer users from moving considerably faster through the playfield, i.e. to standardize maximal movement speed, a delay was implemented in each game: After participants had made a move, the cursor was transformed into an hourglass for 1500 ms. During this time period, no further moves were possible. After each move, a small tail was blended in, pointing to the last hexagon he or she had come from (Figure 1). This tail was blended out after 4000 ms or replaced by the next directional tail if the player had made a move in less than 4000 ms. To avoid influences of colors, all visual components were displayed in grey, black, and white.

When the Single Game was played before the Joint Game (50% of all groups played in this order), four instruction pages were presented (Joint Game: two pages), containing the basic movement instructions (see above). Each participant was told that "the game will end once you will have made at least 10 moves". Due to the 10-move criterion, the Single Game was closed automatically by the game server once the 10-move criterion had been reached by the slowest player. In other words, players could still move as long as the slowest player had not made his or her 10th move. Other than the game-ending 10-move criterion, there was no explicit game goal. When the Single Game was played *after* the Joint Game, only two instruction pages were presented (Joint Game: four pages), leaving the basic movement instructions out.

Joint Game

In the Joint Game, the participants moved in the same virtual hexagon playfield as in the Single Game, with one essential difference: all players were visible to each individual

player as smaller black dots for as long as they remained in the according perception radius of two hexagon fields (Figure 1, (2a) and (2b)). Also, in the instructions, players were told that they could see other players as smaller points in the playfield. A local perception radius limited the range of sight of each player (Figure 1): If players departed more than two fields from each other, they did not see each other anymore, but could still see the whole playfield. Participants were informed in the instructions that directional tails were blended in for other players' dots as well as for theirs, helping to identify previous movement directions of everyone. There was, again, no explicit game goal in the Joint Game. As in the Single Game, players could move as long as the slowest player had not reached his or her 10 moves.

Data Structure

Each player's moves on the playfield were recorded as coordinates in a data file on our server, also containing timestamps with a precision of 1 ms. Although other players were invisible from the individual perspective in the Single Game, we were able to create the same group level variables as in the Joint Game with the assurance that one player's moves did not influence other players due to their invisibility.

Dependent Variables

We created six dependent variables on the group level for each game.

Variables (1) and (2) were created to investigate whether the visual presence of other players caused a general arousal and thus led to faster movement behavior: (1) 'overall gaming time', which was the time 10 players of a group needed to complete each game in seconds; (2) 'mean latency', as in the meantime between two moves of the players per group in seconds.

Variables (3) to (5) described below enabled us to investigate general differences in movement behavior between the Single Game and the Joint Game in terms of spatial dispersion: (3) 'different fields', as in the number of different hexagons which were touched by the respective group for each game; (4) 'overall moves' a group made in each game; and (5) 'dispersion rate', which was calculated by dividing the 'different fields' variable by the 'overall moves' variable to account for the possible bias that more moves increased the probability to touch more fields. The resulting coefficient tends to '0' if the

group did not disperse (touches rather similar fields), and tends to '1' if the group disperses at a maximum level (touches rather different fields).

To provide an in-process measurement of each groups' degree of flocking, we defined the variable (6) 'distance over time': For each group, we divided the time until the last player finished the game into 10% intervals, e.g., if a group played 60 sec, intervals were generated in 6 sec-steps. At the end of each interval, we calculated the mean difference between all group members in number of fields. For instance, if the 'distance over time' variable said '4.31' for the 50%-interval, the mean distance between all members was 4.31 fields after 50% of the overall time of this group had passed. Thus, each group provided 20 data values (10% to 100% time intervals for the Single Game and the Joint Game).

Statistical Analyses

All statistical analyses were carried out using IBM SPSS Statistics 19 (IBM Company, 2011). We checked for normal distribution of our interval scaled variables via Kolmogorov-Smirnov-Tests. All dependent variables met the preconditions required for parametric testing. We used standard t-tests for paired samples and calculated the empirical effect size d_{within} for our variables (1) to (5). To analyze differences between the Single Game and the Joint Game with our variable (6), we used a general linear model for repeated measures (GLM), containing the two within-groups factors 'time interval' (10% to 100%) and 'game' (Single Game vs. Joint Game) and the between-groups factor 'gaming sequence' (Single Game - Joint Game vs. Joint Game - Single Game). All alphas of pair wise comparisons were corrected using the Bonferroni method. Level of significance was set at $p < 0.05$. Means are always reported with corresponding standard deviations (*SD*). All significances are reported two-tailed

<div align="center">Results</div>

Overall Time and Movement Latency

Neither the time each group needed to complete the Single Game ($M = 70.26$, $SD = 33.78$) and the Joint Game ($M = 70.41$, $SD = 32.24$, $t(39) = -0.02$, $p = 0.985$; $d_{within} < 0.01$) nor the mean latency (Single Game: $M = 3.29$, $SD = 0.73$; Joint Game: $M = 3.51$, $SD = 0.93$, $t(39) = -1.01$, $p = 0.319$, $d_{within} = 0.16$) differed significantly between the

games. Thus, the mutual visibility or non-visibility of other players did not affect the overall gaming time and the mean movement latency of the groups (Figure 2).
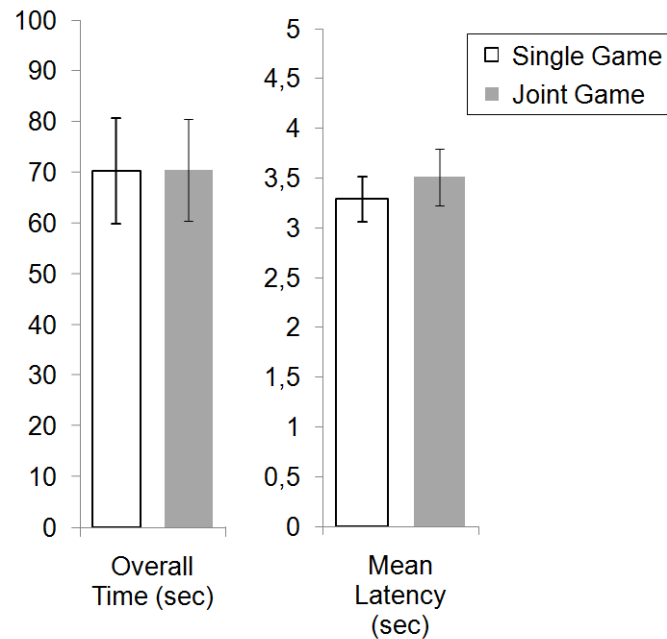

Figure 2. Note. Overall gaming time and mean movement latency of the groups in seconds with 95% confidence intervals, compared between the Single Game (other players are invisible) and the Joint Game (other players are visible).

Different Fields, Number of Moves and Dispersion Rate

The groups touched significantly more different fields in the Single Game ($M = 77.70$, $SD = 11.92$) compared to the Joint Game ($M = 68.25$, $SD = 10.70$, $t(39) = 4.42$, $p < .001$, $d_{within} = 0.70$). There was no significant difference between the Single Game ($M = 202.25$, $SD = 81.51$) and the Joint Game ($M = 194.48$, $SD = 62.98$) in overall moves ($t(39) = 0.51$, $p = 0.612$, $d_{within} = 0.08$). Dispersion rate was significantly higher in the Single Game ($M = 0.41$, $SD = 0.09$) compared to the Joint Game ($M = 0.37$, $SD = 0.08$, $t(39) = 2.66$, $p = 0.011$, $d_{within} = 0.42$). Thus, the visibility of group members in the Joint Game led to lower group dispersion on the field compared to the Single Game (Figure 3).
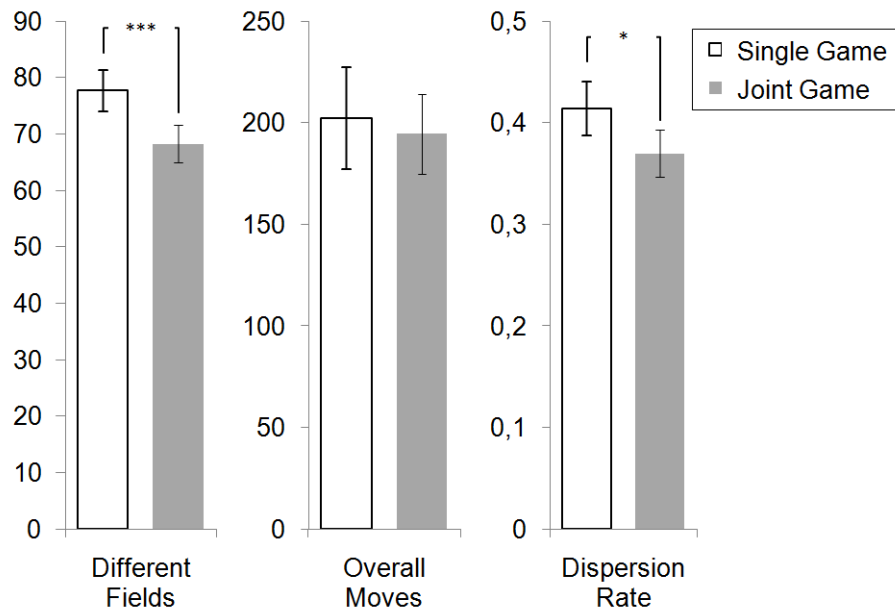
Figure 3. Note. Different fields touched during gaming phase, overall moves and dispersion rate of the groups (from '0' = minimal dispersion to '1' = maximal dispersion) with 95% confidence intervals, compared between the Single Game (other players are invisible) and the Joint Game (other players are visible). Game differences are indicated by t-Tests for paired samples. ***$p < 0.001$; **$p < 0.01$ and *$p < 0.05$.

Distance over Time

Differences between the Single Game and the Joint Game

The groups' distance over time was significantly affected by the type of game, Single vs. Joint (GLM: $F(1, 38) = 61.01$, $p < 0.0001$, partial $\eta^2 = 0.62$). Whereas in the Single Game, players could not see other players and therefore departed from each other unaware, the players could see each other in the Joint Game and the distance within the group was lower in the Joint Game (Figure 4). We did not find a two-way interaction between (advanced) gaming time and game number; the higher distance of group members was consistent over gaming time intervals (Figure 4; GLM: $F(9, 342) = 1.34$, $p = 0.213$, partial $\eta^2 = 0.03$). Overall, the visibility of group members led to significantly smaller distances between players, consistently over gaming time.
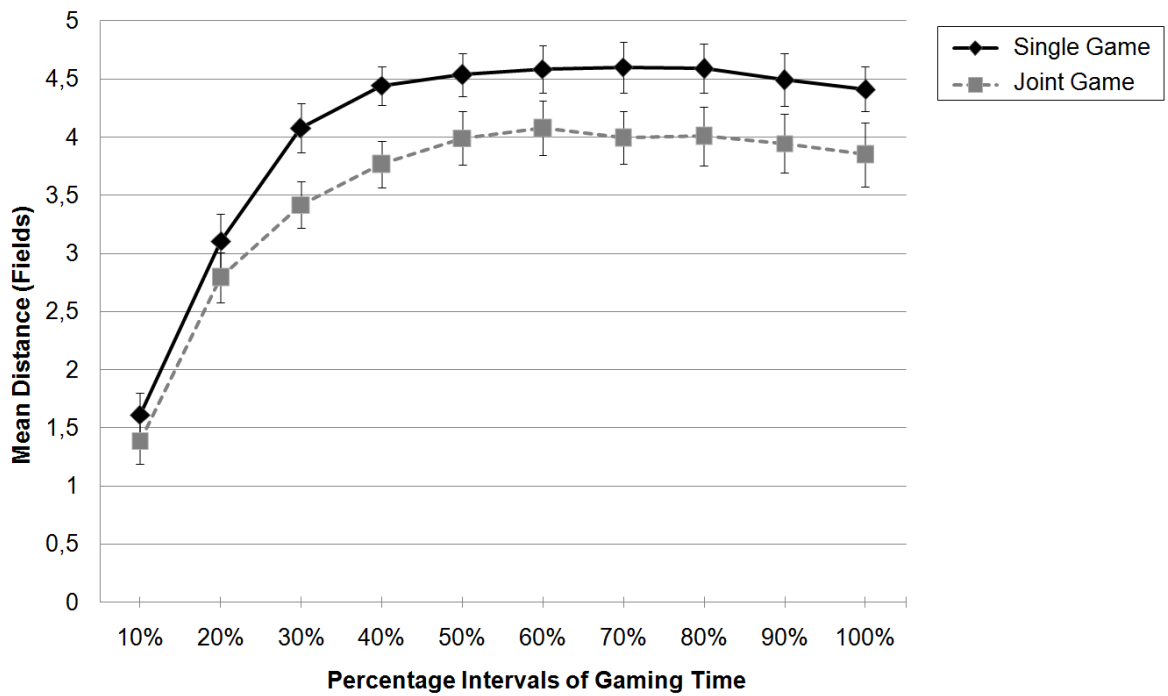
Figure 4. Note. Distance between group members over time during the gaming phase with 95% confidence intervals, compared between the Single Game (other players are invisible) and the Joint Game (other players are visible). The 0%-interval is not displayed because all group members started in the centre of the playing field (Figure 1), which would automatically lead to a distance of '0' fields. Overall, the mean difference in distance between the Single Game and the Joint Game was 0.523 fields, leading to a Bonferroni-corrected $p < 0.0001$.

Changes in distance over gaming time intervals

We observed a main effect of gaming time for both games in terms of significant differences between the 10% intervals (GLM: $F(9, 342) = 187.88$, $p < 0.0001$, partial $\eta^2 = 0.83$): Bonferroni-corrected pair wise comparisons showed significant increase of distance between 10% vs. 20% ($p < 0.0001$); 20% vs. 30% ($p < 0.0001$), and 30% vs. 40% ($p < 0.0001$). Thus, after 40% of the gaming time had passed, most groups had reached a stable level of distance - both in the Single Game, and in the Joint Game.

Effects of game sequences

We found significant differences depending on the order of games (Single Game - Joint Game vs. Joint Game - Single Game; GLM: $F(1, 38) = 15.82$, $p < 0.001$, partial $\eta^2 = 0.29$). If the Joint Game was played first, group members generally departed less far from

each other than if the Single Game was played first (mean difference was 0.408 fields, leading to a Bonferroni-corrected $p < 0.001$).

Discussion

Deprivation of all information sources except for players' movement and the implementation of a limited visual perception radius, making only proximate neighbors' movement visible, did not prevent flocking behavior. Regarding the experiments of Dyer et al. (2008, 2009) and Faria et al. (2009, 2010a), we suggest that the explicit instruction of groups to show flocking behavior ('remain together as group' and 'stay within one arm's length') is more an element of group communication rather than of flocking behavior. Humans, as in other animal groups displaying flocking behavior, seem to approach other human beings implicitly and without being told to do so, even if no incentives for cohesive group behavior are present or information about their co-actors' intentions is given (e.g., during mass gatherings like public speeches or concerts).

One possible explanation for this inherent flocking tendency is an evolutionary legacy. Living together in cohesive groups was crucial for early human societies that had to defend themselves against predators and enemies or hunt cooperatively (Johnson & Earle, 2000). The costs and benefits of flocking in today's human life are strongly situation-dependent and more research is needed to identify specific benefits or costs in different situations. For instance, Faria, Krause, and Krause (2010b) found that direct neighbors of a person who crossed a street tended to follow this individual and traverse the street earlier than others. Apparently, humans in crowds rely on social information that they gather from their neighbors. Our results could help to understand and improve the forecasting of crowd behavior by anticipating implicit and automatic flocking behavior in mass panic scenarios: crowd managers and/or security forces should be proactively prepared for individuals to approach their proximate neighbors when the communication channels are reduced to the perception of movement of neighbors vs. the entire group. Following our results, a cohesive flight response could occur in case of emergencies, especially those where visibility is acutely limited, strongly suggesting designing escape routes in a way being able to manage large amounts of people. Due to our results, it may be unpredictable to which spatial direction the group moves, but it will most likely move as a whole.

Interestingly, movement latencies and overall gaming time were not significantly influenced by the visual presence of group members. This suggests that there is no general activation, competitive or otherwise, caused by the visual presence of others (Zajonc, 1965).

It can be argued that the representation of the human participants in the rather abstract avatars of black dots in a virtual environment aggravated the sense of connection between the participants and their effigy in terms of embodiment (for an overview see Childs, 2011, pp. 25-27). This argument can be invalidated by the following considerations. First, our avatars were designed to reduce social meanings and social roles to a minimum. We intended to avoid influences of e.g., body shape or gender (Biocca, 1997) by reducing the information carried by the avatars as radically as possible. Second, it is empirically confirmed that non-humanoid avatars can mediate the physical body in a virtual setting (extended body; Knudsen, 2004, p. 43). Both anthromorphic as well as polymorphic visual representations in a virtual environment facilitate feelings of embodiment (Murray & Sixsmith, 1999, p. 336).

For future studies, we suggest broadening the focus on human collective behavior in several aspects. First, implementing a movement task which measures individual success (e.g., a virtual foraging task) could give additional insight concerning effects of visual presence of group members on performance and be combined with biofeedback measures to find evidence for the generalized drive hypothesis in our experimental setting (Zajonc, 1965). Second, distances between group members over time did not rise linearly in our experiment. Due to a limited playfield size of 97 hexagons (or a limited area for movements like in the experiments of Dyer et al., 2008, 2009 and Faria et al., 2009, 2010a), it was impossible for individuals to constantly increase the gap between themselves and other group members at some point because of the limiting border which automatically defined a maximum distance between group members. It would be interesting to see how human groups would act on an unlimited playfield, and to investigate if the effect of visible neighbors on flocking behavior was under- or overestimated by our experiment. Without a limiting border, (a) the explorative behavior of single individuals (whose group members are invisible) and thus their spatial distance could increase more linearly, but (b) the threat of losing (visible) group members out of sight would also be higher on a larger playfield, making flocking behavior more difficult.

In conclusion, an unlimited playfield could lead to higher spatial dispersion in both experimental conditions but also allow an additional insight into human flocking behavior in a more natural, unlimited environment. Third, 'collision avoidance behavior' and its relation to flocking behavior should be investigated in more detail, because it was not assessed in this study but is an essential component of the Couzin et al. (2005) and Reynolds (1987) models. In our experiment, an arbitrary number of group members could simultaneously move to one place, making collisions or blocking impossible. In the experiments of Dyer et al. (2008, 2009) and Faria et al. (2009, 2010a), humans managed to avoid collisions yet still moved as cohesive groups. It would be fascinating to observe if human flocking behavior persists if the possibility of collisions was to be implemented in our virtual movement game, i.e. through the instruction to move fast, and, thus, incur costs as described by Reynolds (1987, colliding birds are injured with a high probability).

CHAPTER 1 INDIVIDUAL-BASED REWARDS

STUDY 2: COMPETITIVE OUTCOME INTERDEPENDENCE LEADS TO REWARD-MAXIMIZING BEHAVIOR, LESS PAYMENT SATISFACTION, AND MORE STRESS

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Abstract

Competitive outcome interdependence between individual rewards is commonly described as the degree to which personal outcomes depend on the task performance of others: When one individual gains a high reward within a task she or he coevally lowers the available reward for others. Competitive outcome interdependence has been identified to facilitate peer-disadvantaging, reward-maximizing behavior and negative perceptions related to a more competitive climate in numerous studies. Here, we created a computer-based multi-client game to assess if participants, represented as identical black dots moving on a virtual playground, would show reward-maximizing behavior and different perceptions of pay satisfaction and stress levels between neutral and competitive outcome interdependence. We therefore created two games containing the task to search for virtual coins: (1) Neutral Game, where no interdependence between individual rewards was implemented, and (2) Competitive Game, where high individual rewards were competitively linked. We found that competitive outcome interdependence led to reward-maximizing behavior. We also found lower pay satisfaction, independently from the achieved reward, and higher stress levels under competitive outcome interdependence. We discuss these findings regarding the implementability of competitive outcome interdependence in today's work life.

Keywords

competitive outcome interdependence; reward-maximizing behavior; pay satisfaction; stress

Introduction

In today's work life, multiple forms of rewards are used to compensate the individual contribution (e.g., Gagné & Forest, 2008). Individual-based monetary rewards compared to non-monetary rewards generally account for the link between performance and payment of a single person. Pure pay-for-performance plans (e.g., piece-rate plans), compared to base pay, bonus pay or mixed pay systems (e.g., merit pay) explicitly connect achieved (work) units to individual payment (Durham & Bartol, 2000; Gagné & Forest, 2008). Pay-for-performance plans are implemented in many contexts and effective in terms of motivating high work performance (Condly, Clark, & Stolovitch, 2003) and pay satisfaction (Green & Heywood, 2008; for an overview see Judge, Piccolo, Podsakoff, Shaw, & Rich, 2010).

We argue that monetary rewards as extrinsic motivator facilitate self-interest/proself motivation (e.g., DeDreu, 2007) and lead to reward-maximizing behavior to heighten the own performance and thus payout. However, individual-based rewards do not necessarily depend only on the task performance of the pertinent individual, but can also be connected to the performance of other individuals in different ways, commonly described as outcome interdependence (OI; Vegt, Emans, & Vliert, 1998; Wageman, 1995; Wageman & Baker, 1997): Whereas cooperative OI facilitates promotive interactions between individuals (for an overview see Johnson & Johnson, 2005), competitive OI will motivate individuals to adapt their reward-maximizing behavior according to the competitive setting and try to outperform or disadvantage their group members because their performance and payout is set in relation to the performance of others (Taylor, 2006).

Here, we assess the consequences of competitive OI vs. no OI (here: neutral OI) on the behavioral and perceptional level. Drawing conclusions if competitive OI of rewards can be a suitable payment strategy in today's work life does not only include the activation of potentially effective, reward-maximizing behavior by an extrinsic motivator; we also assess if competitive OI leads to less pay satisfaction as well as more stress and discuss consequences on organizational outcomes.

Definition of Competitive OI

OI is defined as "…the degree to which the significant outcomes an individual receives depend on the performance of others" by Wageman (1995, p. 147). According to

Deutsch's (1949a) theory of cooperation and competition, high OI as defined by Wageman (q.v. Wageman & Baker, 1997) can be classified as promotively interdependent goal of all group members: All individuals aim at a high reward, their goal is cooperatively linked. OI can also be competitive in the according social situation: if the group members' goals are contriently interdependent and thus competitively linked, high collective performance would not determine high rewards for all individuals. For example, Deutsch (1949b) implemented competitive OI in his experiment: Five-person groups solved different tasks (puzzles, discussions, writing). They were informed being rated about their individual performance and rewarded by the relative contribution to the solution of the tasks, compared to their group members. This competitive implementation of OI is related to "zero-sum games" or tasks (Bowles, 2006): The more reward one individual gets, the less reward is available for others (q.v. "competitive programs"; Condly et al., 2003). Thus, like Vegt et al. (1998), we define competitive OI as follows: When an individual attains higher rewards, he or she reduces the amount of reward left for other individuals.

Competitive OI and Reward-maximizing Behavior

Increasing effects of cooperative OI on the behavioral level like on groups' effort, achievement, or productivity have been found in various studies (for an overview see the meta-analysis of Johnson & Johnson, 2005). A number of positive perceptional attributes has also been associated with cooperative OI, like interpersonal trust or perceived safety (for an overview see DeDreu, 2007). We state that most of these variables can be ascribed to proself motivation to achieve a maximal reward as extrinsic motivator (DeDreu, Nijstad, & van Knippenberg, 2008; Judge et al., 2010) in cooperative settings: If cooperative OI is implemented, it pays out to help group members (Deutsch, 1949b), to share subjectively task relevant information (Taylor, 2006), or to engage in high-quality interaction processes (Wageman, 1995). These behaviors obviously strengthen a cooperative climate which is then perceived by all group members and measured by variables like interpersonal trust or perceived safety.

We state that under competitive OI, reward-maximizing behavior can also be expected, but it will be individually adapted to the competitive setting: Deutsch (1949b) found increased obstructiveness in his experiment under competitive OI, Taylor (2006)

showed that competitive OI drives individuals to intentionally withhold crucial information. Against this background, we expect that competitive OI will also motivate group members to show the most efficient, in this case peer-disadvantaging behavior to maximize their own reward. In this case, the behavior would be motivated by self-interest. Here, we compare competitive OI with neutral OI to assess if specific, reward-maximizing behavior is triggered by competitive OI. We used the computer-based multi-client game HoneyComb (Pritz, 2011) which enabled us to implement competitive OI in a standardized virtual setting allowing us to exclusively check for influences of competitive OI on behavioral variables.

_**H1:**_ Competitive outcome interdependence leads to competitive behavior to maximize individual rewards and to minimize other group members' rewards, compared to neutral outcome interdependence.

Competitive OI, Pay Satisfaction, and Stress

Hypothesis H1 expects an effect of competitive OI on the behavioral level. So far, we did not discuss how competitive OI impacts individuals' work experience. What we know from antecedent research is that pay satisfaction has positive long-term influences on job satisfaction and organizational outcomes (e.g, Currall, Towler, Judge, & Kohn, 2005; Green & Heywood, 2008; Whitman, van Rooy, & Viswesvaran, 2010). Focusing effects of competitive OI on pay satisfaction enables us to deduce practical implications about the applicability of competitive OI in work settings, and possible consequences on work performance.

Being outperformed by group members (cf. Daniels, 1989; 2000) or receiving low payouts (Judge et al., 2010) can lower pay satisfaction. Thus, when competitive OI is implemented, at least low performers should perceive less pay satisfaction compared to neutral OI because their rewards are minor. Empirical evidence for a higher pay satisfaction of high performers, on the other hand, is rare: McGee, Dickinson, Huitema, and Culig (2006) discovered that high performers performed better under individual-based pay-for-performance plans. Honeywell, McGee, Culig, and Dickinson (2002) found that high performers prefer such payment. In both studies, no general effects of competitive OI in terms of pay satisfaction between low- and high performers have been assessed. Against the background of the limited empirical evidence that high performers prefer systems which honor their higher effort, our goal is to clarify two issues: Does

competitive OI generally lead to less pay satisfaction than neutral OI, and is this relation both effective for low- and high performers? According to the findings of Judge et al. (2010), McGee et al. (2006), and Honeywell et al. (2002), we expect that competitive OI will lower pay satisfaction for disadvantaged group members, in other words: low performers.

H2a: Competitive outcome interdependence leads to less pay satisfaction than neutral outcome interdependence for low performers.

Fletcher, Major, and Davis (2008) found that a competitive climate, defined as "…degree to which employees perceive […] rewards to be contingent on comparisons of their performance against that of other peers" (Brown, Cron, & Slocum, 1998; quoted after Fletcher et al., 2008, p. 900), leads to higher individual stress levels. In our case, competitive OI should cause a competitive climate: a limited reward is distributed depending on each individual's performance compared to other individuals' performance. We therefore state:

H2b: Competitive outcome interdependence leads to more perceived stress than neutral outcome interdependence.

Method

Overview and Design

Participants in 10-person groups played two computer games which contained either neutral or (highly interdependent) competitive rewards. Group members could move on a virtual playfield and were visible to other group members as black dots.

A one factorial design was implemented to test the hypotheses. The factor was the type of the individual-based reward distribution system: neutral (Neutral Game) vs. competitive (Competitive Game).

Participants

A total of 200 primarily undergraduate students participated in the experiment in May 2011. Participants were recruited as 10-person groups ($N = 20$ groups), and each group

played both games[2]. Effects of game sequences were controlled by randomly assigning the groups to them (Neutral Game - Competitive Game at $n = 10$; Competitive Game - Neutral Game at $n = 10$). The participants were between the ages of 20 and 44 ($M = 23.6$; $SD = 3.4$) and composed of students of 26 different subjects. Of the total sample, 43.2% were female. All participants were naïve as to the purpose of the study.

Procedure

The experiment consisted of three phases: pre-test, gaming, and post-test. In the pre-test phase, participants were acquired and provided with all necessary information to play the games. In the gaming phase, participants played the Neutral Game and the Competitive Game on prepared laptops (see description of games below). In the post-test phase, participants filled out the online questionnaire assessing demographic data (age, gender, field of study, semester) and our dependent variables (see measures) and received payment.

The pre-test phase

Three assistants randomly recruited participants in the lecture building at a German university. They provided standardized information about the experiment: (1) It would last about 25 min; (2) participants could win up to 8 Euros; (3) it would be a multiplayer game played on laptops. Immediately after arriving, 10 participants were welcomed by the investigator and led to their places, each equipped with a pair of earplugs, a mouse, and a laptop (screen size: 13.3 in.; resolution: 1366*768 pixels; all laptops were connected via local area network). These workstations were encased by separation walls, making visual contact to other players impossible during the experiment. All participants were asked to use their earplugs after they had taken a seat. They could navigate through instructions on the screens via 'forward' and 'backward' buttons and click on a 'ready' button after they had finished reading.

The gaming-phase

Participants controlled a black dot - twice as big as the visible dots of other players from each individual point of view - on a virtual 97-hexagons playfield with their mouse,

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[2] All participants played two games without implemented rewards before the experiment (see study 2, Chapter 1). Furthermore, a game was played after the Neutral and Competitive Game (Boos et al., in prep.). A detailed description of HoneyComb is available from the authors (Pritz, 2011).

always starting in the centre of the field (HoneyComb, Boos, Pritz, & Belz, in prep., see Figure 1 for details). By left-clicking into the respective small hexagon, the black dot could be moved to the corresponding field. Only neighbored fields could be chosen for the next move. A grey framework appeared when players moved their cursor to a hexagon to indicate which field would be chosen by left-clicking. In both games, a local perception radius was implemented (Figure 1): If players departed more than two fields from each other, they did not see each other anymore, but could still see the borders of the playfield. By implementing this perception radius, we increased the comparability to large groups (individuals can only perceive neighbors within a limited spatial range and not the whole group at once, see Conradt & Roper, 2009 for an overview).

A movement delay was implemented in both games to prevent experienced computer users from moving significantly faster through the playfield than others. After a move was made, the cursor transformed into an hourglass for 1500 ms, making further moves impossible during this time period. After each move, a small tail was blended in for each player, indicating the last direction he or she came from (Figure 1). After 4000 ms, this tail was removed. If players chose to make a new move in less than 4000 ms, a new directional tail replaced the old one. All visual components were displayed in grey, black, and white to avoid influences of colors.

(a)　　　　　　　　　　　　**(b)**
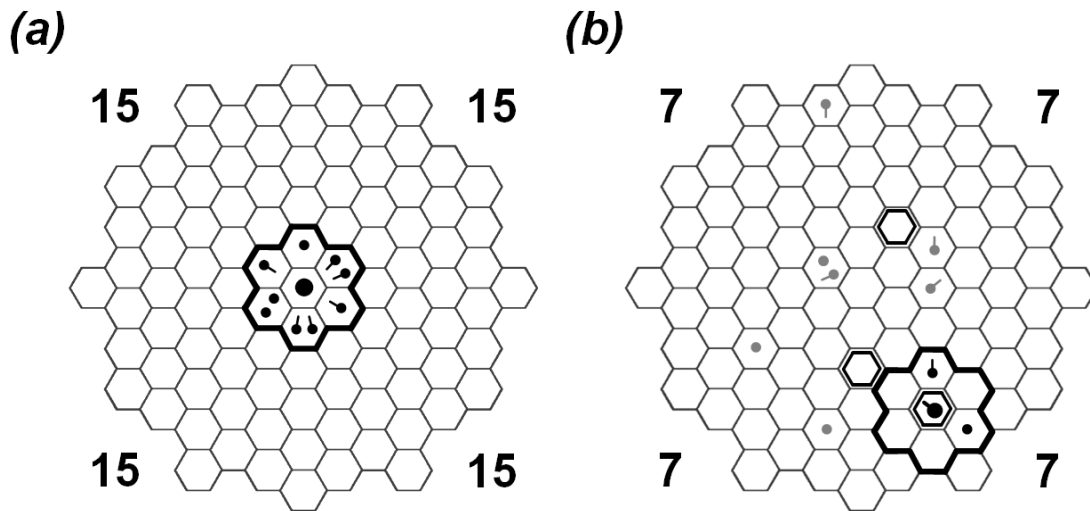
Figure 1. Note. Two exemplary situations in the 97-hexagons playfield; original shades of grey have been removed to increase clearness of display. In *(a)*, the game has just started. The pertinent player has not made a move so far as the numbers in the four corners of the playfield indicate (15 out of 15 moves are still available). All other players are still inside the visual perception radius, which is marked by a black contour.

For the Neutral Game (neutral OI), the situation *(b)* shows that the pertinent player has still seven moves left, and that he or she has already found three coins, which are marked by small black contours. Only two other players are in visible range, the remaining seven players (here marked in grey) are invisible to him or her. In the Neutral Game, the pertinent player would neither know if other players had also discovered coins, nor would other players know that the pertinent player had already collected three coins.

For the Competitive Game (competitive OI), the situation *(b)* would be different: The small black contours would be visible to every player, indicating that the according coin had already been picked up by the pertinent player, or by other players.

Neutral Game

Two instruction pages were presented, similar for all participants. In the Neutral Game, there was one specific goal defined and rewarded for each participant: Instructions said that invisible 0.50 Euro coins could be found somewhere in the playfield by touching the corresponding hexagon. If a participant had found a coin, a black framework was displayed permanently at the corresponding hexagon, but invisible to all other players (see Figure 1 for examples). Participants were also informed that coins could not be taken away by other players: If a coin was found by another player, it would remain in place and could still be found. Participants were not informed about the number of Euro coins (a total of six coins was randomly placed into the playfield by the server) to avoid systematic effects, e.g., resignation after all coins had been found. Furthermore, each

participant had a limit of 15 moves, individually displayed as counter in the four corners of the playfield (see Figure 1). The Neutral Game was over when each participant had made his/her 15 moves.

Competitive Game

As in the Neutral Game, two instruction pages were presented, containing one difference: Again, 0.50 Euro coins could be found somewhere in the playfield (six coins were randomly placed by the server), but this time, participants were informed that each coin could only be found *once*. If a coin was found by another player, it was removed from the game and the black framework was displayed visibly for all players (Figure 1).

The posttest phase

After both games were completed by the groups, participants switched to the online questionnaire. Finally, they were anonymously paid via neutral envelopes according to their individually discovered 0.50 Euro coins and fully debriefed afterwards.

Behavioral Measures

Each player's moves were recorded by the server as coordinates in a data file, with timestamps at an accuracy of 1 ms, number of discovered coins, and group numbers.

General movement behavior

We created four general dependent variables on the group-level for all groups to investigate behavioral differences between both games, the Neutral Game and the Competitive Game: (1) *averaged reward*, the achieved Euros per group divided by the number of group members; (2) *overall gaming time*, the seconds 10 players of a group needed to complete a game; (3) *mean latency*, the mean time between two moves of the players per group in seconds.

Reward-maximizing behavior: Distance over time

To provide an in-process measurement of each groups' dispersion and thus to assess, if the participants consistently and insistently avoided other players in the Competitive Game to maximize their reward, we created the variable *distance over time*. The

empirical overall time per game was divided into 10% intervals for each group (e.g., if a group played the Neutral Game for 120 sec, intervals were created in 12 sec-steps). The group movement was analyzed after each 10% interval. Afterwards, the mean difference between all group members in fields was calculated. For example, if the distance over time variable said '5.32' for the 60% cluster, the mean distance between all group members was 5.32 fields after 60% of the overall gaming time of this group had passed. By assessing the avoidance of other players we generated a measurement of reward-maximizing behavior: Group members who actively avoided others did not only maximize their chances to find coins which had not been found by other players so far. They also reduced the chance of other players to maximize their reward by trying to take away as much coins as possible (peer-disadvantaging behavior).

Perceived Pay Satisfaction, Stress, and Calmness

The reported variables were measured by an overall of 34 items, 17 identical items separately for the Neutral Game and the Competitive Game. Each item was formulated as short statement and answered using five-point Likert scales (5 = *strongly agree* to 1 = *strongly disagree*). Items were partly self-developed and partly taken from the 'work-related behavior- and experience-pattern questionnaire' (AVEM: Schaarschmidt & Fischer, 2003; we modified these statements to fit them to our games, see examples below).

Pay satisfaction

Satisfaction with the achieved rewards was measured via five items taken from the AVEM (e.g.: "Overall, I am satisfied with my performance in Game X") and one self-developed item ("I am pretty disappointed with Game X"; one inverted item, scale reliability: Neutral Game: $\alpha = .79$; Competitive Game: $\alpha = .72$).

Stress

The individually perceived stress during the movement games was measured via six self-developed items, e.g.: "I felt pressed for time in Game X" (no inverted items, scale reliability: Neutral Game: $\alpha = .89$; Competitive Game: $\alpha = .84$).

Calmness

Calmness during the movement games was measured via six items which were completely taken from the AVEM, e.g.: "In Game X, I kept my head calm" (two inverted items, scale reliability: Neutral Game: α = .79; Competitive Game: α = .81).

Demographics and control variables

Age, gender, field of study, and number of semesters were surveyed as demographic questions with attached textboxes (e.g., "What is your age?").

Results

Statistical Analyses

We used two kinds of statistical analyses for our dataset. For our group-level variables averaged reward', 'overall gaming time', 'mean latency', and 'different fields', we used standard t-tests for paired samples. For our group-level variable 'distance over time', we used a general linear model for repeated measures (GLM) to compare 10 values of the Neutral Game with 10 values of the Competitive Game. For the remaining individual-level variables we used GLMs, each accounting for two levels of dependency in our dataset: individual values for the Neutral Game and the Competitive Game were added as within-groups factors, the groups' ID was added as between-groups factor. For multiple comparisons, alphas were corrected using the Bonferroni method (significance was set at $p < .05$). All dependent variables met the criteria for parametric testing.

Behavioral Differences: Neutral Game vs. Competitive Game

General movement behavior

Groups completed the Competitive Game in less time (M = 62.55, SD = 27.46) than the Neutral Game (M = 82.49, SD = 48.43, $t(19)$ = 2.38, p = .028, d = 0.53), and moves were executed significantly faster in the Competitive Game (M = 2.68, SD = 0.95) compared to the Neutral Game (M = 3.13, SD = 1.75, $t(19)$ = 2.88, p = .01, d = 0.64). In sum, competitive OI affected the participants to speed up their movements on the individual- and, as consequence, on the group-level.

Groups also earned less money in the Competitive Game due to the ability of other players to permanently remove coins from the playfield (M = 0.12, SD = 0.02)

compared to the Neutral Game ($M = 0.24$, $SD = 0.09$). This difference was statistically significant ($t(19) = 5.90$, $p < .001$, $d = 1.32$, see Figure 2).
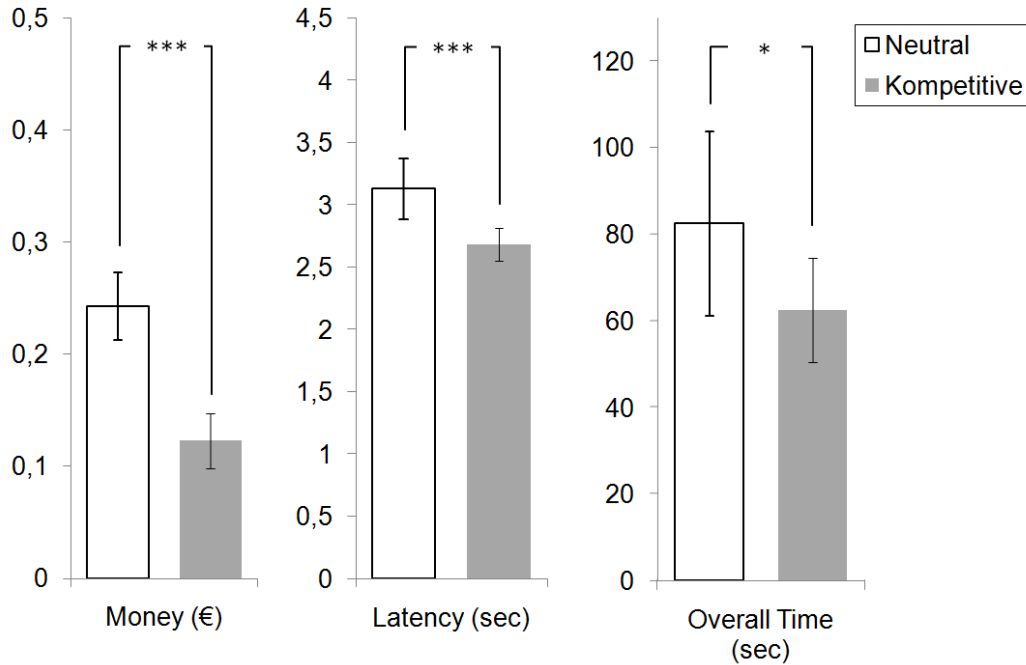

Figure 2. Note. Averaged reward in Euros (*Money (€)*), Mean movement latency in seconds (*Latency (sec)*) and overall gaming time in seconds (*Overall Time (sec)*) , compared between the Neutral Game (neutral OI) and the Competitive Game (competitive OI). *** = $p < .001$, ** = $p < .01$, * = $p < .05$.

Reward-maximizing behavior (Hypothesis 1)

Over gaming time intervals, the mean distance between group members varied significantly (GLM: $F(9, 171) = 80.77$, $p < .001$, partial $\eta^2 = 0.81$). Regarding both the Neutral Game and the Competitive Game, group members decreasingly departed from each other due to the limited playfield size of 97 hexagons. Pairwise comparisons showed significant increase of distance between 10% vs. 20% ($p < .001$) and 20% vs. 30% ($p = .003$). Overall, the distance between group members remained stable after 30% of the gaming time had passed.

We found significant differences in the distance over time between the Neutral Game and the Competitive Game (GLM: $F(1, 19) = 30.07$, $p < .001$, partial $\eta^2 = 0.61$). Group members brought more distance between themselves and other players in the Competitive Game, compared to the Neutral Game. This higher distance was consistent over gaming time clusters, thus we did not find a significant interaction between

(advanced) gaming time and game number (GLM: $F(9, 171) = 1.85$, $p = .06$, *ns*, partial $\eta^2 = 0.09$, see Figure 3 for the progress of distance over time between both games). As hypothesized in H1, players showed reward-maximizing behavior by avoiding their virtual neighbors.
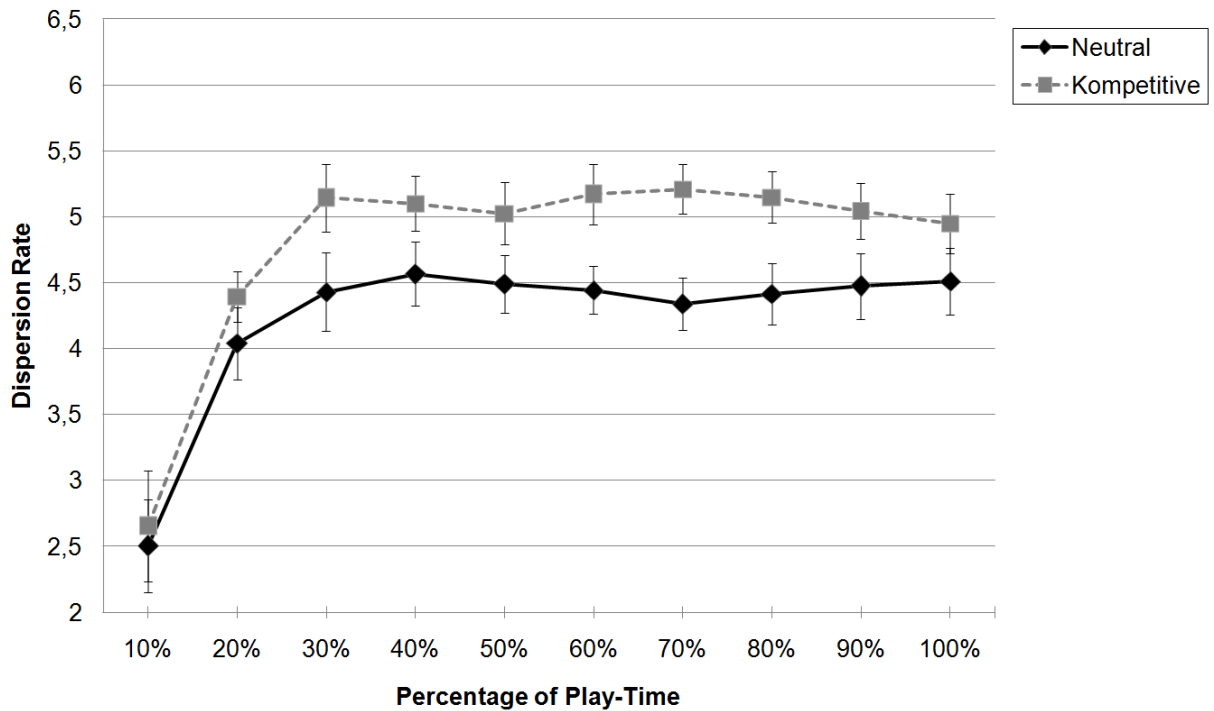

Figure 3. Note. Distance between group members over time during the gaming phase with 95% confidence intervals, compared between the Neutral Game (neutral OI) and the Competitive Game (competitive OI). The 0% interval is not displayed, because all group members started in the centre of the playing field (see Figure 1), which would lead to a distance of '0' fields. Overall, the mean difference in distance between the Neutral Game and the Competitive Game was 0.564 fields, leading to a Bonferroni corrected $p < .001$.

Perceptional Differences: Neutral Game vs. Competitive Game (Figure 4)

Pay satisfaction (Hypothesis 2a)

Satisfaction with the achieved reward was significantly lower in the Competitive Game ($M = 3.07$, $SD = 0.64$) compared to the Neutral Game ($M = 3.20$, $SD = 0.70$, GLM: $F(1, 179) = 8.17$, $p = .005$, partial $\eta^2 = 0.04$).

To differentiate between high- and low-performers and because significantly less rewards were distributed in the Competitive Game compared to the Neutral Game, we

created two linear regression models and assessed, if the individually achieved rewards in both games predicted the corresponding individual satisfaction-ratings (all levels of significance are reported two-tailed). We added the achieved rewards in € as predictor. Achieved rewards did neither have an effect on satisfaction with those rewards in the Neutral Game ($R^2 < 0.01$, $t(198) = 0.44$, *ns*), nor in the Competitive Game ($R^2 < 0.01$, $t(197) = 1.17$, *ns*). Thus, against our expectation in H2a, competitive OI led to less overall satisfaction for *both* high- and low-performers.

Stress (Hypothesis 2b)

Participants perceived significantly more stress in the Competitive Game ($M = 3.09$, $SD = 0.84$) compared to the Neutral Game ($M = 2.29$, $SD = 0.84$, GLM: $F(1, 180) = 147.32$, $p < .001$, partial $\eta^2 = 0.45$). They also felt less calm in the Competitive Game ($M = 2.97$, $SD = 0.72$) compared to the Neutral Game ($M = 3.43$, $SD = 0.67$, GLM: $F(1, 180) = 61.96$, $p < .001$, partial $\eta^2 = 0.26$). Overall, competitive OI led to more stress (and less calmness), as hypothesized in H2b.
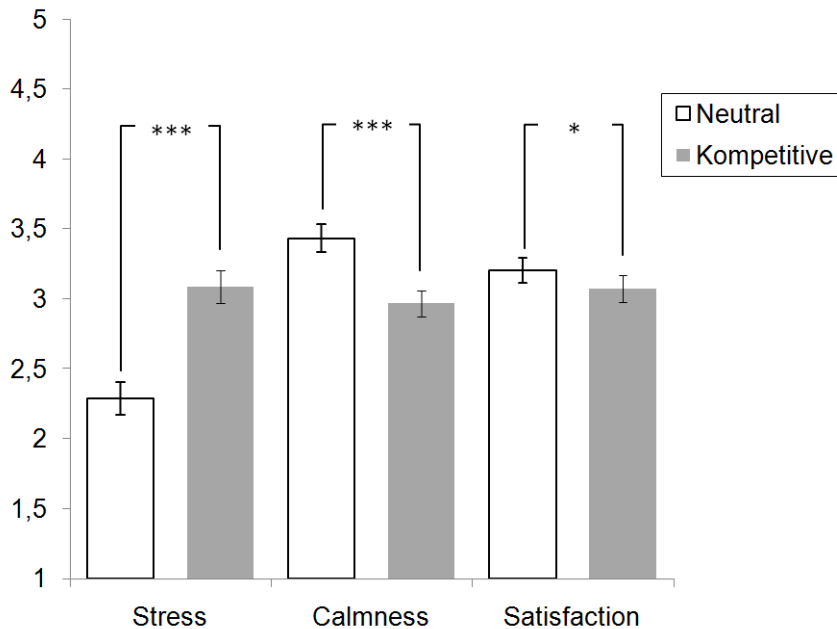
Figure 4 Note. Perceived *stress*, *calmness* and *pay satisfaction,* compared between the Neutral Game (neutral rewards) and the Competitive Game (competitive rewards). *** = $p < .001$, ** = $p < .01$, * = $p < .05$.

Discussion

The results of our study showed that competitive OI (Vegt et al., 1998) compared to neutral OI (Wageman, 1995; Wageman & Baker, 1997) within individual-based rewards (here: pay-for-performance plan) led to reward-maximizing behavior. This behavior was adapted to the competitive setting: Participants specifically avoided their neighbors on a virtual 97-hexagons playfield (HoneyComb; Boos et al., in prep.; Pritz, 2011) to evade the situation that other participants could lurch monetary reward in the form of virtual coins from them. Besides the systematic avoidance of neighbors we found that the participants also moved significantly faster under competitive OI. Both findings support the idea that reward-maximizing behavior also occurs under competitive OI with consideration for the environmental circumstances: In line with the findings of Deutsch (1949b) and Taylor (2006) we showed that competitive OI facilitated behavioral adaptation to the scenario in two ways. By avoiding their neighbors under competitive OI, participants lowered the chance to dissipate their limited moves by heading towards a path which had already been scanned by their group members. By speeding up their movements under competitive OI, participants actively tried to gain an advantage for themselves and to disadvantage their neighbors: Team members who moved faster heightened their chance to find virtual coins before others did. In terms of proself motivation (DeDreu et al., 2008), participants maximized their chance to achieve the highest monetary reward.

The results also showed negative consequences of competitive OI vs. neutral OI on the perceptional level. Pay satisfaction was lower under competitive OI independently from the achieved reward, *both* for low- and high-performers. Keeping Judge et al.'s (2010) findings that there is a linear connection between individual payment level and pay satisfaction in mind, this result is noticeable: competitive OI generally debased the satisfaction of the group members with their reward. Nonetheless of limited research dealing with effects of such payment systems on pay satisfaction, our results suggest that individual-based competitive rewards are not preferred by one "class" of performers (High, average, low; Daniels, 2000, p. 160). Whereas high performers seem to perform better under individual-based pay-for-performance plans (McGee et al., 2006) and also prefer such payment (Honeywell et al., 2002), our results showed that competitive OI did not heighten pay satisfaction for any individual, independently from the performance.

Furthermore, consistent with previous research (Fletcher et al., 2008) we found that competitive OI vs. neutral OI raised the individual stress levels.

Our computer-based multi-client game was designed to maximize internal validity. Confounding factors like eye contact or verbal communication were eliminated to a high extent. Consequently, generalization of our results is limited, though our sample had a high representative value for a larger population: it consisted of students but was very heterogeneous in terms of different subjects (Largest: economics, 17.9%; jurisprudence, 14.7%; agricultural economics, 14.7%; teaching post, 11.1%). Two major issues about the game are discussed in more detail. First, it is important to allude to the visibility of coin-fields which were already cleaned out by other participants beyond the individual perception radius: In the competitive condition, participants had this additional information source (which fields are already empty?), allowing for the avoidance of fields which had already been cleaned by other players. Yet, we randomly placed the virtual coins on the playfield and withheld the information about the exact number of coins to avoid systematic effects. Nevertheless, the additional information about empty fields in the competitive condition might have caused avoidance behavior resulting in moving away from cleaned fields, but this avoidance would have applied to *all* players of a group as soon as a coin had been found and been marked by a black contour (Figure 1), even for the player who discovered the coin. Due to the randomized placement and discovery of the coins we avoided a systematic effect in terms of pushing or pulling the players constantly toward or away from each other. Thus, as our variable measured the mean distance between all group members for all groups with differentially placed (and found) coins it was not systematically affected in terms of over- or underestimation by this additional information. Second, the representation of the participants as abstract avatars in form of black dots in a virtual environment might have handicapped the players' feelings of embodiment (Childs, 2011, pp. 25-27), on one hand. It is empirically confirmed that both anthromorphic and polymorphic visual representations enable humans to develop feelings of embodiment in a virtual environment (Murray & Sixsmith, 1999, p. 336). On the other hand, it was our intention to reduce social meanings like body height or gender (Biocca, 1997) as radically as possible in order to avoid systematic influences on our dependent variables and provide a standardized representation of each participant on the virtual playground.

In sum, our results do not suggest to implement competitive OI within individual-based pay-for-performance plans because of the rather negative perceptional consequences: Indeed individuals seem to adapt their reward-maximizing behavior to the competitive scenario and try to heighten their payout effectively - if the goal for employers was to simply push potentially reward-maximizing behavior and to connect individual performance to rewards via pay-for-performance plans, competitive OI could even force individual performance and thus organizational outcomes up. *But*, the long-term consequences of competitive OI on reward-maximizing behavior remain unknown; longitudinal studies should address this important issue. The results on the perceptional level give a first hint on possible consequences of competitive OI: (a) less pay satisfaction, which can affect job satisfaction and organizational outcomes negatively (Whitman et al., 2010); (b) more stress, which can cause physiological reactions like stress-tinnitus (Scheuch, 2008) or psychological reactions like depression (Dragano, He, Moebus, Jöckel, & Erbel, 2008). Finally, we state that non-monetary rewards (e.g. personal support, recognition) should also play an important role when competitive rewards are assessed in the future.

APPENDIX TO CHAPTER 1: INSTRUCTIONS

Welcome Screen

In study 1 and study 2, a welcome screen was displayed before the participants played the according games.
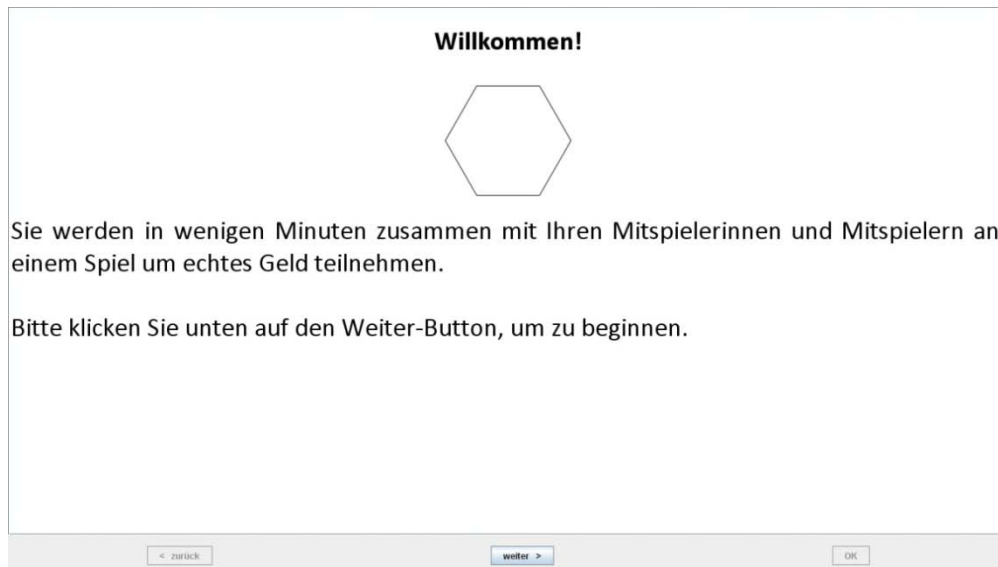
Figure S1. Note. Welcome screen. Translation: "**Welcome!** In a few minutes, you and your co-players will participate in a game for real money. Please click on the next-button below, to begin."

Study 1

In study 1, two different sets of instructions were displayed, depending on the sequence of the *Single Game* and the *Joint Game.* According to both possible sequences, either the Single Game or the Joint Game was called "Game 1", respectively "Game 2".

Sequence 1: Single Game - Joint Game
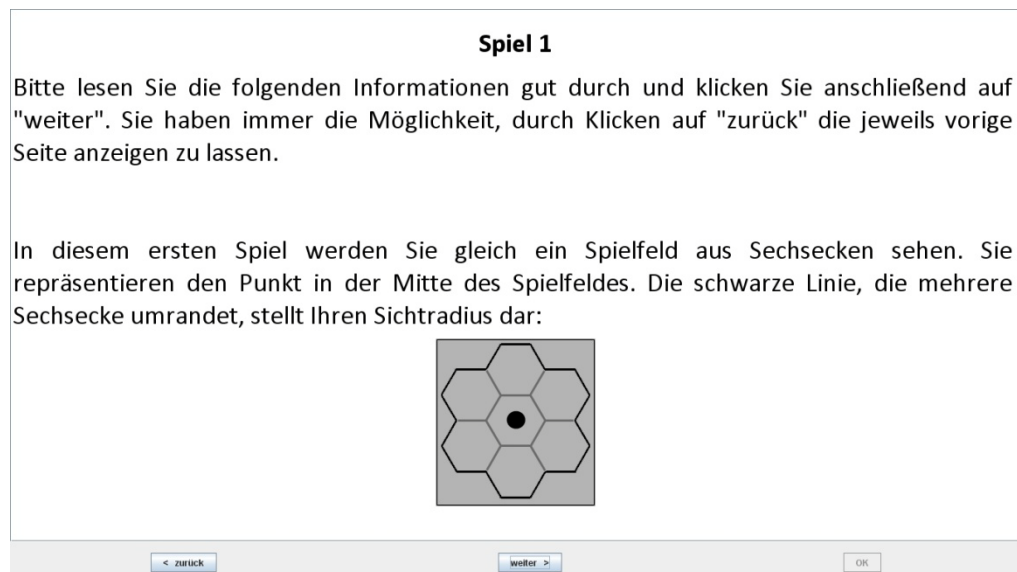
Figure S2. Note. Single Game; page 1 of 4. Translation: "**Game 1**. Please thoroughly read the following information and click on the next-button subsequently. You have always the possibility to display antecedent pages by clicking on the backward-button. In this first game, you will see a playfield consisting of hexagons. You represent the black dot in the middle of the playfield. The black contour, which encases multiple hexagons, represents your sight radius."
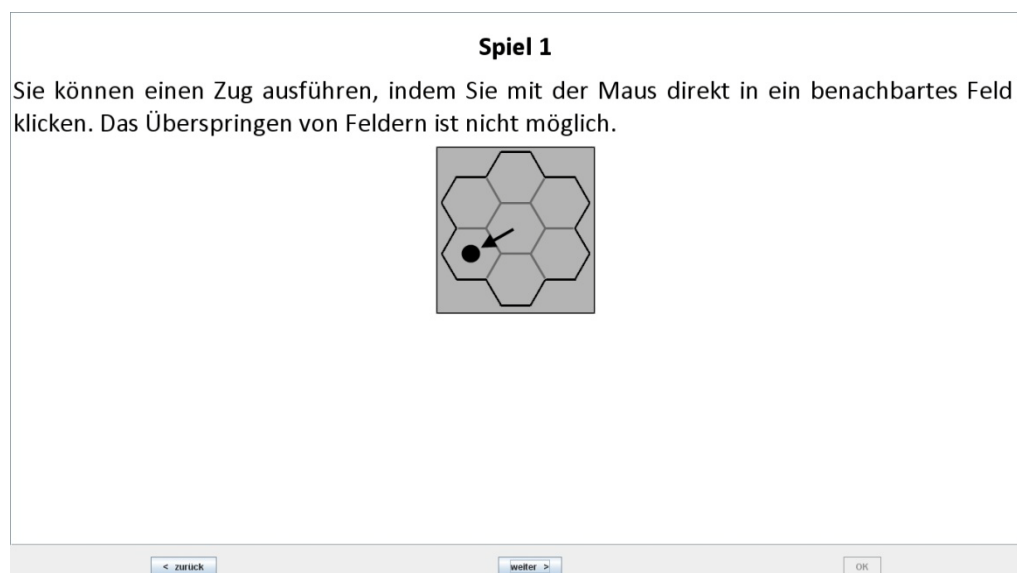
Figure S3. Note. Single Game; page 2 of 4. Translation: "Game 1. You can move by clicking into a neighbored field with your mouse. Jumping over fields is impossible."
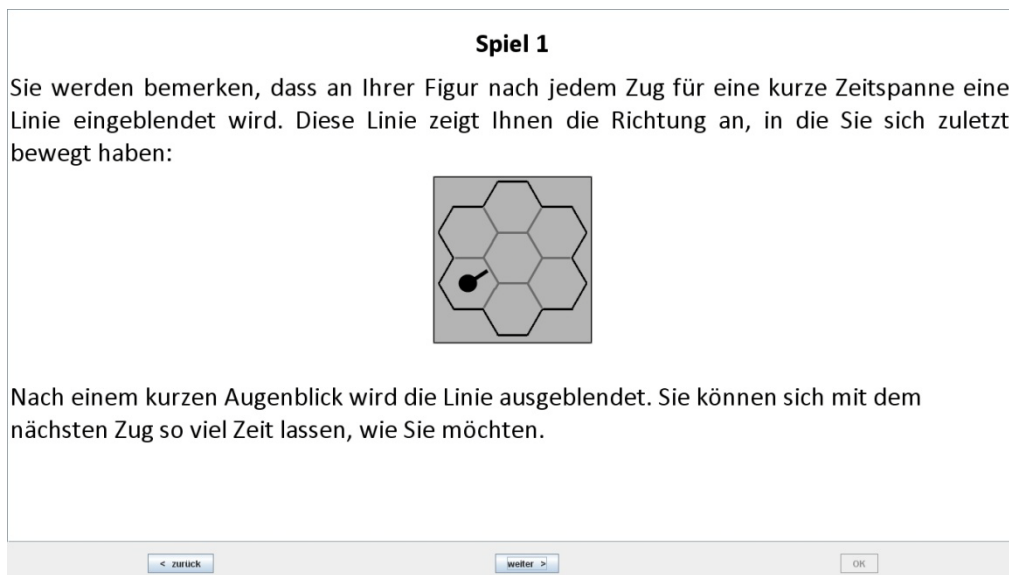
Figure S4. Note. Single Game; page 3 of 4. Translation: "**Game 1**. You will recognize that a black line is attached to your figure for a short period of time after each move. This line shows the direction, you came from with your last move. The line is removed after a short period of time. You can delay your next move as long as you wish."
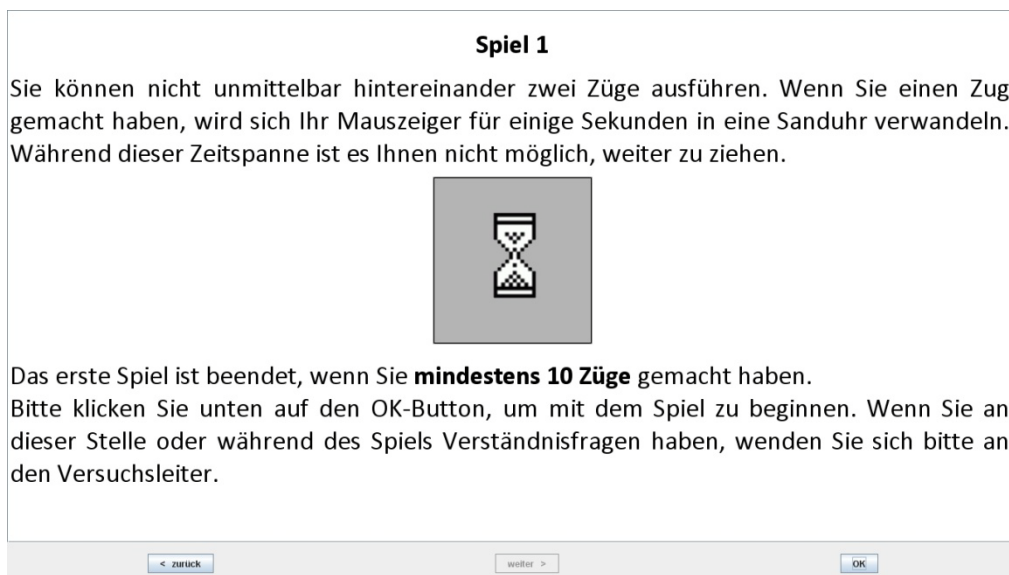
Figure S5. Note. Single Game; page 4 of 4. Translation: "**Game 1**. You cannot do two moves directly one after another. When you made a move, your cursor will transform into an hourglass for a few seconds. Within this period of time, you cannot do any moves. The first game ends, when you made **at least 10 moves**. Please click on the ok-button below, to start the game. If you have any questions now or during the game, please talk to the experimenter."

Figure S6. Note. Joint Game; page 1 of 2. Translation: "**Game 2**. Please thoroughly read the following information and click on the next-button subsequently. You have always the possibility to display antecedent pages by clicking on the backward-button. In this second game, you can move your dot like in the antecedent game. In contrast to the first game, you can see your co-players as small black dots on the playfield. You are the biggest dot:"

Figure S7. Note. Joint Game; page 2 of 2. Translation: "**Game 2**. After each move lines will be displayed illustrating the directions you or your co-players came from. Like in the first game these lines will vanish if you or your co-players do not move for a while. Please remember that you can only see co-players who are within your sight radius (black contour). The second game ends, when you made **at least 10 moves**. Please

click on the ok-button below, to start the game. If you have any questions now or during the game, please talk to the experimenter."
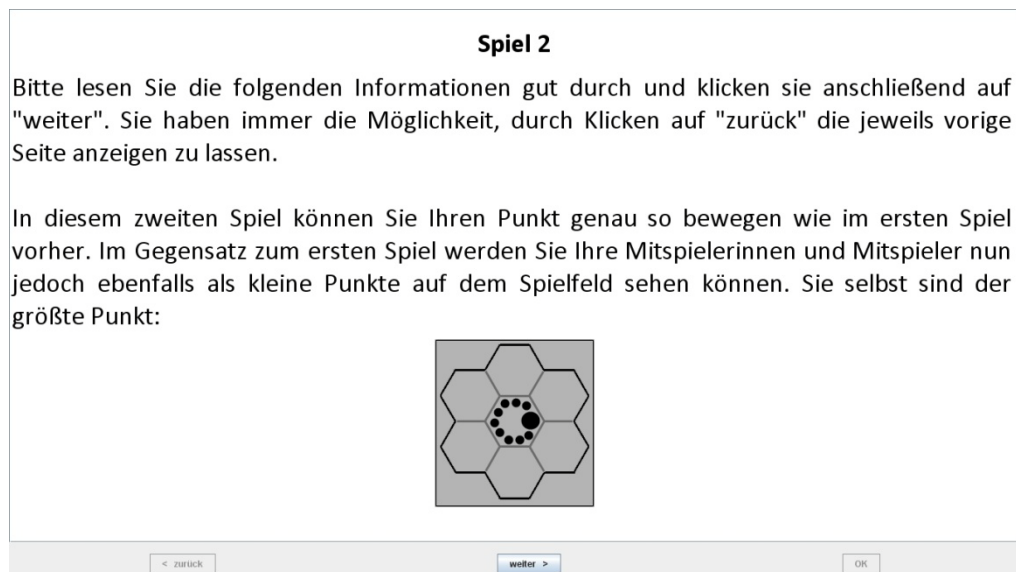
Sequence 2: Joint Game - Single Game

Figure S8. Note. Joint Game; page 1 of 4. Translation: "**Game 1**. Please thoroughly read the following information and click on the next-button subsequently. You have always the possibility to display antecedent pages by clicking on the backward-button. You can see your co-players as small black dots on the playfield; you are the biggest dot. The black contour, which encases multiple hexagons, represents your sight radius."
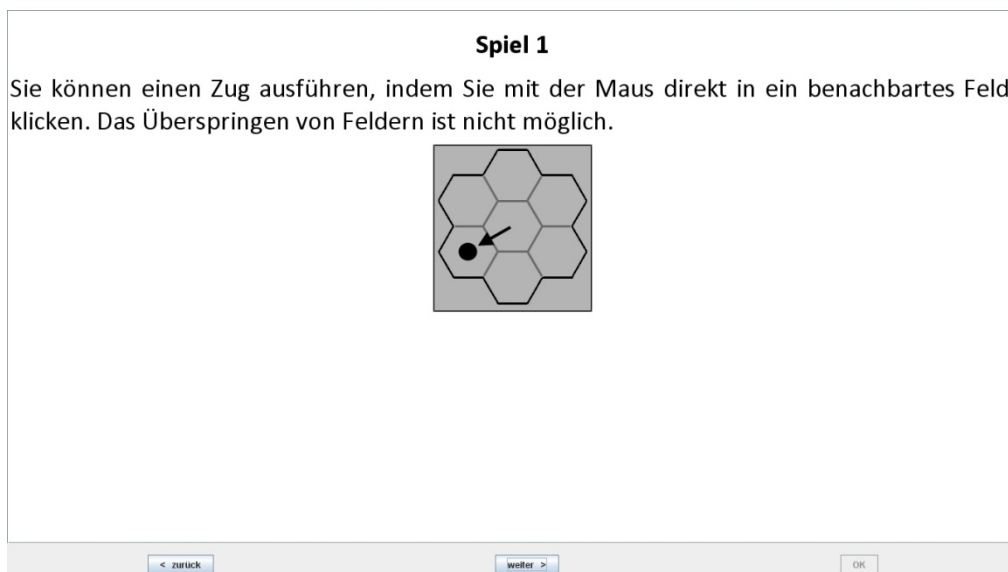
Figure S9. Note. Joint Game; page 2 of 4. Translation: "Game 1. You can move by clicking into a neighbored field with your mouse. Jumping over fields is impossible."

Spiel 1

Nach jedem Zug werden Hilfslinien eingeblendet, die Ihnen verdeutlichen, in welche Richtung sich Ihre Mitspielerinnen und Mitspieler und auch Sie selbst bewegt haben. Nach einer Weile verschwinden diese Linien, falls Sie oder Ihre Mitspielerinnen und Mitspieler keinen Zug ausführen. Bitte denken Sie daran, dass Sie nur Mitspielerinnen und Mitspieler sehen können, die sich in Ihrem Sichtradius (schwarze Umrandung) befinden.

Nach einem kurzen Augenblick wird die Linie ausgeblendet. Sie können sich mit dem nächsten Zug so viel Zeit lassen, wie Sie möchten.
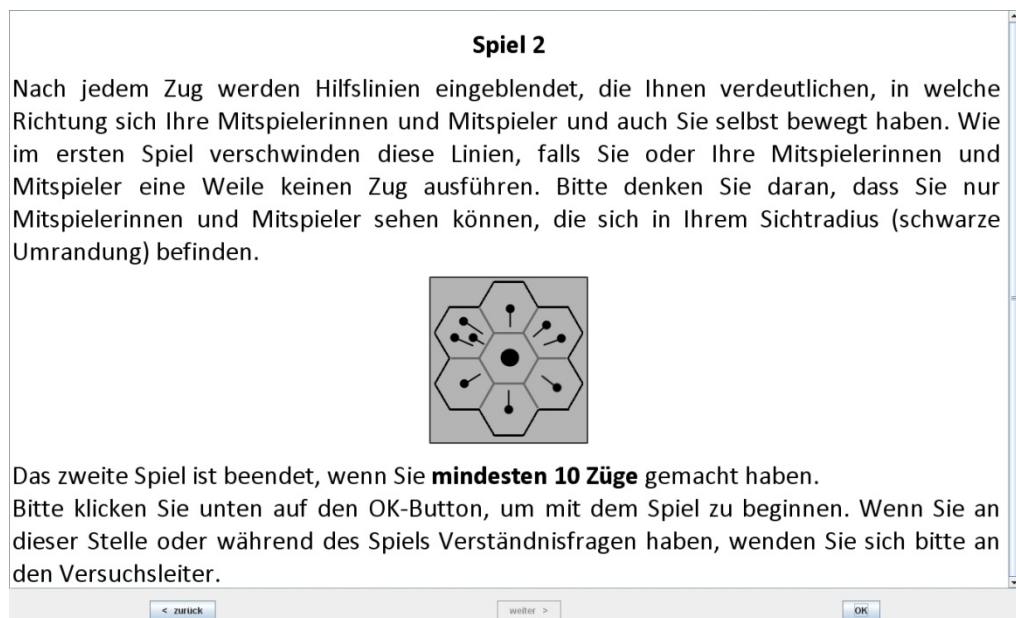
< zurück   weiter >   OK

Figure S10. Note. Joint Game; page 3 of 4. Translation: "**Game 1**. After each move lines will be displayed illustrating the directions you or your co-players came from. These lines will vanish if you or your co-players do not move for a while. Please remember that you can only see co-players who are within your sight radius (black contour). The line is removed after a short period of time. You can delay your next move as long as you wish."

Spiel 1

Sie können nicht unmittelbar hintereinander zwei Züge ausführen. Wenn Sie einen Zug gemacht haben, wird sich Ihr Mauszeiger für einige Sekunden in eine Sanduhr verwandeln. Während dieser Zeitspanne ist es Ihnen nicht möglich, weiter zu ziehen.

Das erste Spiel ist beendet, wenn Sie **mindestens 10 Züge** gemacht haben.
Bitte klicken Sie unten auf den OK-Button, um mit dem Spiel zu beginnen. Wenn Sie an dieser Stelle oder während des Spiels Verständnisfragen haben, wenden Sie sich bitte an den Versuchsleiter.

< zurück   weiter >   OK

Figure S11. Note. Joint Game; page 4 of 4. Translation: "**Game 1**. You cannot do two moves directly one after another. When you made a move, your cursor will transform into an hourglass for a few seconds. Within this period of time, you cannot do any moves. The first game ends, when you made **at least 10 moves**. Please click on the ok-button below, to start the game. If you have any questions now or during the game, please talk to the experimenter."
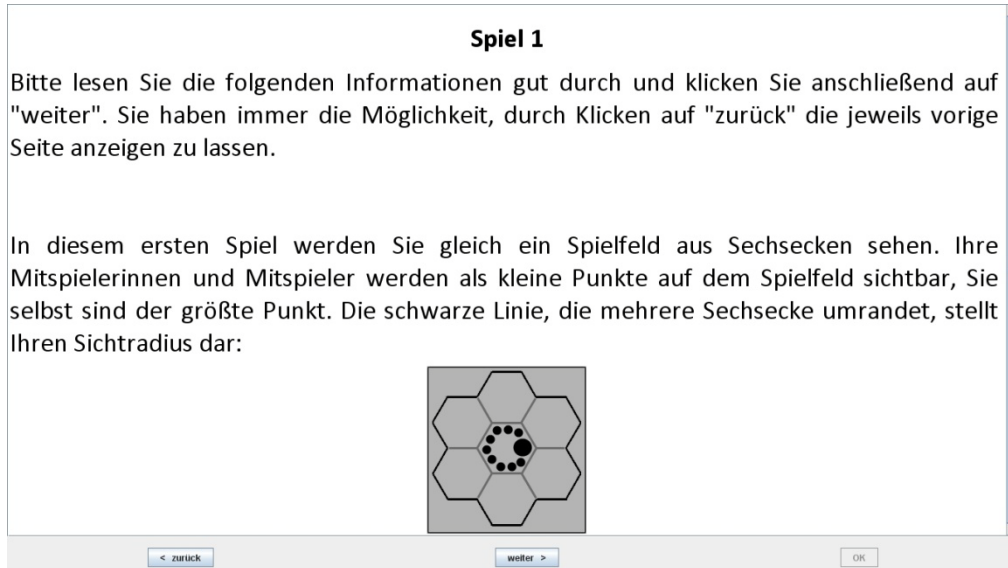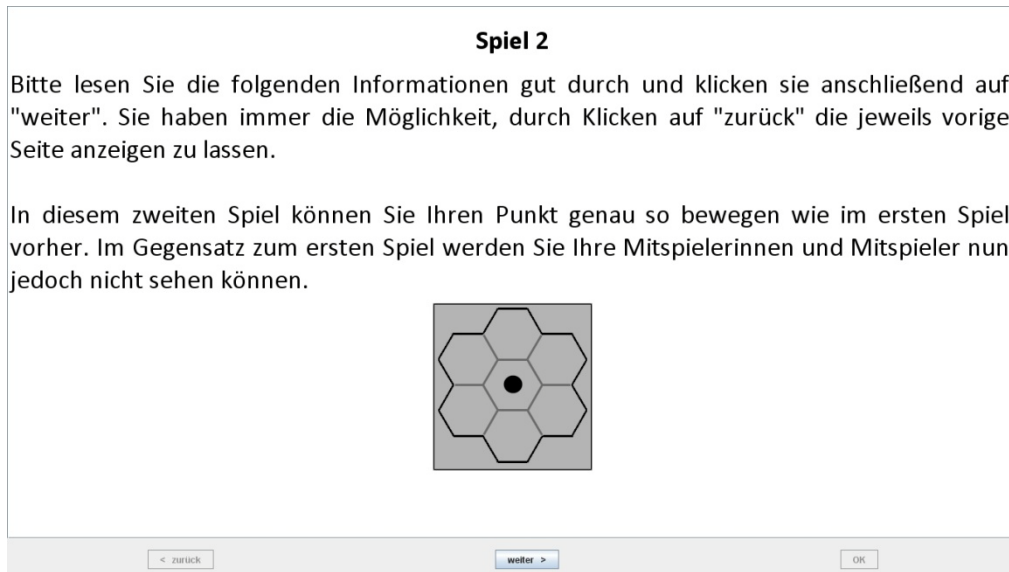
Figure S12. Note. Single Game; page 1 of 2. Translation: "**Game 2**. Please thoroughly read the following information and click on the next-button subsequently. You have always the possibility to display antecedent pages by clicking on the backward-button. In this second game, you can move your dot like in the antecedent game. In contrast to the first game, you cannot see your co-players."
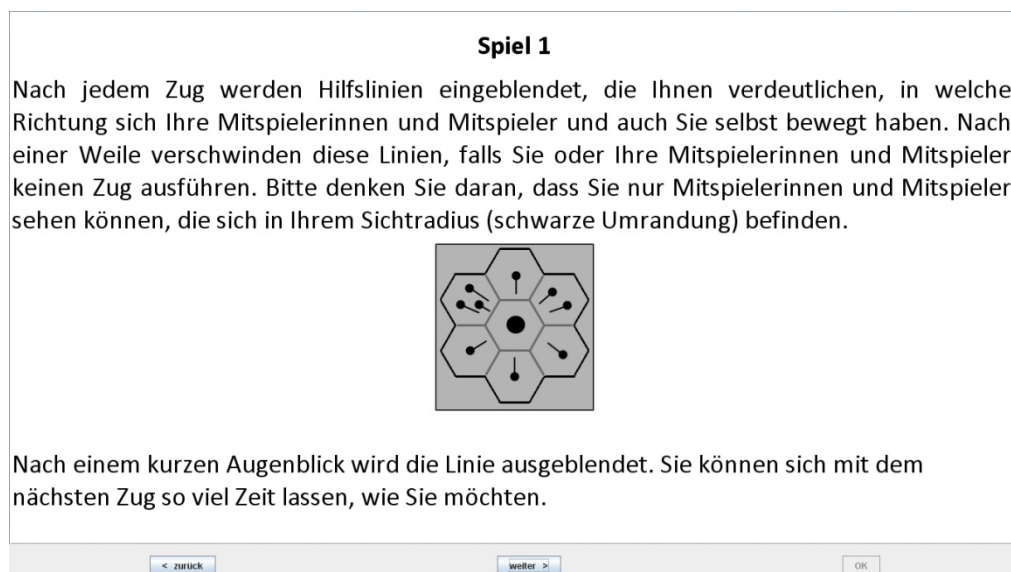

Figure S13. Note. Joint Game; page 2 of 2. Translation: "**Game 2**. After each move lines will be displayed illustrating the direction you came from. Like in the first game these lines will vanish if you do not move for a while. The second game ends, when you made **at least 10 moves**. Please click on the ok-button below, to start the game. If you have any questions now or during the game, please talk to the experimenter."
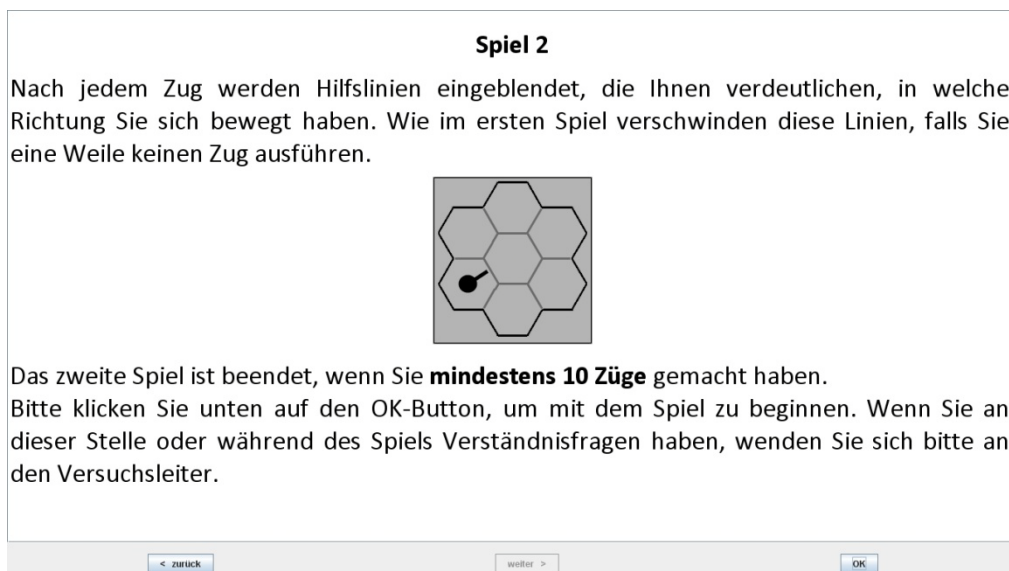
Study 2

In study 2, the sequence of the *Neutral Game* and the *Competitive Game* had no effect on the instructions of the games but the game numbers. Here, only screenshots of sequence 1 (Neutral Game - Competitive Game) are shown; the Neutral Game was called "Game 3", the Competitive Game was called "Game 4".

Spiel 3

Auf dem Spielfeld sind an zufälligen Stellen einige unsichtbare *0,50 Euro-Stücke* versteckt, die Sie und Ihre Mitspielerinnen und Mitspieler finden können. Wenn Sie ein Geldstück auf einem Feld entdeckt haben, gehört es unwiderruflich Ihnen. Es erscheint dann auf dem Feld die folgende, **nur für Sie sichtbare** Markierung:

Jedes einzelne 0,50 Euro-Stück kann **pro Person einmal gefunden werden**. Entdeckt eine Mitspielerin oder ein Mitspieler ein 0,50 Euro-Stück vor Ihnen, hat dies also **keine Konsequenz**; das Geld bleibt an Ort und Stelle und kann immer noch von Ihnen entdeckt werden.

< zurück   weiter >   OK

Figure S14. Note. Neutral Game; page 1 of 2. Translation: "**Game 3**. Invisible 0.50 Euro-coins are hidden at random places within the playfield and can be found by you or your co-players. If you find a coin on a field, it irrevocably belongs to you. A flag, which is **only visible to you**, will then appear: Every single 0.50 Euro-coin can **be found once per person.** If a co-player discovers a 0.50 Euro-coin before you, this has **no consequence**; the money remains in place and can still be found by you."

Figure S15. Note. Neutral Game; page 2 of 2. Translation: "**Game 3**. Please keep in mind that you can do **a maximum of 15 moves**. The remaining moves are displayed in the four corners around the playfield. In this example, you have got 14 moves left: The game ends, when all players have depleted their moves. Please click on the ok-button below, to begin."
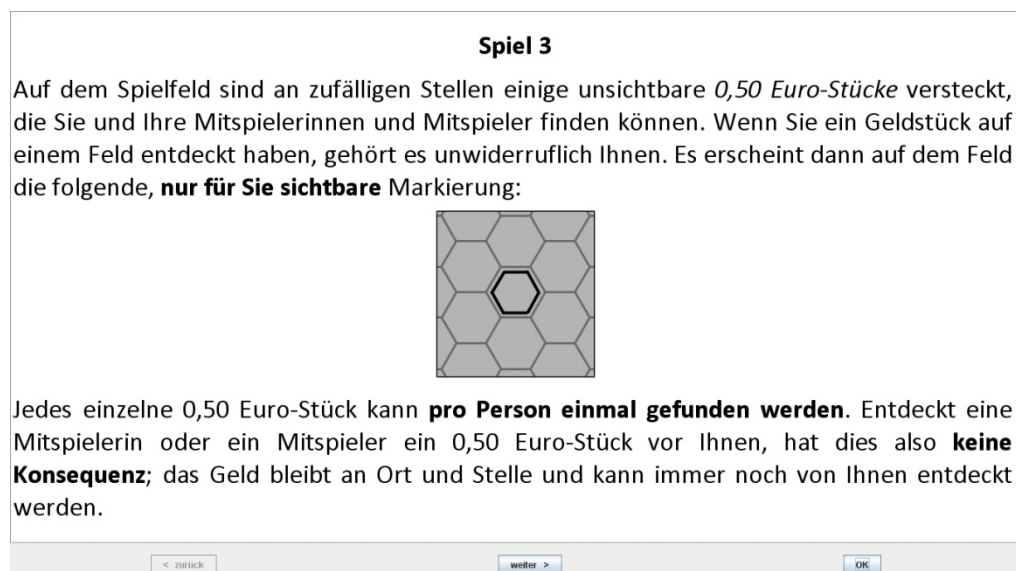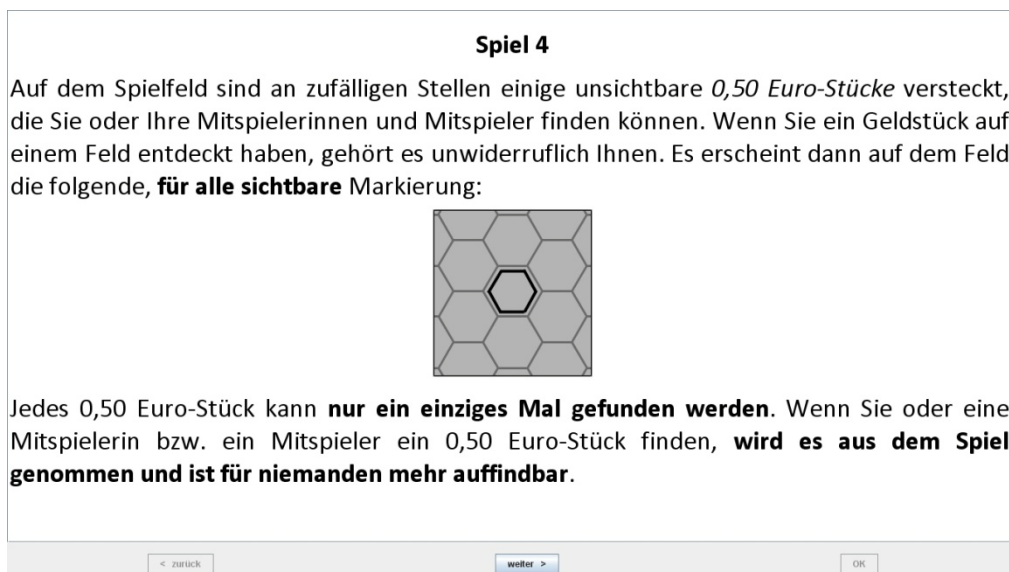

Figure S16. Note. Competitive Game; page 1 of 2. Translation: "**Game 4**. Invisible 0.50 Euro-coins are hidden at random places within the playfield and can be found by you or your co-players. If you find a coin on a field, it irrevocably belongs to you. A flag, which is **visible to all players**, will then appear: Every single 0.50 Euro-coin can **be found only once.** If you or a co-player discovers a 0.50 Euro-coin, **it is removed from the game and cannot be found anymore.**"

Spiel 4

Bitte denken Sie daran, dass Sie **maximal 15 Züge** machen können. Die verbleibenden Züge werden Ihnen in den vier Ecken rund um das Spielfeld angezeigt. In diesem Beispiel haben Sie noch 14 Züge übrig:

Das Spiel ist beendet, wenn alle Spielerinnen und Spieler ihre Züge aufgebraucht haben. Bitte klicken Sie unten auf den OK-Button, um mit dem Spiel zu beginnen.
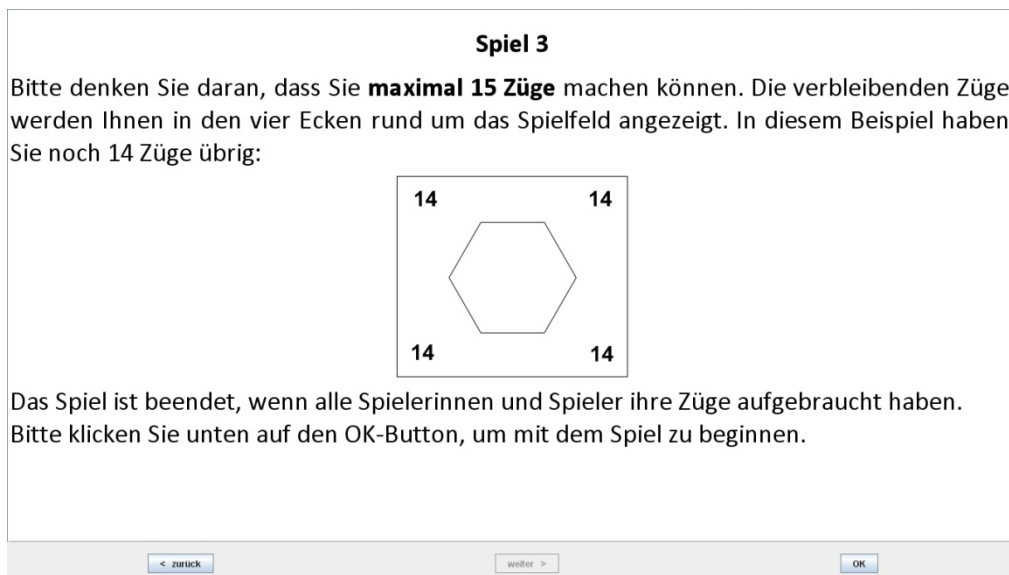
Figure S17. Note. Competitive Game; page 2 of 2. Translation: "**Game 4**. Please keep in mind that you can do **a maximum of 15 moves**. The remaining moves are displayed in the four corners around the playfield. In this example, you have got 14 moves left: The game ends, when all players have depleted their moves. Please click on the ok-button below, to begin."
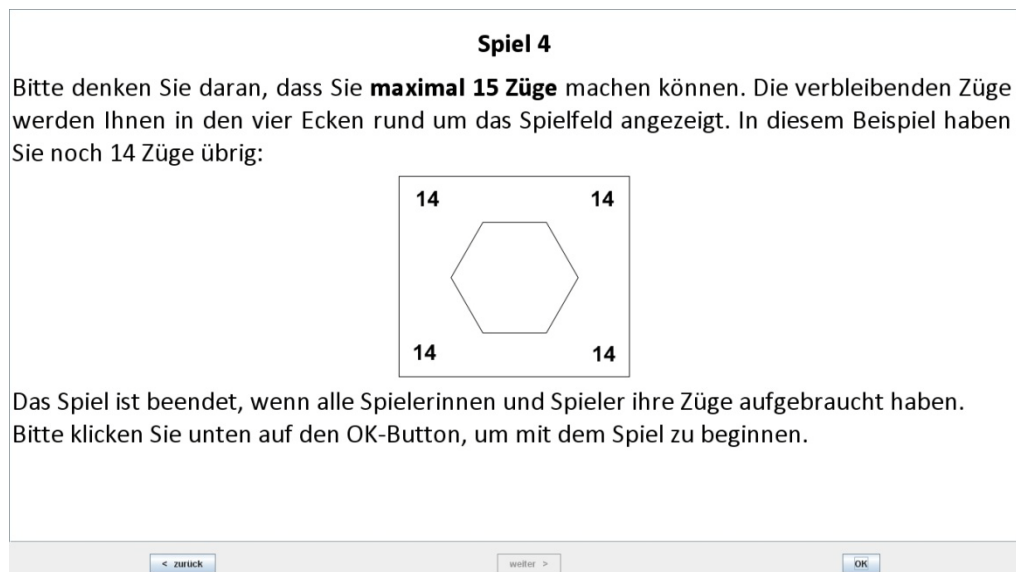
CHAPTER 2 GROUP-BASED REWARDS

STUDY 3: STATUS, FAIRNESS, AND KNOWLEDGE SHARING IN COMPUTER-MEDIATED GROUPS

with Oliver Rack[1], Andrea B. Hollingshead[2], & Margarete Boos[3]

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Abstract

A laboratory experiment investigated the effects of group-based rewards and status differences on knowledge sharing and perceived fairness in computer-mediated groups. Fifty-six (56) three-person groups worked on an online knowledge pooling task. A $2 \times 2 \times 2$ factorial experimental design manipulated (1) high vs. low status within group, (2) whether the group-based rewards were distributed equally (each member received the same share) or status-dependent equitably (members received unequal shares based on their relative status), and (3) whether high status assignments were ostensibly based on contribution (the highest pre-test score) or age (the oldest member was high status). A no reward, no status manipulation control condition was run as a baseline. Analyses revealed that both high and low status members perceived an equality reward as more fair than a status-dependent equitably reward. High status members shared more knowledge under (a) a status-dependent equity system, and (b) if status was based on age. Low status members shared more knowledge under (a) an equality system, and (b) if status was based on pre-test score. The findings are discussed in terms of system justification theory.

Keywords

knowledge sharing; group-based rewards; status differences; distribution strategy; perceived fairness

Introduction

Many tasks performed by teams are unitary (Steiner, 1972). They result in a single product or outcome, which makes it difficult to identify individual contributions. As a result, organizations where members work mainly in project teams often reward group rather than individual performance (DeMatteo, Eby, & Sundtrom, 1998; Nickel & O'Neal, 1990). Group-based rewards are often effective for increasing group motivation and performance relative to individual-based rewards (for face-to-face teams: Honeywell-Johnson & Dickinson, 1999; Lawler, 2002; Taylor, 2006; Wageman, 1995; for computer-mediated groups: Rack, Ellwart, Hertel & Konradt, 2011, for an overview see Boos, Jonas & Sassenberg, 2000) or mixed group individual rewards (Barnes, Hollenbeck, Jundt, DeRue, & Harmon, 2010).

Bartol and Hagman (1992) distinguish between two different strategies for distributing group-based rewards to individual group members: equality and equity. The *equality strategy* divides the group reward into equal shares regardless of the relative contributions of each member to the group outcome. In contrast, the *equity strategy* allocates unequal shares of the group reward based on the relative contributions of each group member. In a meta-analysis, Honeywell-Johnson and Dickinson (1999) found that group rewards distributed to members based on an equity-strategy were often perceived as unfair and dissatisfying by the majority of the group members. Even if equity rewards result in higher group performance, their influence on reward satisfaction can be negative, especially if some group members are consistently outperformed by others (cf. Daniels, 1989; 2000).

There are a range of distribution strategies that provide different shares across members. Equity distribution strategies are most often based on the relative contribution of members to group outcomes. Merit-based bonuses, common in many organizations, are one example. However, distribution strategies that provide unequal rewards can also be based on other characteristics that may *not* be related to relative contribution to the group task such as tenure (those who have been in the group longest get a larger share), age (the oldest child gets the most in the family), or gender (men are paid more than women). Here, we refer to *status-dependent equity distribution system* as the larger category of distribution systems in which members receive unequal shares of the group reward based on one or more characteristics giving one or more group members higher

status: Whereas low status members earn lower rewards depending on their relative contribution to the group outcome, high status members receive the highest reward independently from their contribution.

The present study extended previous research by examining how the nature of the distribution strategy may affect perceptions and behavior of low and high status members in groups differentially. It examined the independent and interactive effects of status assignments and distribution strategy by manipulating each variable separately in the same study. It draws on equity theory, status characteristics theory, and system justification theory to make predictions about the conditions under which high status members versus low status members will contribute more knowledge to their group. It also extended previous research conducted in face-to-face settings to computer-mediated groups.

Status Differences and Status Characteristics Theory

Status is defined as the influence, often in terms of participation, that individuals carry in groups, and is bestowed upon individuals by other members or an organization due to their personal characteristics or formal position (see Berger, Cohen, & Zelditch, 1972 for an overview). It has been well documented that high status members are often afforded more resources, attention, and support by their team members than low status members (Batinic, Selenko, Stiglbauer, & Paul, 2010; Ellis, 1994). When an individual's higher status is based on their value for the group task, low status group members will often accept the status of their privileged teammates (for an overview, see Anderson & Kilduff, 2009). However, if status is determined on the basis of a diffuse characteristic such as age or gender that does not relate directly to the group's task, it will be perceived as less fair by group members (Berger, Rosenholtz, & Zelditch, 1980; Greenberg & Leventhal, 1976).

Status Differences and System Justification Theory

How does the perceived fairness of the status assignment and distribution strategy affect the behavior of group members? At first glance, Adam's (1965) equity theory makes predictions which seem to fit to this question. If group members perceive less fairness of their reward, they can reduce their individual input to the group task and thus reduce internal dissonance.

We manipulated whether a member's high status in the group was assigned based on their potential value for the group's task performance - i.e., the highest score on a pretest: a specific status characteristic - or based on their age relative to other members of the group: a diffuse status characteristic. We chose age specifically because of the expected small age differences in our student sample - thus, we maximized the likelihood that participants would view age as task irrelevant. The present study also manipulated the reward distribution strategy: whether rewards were divided equally or status-dependent equitably among members.

Consistent with equity theory, we expected that an age-based status assignment would have a negative effect on the perceived fairness of the distribution strategy only when it affected members' individual rewards.

H1: Perceived fairness will be lowest in the age-based status condition and the status-dependent equity condition, thus there will be an interaction of Status Assignment × Distribution Strategy.

System justification theory extends equity theory by describing processes and behaviors when reward systems are unfair/not legitimate and do not completely take individual contributions into account. It provides a theoretical lens in which to make predictions about the differential effect of such distribution strategies on the behaviors of high and low status members in the group. It suggests that people are motivated to have favorable attitudes about themselves, their groups and the overarching social order (Jost, Banaji, & Nosek, 2004). The motive to perceive the prevailing social system as fair and just (or to accept the status quo) is not unique to high status members who benefit most, but also to low status members who are disadvantaged in a status-dependent equity distribution system.

In general, when group members feel their outcomes are dependent on a system that is being justified, their intentions and behaviors will change so that they become aligned with it. For example, when there is a challenge to member's self-esteem based on the reward system due to the membership in a disadvantaged low status sub-group (Jost et al., 2004), members will adjust their behaviors accordingly by reducing their contribution to the group task (cf. sucker effect, Kerr, 1983). To extend this theory, we investigated how the alignment between members' status, their expected contribution to

the group task, and the reward distribution strategy would impact members' differential contributions to the group task.

Under an equality distribution system when there are status differences among members, low status members should contribute relatively more and high status members should contribute relatively less to the group task to justify the equal reward. When the distribution system is perceived as unfair, members will adjust their behavior so that it is perceived as more fair. Thus, we expected that high status members would contribute relatively more to the group task when the status assignment was based on age rather than on their pre-test score, to justify their higher reward.

_**H2a:**_ Low status members will share more knowledge in the equality conditions compared to the status-dependent equity conditions, and high status members will share more knowledge in the status-dependent equity conditions compared to the equality conditions. Thus, we expected an interaction of Member Status × Distribution Strategy on knowledge sharing.

_**H2b:**_ High status members will share more knowledge in the age-based than in the individual pre-test score-based status assignment conditions. Thus, we expected an interaction of Member Status × Status Assignment on knowledge sharing.

We did not expect any significant performance differences across the experimental conditions. All conditions imposed status differences on group members, and high versus low status was randomly assigned.

Method

Overview and Design

Participants were asked to complete a 20-question test that assessed knowledge in the domains of science, food, entertainment, American history, and sports (cf. Hollingshead, 1998). They performed the task two times: first, individually via an online questionnaire; and second, in three-person groups communicating via computer chat.

A 2 × 2 × 2 factorial design was implemented to test the hypotheses. One high status member and two low status members were randomly chosen within each group, and each group was randomly assigned to one of the four experimental conditions. The first factor was the type of the group-based reward distribution system: equality vs. status-dependent equity; the second was the nature of the high status assignment: based

on age vs. based on individual performance (score on pre-test). This design allowed for an analysis of the independent and interactive effects of status and of distribution strategy. A control group with no reward and no status manipulation was also run as a baseline.

Participants

A total of 168 undergraduate students voluntarily participated in the study. All participants received course credit in psychology for their participation. Participants were randomly assigned into 56 three-person groups, and the groups were assigned to either the experimental ($n = 46$) or control condition ($n = 10$). Most students were psychology majors (74.2%) or other social sciences majors (22.7%), with a small proportion of other majors (3.1%), and were between the ages of 18 and 48 ($M = 22.4$; $SD = 4.87$).

Procedure

The pre-test phase

Participants were randomly assigned to three-person groups prior to the experiment and then allocated to time slots based on their availability. Immediately after arriving, participants were led into the computer lab and were instructed not to talk to one another. They received a short introduction on how to operate the online chat, and how to complete the online knowledge test. Subsequently, group members were led into separate rooms where they completed the online 20-question knowledge-pooling task individually, and were asked for their age. Each member was randomly assigned a number (Participant 1, 2, or 3).

The online knowledge task consisted of four open-ended questions of varying difficulty from each of five categories of knowledge: science (e.g., What nuclear process takes place in a hydrogen bomb?), entertainment (e.g., What color is Mr. Spock's blood?), sports (e.g., Who is the husband of Steffi Graf?), American history (e.g., Who is the current governor of California?), and food (e.g., A prune is a dried _____.).

In all experimental conditions, team members were informed that rewards would be awarded to the top performing teams: the 1st to 4th place groups would receive 60€, 5th to 12th place groups would receive 30€, and groups placing below 12th place would receive no money. In the *equality conditions*, teams were told that any reward awarded to

the team would be divided evenly (one third) among members regardless of the relative status of group members. In the *status-dependent equity conditions*, the group reward was divided into three unequal portions among members (50%, 33%, & 17%). The high status member received 50% of the group reward; low status members were informed that they could receive 33% or 17% of the group reward, depending on their contribution of correct answers during the group task (incorrect answers did not reduce the score of correct answers). Thus, we did not create a linear status hierarchy, but one high and two low status members. We did this for two reasons: (1) it enabled us to isolate the impact of the high status manipulation since it was held constant for low status members across the two status-dependent equity conditions; and (2) in many organizations, assigned leadership may be based on factors other than contribution (such as nepotism, friendship or tenure) whereas bonuses among subordinates are often awarded based on merit.

The status assignment manipulation was conveyed through a text message on each screen which said high status had been determined based on each member's relative age (the oldest team member was high status) or the highest individual pre-test score. To avoid systematic effects of age and actual pre-test performance, the high status member was chosen randomly, and each participants' number (1, 2, or 3) was presented when the chat started. The 10 groups in the control condition did not receive any instructions concerning group rewards or status assignments.

Two questions with attached textboxes were used to assess if the participants had understood the reward instruction (manipulation check): "If your team would place 1st, what would be your team's reward?" (correct answer: 60€); "How much money would the highest status person receive?" (correct answer: 20€ in equality conditions; 30€ in status-dependent equity conditions). Most participants answered the maximum team reward correctly (89%). The question about the maximum payout for the high status person within the experimental conditions was answered correctly by 81% of participants; 100% of the groups contained at least one member who had answered this question accurately.

The interaction phase

After individually completing the online 20-question knowledge task, participants switched from the online questionnaire to the chat-client as instructed in the pre-test phase. All participants were instructed to complete the 20-question knowledge task

again, but this time as a group using the chat-client. They were also instructed to reach consensus on each answer to every question, and to individually write this answer down on a separate sheet. Unlike the pre-test phase they had no time constraints. Groups had 25 min to complete the 20-question knowledge task. All groups completed the task within the allotted time.

The synchronous chat-client program LANChat[3] was used for all groups. Only text-based communication was possible and members did not have visual access to one another during the experiment. Participants were able to post messages, which appeared on all team members' screens. Participants were able to scroll to see the chronological sequence of the chat conversation at any time. The log file of the chat conversation was recorded by the program.

The posttest phase

After working in three-person groups, participants switched back to the online questionnaire program and answered a short questionnaire (see details below) that assessed perceived fairness and demographic data. Finally, participants were debriefed and thanked. Rewards were paid after the study had been completed, and participants received a hyperlink containing the placement ranks of all groups and associated payments. Rewards were awarded to the top twelve performing groups and were equally divided.

Dependent Measures

Performance

Individual performance scores were based on the total number of correct answers out of 20 questions in the pre-test phase. Group performance was measured by the total number of correct answers in the interaction phase.

Perceived fairness

Perceived fairness of the distribution strategy was measured by two items (Giacobbe-Miller, Miller, & Victorov, 1998; scale-reliability: $\alpha = .90$), using seven-point Likert

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[3] The freeware "LANChat 1.1" can be found at http://christoph.stoepel.net

scales (1 = *strongly disagree* to 7 = *strongly agree*); "I am fully satisfied with the distribution of the reward in my group", and "The distribution of the reward was fair".

Knowledge Sharing

Log files of the chat conversations were used to create two measures of group process: *contribution rate* and *knowledge sharing (content)*.

Contribution rate. The contribution rate for each member was computed by the number of characters typed. This measured the quantity of each member's participation.

Content. Three categories measured the explicit sharing of knowledge during the chat conversation: Solutions, agreements, and other relevant knowledge. This measured the content of each member's contribution. *Solutions* were defined as being the first member to provide an answer to a question (e.g., "On question 2, Andre Agassi is the husband of Steffi Graf."). *Verifications* were defined as confirming an answer previously mentioned by another member (e.g., "Yes, I am also sure that Andre Agassi is the right answer."). *Other relevant knowledge* was defined as task-relevant knowledge that was incomplete but relevant to the question (e.g., "I do not know to whom she is married, but I am sure he is a tennis player.").

Each transcript was coded by two independent raters, who were blind to the experimental condition[4]. We aggregated the three types into a single measure of knowledge sharing for each member to measure individual contribution and effort. Aggregating across the three types also resolved all category coding disagreements among the two coders.

Demographics and control variables

Age, gender, subject of study, and number of semesters were surveyed as demographic questions with attached textboxes (e.g., "What is your age?"). The *ability to type* ("I am able to type very fast") and *experience with chat* ("I am very experienced in using online chat applications") were used as control variables, measured with seven-point Likert scales (1 = *strongly disagree* to 7 = *strongly agree*).

Results

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[4] Overall Cohen's Kappa was .49 across the three knowledge categories), which is within the acceptable range (cf. Fleiss, 1981; Landis & Koch, 1977).

Descriptive Statistics: Individual and Group Performance

We used standard t-tests to assess differences in performance between individuals and groups, the control and experimental conditions, and between high and low status members. In the pre-test phase, the mean individual performance was 9.1 (SD = 1.7), whereas in the interaction phase, the mean group score was 13.1 (SD = 2.4). The difference between individual and group scores was statistically significant (t_{within}(55) = 13.96, p < .001, d_{within} = 1.87). As expected based on random assignment, there were no statistically significant differences in individual performance between the low and high status members (t(135) = 0.46, ns). There were also no group performance differences between the experimental and no-reward control conditions (t(54) = 0.96, ns)

The means for perceived ability to typewrite was 4.4 (SD = 1.9) and for experience with computer chat was 4.1 (SD = 2.1). Both control variables were positively correlated with each other, r_{within}(109) = .61, p < .001.

Hypothesis Testing

Participants were nested in three-person groups resulting in two hierarchical levels: individual (level-1) and team (level-2). To provide a statistical method for investigating and drawing conclusions regarding the influence of differently-leveled variables (Hofmann, 1997), we calculated multiple hierarchical linear models (HLM, Raudenbush & Bryk, 2002).

At level-1, a regression equation was utilized. The mean within-person effects were then used as dependent variables at level-2 (Yeo & Neal, 2004). In the first step, we ran empty models for each dependent variable. This examined the variance in the outcome scores (e.g., knowledge sharing) before accounting for predictor variables. A standard one-way random ANOVA model was used by HLM to test the relation between variance components at level-2 (between variance) and overall variance (intraclass correlation coefficient ICC, cf. Kreft & deLeeuw, 1998). In the second step, predictors on level-1 and level-2 were integrated into the empty model HLM, creating a full model. Means (M_p) were then predicted by the corresponding HLM. Two effect sizes express the explained variance on level-1 (within groups; $R^2_{level-1}$) and on level-2 (between groups; $R^2_{level-2}$).

General influence of rewards

This set of analyses investigated the influence of group rewards by comparing the experimental conditions, which all had a group-level reward, to the no-reward control condition.

The ICCs were .23 for contribution rate and .44 for knowledge sharing. Two separate level-2 HLMs with the independent variable 'group-based reward' on the 2nd level and the dependent variable contribution rate ($R^2_{level-1}$ = .39, $R^2_{level-2}$ = .24) and knowledge sharing ($R^2_{level-1}$ = .02, $R^2_{level-2}$ = .22) were created (see Table 1).

Table 1. Results of Hierarchical Linear Modeling: Contribution and Knowledge Sharing Between Control (No Reward) and Experiment Conditions (Reward)

	coefficient	*SE*	*t*	*df*	*p*
DV1: contribution rate					
Intercept	1380.35	39.55	34.90	53	< .001
reward (L2)	156.53	77.87	2.01	53	.049
experience with chat (L1)	57.48	19.70	2.92	160	.004
ability to typewrite (L1)	113.99	20.26	5.63	160	< .001
DV2: knowledge sharing					
intercept	6.95	0.25	28.15	53	< .001
reward (L2)	1.59	0.43	3.74	53	.001
experience with chat (L1)	0.21	0.10	2.13	160	.034
ability to typewrite (L1)	0.01	0.10	0.03	160	.977

Note. $R^2_{level-1}$ = .39; $R^2_{level-2}$ = .24. Legend: *experience with chat* and *ability to typewrite* = self-rated control variables.

For contribution rate, the analysis revealed a statistically significant effect of rewards on typewritten characters during the group discussion (*coef.* = 156.53, *t*(53) = 2.01, *p* = .049): Participants typed more characters in the experimental conditions (M_p = 1537) than in the control condition (M_p = 1224). The level-2 HLM also revealed statistically significant effects of the control variables 'experience with computer chat' (*coef.* = 57.48, *t*(160) = 2.92, *p* = .004) and 'ability to type' (*coef.* = 113.99, *t*(160) = 5.67, *p* < .001): Participants who reported more experience with computer chat typed more characters, as did participants who appraised their ability to type faster.

For knowledge sharing, the positive effect of group reward was statistically significant (*coef.* = 1.59, *t*(53) = 3.74, *p* = .001). Participants shared more knowledge in the experimental conditions (M_p = 8.6) than in the control group (M_p = 5.4). The control

variable 'experience with chat' also had a significant effect on knowledge sharing (*coef.* = 0.21, $t(160) = 2.13$, $p = .034$): Participants with more computer chat experience shared more knowledge than those with less chat experience.

Perceived fairness of distribution strategies (Hypothesis 1)

ICC was .47 for perceived fairness. One level-2 HLM with factors 'distribution strategy' and 'status assignment' on the 2nd level was created ($R^2_{level-1} < .01$, $R^2_{level-2} = .84$; see Table 2).

Table 2. Results of Hierarchical Linear Modeling: Perceived Fairness Within Experimental Conditions

	coefficient	SE	t	df	p
DV: perceived fairness					
Intercept	4.78	0.13	36.40	41	< .001
equity (L2)	-1.12	0.13	-8.48	41	< .001
age-based status (L2)	0.14	0.13	1.09	41	.285
equity*age-based status	-0.32	0.13	-2.43	41	.020
high status (L1)	0.25	0.24	1.02	126	.312
high status*equity	-0.21	0.25	-0.87	126	.387
high status*age-based status	-0.09	0.25	-0.36	126	.720
high status*age-based status*equity	0.37	0.25	1.50	126	.135

Note. $R^2_{level-1} < .01$; $R^2_{level-2} = .84$. Legend: *equity* = group-based reward divided into different rates, depending on high status (alleged highest performer) and actual performance of two low status members (50%, 33%, and 17% respectively); *age-based status* = high status assignment by alleged age.

The analysis revealed a statistically significant main effect of distribution strategy on perceived fairness (*coef.* = -1.12, $t(41) = -8.48$, $p < .001$). Participants perceived the reward payment as more fair under the equality distribution strategy ($M_p = 5.9$) compared to the status-dependent equity strategy ($M_p = 3.7$).

As expected in H1, the results showed a Distribution Strategy $\times$ Status Assignment interaction (see Figure 1). Members of age-based status-dependent equity groups perceived their distribution strategy as less fair than the other conditions, (*coef.* =

-0.32, $t(41) = -2.43$, $p = .02$). There were no statistically significant differences between high and low status members on measures of perceived fairness.
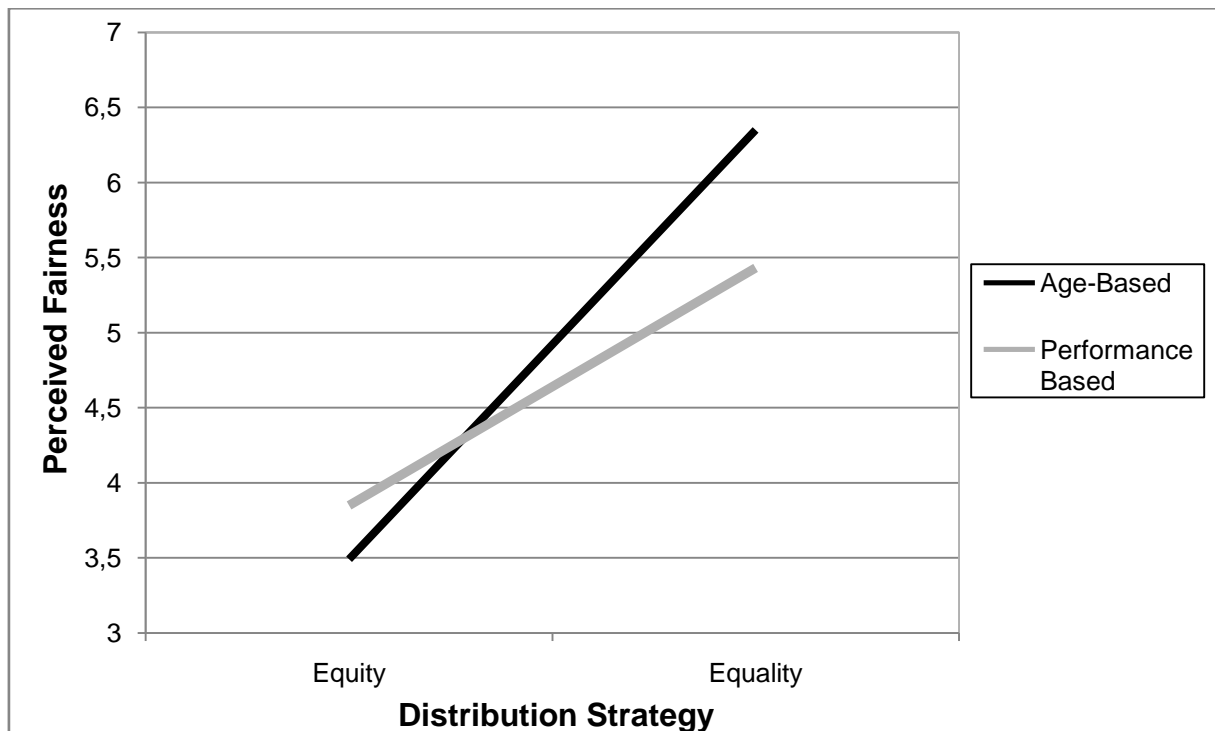

Figure 1. Note. Perceived fairness as a function of distribution strategy and status assignment.

Status and knowledge sharing (Hypotheses 2a and 2b)

ICC was .43 for knowledge sharing. One level-2 HLM with factors 'distribution strategy' and 'status assignment' on the 2nd level was created ($R^2_{level-1} = .07$, $R^2_{level-2} = .03$; see Table 3).

Table 3. Results of Hierarchical Linear Modeling: Knowledge Sharing Within Experimental Conditions

	coefficient	SE	t	df	p
DV: knowledge sharing					
Intercept	7.23	0.29	25.11	41	< .001
equity (L2)	0.23	0.29	0.80	41	.427
age-based status (L2)	0.05	0.29	0.17	41	.868
equity*age-based status	0.35	0.29	1.22	41	.229
high status (L1)	-0.42	0.29	-1.44	124	.152
experience with chat (L1)	0.18	0.12	1.45	124	.148
ability to typewrite (L1)	0.01	0.11	0.10	124	.924
high status*equity	0.74	0.31	2.42	124	.017
high status*age-based status	0.66	0.29	2.26	124	.026
high status*age-based status*equity	-0.01	0.30	-0.02	124	.981

Note. $R^2_{level-1}$ = .07; $R^2_{level-2}$ = .03. Legend: *equity* = group-based reward is divided into different rates, depending on high status (alleged highest performer) and actual performance of two low status members (50%, 33%, and 17% respectively); *age-based status* = high status assignment a by alleged age; e*xperience with chat* and *ability to typewrite* = self-rated control variables.

As expected in H2a, levels of knowledge sharing by high status members were significantly influenced by the distribution strategy (*coef.* = 0.74, $t(124)$ = 2.42, $p < .02$; see Figure 2): As predicted in the equality distribution conditions, low status members shared more knowledge (M_p = 8.2) compared to the status-dependent equity condition (M_p = 7.1), whereas high status members shared less knowledge in the equality distribution condition (M_p = 5.8) compared to the status-dependent equity condition (M_p = 7.8).
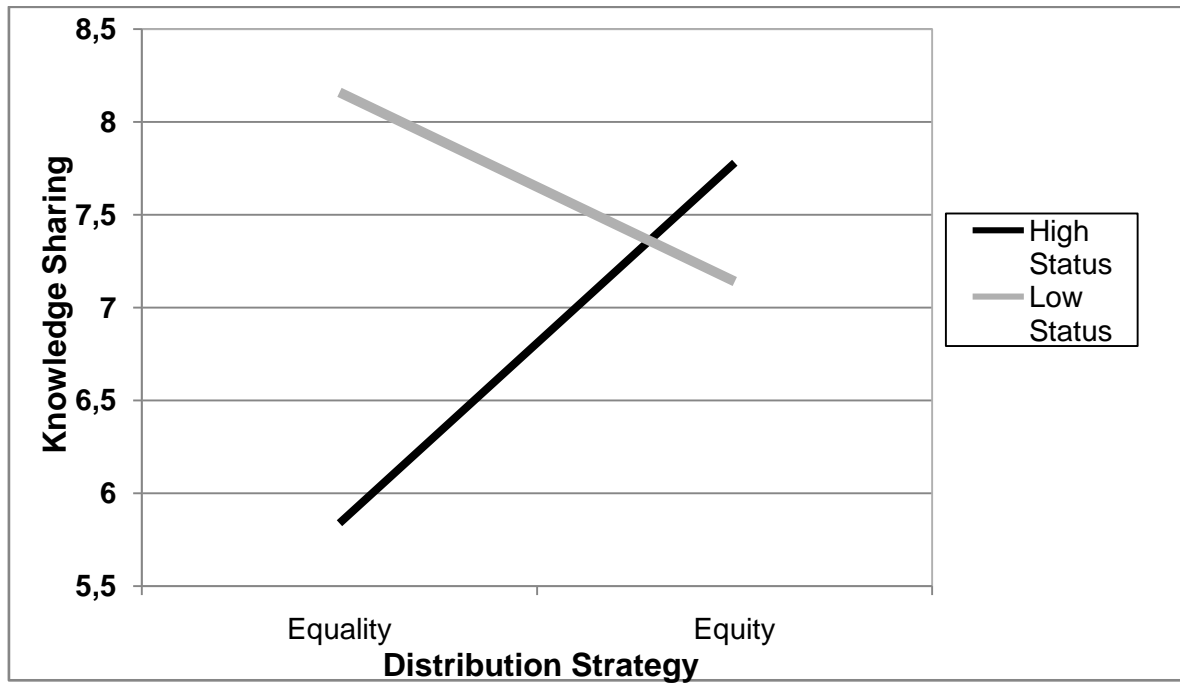
Figure 2. Note. Knowledge sharing as a function of distribution strategy for high and low status members.

Also as predicted in H2b, status assignment had a significant effect on the knowledge sharing of high status members (*coef.* = 0.66, $t(124)$ = 2.26, $p < .03$; see Figure 3): High status members shared more knowledge when their status was based on age ($M_p = 7.5$) compared to pre-test score ($M_p = 6.1$). Low status members shared *less* knowledge if their status was based on age ($M_p = 7.0$) compared to pre-test scores ($M_p = 8.3$). There was no significant three-way interaction between Status-Dependent Equity Strategy $\times$ Status Assignment $\times$ Member Status (*coefficient* = -0.01, $t(122)$ = -0.02, *ns*).
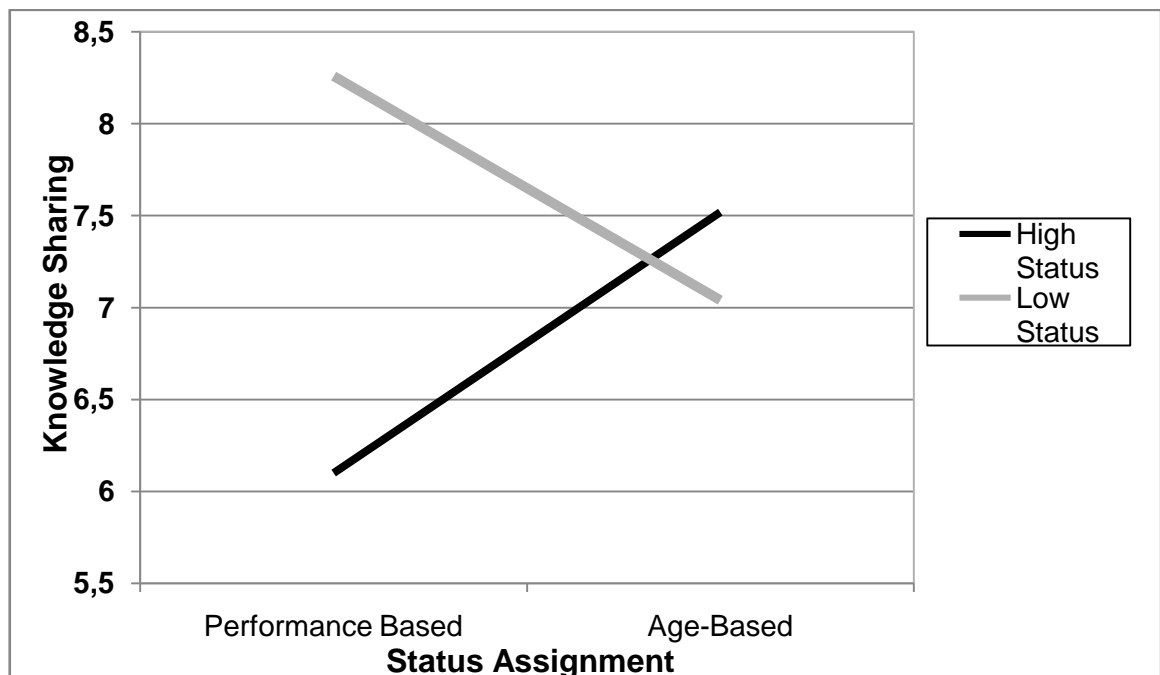
Figure 3. Note. Knowledge sharing as a function of status assignment for high and low status members.

It is interesting to note that we did not find any effects of distribution strategy and status assignment on contribution rate. In addition, participants in the study did not discuss the fairness of the distribution system with their group members during the interaction phase nor did they ask other members their age or how well they performed on the pre-test. They did not discuss dividing the reward evenly in the status-dependent equity conditions should they win a monetary prize.

Discussion

Our findings showed that perceived fairness among group members was significantly higher when group-based rewards were based on equality than on status-dependent equity for both low and high status members. Thus, we replicated and extended the finding that equally distributed rewards are associated with more satisfaction to computer-mediated groups (Rack et al., 2011). In addition, consistent with previous research, status differences are manifested in similar ways in both face-to-face and computer-mediated groups (Weisband, Schneider, & Connolly, 1995; Hollingshead, 1996).

However, those perceptions of fairness in the equality conditions seemed to have different motivational impacts on high and low status members. The behavioral adjustments are consistent with system justification theory, which suggests that members are motivated to view themselves, their groups and the system positively, and will change their cognitions and behaviors when there are inconsistencies. The inconsistencies are different for low status and high status members in the equality condition. The low status members legitimize the equal reward by working harder, whereas the high status members legitimize the reward by working less hard on the group task. High status members shared less knowledge, and low status members shared more knowledge in the equality compared to the status-dependent equity condition.

The present study makes an important empirical contribution to system justification theory. It examined different reward distributions, and focused on "system" mismatches, for example, when members receive unequal pay for doing the same task. We found both similarities and differences of perceptions and responses between high and low status members.

Both high and low status members perceived that a status-dependent equity distribution strategy was more fair when high status was based on pre-test score than on age. However, again, the behavioral manifestations of these similar perceptions were different for low versus high status members. High status members shared more knowledge under an age-based status assignment compared to a performance-based assignment perhaps as a way to justify their unfair, but higher reward. According to system justification theory (Jost et al., 2004), high status members may be making an effort to legitimize their status by connecting their age to task performance (cf. Anderson & Kilduff, 2009).

Low status members contributed more knowledge in the pretest-based status assignment compared to the age-based status assignment although the total amount of communication (typewritten characters) did not vary across the experimental conditions. So it was not how much was said but what was said that was affected by the independent variables.

Assigned status had significant effects on knowledge sharing that were independent of the reward system. One might argue that the status assignment in the equal distribution strategy conditions was meaningless particularly when it was based on age, and should have no effect on knowledge sharing. Yet, regardless of distribution

strategy, low status members shared more information when high status was based on pre-test score rather than age, and high status members shared more information when high status was based on age than on pre-test score.

Individual and group performance did not vary significantly across the control and experimental conditions. Because members were randomly assigned to condition, the individual knowledge baseline was equivalent across the conditions. It was easy for members to contribute their answers to the group without putting forth a lot of effort. In addition, status was randomly assigned, so in many cases, the assigned high status member may not have been the oldest or the person with the best pre-test score in the group. This enabled us to examine with more precision the effects of different status assignments on group members' behavior. However, it is likely that group performance would be negatively affected when high status members have more task relevant knowledge than other group members. Future research should address this issue.

The design of this study maximized internal validity at the expense of generalizability and realism. The results demonstrated that group-based rewards and status assignments have implications for knowledge sharing and procedural justice even in temporary, homogeneous groups of university students working on a knowledge pooling task that may not resemble team tasks in organizations. However, it is likely that the effects observed in the study would only increase in magnitude in teams working on consequential tasks where member status may be based on actual task-relevant knowledge or some other attribute. It is also unknown what the long-term consequences of unfair distribution strategies are not only on group task performance, but also on member relationship and group well-being (McGrath, 1991). Clearly more research is needed on this important topic.

All in all, the results support introducing equally divided group-based rewards in computer-mediated groups to increase individual member fairness perceptions and thus, satisfaction. However, equally divided rewards have differential effects on the knowledge sharing behaviors on low and high status members. If the goal is to increase the participation and performance of low status members, then equally divided group-based rewards may be the most effective distribution strategy. This may not have the same level of effectiveness if the goal is to increase the participation and performance of high status members - for them, status-dependent equitably divided group-based rewards

may be the right strategy. When managers introduce rewards in virtual teams, the method in which team member status is assigned or acquired needs to be carefully considered in order to achieve maximum positive effects, as status can clearly affect knowledge sharing (Gurtner, Kolbe, & Boos, 2007). Moreover, non-monetary rewards such as verbal and written recognition that reinforce feelings of pride, support and appreciation by colleagues and supervisors and/or access to developmental opportunities may also serve as strong performance incentives. More research is needed on the benefits and drawbacks of non-monetary versus monetary rewards in different team settings.

GENERAL DISCUSSION

What do Different Forms of Outcome Interdependence Cause?

In the introduction competitive, neutral and cooperative outcome interdependence and their relation to individual- vs. group-based rewards were outlined. It was argued that these three forms of outcome interdependence partly presume individual- (neutral outcome interdependence) or group-based (cooperative outcome interdependence) reward structures, and can be implemented as competitive outcome interdependence for individual- as well as group-based rewards. The general aim of this thesis is firstly to ascertain if and how competitive, neutral, and cooperative outcome interdependence affect reward-maximizing behavior; and secondly how perceived pay satisfaction, stress, and fairness as individual work experience with those rewards is affected. This thesis extends previous research on outcome interdependence by assessing both the behavioral level and the perceptional level: General conclusions about the expedient implementability of outcome interdependence in organizations cannot be made by only focusing the behavioral level - even successful individuals who show reward-maximizing behavior can be unsatisfied and stressed by competitive outcome interdependence (Chapter 1, study 2). Before drawing general conclusions, the results of the three studies are summarized.

Study 1

In study 1 (Chapter 1), the computer-based multi-agent game HoneyComb (Boos et al., in prep.; Pritz, 2011) was introduced. The effect of visual presence of group members as black dots on a virtual 97-hexagons playfield on flocking behavior (Vine, 1971: the inherent tendency of humans to approach their neighbors) was assessed. This focus was also chosen to assess if humans would be able to handle the HoneyComb game without any reward being implemented. The results showed that the visibility of group members led to flocking behavior: Participants actively reduced the virtual distance between themselves and their group members when neighbors entered their visible range. Results also showed no general activation in terms of the generalized drive hypothesis (Zajonc,

1965): The groups' movement speed and overall gaming time was not affected by the visual presence of group members. The deprivation of all communication channels except for movement did not anticipate the approximation of (virtual) neighbors. Despite no rewards were implemented in study 1, these results provide empirical support for models of group formation which contain the explicit assumption that neighbors are searching each other implicitly and without obvious reason (Couzin et al., 2005; Ichiro, 1982; Reynolds, 1987). This empirical insight can be anticipated in the field of crowd management and help to prevent mass panics when security forces face the inherent tendency of human groups to flock. The results also confirmed that the HoneyComb game was implicitly understood by participants and thus generally provides valid behavioral measures. This was a basic requirement to use it to investigate reward-maximizing behavior in study 2.

Study 2

Study 2 (Chapter 1) addressed the effects of neutral (Wageman, 1995; Wageman & Baker, 1997) vs. competitive outcome interdependence (Vegt et al., 1998), implemented as individual-based reward (pay-for-performance). To assess behavioral and perceptional variables, the HoneyComb game (Boos et al., in prep.; Pritz, 2011) was used and two games were played: Participants could either find six virtual coins on the 97-hexagons playfield once by each player (neutral outcome interdependence) or once at all (competitive outcome interdependence). Results showed, that competitive compared to neutral outcome interdependence led to a significant change on the behavioral level: The reward-maximizing strategy changed between the conditions. In the competitive condition, participants heightened the distance between themselves and their virtual neighbors and fastened their movement speed. These findings support the expectation from the general introduction that competitive outcome interdependence leads to adaptation on the behavioral level to maximize one individual's rewards in terms of proself motivation (DeDreu et al., 2008). However, results concerning perceived stress levels and pay satisfaction clearly demonstrated that competitive outcome interdependence had negative effects. Consistent with previous research (Fletcher et al., 2008; Malhotra, 2010), the competitive situation caused higher stress levels. Regarding pay satisfaction, results did not only show that competitive outcome interdependence led

to less overall satisfaction, it furthermore lowered this pay satisfaction for high- *as well as* low-performers.

Study 3

In study 3 (Chapter 2), effects of competitive (Vegt et al., 1998) vs. cooperative outcome interdependence (Wageman, 1995; Wageman & Baker, 1997) were assessed by implementing a status-dependent equity- (competitive) vs. an equality-distribution strategy within a group-based reward (Bartol & Hagman, 1992). Here, groups solved an online knowledge pooling task (Hollingshead, 1998). Additionally, a randomly chosen group member became a high status member and received the highest reward in the equity conditions regardless of his/her contribution to the group task. This status assignment either based on a specific characteristic (score on a pre-test) or on a diffuse characteristic (age; Anderson & Kilduff, 2009; Berger et al., 1980; Greenberg & Leventhal, 1976). Overall, study 3 revealed that competitive outcome interdependence within groups was perceived less fair than cooperative outcome interdependence. Differences in terms of potentially reward-maximizing behavior between both conditions only occurred in terms of interaction-effects, between low- and high status members.

In detail, results showed that on the perceptional level - perceived fairness with the distribution strategy - competitive outcome interdependence was rated to be less fair than cooperative outcome interdependence. Furthermore, when competitive outcome interdependence was implemented *and* the high status member had been chosen based on age, the perceived fairness was even lower. These fairness perceptions did not differ between high- and low-status members, in line with equity theory (Adams, 1965). The findings also demonstrated that on a behavioral level cooperative outcome interdependence led to no difference in knowledge sharing compared to competitive outcome interdependence (equity strategy) when the participants' high- vs. low status was not controlled. Regarding differences between low- and high status members, two interactions were found: (a) Low status members shared more knowledge under cooperative outcome interdependence, whereas high status members shared more knowledge under competitive outcome interdependence in concordance with the expectations based on system justification theory (Jost et al., 2004). (b) Also in line with system justification theory, low status members shared more knowledge when the high

status member's status had been assigned via specific criterion, whereas high status members shared more knowledge when their high status had been assigned via diffuse criterion; both adapting their knowledge sharing behavior and thus legitimizing their status (cf. Anderson & Kilduff, 2009).

A One-sided Perspective on Reward-maximizing behavior

The results of study 2 suggest that competitive outcome interdependence leads to an adaptation of (reward-maximizing) behavior. Individuals act - from their point of view - in a way which is most efficient to maximize their own individual-based reward. Especially in comparison to the results of study 1 it is interesting to note that competitive outcome interdependence does not only lead to more spatial dispersion of groups (study 2): It also breaks through the implicit tendency to approach neighbors (study 1). When the individual work experience in terms of work- and reward-related perceptions is excluded, implementation of individual-based rewards with competitive outcome interdependence appears attractive for employers. It was already found by Whittemore (1924) that competition on a printing-task led to higher work speed (p. 253)[5]. Following study 2, when pay-for-performance plans proximately link each individual's task performance to his/her reward, competitive outcome interdependence should heighten each individual's effort to raise performance on the short run.

If a group-based reward is implemented, differences between cooperative and competitive outcome interdependence are hard to assess. Overall, e.g. sharing knowledge in a knowledge pooling task like in study 3 is basically a reward-maximizing strategy, independently from the distribution of the reward within the group: Even when an individual with lower status gets the smallest amount compared to his/her group members, high contributions to the group task still maximize the own reward, the smallest amount gets bigger. Here, by implementing two types of status (high vs. low) and two forms of status assignment (pre-test score vs. age), additional motives were created within each group. As system justification theory predicts (Jost et al., 2004), high- and low-status members adapt their reward-maximizing behavior to their status differentially and perceive contrary justness of (a) the distribution strategy and (b) the status assignment itself. These results suggest that, if no status differences would occur in a group, neither competitive nor cooperative outcome interdependence would lead to

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[5] Whittemore (1924) also found that competition led to a poorer quality of work.

more reward-maximizing behavior. From this point of view, competitive outcome interdependence within a group-based reward would have no general effect on reward-maximizing behavior within groups and should not be implemented within organizations.

Perceptions of Outcome Interdependence and Conclusion

Given the results of study 2 on reward-maximizing behavior, it seems tempting for employers to implement competitively linked rewards on the individual level. But besides the behavioral impact it is alarming to see a lowered pay satisfaction - independently from the size of each individual's reward - and heightened perceptions of stress under competitive outcome interdependence. Here, long term influences were not assessed, but even one task under competitive conditions significantly influenced pay satisfaction and the perceived stress level in this negative way. From this point of view the reasonability for competitive outcome interdependence within individual-based rewards has to be strongly doubted. Long-term consequences of low pay satisfaction on job satisfaction and organizational outcomes (Whitman et al., 2010) as well as unhealthful consequences of high stress levels in the working life (Dragano et al., 2008, Scheuch, 2008) clearly argue against the implementation of competitive outcome interdependence of individual-based rewards. Dragano et al. (2008) found that a perceived imbalance between efforts and rewards can be the foundation for chronic perceptions of stress and lead to depressive symptoms. Competitive outcome interdependence between individuals can lead to such chronic imbalances, e.g., when one individual is consistently outperformed by others and does only achieve minimal/no reward even when the individual effort remains high.

For group-based rewards, the results of study 3 suggest not to implement competitive outcome interdependence. In contrast to study 2, reward-maximizing behavior was not generally boosted by competitive outcome interdependence, but caused a low perception of fairness independently from each individual's status within and status assignment between the groups[6]. Furthermore, consequences of low perceptions of fairness with the reward structure can be rather critical and comprise less job satisfaction (Bettencourt & Brown, 1997). Again, negative consequences of chronic job

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[6] Both perceived fairness and pay satisfaction are mostly perceived equivalent and can thus be widely compared (Scarpello & Carraher, 2008).

dissatisfaction in terms of bad organizational outcomes (e.g, Whitman et al., 2010; see general introduction) should be avoided and competitive outcome interdependence should thus not be implemented as group-based reward because of the possibly negative perceptional consequences.

Outlook - a Critical View on Competition for Rewards

A general criticism of competitive outcome interdependence of monetary rewards within the today's western capitalistic society is not carried out based on the studies and the results presented in this thesis. As outlined in the general introduction, monetary rewards are omnipresent today and probably will be omnipresent in the distant future. They are commonly accepted and deeply integrated with our social system. Nevertheless, the role of competition for rewards within our consumeristic society seems to facilitate a broad variety of personal problems.

First, competition for rewards can be clearly associated with the materialistic society; Kasser (2002) provides a good framework. In his book, he reviews studies about the negative relation of the ambition for attaining more money, status, or goods and the psychological well-being (q.v. Burroughs & Rindfleisch, 2002; Rindfleisch, Burroughs, & Wong, 2009), mental disorders (q.v. Huppert, 2009), or interpersonal relationships (q.v. Kasser, Cohn, Kanner, & Ryan, 2007): "People who are highly focused on materialistic values have lower personal well-being and psychological health than those who believe that materialistic pursuits are relatively unimportant" (Kasser, 2002, p. 22). At this point one would not necessarily assume that competition is ineluctable within the materialistic society - why should it be impossible to strive for monetary rewards without competition, in terms of neutral outcome interdependence? In fact, the operative point is that competition for rewards, status, and goods is massively enforced by the materialistic society which can also be described as a "winner-take-all economy" (Ryan; in Kasser, 2002, p. ix), accounting for the widening gap between "winners" who feathered their nest and "losers" who fell through the cracks. Competitive outcome interdependence and a materialistic society seem to have melted into each other, creating an elbow mentality. Therefore it can be argued that competitive outcome interdependence as component of a materialistic society leads to the negative consequences described above. Competitive outcome interdependence can thus be defined as risk factor within our population

(Huppert, 2009) causing less personal well-being, more mental disorders and poor interpersonal relationships.

Second, with the negative consequences of competition for rewards in mind, environmental structures which even strengthen competitive outcome interdependence in the workaday life should be avoided within our society as far as possible. Here, one example is discussed which is not proximately related to working- , but to a student's life: The allocation of Master places at universities. In this case, the reward in terms of Master-places is non-monetary on the short run, whereas the successful accomplishment of a Master of Science or a Master of Art obviously heightens career opportunities and thus the prospect of higher monetary rewards on the long run. The admission regulations for Master places[7] define the basic conditions for their allocation: Basically, students have to collect at least 180 ECTS-points within their Bachelor based on several criteria like major course assessments (§2) to achieve the basic requirement for a Master place. So far, competitive outcome interdependence would not be implemented; the good performance of one student would not actively reduce the chances of other students to achieve a master place. However, 70% of all Master places are allocated by comprising the so-called "especial suitability" of each student (§6). Here, students can collect additional points, majorly based on the overall average grade (max. 52 points for the grade 1.0) and additional 38 points for qualifications in e.g., quantitative methods (§2). Only a basic criterion of 50 points is given to define students are "especially suitable", but the Master places are allocated through rankings (§6): If a student performed well, he or she can still get a low rank and thus no Master place because fellow students performed better. Thus, the motivation rises not only to perform better than others on the individual level, but also to hinder fellow students to perform well. Transferred to the findings presented in this thesis it seems not surprising that students comment on more stress, burnouts, and competition during their Bachelor (q.v. Der Spiegel, 2012[89]; Klug,

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[7] Here, the admission rules for the Master of Science in Psychology, Georg-August-University of Göttingen, are chosen as an example: http://www.uni-goettingen.de/de/104323.html; §2 (pp. 913-916); §6 (pp. 918-919)

[8] Online article "Karriere-Konkurrenz unter Studenten - Burnout beim Bachelor" [Career-competition between students - burnout at Bachelor]: http://www.spiegel.de/karriere/berufsstart/0,1518,810496,00.html

2011[10]). If students are accounted individuals and the allocation of Master places causes competitive outcome interdependence on the individual level, study 2 (Chapter 1) gives a strong hint that this may raise the reward-maximizing behavior - in this case students are maximizing their efforts to become "highly suitable" for Master places and try to make others "less suitable" - but will also lower satisfaction with those places and cause higher stress levels within the Bachelor studies. When Bachelor students are seen as group, the results of study 3 (Chapter 2) suggest they may also perceive the allocation of Master places as unfair and thus become more and more frustrated about their field of study.

In conclusion, negative consequences of competitive- vs. neutral and cooperative outcome interdependence could be shown in this thesis. Implemented within individual-based rewards (study 2, Chapter 1), competitive outcome interdependence vs. neutral outcome interdependence boosted reward-maximizing behavior as short-term effect, but this effect was thwarted by higher perceptions of stress and less pay satisfaction. Implemented within group-based rewards (study 3, Chapter 2), competitive outcome interdependence vs. cooperative outcome interdependence did not affect reward-maximizing behavior, but led to lower perceptions of fairness. These results were applied to our materialistic society and to the allocation of Master places as one example to underline that competitive outcome interdependence should be extensively avoided in each person's work life and workaday life. At this point I want to refer to the external validity of experimental results, which is always limited. Especially in terms of long-term influences, the results of the three studies have to be interpreted carefully.

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[9] Online article „Studenten leiden zunehmend an Burnout-Symptomen" [Students are inreasingly afflicted with burnout]: http://www.spiegel.de/unispiegel/studium/0,1518,817624,00.html

[10] Klug, C. (2011). Psychisch belastet durch Bachelor? [Mentally burdened with bachelor?] Master thesis, University of Göttingen.

Summary

The general goal of this thesis was to compare effects of competitive, neutral, and cooperative outcome interdependence between monetary rewards, on the individual- as well as on the group level. It was aimed at drawing conclusions about the expedient implementability of the different outcome interdependences in work life. To answer this question, effects were assessed on two different categories of variables: (a) reward-maximizing behavior; (b) perceptions of pay satisfaction, stress levels, and fairness. By this approach the psychological view on payment strategies was extended: It was not only investigated if competitive, neutral, or cooperative outcome interdependence caused adapted behavioral responses in order to maximize individual payouts. It was also focused how (un-)successful individuals perceived the accordant form of outcome interdependence.

In study 1 and study 2, the computer-based multi-agent game HoneyComb (Boos et al., in prep.; Pritz, 2011) was used to assess behavioral responses to (a) the pure visibility of group members on a virtual playground without rewards (study 1); (b) behavioral and perceptional responses to neutral vs. competitive outcome interdependence within a monetary reward (study 2). In study 1, it was found that without rewards participants showed an implicit tendency to approach their neighbors, if visible. This tendency to flock was then significantly influenced by individual-based rewards in study 2: When competitive outcome interdependence was implemented, participants actively heightened spatial distance to their group members and coevally speeded up their movements. On the perceptional level, participants showed higher stress levels and less pay satisfaction – independently from the amount of reward they earned – under competitive outcome interdependence in study 2. In study 3, effects of competitive vs. cooperative outcome interdependence within a knowledge-pooling task were assessed; rewards were distributed on the group level. In sum, there was no difference on the behavioral level in terms of knowledge-sharing between cooperative and competitive outcome interdependence in study 3. However, competitive outcome interdependence was perceived less fair than cooperative outcome interdependence.

In conclusion, competitive compared to neutral outcome interdependence partially heightened reward-maximizing behavior. Due to the consistently negative consequences on the perceptional level it is argued that the implementation of competitive outcome interdependence should be avoided in today's work life as well as in other areas of life, like in academic studies.

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ERKLÄRUNG ÜBER EIGENE LEISTUNGEN

Ich versichere, dass ich die vorliegende Arbeit selbstständig verfasst und keine anderen als die angegebenen Hilfsmittel verwendet habe. Die Stellen, die anderen Werken wörtlich oder sinngemäß entnommen sind, sind als solche kenntlich gemacht. Ich versichere weiterhin, dass diese Arbeit in gleicher oder ähnlicher Form noch keiner anderen Prüfungsbehörde vorgelegen hat.

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