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Are Groups more Rational than Individuals? A Review of Interactive Decision Making in Groups

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Abstract

Many decisions are interactive; the outcome of one party depends not only on its decisions or on acts of nature but also on the decisions of others. In the present article, we review the literature on decision making made by groups of the past 25 years. Researchers have compared the strategic behavior of groups and individuals in many games: prisoner's dilemma, dictator, ultimatum, trust, centipede and principal-agent games, among others. Our review suggests that results are quite consistent in revealing that groups behave closer to the game-theoretical assumption of rationality and selfishness than individuals. We conclude by discussing future research avenues in this area.

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Keywords: group decision making, interactive decision making, rationality, discontinuity effect.

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1. Introduction

People play games all the time: they often make decisions in which outcomes depend not only on what they do or on acts of nature, but also on the decisions of others. Such decisions are called interactive decisions, or games. For example, if a student sells her old bike to her friend, she plays a price bargaining game. When drivers maneuver their car in heavy traffic, they play a route selection game. If one lends money to a co-worker upon request, one plays a trust game. Traditional game theory, the science of rational behavior in interactive settings [1], makes a few assumptions—mostly based on the concept of *homo-economicus*. First, it assumes that people have complete, exact knowledge of their interests and preferences [2]. Second, rational human beings are assumed to possess the ability to flawlessly calculate what actions would best serve these interests [3]. The third assumption is that people are self-interested, in the sense that they care only about their own material payoff [4–6]. A final assumption in game theory is that of common knowledge; each player knows the rules of the game, that others are also rational, and that everybody knows that everybody knows the rules, and so on so forth [7,8].

If one accepts these assumptions, comparing the behavior of individual decision makers and the behavior of unitary groups[1] seems almost dull. When there is a unique game-theoretic equilibrium or optimal choice, both individuals and groups should follow the normative prediction, and their choices should not differ at all[2]. It is therefore not surprising that researchers in economics have traditionally overlooked the study of group decision making. For example, the *Handbook of Experimental Economics Results* [9], devotes no attention to how

[1] A unitary group is a group that has to come up with a joint decision and does not face any internal conflicts of interests in terms of payoffs.

[2] Naturally, there are situations with multiple equilibria where the type of the decision maker could, in principle, matter also according to traditional game-theoretic analysis, but that would confine the object of study to a very small subset of research questions.

groups make decisions, *despite* the fact that interactive decisions in the real world are often made by groups. Boards of directors (not individual managers) decide on corporate strategy; congresses (not individual legislators) declare war on other countries; families (not individual family members) decide about budget allocation. Furthermore, work design in organizations is evolving from an individual task to a group task [10,11].

Considering the enormous recent body of literature on individual behavior in interactive contexts, it becomes clear that while traditional game theory is still very useful as a normative theory, it fares less well as a descriptive tool. If game theory is expected to provide a realistic account of human behavior, its assumptions have to be adjusted. One should take into account heterogeneity in levels of rationality [12–14], different extents of other-regarding preferences [15–18], and different forms of uncertainty attitudes [19] among decision makers. Once these assumptions are integrated into classical game theory, the analysis of group decision making becomes interesting and important. Therefore, investigating group decisions in games has slowly picked up in the late 1990s and after the turn of the century, leading Camerer [20] in his widely-used textbook *Behavioral Game Theory* to conclude that the study of group decisions making is among the top ten research programs in behavioral and experimental economics.

The main purpose of this review article is to survey the existing results regarding differences between individuals and groups in interactive tasks. The review reveals that groups tend to behave in these environments in a way that is more rational (as defined by the game-theoretical assumptions described above) than individuals do. Often related to this, groups seem to be more strongly motivated by payoff maximization—although we also refer to the cases where this is not so. Finally, groups seem to be more competitive than individuals—a behavioral tendency that can backfire in certain classes of decision settings.

The remainder of the present paper is structured as follows. We first present a non-exhaustive, selective review of results on group judgment and decision making in non-strategic situations (games against nature). We also examine findings on the process of group decision making, *how* groups arrive at collective judgments and decisions. Next, we center our attention on the focus of this article: a review comparing individual and group decisions in interactive settings. Finally, we discuss the findings and their implications for behavioral game theory, and provide some avenues for future research.

2. Brief Review of Research on Group Decision Making in Non-Interactive Settings

Much research has been conducted on decisions against nature (decisions in non-interactive situations). Many studies show that individuals make choices that differ from normative models, such as rational choice theory [21]. This departure from normative models is systematic. Decisions made by individuals are routinely biased, which has been the focus of the heuristics and biases research program [22]. Based on this framework, a number of researchers examined whether groups exhibit stronger or weaker biases than individuals do, with mixed findings [23,24].

Groups tend to do better than individuals in many domains. For example, consider the hindsight bias (also known as the “I-knew-it-all-along” effect), the tendency to judge events as more likely in presence of outcome information [25]. Stahlberg and colleagues [26] asked individuals and groups to predict how people evaluate national opinion polls. The critical manipulation was that participants in the control condition made this judgment without outcome information, whereas participants in the experimental condition made this judgment with outcome information (they were asked to make the estimation *as if* they had not known the outcome). Although knowing the outcome significantly affected groups' judgments, the effect—and thus the bias—were weaker for groups than for individuals. Another common bias is *overconfidence*, which results when agents are more confident in their judgments than what their accuracy warrants [27]. Sniezek and Henry [28] examined this bias for both individuals and groups. They find that group interaction reduced the standardized overconfidence by 24%, a substantial effect.

Rockenbach, Sadrieh and Mathauschek [29] proposed that groups take "better risks" than individuals. They found greater compliance of group decisions with the principles of portfolio selection theory. In their experiment, teams accumulated significantly more expected value than individuals and this at a significantly lower total risk. Charness, Karni and Levin [30] found that groups make fewer errors than individuals in risky choice, compared to the normative prediction of monotonicity and Bayesian updating, and that the error rate decreases with group size. Sutter [31] showed that group decision making can attenuate myopic loss aversion—a decision making bias that has important consequences for financial markets. Likeweise, Fahr and Irlenbusch [32] reported results from an information cascade experiment in which groups make fewer mistakes than individuals. More specifically, groups abandon their own private signals more often than individuals when it is rational to do so. Blinder and Morgan [33] used experiments designed to simulate decisions about monetary policy in central banks, and found that groups make both faster and better decisions than individuals in an uncertain environment. In contrast, Bone, Hey and Suckling [34] found no evidence supporting the idea that group decisions are more in line with expected-utility maximizing behavior than individual decisions. Using field data on mutual fund performance, Prather and Middleton [35] do not find significant differences in funds performance managed by groups and individuals. Barber, Heath and Odean [36] showed that stock clubs (groups) favor stocks which are associated with a good reason more than individuals, despite the fact that such reasons do not improve performance.

The general question of whether group choices are more risky or less risky than individual choices is still unresolved. Early literature provided evidence that groups tend to polarize individual attitudinal judgment in many circumstances, particularly in the context of decision making under uncertainty. When it comes to risky decision making (with known probabilities) this effect is also known as the *risky shift* [37]. It contrasts the intuitive conjecture that groups tend to moderate extreme positions and was initially demonstrated in many different settings [24,38].

More recent research, however, shows inconclusive results. Although several studies on choices between lotteries [39–41] have found that group decisions are more risk averse than individual decisions, Harrison and colleagues [42] found no significant effect in either direction. Indeed, Zhang and Casari [43] even reported group decisions to be less risk averse than individual decisions. Looking at uncertainty with unknown probabilities—that is, ambiguity attitude—Brunette, Cabantous and Couture [44] did not find any significant difference between individual and group lottery choices, whereas Keller, Sarin and Sounderpandian [45] provided evidence for a cautious shift for both risk and ambiguity attitudes of groups. Keck, Diecidue and Budescu [46] demonstrated that group decisions are closer to ambiguity neutrality than the decisions of individuals.

Groups are more prone to some types of heuristic-based biases. One such bias is the decoy effect, which occurs when preferences between two alternatives reverse as a result of the manipulation of a third, inferior alternative (violating the normative principle of regularity; [47]).

Slaughter, Bagger, and Li [48] asked individuals and groups to make decisions in hypothetical employee selection scenarios, and found that the inferior alternative manipulation had a stronger effect on groups than on individuals. A second bias is the escalation of commitment phenomenon, also known as the "too much invested to quit" bias or the sunk cost fallacy [49]. Whyte [50] presented participants with decision situations in which considerable funds had been invested in a failing course of action. Subsequent investment could potentially reverse the situation, but was more likely to make things worse. Whyte demonstrates that groups, compared to individuals, committed more errors in these escalation situations.

A distinction that is particularly important in the context of non-interactive decisions, but is also relevant to interactive decisions is the one between *intellective tasks* and *judgmental tasks*. Intellective tasks have a clear ex-post evaluation criterion for the quality of performance, whereas judgmental tasks do not. Intellective tasks can be further differentiated with respect to their *demonstrability* [51], the degree to which the knowledge of the solution to the task is recognized by group members once it is voiced in the group discussion (a phenomenon referred to as *truth wins*). Tasks that score high on demonstrability are often referred to as *eureka* tasks. In intellective tasks, groups typically perform better than individuals [52,53]. This is particularly the case for decision tasks that are easily demonstrable. In these tasks groups usually do better than the average individual, and sometimes even better than the best individual [54]. A large scale field study on the differences between individuals and groups in betting on yearly ice break-ups in Alaska [55] shows that group bets are closer to realized break-ups and that they exhibit a smaller variance.

3. The Process of Group Decision Making

In the previous section, we surveyed some results regarding group decision making in non-interactive settings. We now examine the decision making process in these settings. A topic that has generated a longstanding interest is groupthink. Janis [56,57] proposed that, in order to minimize conflict and maintain cohesiveness, group members are less critical in analyzing or assessing ideas. This, in turn, leads to defective decision making. Some key factors that aggravate groupthink, according to the theory, are high initial cohesiveness, directive leadership and conditions of high stress [58]. Despite its popularity and intuitive appeal, findings supporting groupthink are sparse [59]. Some studies suggest that groupthink does not emerge even when the hypothesized antecedent conditions are present [60]. Others find that factors such as directive leadership do indeed limit discussion but do not affect other decision making processes [61]. More importantly, experimental studies seldom document the most important dependent variable of the groupthink model: defective decisions [62,63].

Risky shift (already mentioned above), and group polarization are two related processes that generated considerable interest [64]. Stoner [37] asked people to give advice to others who were facing a dilemma. This involved choosing (a) to work on a big, difficult problem that would bring high rewards if successful but almost nothing if unsuccessful; or (b) a number of small problems that were easy to solve but were associated with small rewards. Participants in the study were first asked to make individual recommendations, and then they discussed in small groups and made group recommendations. Stoner found that group choices were characterized by a risky shift: groups were more likely to recommend the risky option than individuals. Subsequent research, however, found that groups sometimes recommend decisions that are more cautious than those recommended by individuals [65].

Group members often increase the extremity of their position following discussion of a relevant issue, a phenomenon referred to as *group polarization* [66]. Research shows that group discussion results in an intensification of existing individual attitude and judgment on a wide array of issues and decisions. There is substantial evidence supporting the group polarization phenomenon [67]. Researchers provide several explanations for group polarization [68]. One account is self-categorization, whereby group polarization is caused by group membership. When membership is made salient, people generally wish to be 'bona-fide' group members, which encourages conformity to the norms and behaviors that promote group distinctiveness [69]. A second explanation is social comparison [67]. According to this perspective, when engaged in group discussion, individuals are motivated to present themselves in a socially desirable way. Because of this, individuals try to differentiate themselves in the "right" direction—the direction perceived as the group norm. This makes the final judgment of the whole group more extreme than that emanating from the average of the initial individual judgments [70].

Group polarization has also been explained using the *persuasive argumentation* account[71], which is related to the way members share information within groups, and has been profusely investigated beyond its link to group polarization [23,72]. Groups tend to bring up and repeat shared information (information that most members possess) at the expense of raising other—potentially important—hidden information that only a few members have [73]. Groups consider shared information as more important, and members are perceived as more competent when they bring up information that others already know. Several studies support the idea that groups may fall prey to an information bias when confronting *hidden profile* situations, leading to more extreme (and often impaired) decisions [74,75].

Finally, group decision researchers have examined how individual preferences are aggregated into a single group choice [76]. Since experiments usually do not involve a fixed protocol such as a voting scheme, public choice theory [77]—the economic theory of preference aggregation in groups and societies—is not directly applicable. A theoretic approach that has received a great deal of attention is the Social Judgment Scheme model, which is in turn an extension of the Social Decision Scheme theory [38,78,79]. The social judgment scheme model proposes that members whose preferences are similar to each other are given larger weights than those whose preferences deviate from other members.

Having briefly reviewed some results in group decision making in non-interactive tasks, as well as studies on how groups tend to make decisions, we now turn our attention to the main part of the paper—a review of empirical studies on group decision making in interactive (strategic) settings.

4. Review of Studies on Interactive Decision Making in Groups

We structure this part of the review around four sub-sections. In the first, we examine findings in Prisoner's Dilemma Games, which have been extensively researched. We then present results from Ultimatum and Dictator Games. Next, we examine Trust Games and other lesser known sequential games. We end this section by reviewing simultaneous games other than the Prisoner's Dilemma Game.

4.1 Prisoner's Dilemma Games

Insko, Schopler and their colleagues were among the first to examine the tendency of small groups to behave more competitively—an effect dubbed the inter-individual inter-group discontinuity effect [80–86]. These authors first examined group behavior in Prisoner's Dilemma (hereafter PD) games, perhaps because of this game's enormous popularity in previous decades. Nearly all of their studies show that groups defect in PD games more often than individuals. They identify two primary motives for groups to compete more in a PD game [87]. The *social support of shared self-interest* (or, *greed*) hypothesis argues that groups are greedier than individuals because group members provide each other with support for acting in a selfish, ingroup-oriented way. The *schema-based distrust* (or, *fear*) hypothesis postulates that in contrast to individuals, groups *expect* their opponents to act greedily, and therefore want to protect themselves against the possibility of being exploited. If indeed groups have more negative expectations regarding the behavior of the group that they are interacting with than the individuals' expectations regarding other individuals, then groups are less likely than individuals to cooperate in hope that the opponent will cooperate as well (behavior that results in higher payoff for both players).

An additional motive for groups to compete more in a PD game is the *identifiability* hypothesis, which proposes that in inter-individual interactions players assume that they are identifiable and thus can be held "accountable" if they make a competitive or selfish choice [88]. In inter-group interactions responsibility for a choice is by its very nature obscured. Therefore, group membership provides a chance to evade accountability, and it thus makes it easier for group members to propose and make a competitive choice.

Insko, Schopler, and their colleagues also studied different variations of the PD game, identifying some factors that increase the magnitude of the discontinuity effect [85]. One such factor is (un)constrained communication—the possibility given to different parties to communicate with one another before making their decisions (i.e., allowing inter-team discussion in addition to intra-team discussion). Unconstrained communication is very effective in reducing competition between individuals [89]. However, the schema of distrust of out-groups makes communication less effective and credible, thus reducing its benefits in intergroup interactions [82]. A second factor is procedural interdependence, which refers to the interrelationship between own-group member choices and outcomes. For example, because in a majority rule group members' individual decisions are combined into a collective group decision, they cannot be traced back to the individual members. This creates procedural interdependence among group members. Wildschut and colleagues [90] found that groups that are procedurally interdependent are more competitive, because this feature creates a "shield of anonymity", facilitating self-interested behavior. This finding is clearly related to the above-mentioned identifiability hypothesis.

The discontinuity effect in the PD game has been replicated and extended by others. Charness, Rigotti and Rustichini [91] found that when group membership is made salient, group members become more competitive. Morgan and Tindale [92] reported that groups behave more competitively than individuals, and that a single group member wanting to defect caused the whole group to defect in over 50% of the cases. Both groups and individuals did not seem sensitive to whether the opponent in the game is a group or an individual. Takemura and Yuki [93] take a cross cultural perspective and replicate the result in Japan, a society that is believed to be lower in trust than Western societies.

Garza, Becker and Kugler [94] reported a study designed to differentiate between fear and greed as motives for competitive behavior in the PD game. In addition to this game, they compared individual and group behavior in the Chicken game and the Stag Hunt game. The two other games acted as controls, given that in the Chicken game greed is a reason to compete while fear leads to cooperating; in contrast, in the Stag Hunt game only fear is a reason to compete, but greed should lead to cooperative behavior. They found that the discontinuity effect was present to similar extent in the two games that include only one motive for competitive behavior, but that it was significantly stronger when both motives are present (in the PD game). They also reported that the size of the discontinuity effect increases dramatically when players (individuals or groups) are given the possibility to engage in free discussion before the decisions are made.

4.2 Ultimatum and Dictator Games

Bornstein and Yaniv [95] compare the behavior of individuals and three-person groups in the Ultimatum game [96]. In this game, two players bargain over the allocation of a pie. It is meant to capture a simplified and stylized form of “take it or leave it” bargaining. The first player (the proposer) proposes an allocation to the second player (the responder), who then gets to either accept the proposal, in which case the allocation takes place as proposed, or reject the allocation, in which case both players get nothing. The game-theoretical prediction (subgame perfect equilibrium [97]) based on standard assumptions (payoff maximization) states that, given that the responder prefers any positive payoff over zero, and the proposer knows this, she will propose to keep almost everything for herself—offering only the minimal unit to the responder—and the responder will agree to this proposal. It is clear that behavioral findings from individual play do not support this prediction. Proposers offer on average 40% of the pie (with a median of 50%), and responders often reject offers lower than 30% [98,99]. Bornstein and Yaniv demonstrated that groups of three members make and possibly accepted smaller proposals in this game—so group behavior is closer to the rational and selfish (game-theoretic) prediction than individuals. In a similar study, Robert and Carnevale [100] showed that groups made lower offers in the Ultimatum game. Further, if group members had the opportunity to participate in the game again, this time as individuals, their offers remained lower. This suggests that the group process changed individual preferences or individual beliefs about the acceptance threshold of the opponents. They also found that the most competitive members of each group had the largest effect on the group's decision (i.e., the group offers were best predicted by the offer made by these individuals). The paper focused only on the proposer and therefore the authors did not test whether group responders behaved differently than individual responders. Similar results in a structured voting environment without direct group interaction are provided by Elbittar, Gomberg and Sour [101]. These results are consistent with the *social support for shared self-interest* explanation and with the *groups are more rational* explanation. If groups are more rational or greedier they are expected to allocate a smaller share to the responder, as indeed reported in the work we surveyed above.

A similar game, the Dictator game [102] helps distinguishing further between fear and greed as motives for group decisions. This allocation task is similar to the Ultimatum game, except for the fact that the responder does not get to accept or reject the allocation offer (so strictly speaking it is not a game). It is important to note that in this game fear of the opponent should not guide behavior of groups (or individuals), because responders cannot reject the allocation. Therefore, if groups allocate less to others, only selfishness (or greed) can explain the results.

Experiments using the Dictator game yield mixed results. Cason and Mui [103] reported a tendency of groups to be more generous in giving than individuals, whereas Luhan, Kocher and Sutter [104] found significantly smaller transfers by groups than by individuals playing the role of the dictator. Luhan and colleagues argued that the differences in these findings may be due to two reasons. First, these authors used groups of three members, whereas Cason and Mui used groups of two members. With fewer members per group, the "shield of anonymity" explanation is reduced, and so is the "social support of shared self-interest". Second, Cason and Mui used a procedure where participants could be easily identified (i.e., groups were called to the front of a main room to receive feedback and payment and then excused to the hallway). Since this procedure was common knowledge, it reduced further the effects of the two motives above, and may have enhanced a need to publicly obey social norms of generosity. Finally, while in Cason and Mui the discussion engaged by group members was face-to-face, in the study by Luhan and his colleagues it was computer-mediated, increasing anonymity even further.

4.3 Trust Games and Other Sequential Games

The Trust game [105] is another two-person game that shares some similarities with Ultimatum and Dictator games. In this game the first player (the Trustor) receives an initial endowment and gets to choose how much of this endowment, if any, to send to a Trustee. The amount sent to the Trustee is multiplied by a commonly known factor (often tripled) before being given to the Trustee. The Trustee then gets to return any part of the money back to the Trustor. Following a backward induction logic, the Trustee has no reason to return any of the money she receives. Knowing that, the Trustor has no reason to send anything to begin with. This game captures a wide-spread definition of trust as "a psychological state comprising the intention to accept vulnerability based upon positive expectations of the intentions or behavior of another" [106]. Results from individual behavior indicated that despite the game-theoretic prediction, experimental Trustors send on average half of the initial endowment, and trustees return around 95% of what was sent before tripling [20].

Kugler and her colleagues [107] showed that groups of three people sent on average lower amounts than individuals did. They also analyzed asymmetric interaction of individual Trustors with group Trustees and group Trustors with individual Trustees. However, the amounts that are sent to individuals Trustees do not differ significantly from those sent to group Trustees. Cox [108] showed that Trustees return smaller amounts in this game. Song [109] found that group Trustors (using a consensus rule) exhibited lower psychological trust than individuals, but higher behavioral trust when controlling for psychological trust. Song also found that group Trustees sent back less money than individual Trustees, thus replicating Cox's main result.

The Centipede game [110] is an extensive form of the trust game: two players repeatedly bargain over the allocation of an increasing pie. They alternate in deciding whether to stop the game or transfer the decision to the other player. In the standard version of this game, every time the decision is transferred, the size of the pie increases. However, if a player decides to transfer the decision, which could result in the other player stopping the game, then the first player will end up with a lower payoff than she would have gotten had she stopped the game one step earlier. Given that the game has a finite number of steps, backward induction predicts that the game will stop on the first step, giving both players small payoffs and foregoing a much higher level of overall efficiency. McKelvey and Palfrey [111] reported that for individuals this is rarely the case: only 37 of the 662 games ended with the first player taking the money at the first decision node, while 23 games ended with both players transferring at every node. Bornstein, Kugler and Ziegelmeyer [112] showed that groups stopped the game significantly earlier than individuals do. Once again, this means that group behavior is closer to the game-theoretic prediction. Using a constant-sum variant of the Centipede game, they also demonstrated that groups were less altruistic in the game and also less prone to reasoning errors.

The principal-agent game, sometimes called the Gift-exchange game [113,114] is modeled to capture the problem of incomplete contracts in the labor market. In the game there are two players: a principal and an agent. The principal determines a wage. In return, the agent decides on an effort level. Effort is costly to agents, but results in increased efficiency and therefore a higher profitability for the principal. Since the game is designed in a way that makes it impossible for principals to enforce effort levels, agents are expected to choose the lowest level of effort, once wage is determined. Therefore, principals have no reason to pay agents more than minimal wages.

Contrary to this prediction, Fehr and colleagues [114] find that principals award agents with 42 percent of the surplus (and payments significantly above the minimal wage), and the average effort chosen by the agents is significantly higher than the effort predicted by standard theory. Kocher and Sutter [115] reported that groups chose lower wages than individuals in the role of principals, but only when communication was computer-mediated—they failed to find differences between individuals and groups who discussed their decisions face-to-face. In terms of the agents' effort, there were no differences between groups whose discussion was computer-mediated and individuals, whereas groups who communicated face-to-face decided on higher effort levels than individuals.

Cooper and Kagel [116] examined group behavior in a signaling game. They showed that groups play more strategically than individuals do. The increased strategic play is a result of the ability of groups to put themselves in the position of another player, and therefore adjust their behavior to the other's strategies. This leads to positive learning transfers, an ability of groups to generalize their learning regarding the game to similar situations with other parameters (i.e., the groups learn more than just the correct behavior, they learn the principles leading to this behavior, and can implement them in related situations). Individuals, on the other hand, exhibited less strategic play and no learning transfer.

Bosman, Hennig-Schmidt and van Winden [117] investigated group behavior in the Power-to-Take game (a variant of the Ultimatum game) and report no differences between individuals and groups. In this game, a taxing agency ("Take Authority") decides how much of the endowment of another player (the responder) to take. The responder then gets to choose to agree, or burn his endowment or parts of it. This results in reduced or zero income for the responder and a smaller income for the take authority. Just like in the Ultimatum game, game theory predicts that the taxing agency will take all the endowment except for a minimal unit, but experimental results show that takes are lower (on average, 58.5% of the whole endowment), and responders are willing to burn the endowment for large takes: when the taxing agency takes 80% or more of the endowment, the responder typically destroys most of her endowment (62.4% on average; [118]). The fact that Bosman et al. [117] found no differences between individuals and groups is in contrast to most of the results surveyed above.

Müller and Tan [119] compared the behavior of individuals and groups in a sequential Stackelberg market game. In this game two players sequentially set quantities for production. Both have the same costs of production and are restricted by the market demand. Interestingly, this study reports behavior of groups to be farther away from the subgame-perfect equilibrium of the stage game than that of individuals. First-mover groups set quantities that are lower than first-mover individuals and lower than predicted by standard theory. There is also research on group versus individual behavior in common pool resource problems. These problems are characterized by the tragedy of the commons (i.e., by a tendency to be overused). Gillet, Schram and Sonnemans [120] showed that groups are less myopic than individuals in an isolated resource extraction problem, but are more competitive than individuals in a strategic setting, where several users can extract the same resource.

4.4 Simultaneous Games

With the exception of the PD game, all the games surveyed above are two-person sequential games (where one player chooses an action first, and the second player observes this action before making her choice). In contrast, Kocher, Sutter and Strauß [121–123] investigated individual and group decisions in (simultaneous) beauty-contest games. In the beauty-contest game (named after a note by economist J. M. Keynes who likened the stock market to a beauty-contest in one of his famous treatises; also referred to as the guessing game), decision makers simultaneously select a number from 0 to 100. The winner, who receives a fixed prize, is the player who chooses a number closest to *p* times the mean of the numbers chosen by all participants (*p* is known to all players beforehand and can range from 0 to 1). The game is then repeated a number of trials, which varies across studies. For $p < 1$, the unique Nash equilibrium of the game is zero, which can be obtained by a process of iterated elimination of weakly dominated strategies[3]. The Beauty-contest game is commonly used to measure the depth of reasoning of a player and learning dynamics. Usually *p* is set at 2/3, and the game is repeated four times. The main finding of the papers on the beauty-contest game is that although individuals and groups do not differ in their choices in the first round, groups choose lower numbers (i.e., closer to equilibrium) than individuals do in rounds 2, 3, and 4—so groups appear to converge to the equilibrium faster than individuals. Further, they found that groups adapt much faster to the feedback regarding the choices of other players. When interacting with

[3] To illustrate this, imagine that a player believes all other players choose randomly over the range of options. She should then choose p times 50, the expected mean, to win the prize. If all players choose this strategy, then a sophisticated player should choose p^2 times 50, and so on, until the only strategy left is to choose zero.

individuals, the authors found that groups outperform individuals in terms of payoffs (being able to guess correctly the choices of individuals. Furthermore, larger groups converge quicker to the equilibrium than smaller groups, and less able participants are more likely to select themselves into a decision making group. Nevertheless, despite adverse selection, groups learn faster than individuals also in the self-selection experiments.

Van Vugt, De Cremer, and Janssen [124] investigated an n-person step level public goods game, which is another example of a simultaneous game. Just like in the PD game, they find that groups cooperate less than individuals do. Cox and Hayne [125] tested the interesting case where rationality, as defined by the game-theoretic prediction, is teased apart from competitiveness. They look at common value auctions, where competitive behavior leads to over-bidding (the *winner's curse*) and therefore lower payoffs, and find that groups are more prone to experiencing the winners curse. However, their result emerged only after participants had a chance to gain experience with the task, and only when group members shared the same information. Stutter, Kocher and Strauß [122] analyzed laboratory license auctions (a combination of a private value and a common value auction format) with individuals and groups, and their conclusion is similar. Groups are more likely to overbid than individuals. In contrast, Casari, Zhang and Jackson [126] reported that in a company takeover experiment groups placed better bids than individuals and substantially reduced the winner's curse. Likewise, Sheremeta and Zhang [127] found less overbidding of groups in Tullock-contests than individuals, and Cheung and Palan [128] provided evidence that groups are less prone to create bubbles than individuals on a stock market based on a double auction mechanism.

Another setting that is related to cooperation is coordination. Feri, Irlenbusch and Sutter [129] studied six different coordination games, where either individuals or teams interact with each other. They found that teams coordinate much more efficiently than individuals and, thus, are able to achieve higher levels of payoff. In a related coordination game, the Stag Hunt game, Charness and Jackson [130] showed that the voting rule in the group plays an important role in shaping group choices between the risk-dominant and the pay-off dominant equilibrium.

5. Discussion

The purpose of the present article was twofold. We first sought to review some of the findings on games against Nature, in which group decisions are made in environments where a rational decision or judgment exists, but there are no other players involved. In such tasks, findings regarding group rationality are somewhat mixed. While the results of many experiments reveal that groups more rational than individuals [26,28,39,41,29], others suggest that groups are less rational than individuals [48,50]. We also reviewed a number of studies on the process of group decision making. Although there are deficient features in the group decision process (e.g., groupthink, sub-optimal information sharing), aggregate judgments often lead to more reliable and accurate estimates, a pattern first noted by Sir Francis Galton [131]. This makes group decision making quite robust [132].

The second and main purpose of the paper was to review a large set of studies on interactive decision making made by groups. Based on the literature surveyed here, it is fair to conclude that the majority of experimental findings reveal that group behavior in games is more in line with rational and selfish predictions than individual behavior is. Trying to understand the implications of this statement, let us have a closer look at the decision process in an interactive game.

The games employed in the reviewed literature are laboratory decision tasks, and participants are not likely to have experience with them. Some of the games are complex, or require processing of substantial amounts of new information. Therefore, the first objective a decision agent faces is to get a full and coherent picture of the decision problem. It is not surprising that groups are superior to individuals in this aspect. Understanding the rules and structure of the game is an intellective task, and groups are provided with more information processing capabilities, as well as opportunities to catch and correct errors of other group members through discussion—something not available to individuals. It is likely, therefore, that groups understand the structure and rules of the decision tasks better than individuals do.

Once the rules of the games are clear, players have to decide on a strategy. To do so, they first need to construct beliefs regarding the behavior of the other player (or players) in most games and in most roles. Note that this point is unique to interactive decisions and constructing realistic beliefs is a crucial step in selecting the right strategy. Results supporting the schema-based distrust hypothesis point that groups may have different beliefs regarding the behavior of other players and expect other players to be greedier. Therefore, fear of the opponent's behavior may cause groups to believe that other players will choose certain strategies. Individuals who are less afraid of the behavior of the other players may have a different probability distribution over the possible acts of others. Overall, the literature is vague regarding the construction of beliefs. Only few of the studies measure beliefs regarding the behavior of the other player explicitly. Kugler et al. [107] measured expectations of others' behavior in the trust game and showed that individuals expect higher returns than groups do. Song [109] found a similar result: individuals have higher expectations of others' trustworthiness (i.e., expectations of reciprocity) than groups. Wildschut et al. [133] found that groups are as affected by manipulations of opponents' expectations as individuals. Sutter, Czermak and Fer i[134] studied strategic thinking and behavior of individuals and groups in a set of one-shot normal-form games, as well as explicitly elicit beliefs. They found that groups are more likely to play strategically than individuals.

A promising direction for future research is to conduct group experiments with mixed designs—groups and individuals playing against each other. To the extent that players are sensitive to the nature of their opponents, and expect groups and individuals to behave differently, they should choose different behavioral strategies when facing groups or individuals. Thus, one can infer beliefs from actions. For example, using a PD game, Wildschut, Insko and Pinter [133] found that of all possible combinations, actions are most competitive in the group-on-group condition; actions are least competitive in the one-on-one condition; and group-on-one conditions are in between. They conclude that the discontinuity effect is a joint function of acting *as a* group and interacting *with a* group. However, both Kugler et al. [107], and Morgan and Tindale [92] failed to find this effect.

Once players finish analyzing the game structure and considering the opponents' expected behavior and its consequences, they need to decide on their own strategy. At this point groups differ from individuals not only in the information they accumulated and processed, but also in their preferences (social or otherwise). The social support of shared self-interest hypothesis supplies one explanation to why groups may have different preferences than individuals. Specifically, it seems like the dynamics that lead to aggregation of individual preferences into group preferences allow group members to express more greed and less altruism towards the other players, thus making groups more similar to the "ideal" player modeled by standard game theory—a player who cares only about her payoffs, and has no preferences regarding the payoffs of other players involved in the game. Kugler et al. [107] sketched a theoretical model based on individual models of social preferences. Specifically, they extended Fehr and Schmidt's [17] inequity aversion model to groups, and argued that based on this model groups are likely to be more selfish.

It is important to qualify the general conclusion that groups are more rational and selfish than individuals. Two exceptions make groups appear sometimes even less rational or selfish than individuals. First, if less selfish behavior can create large profits, and the worst-case payoff is not particularly low, the temptation to secure the larger payoff (that is stronger among groups than among individuals) might take over, even at the risk of not succeeding, and groups might become less selfish. This can occur in games with high potential efficiency gains such as the gift-exchange game [115]. However, Bornstein et al. [112] presented contrasting evidence in the Centipede game, where higher efficiency gains are foregone by groups. Second, groups may become less rational than individuals in highly competitive settings. Auction fever and the proneness to the winner's curse are examples, and groups have indeed been shown to perform worse in auctions than individuals.

It is clear that there is still much that is not understood regarding the process that leads to groups (usually) behaving more rationally and selfishly than individuals in interactive tasks. Future research will have to systematically address many variables before we have a better understanding of the processes underlying this phenomenon. Specifically, we will need to address variables such as group size, testing whether two-person groups differ from groups of three or more, and what happens when groups become larger. Further attention should be paid to within-group interaction and communication, examining the apparent differences between face-to-face communication and computer-controlled communication. Similar attention should be drawn to the official decision rules within groups, investigating whether groups vote, use unanimity rules or have no explicit rules. In addition, there is a need for a better classification of the decision tasks—differentiating between sequential or simultaneous games, two player and n-player games, and other factors such as the complexity of the rules, whether the game requires substantial analysis and strategizing, whether it is played once or repeatedly, and whether there is a possibility to learn over time. Researchers will have to face the task of analyzing group discussion content in order to learn more about group dynamics, and find support for the theoretical claims presented in this section. Content analysis of group discussion is not a trivial task, and therefore not done in most of the studies. Finally, it will be important to develop theoretical models of the group interaction. Economic theory is surprisingly silent about decision making of unitary groups, but ultimately it will be crucial to rigorously model the decision making process of unitary groups.

6. Conclusion

Important decisions are often made by groups that have more previous experience, increased processing capabilities, the ability to monitor each other for mistakes, and share information regarding the task and the expected behavior of others. Therefore, groups (mostly) act as more rational and selfish players, which means that their behavior is more in line with the theoretical predictions. Game theory based on standard assumptions may be, after all, a much better descriptive theory than currently believed.

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