HOW GROUPS REACH AGREEMENT IN RISKY CHOICES: AN EXPERIMENT

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This paper studies how groups resolve disagreement in lottery choices. In an experiment, subjects submit individual proposals, exchange chat messages, and must reach unanimity. Overall, group choices are more coherent and closer to risk neutrality than individuals'. The proposal of the minority prevails in about one instance out of five. About one third of the groups do not reach immediate agreement after communication. In these groups, extrovert subjects are more likely to lead the group outcome than confused or conscientious subjects. The amount, equality, and timing of chat messages help us to predict which choice prevails in the group. (*JEL* C92, D81)

I. INTRODUCTION

Although economists model decision makers as isolated individuals, within firms and organizations decisions are often taken through deliberations in groups and committees. Many of those decisions involve options with different degrees of risk. In the last decade economists have produced a growing number of studies on this issue.

In an experiment, we study decision-making procedures of individuals versus groups in a series of choices between a safe and a risky option. How do groups aggregate individual preferences when members are initially in disagreement? In the laboratory, one can design a clean set up, which is free from external confounding factors, in order to better answer this question. Eliciting risk attitudes for groups was initiated in management and social psychology (Lamm and Myers 1978; Pruitt 1971; Stoner 1961) and recently involved also economists (Baker et al. 2008; Masclet et al. 2009). When a group decides whether to enter a lottery or not, there is no obvious correct choice and individuals may legitimately differ in their proposals due to their preferences. For this reason, the psychological literature on groups and teams would classify this task as "judgmental." On the contrary, "intellective" tasks have a demonstrably correct solution. For instance, Cooper and Kagel (2005) study a strategic market entry task, which is mostly intellective. The only intellective aspect of our lottery task is that choices should be coherent.[1] Earlier studies in social psychology introduced the concepts of risky shifts and cautious shifts. "Risky shift" denotes situations where groups make riskier decisions than individuals, and "cautious shift" otherwise. Depending on the study, the results reported in the literature are sometimes in one direction and sometimes in the other. One reason for this diversity of findings may be the presence of important, but overlooked, differences in the design and methodology among studies. Hence, we first proceed by mapping the approach of

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1. Tasks involving other-regarding preferences are mostly judgemental tasks, Cason and Mui (1997) or Luhan et al. (2009). The beauty contest game is a task with both components (Kocher and Sutter 2005).

ABBREVIATION

CRRA: Constant Relative Risk Aversion

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some recent experimental studies. In the present work, we designed group interaction rules to facilitate information exchange, to encourage participation by all members, and to focus the interaction on how to aggregate individual preferences. The main aim is to understand in detail how groups of three members deal with disagreement. Our design is novel because there is a written record of the communication among group members to understand internal dynamics and to correlate with actual differences in outcomes. It is the first, among the studies of group risk attitude, where before the discussion, each participant must post her proposal, a feature that saves discussion time and prevents shy members from being silenced. This piece of information allows us to perform an individual-level analysis of preference aggregation. Moreover, in case of disagreement, the minority has veto power over the group decision. Like many other studies, we call for a unanimous decision but, unlike others, here the sanction for disagreement is severe: no choice and zero earnings. In the field this rule is observed in international bodies that do not take a stand on an issue when they do not reach consensus, or in organizations that do not participate in an auction unless the board of directors agree on a bid. This rule creates a common interest within the group to communicate and reach a decision. Other default rules do not generate this positive group dynamic.

Through the group process, we find that lottery choices become more coherent and closer to risk neutrality. In resolving disagreement, the proposal of the majority did not always prevail. It prevailed more often when its proposal was closer to risk neutrality. There are some interesting personality and demographic effects, which we report in detail below.

The remainder of the paper is organized as follows. Section II reviews literature. Section III describes experimental design and procedures. Section IV reports the results and Section V concludes.

II. LITERATURE REVIEW

This section focuses on four recent papers that examine decisions made by groups facing risky choices, Baker et al. (2008), Harrison et al. (2010), Masclet et al. (2009), and Shupp and Williams (2008). Table 1 presents a design comparison with the present study. All studies, including ours, compare lottery choices of groups of three members with individuals

TABLE 1

Design Comparison across Five Studies of Group Lottery Choices

	Number of Groups in the Experiment	Includes Between-Subject Design	Group Composition across Choices	Default Choice When No Group Unanimity	Maximum Attempts to Reach Group Choice	Every Individual Posts a Nonbinding Proposal	Communication	Positive Incentives to Talk/Listen to Others
Zhang and Casari (this study)	40	No	Fixed	None (zero earnings)	3	Yes	Chat (2 min)	Yes/yes
Masclet et al. 2009	36	No	Random	Random	5	No	None	Yes/no
Shupp and Williams 2007	28	Yes	Fixed	Mean of individual bids	1	No	Face-to-face (20 min)	Yes/no[a]
Baker et al. 2008	40	Yes	Fixed	Majority rule	1	No	Face-to-face	Yes for minority/no
Harrison et al. 2010	36	No	Fixed	Majority rule	1	No	None	Yes for minority/no

[a]It may be "yes/yes," a short explanation follows. Shupp and Williams (2007) asked to price each lottery and then awarded the lottery using an incentive compatible mechanism. The default bid without unanimity is the average of individual bids. An individual player may have an incentive to manipulate the group price by strategically over- or under-bidding in order to generate a group bid closer to her preferred level.

choosing in isolation. In both treatments, subjects face the same set of lottery choices (ranging from 8 to 15) and identical monetary incentives. At the end of the session, only one of the lotteries is randomly selected for payment. Baker et al. (2008), Masclet et al. (2009), and Shupp and Williams (2008) all found that groups are more risk averse than individuals. On the contrary, Harrison et al. (2010) report no group effect.

Existing studies exhibit a significant diversity in design along a number of dimensions (Table 1). The most interesting differences pertain to group interaction. First, Masclet et al. (2009) randomly changed group composition for each lottery choice, whereas the others kept it fixed. This generates different dynamic incentives to "tune-in" with the group. Second, communication ranges from none, to anonymous chat rooms, to face-to-face interaction. We know from experiments on social dilemmas that communication can have profound effects on choices.[2] With lottery choices, the issue is not to overcome free riding but rather to aggregate preferences. Hence, communication fulfills other aims.

In all studies in Table 1, the instructions call for a unanimous group decision except in Harrison et al. (2010) that employed a majority voting rule. Within the consensus call, there are substantive differences in the default choice when a group does not reach unanimity. Although often downplayed in experiments with groups, this aspect is theoretically extremely important. Among the criteria to resolve disagreement there are random choice, majority rule, mean choice, and no choice. Each default rule implicitly sets different incentives for group discussion, which includes incentives to "talk" and to "listen." Let us adopt the standard assumption that subjects have well-defined preferences toward risk and assume that they are informed about the intended choices of others in their group. The last column of Table 1 lists whether a subject would benefit from successfully persuading others to change their intended choice ("talk"). Except Shupp and Williams (2007), all studies asked the subjects to make a binary decision between a safe and a risky option. Thus, the initial opinions must be a majority of two versus a minority of one.[3] All default rules exhibit positive incentives to talk, except majority rule, where if you are already part of the majority you do not have any incentive to persuade others. Another crucial aspect is the incentive to "listen." The default rules implemented in the previous studies may not generate positive incentives to listen (Table 1). Of course, there may be other types of advantages from listening to others besides those considered in Table 1. Communication may enhance the understanding of the task as well as learning about the intended choices of others and so benefit everyone in the group. Table 1 considers incentives under the more narrow view of rational subjects endowed with precise utility functions, which are common knowledge.

Like some of the experiments, we employed a within-subject design which allows a more direct comparison of choices in isolation (I) and in group (G) but may exhibit order effects. To control for order effects, Masclet et al. (2009) run sessions with I–G and G–I sequences and do not find any. Others employed a between-subject design, which relies instead on an assumption of similar preferences of the two experimental samples for I and for G treatments.

Other experimental studies have groups facing more challenging choices under risk. Rockenbach et al. (2007) compared individuals and groups with respect to choices among alternative financial investments and found that groups accumulate significantly higher expected values at a significantly lower total risk. Charness et al. (2007) study choice monotonicity over lottery and Bayesian updating by individuals and groups. They find that social interaction reduces violation rates, and thus groups make substantially fewer errors than individuals and the error rate decreases with group size.

III. EXPERIMENTAL DESIGN AND PROCEDURES

Each session had four parts plus a questionnaire and involved 15 participants. Overall 120 students participated in the experiment. In part 1, we measured subjects' risk attitude with 15 binary choices between lotteries. In part 2,

2. It has been documented in the experimental literature that pre-play face-to-face communication significantly improves cooperation in public good game (for instance, Cason and Khan 1999; Isaac and Walker 1988) and common-pool resource experiments under conditions of heterogeneity in resource endowment and payoffs (Hackett et al. 1994).

3. Shupp and Williams (2007) asked to price each lottery and then awarded the lottery using an incentive compatible mechanism. The default bid without unanimity is the average of individual bids.

subjects were randomly divided into groups of three persons and faced the same task as in part 1. The per-capita expected payoff in part 1 was equal to that in part 2. We report results of parts 3 and 4, which involved a different task, in Casari et al. (2010). The overall incentive structure was similar to that in Holt and Laury (2002). Subjects chose between a "safe" Option A and a "risky" Option B. The payoff for Option A was deterministic (50 tokens) and the payoff for Option B was either 150 or 0. On the first decision, the probability of the high payoff (150) for Option B was 0. In subsequent choices, the probability of the high payoff increased by 1/20 each line, 0, 1/20, . . . , 14/20. A risk-neutral person would choose Option A in lotteries 1 through 7 and then switch to Option B in lottery 8. Risk seeking agents may switch to Option B earlier than lottery 7 and risk-averse agents may switch later than lottery 7. Any rational agent should choose Option A over Option B in the first lottery (50 vs. 0 francs always) and later on eventually switch to Option B. Multiple switches would be a signal of confusion. We paid only one of the 15 decisions, chosen randomly at the end of the session. Random choices were all implemented through drawings from a bingo cage.

In part 2, there were five groups in each session. There was a proposal phase, a chat phase, and a group choice phase. Everyone simultaneously made an individual proposal about each of the 15 lottery choices. Then any line with disagreement was highlighted for all three group members to see. At this point, participants could switch to a chat window and had 2 minutes to send free-format messages to others in their group. We asked participants to follow two basic rules: (1) to be civil to one another and do not use profanities and (2) not to identify themselves in any manner. Messages were recorded. In the chat window, subjects received an id number from 1 to 3 based on the order in which they sent messages in that specific period. After the chat stage, everyone had to submit a choice for the group decision. If the choices of all three group members were identical for a specific decision line (unanimity), then we had a group choice. If there was unanimity on all 15 choices, then part 2 was over. Otherwise, the line(s) with disagreement was (were) highlighted and all three group members were asked to submit their new proposals. If there was still disagreement, there was another, final round of proposals. At this point part 2 was over even if disagreement remained. The design followed a default rule of "no choice": if the group reached no unanimous decision, no decision was placed, so earnings were zero for everyone in the group. Such a default rule generates positive incentives both to talk and to listen to others in the chat. In fact, these incentives are the highest among the studies listed in Table 1. With disagreement between a safe and a risky option, a default rule with random selection induces a game where a subject's dominant strategy is to choose her most preferred option. Instead, a default rule of "no choice" induces a battle-of-the sexes game where a subject would always switch choice to avoid a disagreement outcome. We paid only one of the 15 decisions, chosen randomly at the end of the session. Random choices were all implemented through drawings from a bingo cage. If for the line selected the group was still in disagreement, then the group earned 0 for part 2. Overall, there were 40 groups and 600 group decisions taken.

We distributed written instructions and read them aloud, taking questions as they arose. The experiment was performed with a z-tree application (Fishbacher 2007). No person participated in more than one experimental session. We guaranteed a minimum payment of $5. We converted each experimental token to an actual dollar at the rate of $0.03. Including all parts, a session lasted on average about 2 hours and average earnings per person were about $20. We conducted eight experimental sessions at Purdue University (USA) between 25 September and 28 October, 2007. Participants were recruited from the undergraduate campus population by email.

IV. RESULTS

We report five main results.

A. Result 1: The Monotonicity of Lottery Choices Improved from the Individual to the Group Treatment

We employed a table format to elicit risk attitude, where a subject with monotonic risk preferences would choose Option A in decision 1 and then eventually switch forever to Option B at one later decision. A subject who switched from A to B more than once, or who switched from B back to A, is classified as nonmonotonic, which is taken as a proxy of confusion or irrationality.[4] Recorded levels

4. Some multiple switches could also be a sign of preference indifference over a certain range.

of monotonicity in the experiment were very high, ranging from 87.5% for individual choices (105/120) to 95.0% for group choices (38/40) (one-sided t test, $m = 120$, $n = 40$, p-value = 0.034). A small portion of this improvement may be attributed to task learning, but we find no significant difference in monotonicity levels between individual proposals and individual choices (90.0% vs. 87.5%, one-sided t test, $m = 120$, $n = 120$, p-value = .27). In part 2, individual proposals do not have significantly different level of monotonicity in lottery choices than group final decisions (90.0 vs. 95.0%, one-sided t test, $m = 120$, $n = 40$, p-value = .32).

B. Result 2: Group Choices Were Closer to Risk Neutrality Than Individual Choices. In Particular, Group Choices Exhibited a Risky Shift from Individual Choices

Support for Result 2 comes from Table 2 and Figure 1. We discuss separately lotteries 1–7 from lotteries 8–15. In lotteries 1–7, only a risk-seeking agent would choose the risky Option B. Differences here were rather limited because risk seeking behavior was rare: on average, only 2% of individual choices and 0.4% of group choices were for B. In these lotteries, groups were less risk seeking than individuals. Most of the differences came from lotteries 8–15 where a risk-neutral agent would choose the risky Option B. In these lotteries, groups were more risky than individuals. On average, 57.4% of individual choices and 61.7% of group choices were for B. Group choices are more risky than individual choices (p-value < 0.05).[5] Recall that part 1 elicited individual choices while part 2 elicited individual proposals and group choices. Although this fixed order may have had some impact on results, order effects are unlikely to explain the risky shift. First, we stated in part 1 of the instructions that the tasks in parts 1 and 2 were the same lottery choices. Hence subjects could optimize considering the overall level of uncertainty. Second, little evidence can be traced from a comparison of the individual choices in part 1 with the individual proposals in part 2. We elicited individual proposals before any communication could take place in the group setting and report only minimal differences with part 1 choices, which helps to rule out large order effects. As mentioned after Result 1, some of this difference is simply a correction of nonmonotonic behavior. Third, Masclet et al. (2009) explicitly studied order effects but did not find any.

Result 2 may be a consequence of the default rule adopted in the design. The "no choice" rule may have generated a different group dynamic. In particular an asymmetry in payoffs between risk-averse and risk-neutral subjects in the negotiation over disagreement. More risk-averse subjects may have less to lose from switching to their least preferred choice.[6]

C. Result 3: When in Disagreement, the Majority Proposal Did Not Always Prevail. It Prevailed More Often When Its Proposal Was Closer to Risk Neutrality. Proposals from Nonmonotonic Subjects Were Less Likely to Prevail

Support for Result 3 comes from Tables 3–5 and Figure 2. We focus explicitly on group decisions where there was an initial disagreement. We define disagreement as a situation where not all three individual proposals were equal. All groups disagreed on at least one decision, 77.5% found an agreement on the first round, 20% after a second or third round, and only 2.5% (1 group) never found complete agreement.[7] On average, a group disagreed on four lottery decisions (27% of decisions). The bulk of the disagreement (85%) was in lotteries 8–13, where risk neutrality pointed toward Option B

5. The two-sample Kolmogorov–Smirnov test rejects the equality of two distributions of the switching points from A to B with monotonic preference ($n = 105$, $m = 39$, p-value = 0.0476). About 58.8% of individual proposals were for B (1.4 points more than individual choices). The distribution of the switching points in individual proposals does not significantly differ from group decisions (Kolmogorov–Smirnov test, $n = 108$, $m = 39$, p-value = 0.978), neither from individual choices (Kolmogorov–Smirnov test, $n = 108$, $m = 105$, p-value = 0.998).

6. Without pretence of generality, below we illustrate this point. Consider a game with two players with different risk attitudes who choose between a safe option $S = 50$ and a risky option $R = (150, p; 0, 1 - p)$. Assume player 1 has a CRRA utility function and is risk averse, $u(x)$, $u' > 0$, $u'' < 0$ and player 2 is risk neutral, $v(x) = x$. Assume disagreement, that is player 1 prefers S, $U[S] > U[R]$, and player 2 prefers R, $V[S] < V[R]$: $u(50) > pu(150)$ and $50 < 150\ p$, which implies that $1/3 < p < u(50)/u(150)$. One can show that for lotteries 9–15 we have that $V[R]/V[S] > U[S]/U[R]$, i.e., $3p^2 > u(50)/u(150)$, which holds for $p > 1/\text{sqrt}(3)$ and, given the actual values of p, for lotteries 9–15. There were instances of disagreement also for lotteries 6–8.

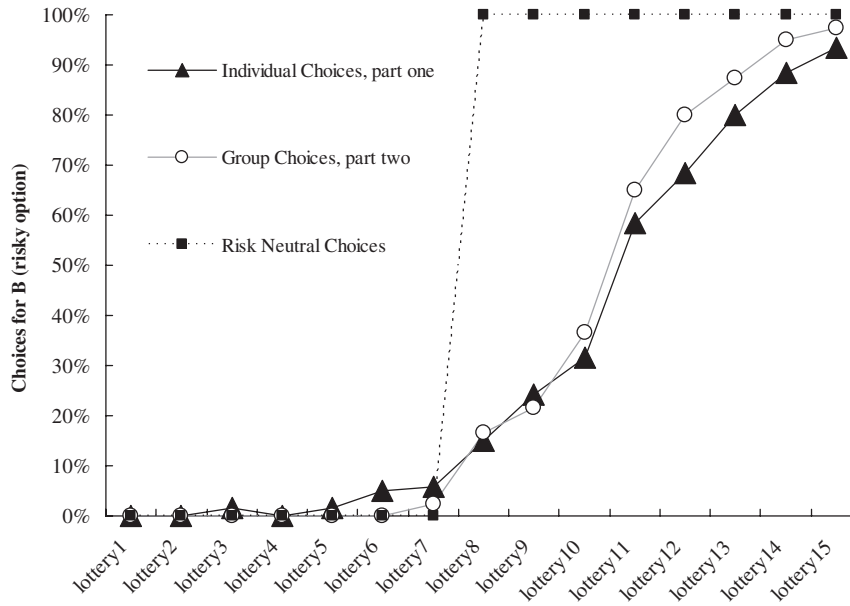
7. The group reached agreement on 12 of the 15 lottery choices (disagreement over lotteries 8–10). Analyses with 159 groups (477 proposals) dropped those three observations while analyses with 162 groups (486 proposals) replaced those three group lottery choices with the individual inputs in the third attempt to reach a group decision.

TABLE 2
Lottery Choice Task

	Option A	Option B			Risk Preference	Individual Choices	Individual Proposals	Group Choices
Lottery Number	Payoffs	Payoffs	Probability of Getting 150 Tokens	Expected Payoff of Option B	Range of CRRA if Switch from A to B at the Following Lottery	Frequency of Choices for B (%)	Frequency of Choices for B (%)	Frequency of Choices for B (%)
1	50	150 or 0	0	0	$r < -1.73$	0	0.8	0
2	50	150 or 0	0.05	7.5	$-1.73 < r < -1.1$	0	0	0
3	50	150 or 0	0.1	15	$-1.1 < r < -0.73$	1.7	0	0
4	50	150 or 0	0.15	22.5	$-0.73 < r < -0.47$	0	0	0
5	50	150 or 0	0.2	30	$-0.47 < r < -0.27$	1.7	0	0
6	50	150 or 0	0.25	37.5	$-0.27 < r < -0.1$	5	2.5	0
7	50	150 or 0	0.3	45	$-0.1 < r < 0.04$	5.8	6.7	2.5
8	50	150 or 0	0.35	52.5	$0.04 < r < 0.16$	15	20	16.7
9	50	150 or 0	0.4	60	$0.16 < r < 0.27$	24.2	26.7	21.7
10	50	150 or 0	0.45	67.5	$0.27 < r < 0.36$	31.7	32.5	36.7
11	50	150 or 0	0.5	75	$0.36 < r < 0.45$	58.3	58.3	65
12	50	150 or 0	0.55	82.5	$0.45 < r < 0.53$	68.3	67.5	80
13	50	150 or 0	0.6	90	$0.53 < r < 0.6$	80	80	87.5
14	50	150 or 0	0.65	97.5	$0.6 < r < 0.66$	88.3	90.8	95
15	50	150 or 0	0.7	105	$0.66 < r$	93.3	95	97.5
		Percentage of monotonic decision makers				87.5	90	95

Notes: Everyone should choose Option A in decision 1. Risk-neutral subjects would switch to Option B in decision 8. A switch in later decisions reveals risk aversion and a switch in earlier decisions reveals risk-seeking behavior. CRRA stands for a utility function exhibiting constant relative risk aversion. Number of individual observations for each line is 120.

FIGURE 1
Individual versus Group Risk Attitude. Fraction of Risky Lottery Choices by Groups and Individuals



Notes: $N = 120$. One group did not agree on three lottery decisions. For those decisions, the graph employed their individual third attempt proposals. Lottery numbers are the same as in Table 2.

TABLE 3
Risk Neutrality When Disagreement

	Majority Prevailed	Minority Prevailed	
Majority at risk neutrality	79	12	91 (57.2%)
Minority at risk neutrality	50	18	68 (42.8%)
Totals	129 (81.1%)	30 (18.9%)	159 (100%)

Notes: The unit of observation is a decision a group made in a lottery in part 2. This table includes only group decisions with disagreement (159/600 obs.). The table compares individual proposals with group choice. The majority proposal was A when AAB and B when ABB.

TABLE 4
Risky Shift When Disagreement

	Majority Prevailed	Minority Prevailed	
Majority more risky	68	11	79 (49.7%)
Minority more risky	61	19	80 (50.3%)
Totals	129	30	159

Notes: The unit of observation is a decision a group made in a lottery in part 2. This table includes only group decisions with disagreement (159/600 obs.). The table compares individual proposals with group choice. The majority proposal was A when AAB and B when ABB.

while risk-averse subjects may have preferred the safer Option A (Figure 2).

The analysis of disagreement is particularly interesting because one can understand the internal process that led to a decision and shed light on Result 2. Given that the decision was binary, A or B, and a group comprised three individuals, there were only two possible patterns of disagreement, a majority for A (AAB) or a majority for B (ABB). Out of a total of 600, there were 159 group decisions with disagreement. In order to study how disagreement was resolved through group interaction, we consider two possible benchmarks: the outcome with a dictator selected at random in the group and the outcome with majority voting. Following a random dictator process the proposal of the majority would prevail in 66.7% of the cases while following majority voting the proposal of

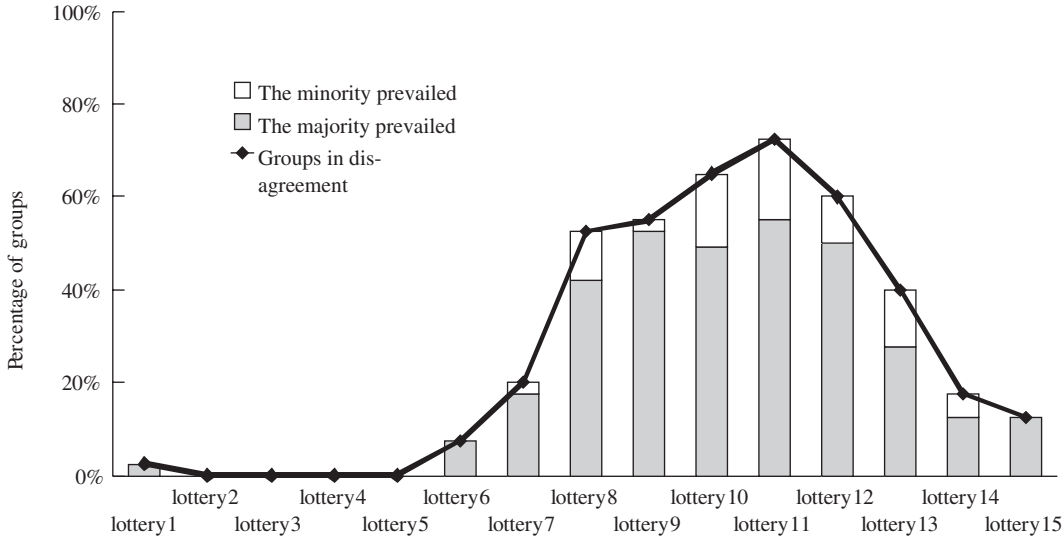
TABLE 5
Probit Regression on How Groups Resolve Disagreement

Sample*: Decisions with Disagreement Only** ***Dependent variable: **1 = my proposal equals group choice, 0 = otherwise**	**All (1)**	**Majority Prevails (2)**	**Minority Prevails (3)**	**Multiple Attempts before Unanimity (4)**	**One Attempt before Unanimity (5)**
Independent variables:					
My proposal was the risk-neutral choice (1 or 0)	0.20*	0.14*	0.15*	0.09	0.34**
	(0.103)	(0.060)	(0.063)	(0.114)	(0.121)
My proposal was in the majority (1 or 0)	0.65**	—	—	0.71**	0.63**
	(0.081)	—	—	(0.160)	(0.112)
My individual choice was different than my proposal	−0.27	−0.40*	0.05	−0.38**	−0.33*
	(0.138)	(0.191)	(0.120)	(0.144)	(0.158)
My proposals were not monotonic (1 or 0)	−0.29**	−0.19	−0.07	−0.23	−0.32**
	(0.074)	(0.103)	(0.043)	(0.118)	(0.116)
Number of lottery decisions on which the group disagree	−0.00	0.00	−0.00	−0.03	0.01
	(0.011)	(0.010)	(0.019)	(0.034)	(0.011)
Multiple attempts to decide (1 or 0)	0.05	0.04	−0.06	—	—
	(0.048)	(0.036)	(0.073)	—	—
Chat messages					
I talked first (1 or 0)	0.08	0.09*	0.10	−0.07	0.04
	(0.066)	(0.036)	(0.083)	(0.129)	(0.074)
I talked last (1 or 0)	−0.10	−0.06	−0.06	0.14	−0.11
	(0.058)	(0.030)	(0.048)	(0.103)	(0.074)
Number of words I wrote in my group (×100)	0.18	−0.19	0.55**	0.04	0.15
	(0.453)	(0.190)	(0.210)	(0.429)	(0.579)
Number of words that all other members wrote (×100)	−0.38	−0.36**	0.16	−0.49**	−0.30
	(0.253)	(0.111)	(0.176)	(0.181)	(0.334)
Demographics					
Science and Engineering Major (1 or 0)	0.07	0.06	−0.06	0.29**	0.03
	(0.079)	(0.034)	(0.071)	(0.103)	(0.094)
Above 75 percentile SAT/ACT (1 or 0)	0.05	0.04	−0.02	−0.05	0.21**
	(0.059)	(0.035)	(0.059)	(0.138)	(0.057)
Below 25 percentile SAT/ACT (1 or 0)	0.09	0.08**	0.08	−0.00	0.20**
	(0.076)	(0.028)	(0.097)	(0.085)	(0.068)
Male (1 or 0)	−0.03	−0.03	0.04	0.17	−0.17*
	(0.080)	(0.041)	(0.082)	(0.187)	(0.084)
Missing SAT/ACT or demographic data (1 or 0)	0.10	0.06	−0.02	−0.33	0.23**
	(0.085)	(0.033)	(0.056)	(0.339)	(0.084)
Personality traits					
Agreeableness	0.00	0.01	0.03	−0.00	−0.05
	(0.045)	(0.029)	(0.037)	(0.105)	(0.055)
Conscientiousness	−0.10	−0.08*	0.01	0.15	−0.11
	(0.059)	(0.038)	(0.082)	(0.129)	(0.083)
Neuroticism	−0.01	−0.03	0.01	0.08	−0.06
	(0.066)	(0.035)	(0.053)	(0.205)	(0.069)
Openness	0.02	−0.00	0.00	0.06	0.04
	(0.050)	(0.027)	(0.052)	(0.090)	(0.056)
Extroversion	−0.00	−0.00	0.00	0.20**	−0.03
	(0.048)	(0.021)	(0.056)	(0.062)	(0.050)
Number of observations	477	318	159	150	327
Pseudo R^2	0.361	0.284	0.205	0.498	0.375
Log likelihood	−204.7	−110.2	−61.23	−49.97	−137.9

Notes: Marginal effects, robust standard errors in parentheses, clusters on groups. Sample: decisions with disagreement only. The regression includes lottery decision dummies, which have not been reported in the table. One group did not agree on three lottery decisions and those decisions are excluded from this table.

Statistical significance $^{**}p < .01$, $^{*}p < .05$.

FIGURE 2
Which Lottery Decisions Were Most Controversial. Disagreement within Groups for Each Lottery ($n = 600$)



Note: Lottery numbers are the same as in Table 2.

the majority would prevail in 100% of the cases. As Table 3 illustrates, when in disagreement, the proposal of the majority prevailed in 81.1% of the decisions, while the minoritarian proposal prevailed in the remaining 18.9% (two Pearson chi-squared tests, p-value $< .01$, $n = 159$). The actual outcome is in-between a random dictator and a majority rule process and exhibits some interesting biases in group decision making.

When in disagreement, 52.7% of individual proposals and 61.0% of group choices were the same as those of a risk-neutral agent. Table 3 suggests that the proposal of the majority prevailed more often when its proposal was the same as that of a risk-neutral agent (79/91 vs. 50/68, Pearson chi-squared test, p-value $= .011$). Hence the group interaction generated a shift toward more risk-neutral choices.

Table 4 presents a breakdown with respect to whether the more risky proposal prevailed. Overall, with disagreement the more risky proposal prevailed in 54.7% of the decisions, which is slightly higher than predicted by a coin flip resolution of disagreement (50.0%) and higher than what is expected had the proposal of the majority always prevailed (49.7%).[8] In particular, when the majority prevailed, in 52.7% of the decisions it had the more risky position; when the minority prevailed, in 63.3% of the decisions it had the more risky position.

Table 5 presents the marginal effect from a probit regression on individual proposals. The dependent variable is equal to one when an individual proposal equals the actual group choice (hence it prevails in case of disagreement). Among the independent variables, we included some aspects of lottery choices, demographic and personality traits, and chat activity. The focus is on individual proposals in disagreement with others in the group. We will postpone the discussion of chat activity to Result 4 and discuss the other findings. Demographic regressors include skill, gender, and major. Skills are proxied by the ACT/SAT scores obtained from the university Registrar's Office. We have either SAT or ACT scores for 92.5% of the subjects (missing data = 0), who are coded using the US nationwide distribution of the SAT-takers (College Board of Education 2006) and ACT-takers. The threshold for high ability is being in the top quartile of the distribution and for low ability is being in the lower quartile. The variables are primarily based on SAT scores and, when missing, on ACT scores. The cutoff values are

8. These differences are not statistically significant.

the average between male and female national tables.

Another class of regressors code five personality traits using questionnaire answers. The personality traits are designed based on the big five inventory by John et al. (1991), agreeableness, conscientiousness, neuroticism, openness, and extroversion. For example one variable measures conscientiousness through the average rating on nine statements.[9] Subjects circle a number 1 through 5, where 1 stands for "strongly disagree," 2 for "disagree," 3 for "neutral," 4 for "agree," and 5 for "strongly agree."

Table 5 presents results from the same econometric specification run on five data samples. Column 1 includes all decisions with disagreement, columns 2 and 3 show a breakdown of the sample into cases where the majority or minority prevailed, respectively. We will later comment on the other columns. The results corroborate five points. First, there was a significant shift toward risk neutrality as stated in Result 2 (columns 1, 2, and 3). Second, as already discussed, being in a majority substantially raised the likelihood to prevail in case of group disagreement (column 1). Third, subjects who are confused with the task are less likely to prevail (columns 1 and 2). We proxied a subject's confusion using a lottery-specific dummy for her individual choice being different from her proposal and a subject-specific dummy for her proposal not being monotonic. Fourth, personality matters, in the sense that more conscientious subjects conceded more chances to the proposal of the minority when they were in a majority that prevailed (column 2). Fifth, skill sometimes matter but not in an expected way: low skilled subjects were more likely to prevail (column 2).

D. Result 4: About One Third of Groups Did Not Find Agreement Immediately after Communication. Groups with High Skill and Science and Engineering Members Were More Likely to Find an Immediate Agreement as well as Those with Monotonic and More Extrovert Members

Tables 5 and 6 provide support for Result 4. Table 6 presents a probit regression on the difficulty of reaching a group agreement in the first attempt. Predictably, the higher the number of lotteries with disagreement the less likely the groups would resolve disagreement immediately. In addition, both skill and personality measures had an impact. Groups with members with SAT/ACT score above the 75th percentile and with monotonic proposals were more likely to find an immediate agreement. Groups with more extrovert members were also more likely to find an immediate agreement (also more conscientious members, albeit at a 10% significance level). There was also a strong effect of Science and Engineering although no gender effect was recorded. We will comment on the impact of chat activity in Result 5.

When disagreement persists after the communication stage, group processes may change substantially. In column 4 of Table 5 we restrict the sample to those groups who required multiple attempts before converging toward unanimity. Those groups faced an emergency situation since they would have obtained 0 payoffs if they had not reached an agreement after three attempts. When disagreement is not resolved immediately, our previous conclusions need qualification. Putting forward a risk-neutral proposal is no longer important in the emergency situation (risk-neutral proposal prevailed in 95 out of 109 in one attempt vs. 30 out of 50 in multiple attempts); different personality traits prevailed: extroversion has now a significant impact while conscientiousness is no longer important; finally, proposals from Science and Engineering majors were more likely to prevail.

E. Result 5: Chat Activity Was Intense, Growing with the Level of Disagreement and Aimed at Finding Consensus. The Amount and Timing of Chat Messages Help to Predict Group Choices

Figures 3 and 4 and Tables 5 and 6 provide support for Result 5. All of the 120 subjects intervened in the 2 minutes of chat time. On an average, a person intervened 4.3 times and wrote a total of 23.9 words. Hence, the average length of an intervention was rather short (5.6 words). Interestingly, the higher the number of decisions with disagreement the more intense was the chat activity, suggesting that messages were aimed at finding a common ground. With more disagreements, participants intervened on average about the same number of times but with longer messages (Figure 3).

Figure 4 informs about the content of the communication by giving an uncensored list of

9. I do a thorough job. I do things efficiently. I make plans and follow through. I am a reliable worker. I persevere until the task is finished. I am easily distracted. I can be somewhat careless. I tend to be lazy. I tend to be disorganized.

TABLE 6
Probit Regression on Group Difficulty of Reaching an Agreement

***Sample*: Decisions with Disagreement Only**	
Dependent variable: **1 = my group required more than one attempt to decide; 0 = otherwise**	
Independent variables:	
My proposal was the risk-neutral choice (0/1)	−0.02
	(0.068)
My individual choice was different than my proposal	0.07
	(0.116)
My proposals were not monotonic (0/1)	0.40**
	(0.139)
Number of lotteries with disagreement in the group	0.17**
	(0.051)
Number of words written overall by group (× 100)	−0.57
	(0.313)
Number of words written in the last intervention (× 100)	0.02
	(0.020)
Number of words written in the second to last intervention (× 100)	0.04**
	(0.012)
Difference in words written between the most and the least active individual (× 100)	1.35*
	(0.617)
Science and engineering major	−0.28**
	(0.104)
Above 75 percentile SAT/ACT	−0.19*
	(0.076)
Below 25 percentile SAT/ACT	0.03
	(0.111)
Male	0.12
	(0.088)
Missing SAT/ACT or demographic data	0.04
	(0.113)
Agreeableness	−0.01
	(0.060)
Conscientiousness	−0.14
	(0.074)
Neuroticism	0.06
	(0.073)
Openness	−0.10
	(0.090)
Extroversion	−0.14*
	(0.063)
Observations	477
Pseudo R^2	0.523
Log likelihood	−141.8

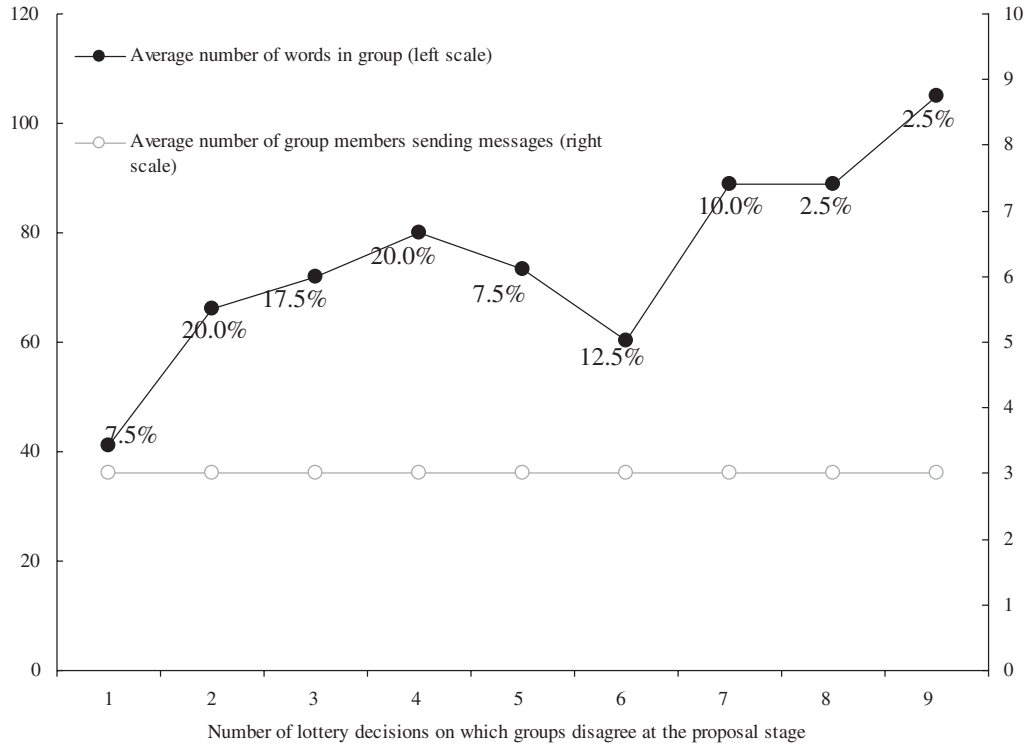
Notes: Marginal effects, robust standard errors in parentheses, clusters on groups. Sample: decisions with disagreement only.

The regression includes lottery decision dummies, which have not been reported in the table.

Statistical significance ** $p < 0.01$, * $p < 0.05$.

the top 100 words employed. In the figure, the character size is proportional to frequency of use. "A" and "B" were the option names and were among the most frequently used. Notice numbers 1–15, whose sizes are roughly linked to how controversial that particular lottery decision was. "I" and "we" suggest the tension between individual and group. Overall, the words employed denote a very practical use of communication to reach consensus or express opinions for or against a choice. This content analysis did not rely on human coders, as Cooper and Kagel (2005) but on quantitative statistics on the text, which delivered interesting results.

FIGURE 3
Chat Activity



Notes: $n = 40$ groups; all groups disagreed on at least one decision; percentages refer to the number of observations, which sums up to 100%.

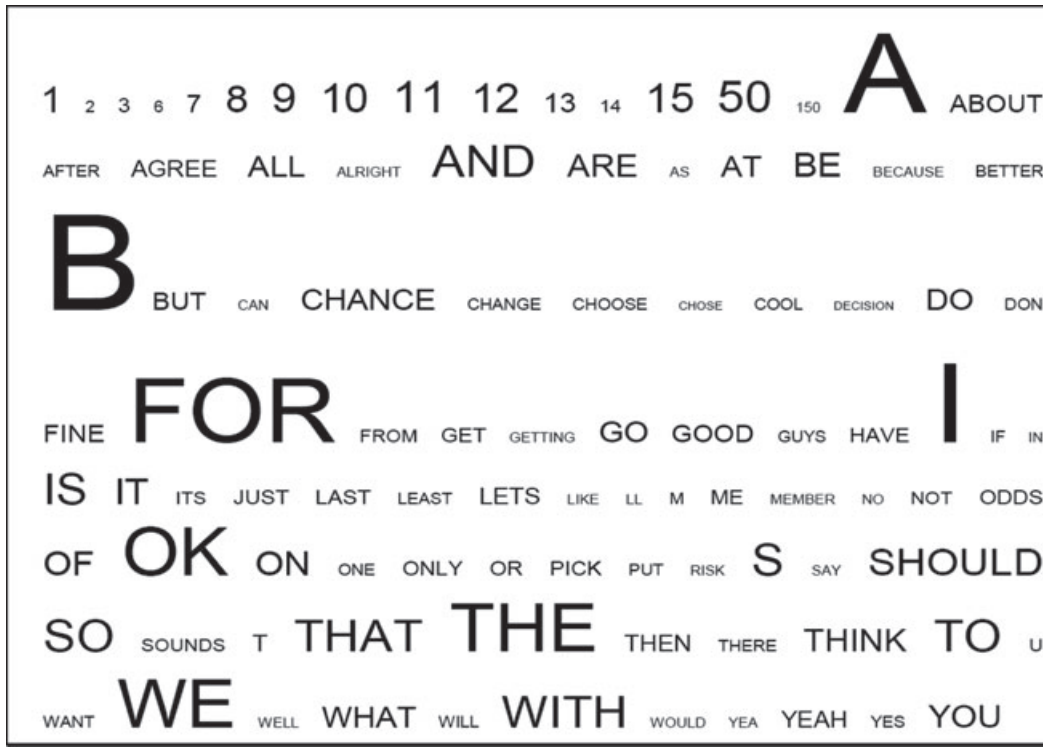
The probit regressions in Tables 5 and 6 show that chat activity helps to predict how groups resolved disagreement. In Table 5 four variables summarized chat activity: who talked first, who talked last, number of words written by the subject, and total number of words written by the other two people in the group. Even without analyzing the content of the messages, one can see the effects on whose choice prevailed in group decision making. The persuasion effort as measured by the number of words written paid off in the expected direction. Not voicing your own reasons lowered someone's chances of determining the group decision. In particular a subject with a majority proposal was more likely to be the first to express opinions and to render the majority proposal to prevail. A subject in a minoritarian position had chances to convince the other two if she wrote longer messages. This evidence is consistent with Eliaz et al. (2007)'s theory which predicts that the majority prevails through greater voice and larger group size and, whenever the minority prevails, voice more than compensates for the group size.

In Table 6, four other variables that are based on the count of the number of words summarized the chat activity: overall activity in the group, difference in activity between the most and least active member in the group, length of the last intervention and of the second to last intervention. We report two major effects of chat activity on the difficulty of reaching a group agreement in the first attempt. First, groups with more words written in the chat can sort out disagreement more quickly. Second, a large inequality in chat activity among group members and more words in the second to last intervention correlate with more difficulties of reaching a consensual group choice.

V. CONCLUSIONS

We study group decision making with the aim to understand how small groups resolve

FIGURE 4
One Hundred Most Frequent Words in Chat Messages



Notes: "B" is the most frequently used word in the chat (122 times). "DECISION" is the least used (seven times). Character size is proportional to frequency of use.

disagreement when facing a safe versus a risky option. We present experimental evidence both at the aggregate and at the individual level.

In the aggregate, we report that group decisions generate a "risky shift" in comparison to individual decisions. This shift occurs because group choices were 4.3 percentage points more frequently closer to risk neutrality than individual choices; groups made choices that were less risk averse than those of their members. In addition, group choices followed monotonicity more often than individual choices. These aggregate results contribute to the debate on whether group decision making generates a risky or a cautious shift. Baker et al. (2008), Masclet et al. (2009), and Shupp and Williams (2008) all found that groups are more risk averse than individuals. On the contrary, Harrison et al. (2010) report no group effect. We put forward the explanation that the attitude of group decisions over risk depends on the interaction rules and on group size. These conjectures spring from considering the variety of default rules adopted in the literature in case of group disagreement. Chat communication alone did not always generate unanimity because individuals may hold genuinely different stands over what risks to take. In these cases, as Baker et al. (2008) note, the unanimity rule is more likely to induce more pressure toward conformity in groups than the majority rule. We carried out analyses of the incentives set by alternative default rules, which makes clear that our design gives the highest incentives to negotiate and reach consensual decisions within the group. In addition to formal incentives, there may be a behavioral group pressure to conform, which depends on members' personality and group size. We did not explore differences in group sizes but conjecture that in a group of three members, a two-against-one situation is qualitatively different than a disagreement in a group of two of one-against-one. In our experiment, in situations of two-against-one the minority proposal prevailed on average

in 19% of cases. This fraction is positive but less than one third, as a random selection would suggest, and further reduced to 14% in case the disagreement persisted over multiple attempts to decide, which signals an even stronger attraction toward the opinion of the group majority.

Lack of agreement caused an emergency situation because without unanimity in a lottery choice, participants' payoff was zero for that lottery. Agreement could eventually be reached without further communication in a second or third attempt. In these emergency situations, the mode of interaction within group members changed substantially.

We report evidence that personality and communication abilities mattered. In particular, the presence of extrovert and conscientious members influences group choices. A conscientious subject may be more willing to give in to minimize the chances of no choice in case of disagreement. Extrovert subjects were more likely to push for an immediate agreement or to voice his or her proposals when in emergency situation. The patterns of communication in terms of amount, equality, and timing significantly influence the outcome. In the experiment, the more one writes relative to others, the more likely is one's opinion to prevail. Moreover, a balanced exchange of messages among members makes immediate agreement more likely.

To conclude, in a group with clearly outlined individual preferences and incentives to solve disagreements, group decisions exhibited a shift toward risk neutrality. This "risky shift" was not found in other studies and likely depends on the incentives to internally negotiate an agreement. We conjecture that the risk attitude of group decisions is rule-specific: it depends on the interaction rules in place within the group.

REFERENCES

Baker, R. J., S. K. Laury, and A. W. Williams. "Comparing Small-Group and Individual Behavior in Lottery-Choice Experiments." *Southern Economic Journal*, 75(2), 2008, 367–82.

Casari, M., J. Zhang, and C. Jackson. "Do Groups Fall Prey to the Winner's Curse?" Working Paper No. 504, Institute for Empirical Research in Economics, University of Zurich, 2010.

Cason, T. N., and F. U. Khan. "A Laboratory Study of Voluntary Public Goods Provision with Imperfect Monitoring and Communication." *Journal of Development Economics*, 58(2), 1999, 533–52.

Cason, T. N., and V.-L. Mui. "A Laboratory Study of Group Polarization in the Team Dictator Game." *Economic Journal*, 107(444), 1997, 1465–83.

Charness, G., E. Karni, and D. Levin. "Individual and Group Decision Making Under Risk: An Experimental Study of Bayesian Updating and Violations of First-Order Stochastic Dominance." *Journal of Risk and Uncertainty*, 35(2), 2007, 129–48.

College Board of Education. "SAT Percentile Ranks for Males, Females, and Total Group, College-Bound Seniors—Critical Reading + Mathematics + Writing." 2006. Accessed December 14, 2010. http://www.collegeboard.com/prod_downloads/highered/ra/sat/SATPercentileRanksCompositeCR_M_W.pdf.

Cooper, D. J., and J. H. Kagel. "Are Two Heads Better Than One? Team versus Individual Play in Signaling Games." *American Economic Review*, 95(33), 2005, 477–509.

Eliaz, K., D. Ray, and R. Razin. "Group Decision-Making in the Shadow of Disagreement." *Journal of Economic Theory*, 132, 2007, 236–73.

Fischbacher, U. "z-Tree-Zurich Toolbox for Readymade Economic Experiments." *Experimental Economics*, 10(2), 2007, 171–78.

Hackett, S., E. Schlager, and J. Walker. "The Role of Communication in Resolving Commons Dilemmas: Experimental Evidence with Heterogenous Appropriators." *Journal of Environmental Economics and Management*, 27, 1994, 99–126.

Harrison, G. W., I. L. Morton, E. E. Rutström, and M. Tarazona-Gómez. "Preferences over Social Risk." Working Paper No. 19, J. Mack Robinson College of Business, Georgia State University, 2010.

Holt, C. A., and S. K. Laury. "Risk Aversion and Incentive Effects." *American Economic Review*, 92, 2002, 1644–55.

Isaac, R. M., and J. M. Walker. "Communication and Free-Riding Behavior: The Voluntary Contribution Mechanism." *Economic Inquiry*, 26(4), 1988, 585–608.

John, O. P., E. M. Donahue, and R. L. Kentle. *The Big Five Inventory.* Berkeley: University of California, 1991.

Kocher, M. G., and M. Sutter. "The Decision Maker Matters: Individual versus Group Behavior in Experimental Beauty-Contest Games." *Economic Journal*, 115(500), 2005, 200–23.

Lamm, H., and D. G. Myers. "Group-induced Polarization of Attitudes and Behavior." *Advances in Experimental Social Psychology*, 11, 1978, 145–95.

Luhan, W., M. Kocher, and M. Sutter. "Group Polarization in the Team Dictator Game Reconsidered." *Experimental Economics*, 12, 2009, 26–41.

Masclet, D., Y. Loheac, D.-B. Laurent, and N. Colombier. "Group and Individual Risk Preferences: A Lottery-Choice Experiment." *Journal of Economic Behavior and Organization*, 70(3), 2009, 470–84.

Pruitt, D. G.. "Choice Shifts in Group Discussion: An Introductory Review." *Journal of Personality and Social Psychology*, 20, 1971, 339–60.

Rockenbach, B., A. Sadrieh, and B. Mathauschek. "Teams Take the Better Risks." *Journal of Economic Behavior and Organization*, 63, 2007, 412–22.

Shupp, R., and A. W. Williams. "Risk Preference Differentials of Small Groups and Individuals." *The Economic Journal*, 118(525), 2008, 258–83.

Stoner, J. A. F. "A Comparison of Individual and Group Decisions Under Risk." Unpublished Master's Thesis, Massachusetts Institute of Technology, School of Management, 1961.