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Free-Riding and Performance in Collaborative and Non-Collaborative Groups[*]

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Abstract: Individuals bring effort to a group to achieve a common objective. Group membership introduces a free-riding incentive, reducing effort, as well as a sense of social responsibility, increasing effort. We show experimentally that the free-riding effect is stronger. Group members significantly reduce their effort in non-collaborative groups. With collaboration, the negative effects of free-riding are not observed. Collaborating groups outperform both groups without collaboration and individuals. They do as well, statistically, as the best constituent member would have done on her own. Thus, groups aggregate existing knowledge rather than create new knowledge.

JEL Codes: C92, D71, Z13

Key Words: group behavior, decision making, free-riding, experiments

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I. Introduction

Economists have recently started paying more attention to group decision making as many economic decisions from the family dinner table to the corporate boardroom reflect the opinions of groups. Within a group, individuals offer input into the decision and collectively share in the resulting outcome. Despite the conventional wisdom that two heads are better than one, researchers are more equivocal about the ability of groups to make better decisions. For example, team-managed mutual funds do no better, and sometimes worse, than funds managed by individuals (Chen et al. 2004, Prather and Middleton 2002). Conversely, others have documented "assembly bonus effects," where groups outperform even their most capable members (Laughlin, Bonner, and Miner 2002). Even without collaboration, group membership and the interdependence of members' payoffs can, in itself, alter individual decision making (Sutter 2009; Charness, Rigotti, and Rustichini 2007). Thus, group performance depends both on the effort individuals bring *to* the group and the collaborative process leading to a collective decision *within* the group. The goal of this manuscript is to disentangle these two effects.

Individuals often exert a different level of effort when making decisions as part of a group versus for themselves. Because personal responsibility for decisions is diluted in a group setting, members may free-ride or engage in "social loafing," by reducing personal effort when part of a group (Latané, Williams, and Harkins 1979; Karau and Williams 1993). For example, groups often produce fewer ideas for how to approach a problem than the same number of individuals working alone (Diehl and Stroebe 1987; Mullen, Johnson, and Salas 1991). Conversely, as one's decisions impact the payoffs of other group members, altruism, social pressures, shared responsibility, social identity, and group salience may lead to increased effort (Tajfel and Turner 1985; Wagner 1995; Charness, Rigotti and Rustichini 2007; Sutter 2009). Thus, group membership may induce two opposing forces on an individual's provision of effort.

Whatever effort each group member brings, the group translates individual problem-solving approaches into a single collective action. Some groups are able to identify the member with the greatest task-specific expertise (Hill 1982; Henry 1993). In some cases groups create knowledge, resulting in a strategy superior to what any member could obtain alone. For example, Charness, Karni, and Levin (2007, 2010) find that collaboration improves the likelihood of correctly answering questions concerning stochastic dominance and conjunctive events. Alternatively, groups might adopt the approach of the most charismatic but not necessarily the most capable member allowing misleading intuition or persuasion to win over truth (Isenberg 1986; Kerr, MacCoun, and Kramer 1996). Similarly, Tindale et al. (1996) find that groups often favor intuitive but incorrect answers in tasks requiring an understanding of probability. Rather than battling for "the truth" to win out, people often practice self-censorship to provide the appearance of unanimity (Janis and Mann 1977).[1]

We employ an experimental design which allows us to separate the effect of group membership on effort from the overall effect of collaboration within groups. Past research includes experiments in which groups make a joint decision[2] and experiments where subjects are members of groups but do not make a joint decision.[3] The former is concerned with the effect of groups on collective behavior, while the latter is concerned with the effect of group membership on individual actions. Our experiment includes both types of groups, similar to Sutter (2009).

Our subjects participate either as individuals or in one of two group treatments in a series of multi-state choice tasks. The tasks are context-free, but may be thought of as selecting an insurance plan (option) from among several that cover some eventualities (states) but not others. The probability of each eventuality is provided to subjects. Therefore, options may be objectively ranked based on each option's probability of payment. In the *individual* treatment, subjects make decisions and earn payments on their own. In the *collaborative group* treatment, subjects complete the task in groups of three, engaging in free-form, face-to-face discussion. Each group makes a joint decision and members earn identical resulting payments. In the *non-collaborative group* treatment, subjects are placed in groups of three, but make individual decisions without any communication with other group members. Decisions of a single group member, selected at random, determine each group member's identical payment. Collaborative groups have both payoff commonality and joint decision making, while non-collaborative groups have payoff commonality but individual decision making. While the individual and collaborative treatments have many obvious parallels outside of the lab, the non-collaborative treatment does not. However, this ability to create counterfactual situations is a major advantage of laboratory

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[1] This phenomenon, termed "groupthink" (Janis 1971), has been well-documented since at least Sherif (1936) and Asch (1951). Perhaps for self-validation, people often prefer to conform to the majority view even when it is known to be wrong, and prefer to restate known and accepted ideas rather than present new ones (Wittenbaum, Hubbell, and Zuckerman 1999).

[2] Such as Cooper and Kagel (2005), Blinder and Morgan (2005, 2008), Kocher and Sutter (2007), and Sutter (2009).

[3] Such as Charness, Rigotti, and Rustichini (2007), Sutter (2009), Hargreaves-Heap and Zizzo (2009), Chen and Li (2009), Charness, Karni, and Levin (2010), Morita and Servátka (2011), and Ioannou, Qi, and Rustichini (2011).

experiments enabling the dissection of hypotheses that may not be possible otherwise. Our artificial groups allow us to address two questions. First, how does group membership, in itself, influence individual effort and performance in the absence of collaboration? Second, how does collaboration within groups affect effort and the optimality of decisions controlling for the commonality of payoffs?

We report two main results. First, non-collaborative group members engage in free-riding resulting in a loss of $1.20 on a $20 task payoff. They perform slightly worse than subjects in the individual treatment across all tasks, making an optimal decision in 67% of tasks as compared to 72% for individuals. However, as task complexity increases, raising the cost of effort, the performance disparity between non-collaborative groups and individuals widens, with non-collaborative groups making an optimal decision in less than a half of tasks (47%), while individuals do so in two-thirds of tasks (65%). We conjecture that the uncertainty of each members' effort impacting payoffs increases free-riding tendencies. Each member's effort pays off with a constant 1/3 probability, thus preserving the benefit of investing more effort, while the cost of providing effort increases with task complexity. This free-riding effect appears to outweigh the social concerns created by payoff commonality. Free-riding is primarily observed among men.[4] Additionally, individuals with highest aptitude for these tasks, as measured by the cognitive reflection test (Frederick 2005), exhibit higher levels of free-riding. Thus, the primary effect of group membership, absent collaboration, is to reduce the effort that the most capable members bring to the group.

Our second result is that once group members can collaborate, the negative effect of free-riding on performance is no longer observed. This suggests that it is the collaborative aspect of groups, rather than payoff commonality that triggers social concerns and effort. The collaborative groups' superior performance is due to them being effective aggregators of information, rather than knowledge creators. Collaborative groups do as well as the best individuals, but not better, making optimal decisions in 87% of all tasks.

Our first finding, that subjects in non-collaborative groups free-ride and do no better than individuals relates to two recent results. Charness, Rigotti, and Rustichini (2007) showed that groups affect strategic decision making when group membership is made sufficiently salient

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[4] Conclusions on the role of sex in free-riding based on public goods experiments have been mixed. Nowell and Tinker (1994) report more free-riding by women, while Brown-Kruse and Hummels (1993) report the opposite and Cadsby and Maynes (1998) find no difference.

through payoff dependence or observation of play by group members. Sutter (2009) extends those results to a non-strategic setting, and finds that individuals who are part of groups but cannot communicate yield similar decisions to those achieved by collaborative groups. These studies show that non-collaborative group performance depends on the level of group saliency, or social, psychological, and economic ties among group members. Our non-collaborative groups differ from those in Charness, Rigotti, and Rustichini (2007) and Sutter (2009) in the way individuals' decisions translate into group outcomes. In Charness, Rigotti, and Rustichini (2007) each individual receives a payment resulting from his or her actions as well as a third of the payment received by all other members of his or her group. In Sutter (2009) each group member is solely responsible for one-third of all decisions with all group members' performance summed to arrive at the group's payment. In our experiment each non-collaborative group member makes every decision, and one randomly chosen member's decision is solely responsible for the entire group outcome, while other group members' decisions are undisclosed.

In the social psychology literature, the level of individual effort in groups depends on (*i*) the indispensability of one's effort to the group outcome (Kerr and Bruun 1983; Jones 1984; Karau and Williams 1993) and (*ii*) the observability of individual performance (Williams, Harkins, and Latané 1981; Weldon and Gargano 1988). Depending on their level of indispensability and observability, collaborative groups provide varying degrees of opportunity and incentive to "hide" yet nevertheless share in the group's outcomes (Jones 1984; Albanese and Van Fleet 1985; Williams and Karau 1991). Experiments which make each group member indispensable and identifiable by design eliminate these incentives to hide, and thus offer little balance to the positive motivations derived from group salience. Our probabilistic design preserves incentives for free-riding alongside these positive motivations in our non-collaborative groups.

The distinction between the social psychology notion of social loafing and the economic notion of free-riding is subtle. Both imply reduced effort when responsibility is diffused. However, while the antecedents of social loafing are psychological, free-riding is a strategic decision weighing the costs of effort against the potential benefits. Our design allows us to differentiate these effects. By varying the numbers of options and states, we create tasks of varying difficulty, while holding the rewards constant. Propensity for social loafing applies uniformly to all tasks, or potentially occurs even more on easier tasks as these offer less intrinsic reward (Harkins and Petty 1982; Jackson and Williams 1985). Conversely, free-riding is much more likely on harder tasks, holding potential rewards constant, as these reduce the pecuniary returns on one's effort. In our non-collaborative treatment, we find significantly reduced performance on harder tasks, but not easier ones, suggesting that free-riding is a more likely explanation than social loafing.

An important aspect of our experimental design is that we compare group and individual performance on an intellective, non-strategic task where choices can be objectively ranked from best to worst. A number of past studies on group decision making have used judgmental tasks involving a strategic setting in which decision optimality depends on beliefs about other players[5] or a task in which decision optimality depends on idiosyncratic personal traits.[6] For example, observing that a group selects a more risk-neutral lottery than individuals could suggest either that people are less risk averse collectively than individually or that people are naturally risk neutral but make better decisions within groups. In these tasks differences between group and individual decision making may conflate objective decision-making performance with groups' tendencies to alter individual beliefs and traits (Stoner 1968). In contrast, choices in our experiment are invariant to personal traits and require only that subjects prefer more money to less.[7] Our effort departs from studies which examine non-strategic play such as Gillet, Schram, and Sonnemans (2009) [8] and Charness, Karni, and Levin (2007, 2010) in one important dimension: *our design makes it possible to vary the difficulty of the task by changing the number of options and the number of states describing each option.* It is precisely this variability that

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[5] For example, in bargaining games, Cason and Mui (1997) find more altruism among groups than individuals while Bornstein and Yaniv (1998) and Luhan, Kocher, and Sutter (2009) find the opposite. In trust games, Kugler et al. (2007) find that groups send less than individuals in the first stage, while Cox (2002) finds no significant differences. Groups are better at deducing optimal strategies in *p*-beauty contests (Kocher and Sutter 2005), centipede games (Bornstein, Kugler, and Ziegelmeyer 2004), and signaling games (Cooper and Kagel 2005) but are no better at eliminating dominated strategies (Cooper and Kagel 2009) and are more likely to overbid in common value auctions (Cox and Hayne 2006; Sutter, Kocher, and Strauss 2009). Ioannou, Qi, and Rustichini (2011) argue that the role of group identity on individuals has been exaggerated.

[6] For example, differences between group and individual decision making may conflate decision-making processes with participants' other-regarding preferences (as in bargaining experiments, e.g., Cason and Mui 1997; Luhan, Kocher, and Sutter 2009), risk tolerance (as in lottery experiments, e.g., Baker, Laury, and Williams 2008; Masclet et al. 2009; Deck et al. 2010) or other personal traits.

[7] Charness, Karni, and Levin (2007, 2010) compare individual and group understanding of probability, including stochastic dominance and conjunctive events, finding that collaboration improves the likelihood of correct answers. Conversely, Tindale et al. (1996) find that groups often favor intuitive, but incorrect, answers in tasks requiring an understanding of probability.

[8] Gillet, Schram, and Sonnemnans (2011) conduct a common pool dilemma experiment finding that groups make qualitatively better decision in a non-strategic setting. Groups are more competitive than individuals in a strategic setting with their efficiency relative to individuals depends on the nature of the joint decision making process.

allows us to examine the balance between the free-riding and social responsibility forces by allowing us to increase the effort required to solve the task while preserving the benefit from solving it.

Our second finding, that collaborative group performance is commensurate with the performance that its best member would have achieved on her own, implies that groups neither create knowledge nor, on average, suppress the most superior problem-solving approaches. This does not necessarily imply that each group actually identifies the most able member and blindly follows him or her. However, our results do suggest that, statistically, the best member’s likely outcome serves as an upper bound of what the group can achieve through joint effort, which is far better than what the group would do in the absence of collaboration. Taken together, our results suggest that payoff commonality is insufficient on its own to make group membership salient or, alternately, that free-riding can be a stronger incentive than that offered by group saliency. Yet, when groups collaborate, they can effectively identify and adopt the problem-solving approach of their strongest members.

II. Experimental Design and Procedures

Our experiment consists of either individuals or groups completing a series of decision tasks in a task booklet. In every task, there are a number of mutually exclusive states that occur with known probability. Subjects choose among a set of options where an option covers a given set of states. The tasks are identical to those used by Besedeš et al. (2011) in their study of individual decision making among the elderly. Figure 1 illustrates a task with four options, denoted A, B, C, and D. Options differ in the states they cover and no two options cover identical states. States are denoted and presented as 100 colored beads to be drawn from an urn. In Figure 1, there are 8 lime, 36 pink, 45 white, and 11 green beads. After all subjects complete their tasks, the task to be used for payment is randomly determined. Then one hundred colored beads corresponding to the states of the chosen task are placed into a container, and one is drawn. Should a pink bead be drawn and the chosen option contains pink (only option A in Figure 1), a $20 payment is earned in addition to a $5 participation payment. If a green bead is drawn when green is not included in the chosen option (only option D in Figure 1), only the $5 participation payment is earned. If a lime or a white bead is drawn, they will result in payment only if the chosen option contains the drawn color.

BEADS	**#**	**OPTIONS** **Circle the letter option of your choice.**			
		A	B	C	D
Lime	8	✓		✓	
Pink	36	✓			
White	45		✓		✓
Green	11	✓	✓	✓	

Figure 1: Sample choice task

As subjects enter the lab, they are randomly assigned to one of three concurrently-conducted treatments: (*i*) individual, (*ii*) collaborative group, or (*iii*) non-collaborative group. Both collaborative and non-collaborative groups consist of three subjects each. Subjects in the individual and non-collaborative group treatments were directed to one large room where they were separated by cubicles to make their decisions. Subjects in the non-collaborative group treatment are introduced to their group and are seated next to their group members, but are not allowed to speak to one another during the experiment. Each member is told to complete his or her own task booklet individually. After all group members completed their task booklets, one member was randomly chosen to have his or her decision determine the payment for the entire group. All group members earn the same amount of money based on this randomly-chosen member's decision. The booklet chosen for payment was revealed to all members, so that each member in a group knew who made the decision which determined their payment. Booklets of the other two group members were kept private. While only one member's responses were used to determine earnings, in our analysis below we use responses of all members of non-collaborative groups.

Each collaborative group was taken to a private room. Each member read the instructions individually, allowing each to form his or her own opinion on the best procedure to solve the tasks. After all members finished reading the instructions, an experimenter gave the group one pen and one task booklet. From this point on, group members were allowed to talk and interact, and were required to complete a single task booklet as a group.

The first task is a small 3-option 3-state task designed as a familiarization tool and used as an introduction to the experiment. Subsequently, each subject is presented with 18 tasks constituting a 3×3×2 within-subject design (Table 1). The first dimension denotes the number of options, the second the number of states, and the third the probability distribution over states. Tasks have 4, 8, or 12 options each described by 4, 8, or 12 states (colors of beads). Two different probability distributions of colored beads are used. In PDF 1, some colored beads are more likely than others, while in PDF 2, each colored bead is roughly equally likely to be drawn. Figure 1 presents the 4-option, 4-state, PDF2 task. Subjects can calculate the expected payoff of an option by summing the probabilities (number of beads) of states covered by that option.

Table 1: Experimental Design

States			PDF1			PDF2			12 Options											
									8 Options											
			States			States			4 Options											
4	8	12	4	8	12	4	8	12	A	B	C	D	E	F	G	H	I	J	K	L
Lime	Lime	Lime	8	2	2	28	7	7	■		■				■	■		■		■
	Purple	Purple		6	3		21	5	■		■				■	■		■		■
		Orange			2			7	■		■				■	■		■		■
		Lt Blue			1			9	■		■				■	■		■		■
Pink	Pink	Pink	36	22	18	24	11	6	■				■	■			■	■	■	■
		Yellow			4			5	■				■	■			■	■	■	■
	Blue	Blue		14	14		13	13	■				■	■			■	■	■	■
White	White	White	45	11	11	26	8	8		■		■	■		■	■			■	■
	Brown	Brown		34	19		18	7		■		■	■		■	■			■	■
		Red			15			11		■		■	■		■	■			■	■
Green	Green	Green	11	8	8	22	13	13	■	■	■				■		■		■	
	Navy	Navy		3	3		9	9	■	■	■				■		■		■	

The optimal choice is always the option which contains the largest number of beads, since that option has the highest likelihood of yielding a $20 payment. Nevertheless, past experiments indicate that most subjects do not select optimally; indeed, many subjects believe that the right approach involves selecting the option that covers the most states, rather than the sum of the states' probabilities (Besedeš et al. 2010). This task is well-suited to addressing our research questions. First, as previously noted, it is an intellective task which allows for objective comparisons of individual and group performance. Second, even when a group member recognizes the optimal decision rule, she nevertheless must win over adherents to the suboptimal but intuitively appealing rule to select the option that covers the most states. Past research has found that a simple, intuitive, though incorrect approach often triumphs in groups over truth (Tindale et al. 1996). Lastly, we can manipulate task complexity by changing the number of states and options in a decision. This allows us to examine free-riding as a function of the effort required.

Tasks are given to subjects in the form of a response booklet which lists the 19 tasks on separate pages. Subjects record their responses in the booklet with a provided pen. To control for order effects, three different versions of the response booklet are used to vary the order of the tasks. Subjects were not allowed to go backwards in their task booklets, a rule enforced by experimenters.[9] After completing the response booklet, each subject independently and privately completed a survey provided in a separate booklet.[10] The survey included questions about subject demographics and the three-question cognitive reflection test (CRT, Frederick 2005). Given past research that groups often select "intuitive" answers over correct ones (Isenberg 1986; Kerr, MacCoun, and Kramer 1996) the CRT examines tendencies to suppress spontaneous answers in favor of reflective ones.[11]

The experiment was conducted in the Behavioral Business Research Laboratory at the University of Arkansas in Spring of 2010. Subjects were recruited from undergraduate businesses classes. A total of 150 individuals participated in sessions over the course of 3 days. These included thirty subjects each in the individual and non-collaborative group treatments, and thirty groups (90 subjects) in the collaborative group treatment, for a total of 150 subjects. The subject pool was 33% female, 80% white (non-Hispanic), and averaged 20.2 years of age.

III. Results

A. Overall Performance

We begin with a comparison of overall performance across treatments. Each task has a unique optimal option associated with the highest probability of payment. Collaborative groups make the optimal decision in 87% of all tasks, followed by individuals in 72% and non-collaborative

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[9] We employed a two-pronged enforcement: experimenters observed the subjects throughout the experiment and decisions we marked with a special marker which made it impossible to secretly change a decision.

[10] Both the experimental task booklet and the survey instrument are available on request.

[11] For example, one of the three items asks "A bat and a ball cost $1.10 in total. The bat costs $1.00 more than the ball. How much does the ball cost?" The answer of ten cents is common, but on reflection, is clearly incorrect.

groups in 67%. Expected payoffs, defined as the probability of payment from the chosen option, follow a similar pattern. Collaborative groups average a 75.5% chance of payment, followed by individuals with 73.7% and non-collaborative groups with 72.3%. For both frequency of optimal decisions and the average chance of payment, the difference between collaborative groups and the other two treatments is highly significant (Mann-Whitney *p*<0.004).[12] In fact, collaborative groups more frequently select the optimal option and have the highest average chance of payment as the two other treatments in *each* of the 18 experimental tasks. The differences between the non-collaborative groups and individuals are not significant for both measures (*p*>0.100).

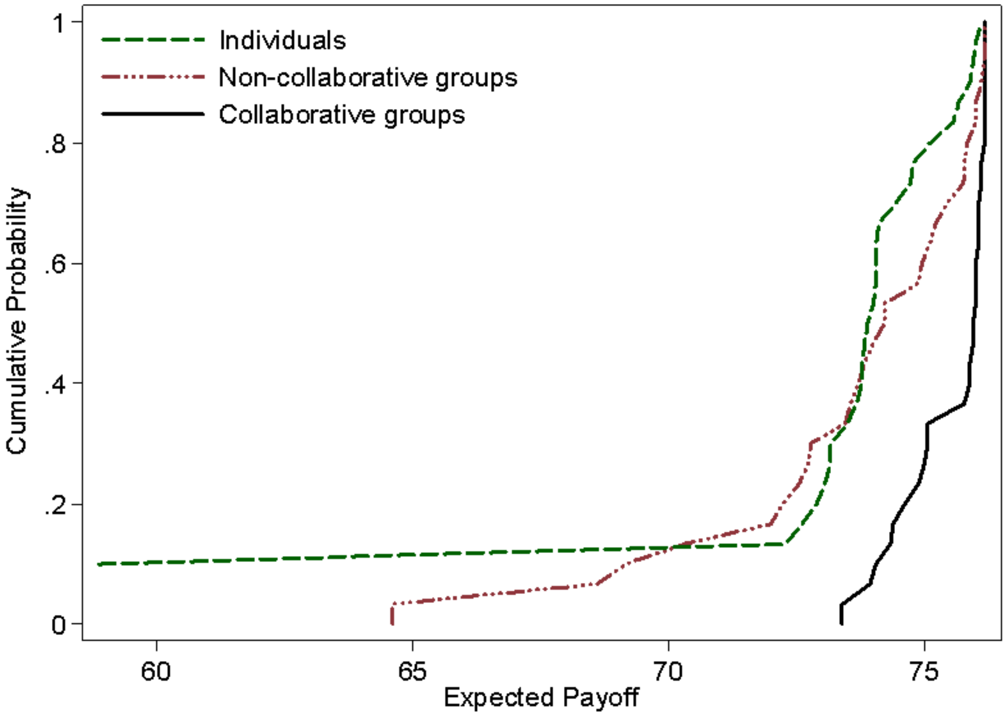

Figure 2: Cumulative distribution of expected payoffs by treatment

Figure 2 presents the distribution of expected payoffs by treatment. An optimal choice on each task would result in an expected payoff of 76.2% across all tasks. Nearly one quarter of all collaborative groups achieve this outcome, selecting the optimal option in each task. Again, we find that collaborative groups significantly outperform subjects in both the individual and non-

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[12] Three subjects in the individual treatment and one subject in the non-collaborative treatment failed to provide a choice for one of their 19 tasks. Our statistical results are not sensitive to dropping these four tasks or to coding them as the minimum, average, or maximum obtainable payoffs on that task.

collaborative group treatments, with the collaborative group distribution of payoffs stochastically dominating the other two treatments (Kolmogorov-Smirnov p<0.004). For example, while 80% of all collaborative groups achieve an expected probability of payment above 75%, less than half of subjects in the individual treatment and less than one-third of subjects in the non-collaborative treatment do so.

B. Individual Effort and Free-Riding

Next, we compare performance in the individual treatment to that in the non-collaborative group treatment. In both treatments, subjects complete the tasks independently and without any assistance from others. However, the non-collaborative group introduces two countervailing incentives. First, group membership and payoff dependence may encourage higher effort through, for example, a sense of responsibility for the welfare of others in the event one's decisions are binding upon all group members. Second, effort is subject to a free-riding incentive as a member can benefit from other group members' efforts, and one's own actions have a two-thirds chance of being inconsequential. Which of these incentives dominates determines whether non-collaborative group members perform better or worse than individuals.

To examine if free-riding is exhibited, we take advantage of our experimental design by comparing performance on tasks of varying difficulty. A task with twelve options and twelve states, for example, requires more effort to identify the optimal option than a task with four options and four states. As task difficulty increases, the demands on effort increase. The benefit from exerting that effort remains constant as each task is equally likely to be selected for payment. We would expect performance to decline with task complexity across all treatments. However, if members of non-collaborative groups are free-riding on the effort of others, we would expect a greater discrepancy between non-collaborative groups and individuals on hard tasks than on easy ones.

Although we cannot directly observe an individual's effort, we make the assumption that the effort subjects invest in solving a problem is reflected in their performance. To the extent that an individual's abilities and effort are correlated with the cognitive reflection test, we can compare subjects in the three treatments along the CRT dimension. Subjects in the individual treatment perform the best, answering correctly an average of 1.33 out of 3 questions. Subjects in the non-collaborative group answer correctly an average of 1.2 questions, while collaborative group subjects perform the worst answering correctly an average of 0.99 questions. We find it useful to divide subjects into two groups based on their CRT scores. High CRT subjects are those who answered at least two questions correctly, while those answering at most one question correctly are identified as low CRT subjects. Half of subjects in the individual treatment are high CRT individuals, while less than a third of those in collaborative groups are high CRT (25 from 90), a statistically significant difference (Fisher's exact test *p* =0.043). In non-collaborative groups, 12 of 30 (40%) of subjects are high CRT, statistically indistinguishable from either collaborative group subject or individuals. Thus, the better performance of collaborative groups cannot be explained by them being composed of individuals who are less likely to quickly choose an intuitively appealing, but suboptimal option.

We examine the frequency of selecting the optimal option in relatively harder and easier tasks in Table 2. We define harder tasks as those with 12 options and 12 states while all other tasks are defined as "easier."[13] Overall, subjects are much more likely to select the optimal option on easier tasks than harder ones (Wilcoxon p<0.001). Individuals select the optimal option in 73% of easier tasks, while non-collaborative group members do so in 70% (Mann-Whitney p=0.593). However, individuals select the optimal option in 65% of harder tasks, while non-collaborative group members do so in only 47% (p=0.032). Expected payoffs follow the same pattern, with individuals earning the same payoffs as non-collaborative subjects on easier tasks (p=0.525), but significantly higher payoffs on harder tasks (p=0.019).

Table 2: Frequency of optimal choice in tasks of varying difficulty

	Non-Collaborative Group	Individual
Easier tasks	70%	73%
Harder tasks	47%	65%

We conclude that subjects free-ride in non-collaborative groups. Of course, free-riding can occur to varying degrees, from slightly decreasing effort to completely abandoning effort and choosing randomly. Evidence suggests that the extent of free riding is limited. For example, non-collaborative group members select the optimal option in nearly half of harder tasks, which is below the rate in the individual treatment, but also well above the one in twelve chance implied by random choice.

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[13] Similar results follow from a less-restrictive definition of a harder task as one with at least eight options and at least eight states.

To determine if subject-specific differences across treatments can account for this result, we estimate the determinants of optimal choice in a probit model (Table 3). We include controls from our post-experiment survey for a subject's sex, race, and the number of correctly answered questions on the cognitive reflection test (CRT score), with each variable reflecting a subject's characteristics, rather than an average for all non-collaborative group members. Additionally, to identify whether there are significant differences between treatments in easier and harder tasks, we incorporate treatment-specific dummies for task types. The reference category is the individual treatment in easy tasks.

Table 3: Optimal choice in individual and non-collaborative group treatments

	Selecting the optimal option
Harder Task	-0.251*
	(0.152)
Non-collaborative Group	-0.520**
× Harder Task	(0.216)
Non-collaborative Group	-0.159
× Easier Task	(0.133)
Male	-0.052
	(0.100)
White	0.417***
	(0.143)
CRT Score	0.170**
	(0.070)
Constant	0.170
	(0.133)
Observations	1,080
Log pseudolikelihood	-630

Estimate coefficients with robust standard errors clustered by subject in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Confirming our aggregate results, there is no significant difference between individuals and non-collaborative groups on easier tasks while non-collaborative groups do significantly worse on harder tasks. Not surprisingly, subjects in both treatments do worse overall on harder tasks than on easier ones. Subjects with better performance on the cognitive reflection test also generally do better. Thus, we find evidence in favor of non-collaborative group members being less likely to invest effort in difficult problems and more likely to free-ride on the effort of other members.

The tendency to free-ride is not observed uniformly across subjects. Instead, free-riding is observed primarily among men and among subjects who do relatively well on the cognitive reflection test. Figure 3 compares performance in individual and non-collaborative groups for these subcategories of subjects. The top-left panel indicates how women perform on tasks of varying complexity in the two treatments. On easier tasks, they select the optimal option slightly more in the non-collaborative treatment than in the individual treatment, while on harder tasks, they select it slightly less. However, these differences are not significant (Mann-Whitney $p>0.429$). Men, similarly, show no significant difference in performance across treatments on easier tasks ($p=0.216$) but do exhibit significantly different performance across treatments on harder tasks ($p=0.039$). Thus, men appear to free ride by decreasing effort, especially on harder tasks, upon joining a group. Women, conversely, do not.

The middle two panels of Figure 3 reveal a similar result for the 45% of subjects who answered at least two out of three questions correctly on the CRT, termed high CRT. Low CRT subjects show no significant differences in performance between the two treatments on easier or harder tasks, and high CRT subjects showed no difference on easier tasks ($p>0.460$). However, high CRT subjects performed significantly worse on harder tasks in the non-collaborative treatment than in the individual treatment ($p=0.010$). We observe similar differences by race. Non-white subjects show no differences across treatments on either task type ($p>0.380$), while white subjects show a significant change in performance, especially on harder tasks ($p=0.009$).

Since CRT scores are correlated with both race and sex in our sample ($p<0.001$), it is possible that one or more of these effects is spurious. We examine this possibility in Table 4 by introducing dummy variables for non-collaborative group performance on harder tasks for male, white, and high CRT subjects, in addition to a general dummy variable for harder tasks.[14] The dummy for harder tasks is not statistically significant, while males and high CRT subjects do worse on harder tasks in non-collaborative groups. This indicates that free-riding, and the resulting reduced performance of non-collaborative groups, is primarily the result of effort reduction on the part of males ($p=0.042$) and high CRT subjects ($p=0.019$).

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[14] We examined the effect of other variables collected in our survey, including age, risk attitudes, and mathematical aptitude. These variables do not contribute significantly either individually or collectively, and do not change the sign or significance of the variables of interest.

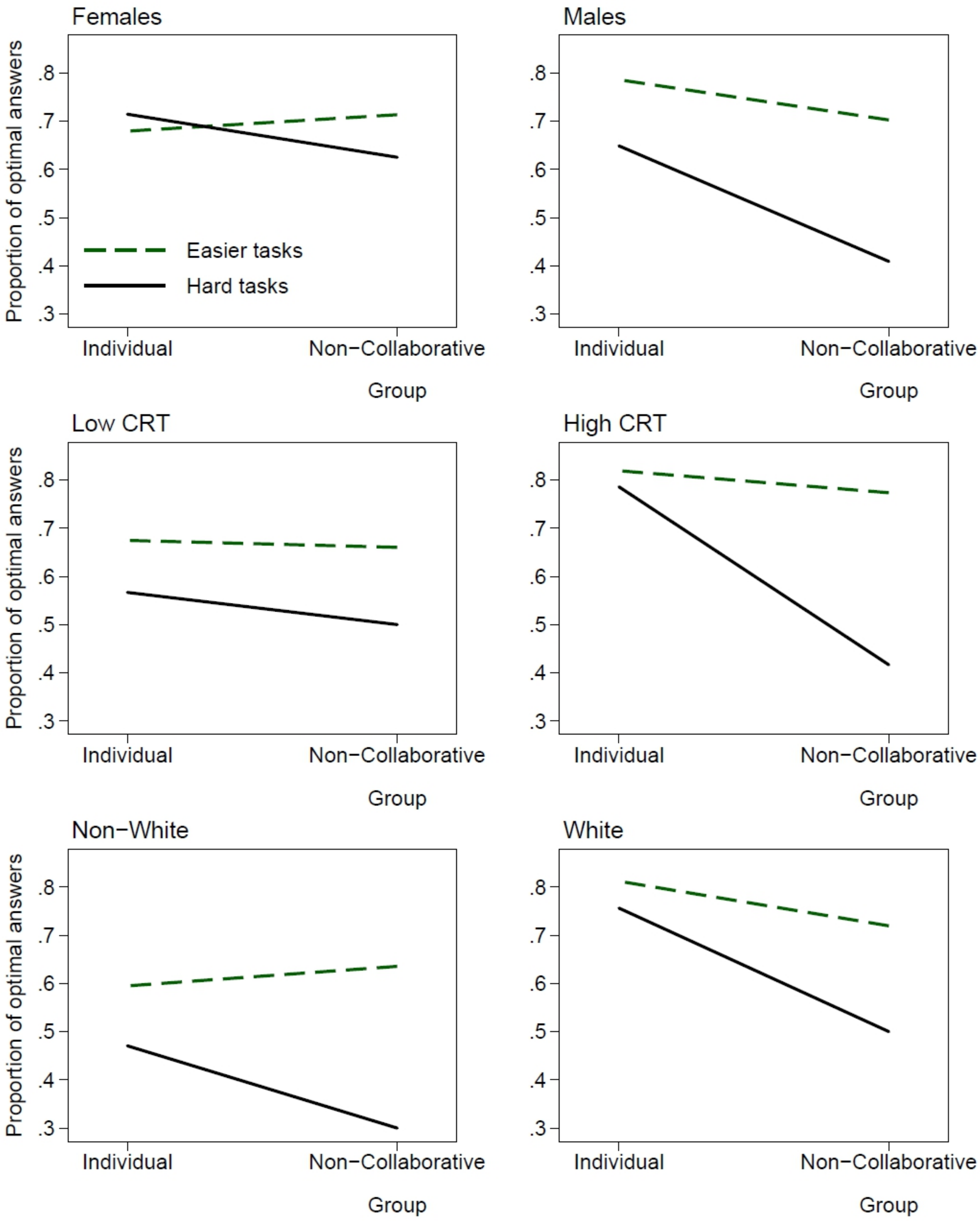

Figure 3: Free-riding in non-collaborative groups
Performance on hard tasks and easier tasks in non-collaborative group versus individual treatments

Table 4: Free-riding in non-collaborative groups by subject characteristics

	Selecting the optimal option
Harder Task	-0.178
	(0.239)
Non-collaborative Group	-0.489*
× Harder Task x Male	(0.240)
Non-collaborative Group	0.126
× Harder Task x White	(0.289)
Non-collaborative Group	-0.637**
× Harder Task x High CRT	(0.019)
Male	-0.055
	(0.106)
White	0.380***
	(0.141)
CRT Score	0.189***
	(0.071)
Constant	0.096
	(0.109)
Observations	1,080
Log pseudolikelihood	-630

Estimate coefficients with robust standard errors clustered by subject in parentheses
*** p<0.01, ** p<0.05, * p<0.1

In the absence of collaboration and communication, joining a group reduces overall performance. In terms of the dichotomy between free-riding (which is expected to reduce effort in groups) and social responsibility (which is expected to increase effort), the free-riding effect is a stronger force for males, while women do neither better nor worse in non-collaborative groups than as individuals. Additionally, free-riding is predicted not only by demographic factors, but also by ability. As CRT scores are correlated with overall performance, it is the most capable subjects who free ride in groups.

We end this section by examining the dispersion of choices and its implications for payoff. We do so by comparing the difference between the highest and lowest probability of payment based on actual choices of non-collaborative group members in each task. The average spread for non-collaborative groups is 8.06 percentage points in easy tasks, meaning that on average the best choice selected by a group member has 8 percentage point higher probability of payment than the worst choice. For hard tasks the average spread is 10.90 percentage points.

With a payment of $20 at stake, this implies an expected loss of between $1.61 and $2.20 if the worst member in the non-collaborative group determines the payoff.

We can compare these amounts to what the average spread would be in groups in which members behave as if they were not in groups, or to put it differently, in instances where there is no incentive to free ride and no social responsibility pressure. We can obtain such groups by creating all possible three-member groups with subjects in the individual treatment. We can form 4,060 such hypothetical groups. In these hypothetical groups the average spreads are only 5.03 percentage points in easy tasks and 5.22 percentage points in hard tasks, suggesting approximate potential losses of only $1 given the $20 stakes. Thus, free-riding in non-collaborative groups in hard tasks may result in more than twice the loss relative to individuals working alone. In other words, free-riding imposes a loss of up to $1.20. We next turn to examining the effect of groups that are free to communicate and collaborate.

C. Collaboration

Before we can examine how collaboration affects the balance between free-riding and social responsibility, we need to examine how groups use each member's knowledge. When individuals collaborate on a common decision, the degree of success depends on both the group's aggregation of its members' knowledge, and on the group's ability to create knowledge beyond what any one member possesses. Aggregation can take several forms. If a group member is chosen to solve the problem for reasons uncorrelated with ability (e.g., charisma), then groups would do as well as individuals, on average. A proportionality or majority procedure can be expected to reinforce predominant attitudes of its members. In the best case, the approach of the most capable member is adopted, a so-called "truth wins" standard (Steiner 1972; Davis 1973; Cooper and Kagel 2005). If groups create knowledge and not merely aggregate it, then groups exhibit "assembly bonus effects" by which performance exceeds even what the most capable member could have achieved on her own (Laughlin, Bonner, and Miner 2002). However, most evidence suggests that "assembly bonus effects" and even "truth wins" are rare, as groups rarely perform as well as their best member (Hill 1982; Tindale and Larson 1992; MacCoun 1998; Kerr and Tindale 2004; Forysth 2009).

To examine which of the aggregation benchmarks best describes our data, we compare the outcomes of collaborative groups with the aggregated judgments of the same number of subjects in the individual treatment. We formulate all 4,060 possible combinations of three subjects from the individual treatment. We call these three-member hypothetical groups, "triads." For each triad, we calculate both the highest payoff of the three individuals (a "truth wins triad") and the average payoff of the three individuals (an "averaging triad"). These hypothetical payoffs of triads are compared to the actual payoffs of collaborative groups.

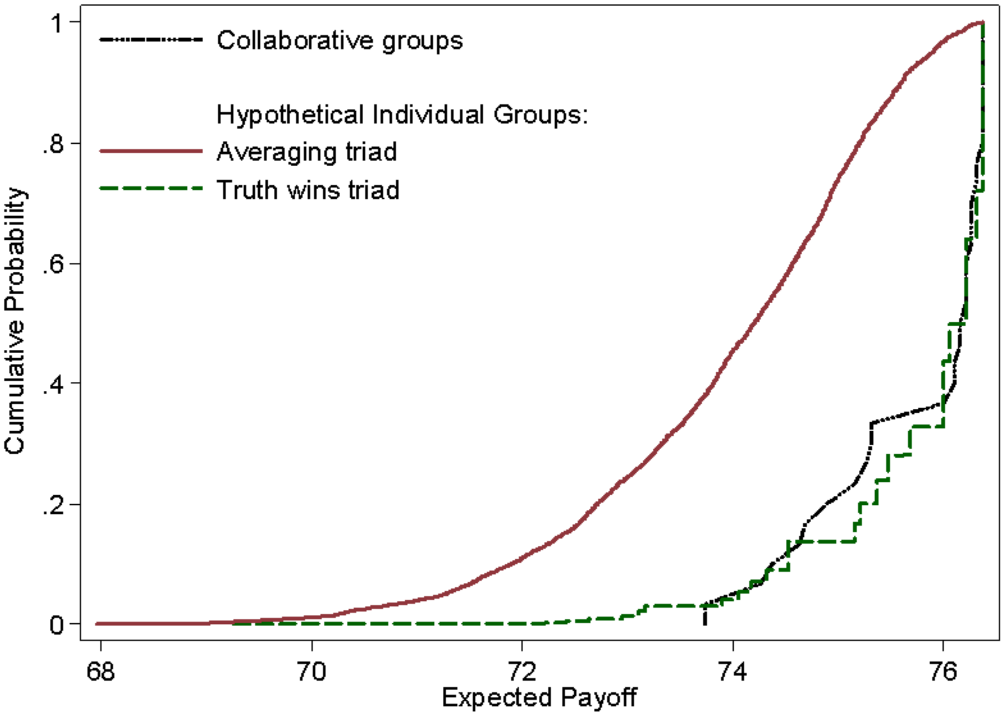

Figure 4: Performance of collaborative groups and hypothetical groups of individuals

In Figure 4, we present the cumulative distribution of payoffs for both collaborative groups and for averaging triads and truth wins triads. Collaborative groups do not appear to select one member randomly to make the decision for the group as collaborative group performance is far better than averaging triads in expectation (Mann-Whitney $p<0.001$) and stochastically dominates averaging triads (Kolmogorov-Smirnov p<0.001).[15] However, the performance of collaborative groups is indistinguishable from that of the truth wins triads. Both in expectation and in distribution, we cannot reject that collaborative groups do as well (p>0.594).

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[15] Both the parametric and non-parametric test results also hold with p<0.001 if variance is adjusted using Abrevaya's (2008) recombinant estimator.

Simply put, the performance of collaborative groups is statistically similar to the performance of the best-performing group member. However, this does not appear to be a literal description of group dynamics. If groups simply adopted the optimal decision rule whenever one of their group members understood it, we would see variance in performance *across* groups (based on whether or not such a member exists), but not across decisions *within* groups. Instead, while seven collaborative groups never select a suboptimal option, seven other groups select a suboptimal option at least four times. In addition, suboptimal choices should cease once group members understand the optimal decision rule, which we can reasonably expect to occur relatively early in the experiment. Yet we find that of the 23 groups which make at least one suboptimal decision, only two groups make their last such choice in the first two rounds. The remaining 21 groups make the last suboptimal decision in the latter half of the experiment (in rounds 9 through 18) with ten groups making their last suboptimal choice in the last two rounds. Thus, many groups fail to adopt the optimal decision-making rule consistently.[16] Nevertheless, we conclude that while groups, statistically, are great aggregators of existing knowledge, they do not outperform the truth wins triad, and thus do not create knowledge.

In the previous subsection, we identified free-riding among male and high CRT subjects in non-collaborative groups. These subjects performed significantly worse on harder tasks as members of non-collaborative groups than as individuals. We next examine whether similar free-riding is exhibited in collaborative groups.[17]

In Table 5, we compare performance in individual and collaborative treatments using the same variables as in Table 4. As these treatments are not directly comparable (we do not observe individual choices in the collaborative treatment), we adopt two empirical strategies. First, we analyze the likelihood of selecting the optimal strategy at the subject level with each

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[16] Anecdotally, some groups had discussions and arguments between using the optimal decision rule (selecting the option with the largest frequency of states) and one that seemed more intuitive to group members (selecting the option with the largest quantity of states). At least two groups settled on compromises, limiting consideration to the two or three options with the highest number of states before taking account of probabilities, or using probabilities to handle “ties” among options with the same number of states, This illustrates that truth need not always win, but also offers an explanation for better performance in groups even when optimality is not obtained.

[17] On one hand, some individuals may have even greater incentive to free-ride in collaborative groups than non-collaborative ones, especially if they perceive their effort as dispensable (Kerr and Bruun 1983; Jones 1984; Karau and Williams 1993). On the other hand, the greater saliency of group membership brought about by joint decision making and collaboration may reduce psychological incentives to reduce effort (Tajfel and Turner 1986; Wagner 1995; Charness, Rigotti, and Rustichini 2007; Sutter 2009).

collaborative group member inheriting the outcome of the group. We conduct a weighted probit, with each collaborative group member receiving one-third weight. Second, we perform the same analysis at the group level. Here, we compare the actual decisions of collaborative groups with those of our 4,060 “truth wins” triads to reflect hypothetical group performance from the individual treatment. Demographic variables (male, white, CRT score) reflect the average of each of these variables for collaborative groups and truth wins triads. For example, a group with two male members and one female member is assigned a value of 2/3 for the variable “male.” We apply a weight of 30/4060 to each triad to equalize the relative importance of each treatment.

Table 5: Optimal choice in individual and collaborative group treatments

	Subject Level	Group Level
Harder Task	-0.504***	-0.138
	(0.140)	(0.110)
Collaborative Group × Harder Task × Male	0.151	-0.253
	(0.237)	(0.431)
Collaborative Group × Harder Task × White	0.089	-0.264
	(0.240)	(0.394)
Collaborative Group × Harder Task × High CRT	-0.065	-0.680
	(0.232)	(0.678)
Male	-0.008	-0.090
	(0.132)	(0.234)
White	0.518***	0.232
	(0.163)	(0.167)
CRT Score	0.162***	0.533***
	(0.061)	(0.098)
Constant	0.350***	0.748***
	(0.122)	(0.140)
Observations	2,160	73,260
Log pseudolikelihood	-1,026	-20,762

Estimate coefficients with robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The subject level analysis assumes that each collaborative group subject did as well as the entire group, while the group level analysis assumes that each subject in the individual treatment did as well as the best of each three-member triads in which he is a member. Both approaches yield the same overall result: while performance depends on subject and task characteristics, there is no evidence of free-riding. While performance on harder tasks is generally lower for all subjects, neither men nor high CRT subjects—the two groups that exhibited free-riding in non-collaborative groups—appear to perform any differently from other subjects in collaborative groups.[18]

IV. Conclusion

The effect of group decision making depends on both the effect of group membership and the effect of collaboration within groups. Group membership, in itself, introduces an additional sense of responsibility, especially if others are sharing in the fruits of one's labor. However, groups can also diffuse responsibility, providing both psychological and economic incentives to reduce one's effort. Charness, Rigotti, and Rustichini (2007) and Sutter (2009) find that payoff commonality, in itself, leads to better decision-making. In their designs, each group member is solely responsible for a fraction of the group's decisions and payoffs. Our results on non-collaborative groups are contrary.

We find our results complimentary to Charness, Rigotti, and Rustichini (2007) and Sutter (2009). Our design allows us to differentiate between the psychological motivations in groups (e.g., accountability and responsibility versus social loafing) and the economic incentive to free-ride, which is exhibited by different behaviors on harder tasks than easier ones. In this context, these other papers demonstrate that group salience in addition to individual accountability and responsibility encourages better decision-making. Our results indicate that the diffusion of responsibility which often accompanies groups is a negative, offsetting, and stronger force. Thus, Charness, Rigotti, and Rustichini (2007) and Sutter (2009) find little evidence of the psychological construct of social loafing in groups. Our evidence agrees with this conclusion, but finds evidence of economic free-riding when groups alter the balance between the costs of effort and the rewards. As task difficulty increases, non-collaborative groups perform particularly poorly.

Yet, the change in design between our experiment and that of Sutter (2009), for example, is fairly subtle. Instead of each subject being responsible for one third of the group's decisions, we have each subject responsible for all of the group's decisions with one-third probability. While these are identical in expectation, they produce entirely different results on the effect of

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[18] Results are similar if we instead use a non-weighted probit estimation to compare collaborative groups with individuals. There is no evidence of free-riding in collaborative groups.

groups. This suggests that the specific nature of payoff dependence is quite important for group performance. In our design, we observe that men engage in free-riding while women do not. Additionally, individuals with stronger analytical ability engage in more free-riding. This last observation is especially troubling for the performance of groups as these individuals are also more likely to do well on the tasks as individuals. Charbonnier et al. (1998) conjecture that those who perceive themselves as better than other group members may exert less effort as they perceive less individual glory from their effort in a group setting. Overall, more research on the link between specific group mechanisms and performance is warranted.

When groups make a joint decision collaboratively, we no longer find the free-riding effect. Thus, we agree with Charness, Rigotti, and Rustichini (2007) and Sutter (2009) that sufficient group salience improves performance within groups. We disagree that payoff commonality, alone, is sufficient to achieve such salience. However, allowing for communication offsets the free-riding incentives which exist in the absence of communication. We find that groups which are allowed to collaborate freely outperform both individuals and non-collaborative groups by a wide margin, selecting the optimal option with a much higher frequency. In particular, collaborative groups do as well as the best individual member would have done on her own. Thus, collaborative groups appear simultaneously to minimize free-riding and to be very good aggregators of existing knowledge. We conclude that better performance does not necessarily follow from group saliency, in itself, but from the collaboration among group members.

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Appendix: Experiment Instructions

Instructions for Individual Treatment

You will receive $5 for participating in this experiment and completing a brief survey. You can also earn an additional sum of money based on performance in the experiment. The experiment consists of 18 tasks. You will be given a booklet containing the 18 tasks, and each task is on a separate page in the booklet. It is important that you make the choices in the order in which they are presented in the task booklet. That is, you must complete the tasks in order, and once you complete a task you cannot go back to it. Please do not go back to any previous pages.

Each task requires the completion of a response form on which you will make a choice from a set of options appearing in a table such as the one below. In each task, you will select one of the options.

TASK

BEADS	#	OPTIONS Circle the letter option of your choice.					
		A	B	C	D	E	F
Red	10			✓	✓		✓
Orange	30		✓			✓	✓
Yellow	60	✓			✓	✓	

There will be a container of colored beads and one bead will be randomly drawn from the container at the end of the experiment. A volunteer will conduct the drawing in front of you. The column "BEADS" will list the colors of beads in the container and the column "#" will list the number of beads of each color in the container. There will always be a total of 100 beads. Thus according to the above table the container will have 10 Red beads, 30 Orange beads and 60 Yellow beads adding up to a 100 beads. The chance that a particular color will be drawn is the number of beads of that color/100. In this example, there is a 30/100 = 30% chance that an orange bead will be drawn.

Under the "Options" heading will be a set of letters. The letters correspond to the different options that you may choose. In the example above, you could choose option A, B, C, D, E, or F. Each option contains a series of marks corresponding to the colored beads. For example, Option C has a mark for the color red only while Option D has marks for both red and yellow. Alternatively note that Yellow beads are present in Options A, D and E.

For each task you must choose only one option by circling the letter of your choice with the provided pen. Do not add any other marks on the page; just indicate your selected option by circling it. If you make a mistake or wish to change your response, please raise your hand and inform an experimenter. Circling multiple options or making additional marks without informing an experimenter may result in a loss of compensation.

After you have selected an option for each task, please close your booklet. You may then complete the brief survey.

Once everyone has finished, a volunteer will pick a number at random to determine which of the 18 tasks will be used to determine your payment. Note that even though you are making 18 decisions, only one randomly chosen task will affect your payment.

First the container will be filled with 100 colored beads according to the "#" column of the selected task. Then one bead will be randomly drawn from the container. If the option you chose for the selected task does not have a ✓ mark for the color of the bead drawn, you will leave with your $5 participation payment. However, if the option you chose does have a ✓ mark for the color of the bead drawn, you will receive $20. This will be in addition to the $5 participation payment, making your total earnings $25.

Below is an example. Suppose the following task was randomly selected and the person had chosen Option F by marking it as shown below.

TASK

BEADS	#	OPTIONS Circle the letter option of your choice.					
		A	B	C	D	E	[✓ F]
Red	10			✓	✓		✓
Orange	30		✓			✓	✓
Yellow	60	✓			✓	✓	

If an orange bead is drawn from the container, then this person as well as anybody else who chose Option F would be paid the $5 participation payment plus $20 (for a total of $25). Also persons who chose Options B and E would receive the $20 (for a total of $25) since they contain a mark for orange. Anyone selecting options A, C, or D would only receive the $5 participation payment.

After the drawing, a researcher will come to you to verify what you have earned. The researcher will give you a claim slip that you can use to collect your payment as you leave. When called, you will hand the claim slip to a researcher who will ask you to sign a receipt in exchange for your money. You will then drop your response booklet, survey, and pen in a large box. This process is designed to ensure that no one, including the researchers, can ever know the responses of any individual.

If you have any questions about the experiment, please ask now.

Otherwise, please wait quietly until you are taken to a room to complete the response booklet. Once there, you may open your response booklet and begin with Task 1. Keep in mind that you cannot go backwards through the booklet and should not skip around. Once you complete the booklet, close it and begin the survey. Please do not go back to the booklet once it has been closed.

Instructions for Collaborative Group Treatment

You will receive $5 for participating in this experiment and completing a brief survey. You can also earn an additional sum of money based on performance in the experiment. The experiment consists of 18 tasks. You will be given a booklet containing the 18 tasks, and each task is on a separate page in the booklet.

You will be put into a group of three to complete the task booklet. Group members will be randomly chosen. You will all work together to make choices for the 18 tasks. It is important that you make the choices in the order in which they are presented in the experiment booklet. That is, you must complete the tasks in order, and once you complete a task you cannot go back to it. Please do not go back to any previous pages.

Each task requires the completion of a response form on which you will make a choice from a set of options appearing in a table such as the one below. In each task, you will select one of the options.

TASK

BEADS	#	OPTIONS Circle the letter option of your choice.					
		A	B	C	D	E	F
Red	10			✓	✓		✓
Orange	30		✓			✓	✓
Yellow	60	✓			✓	✓	

There will be a container of colored beads and one bead will be randomly drawn from the container at the end of the experiment. A volunteer will conduct the drawing in front of you. The column “BEADS” will list the colors of beads in the container and the column “#” will list the number of beads of each color in the container. There will always be a total of 100 beads. Thus according to the above table the container will have 10 Red beads, 30 Orange beads and 60 Yellow beads adding up to a 100 beads. The chance that a particular color will be drawn is the number of beads of that color/100. In this example, there is a 30/100 = 30% chance that an orange bead will be drawn.

Under the “Options” heading will be a set of letters. The letters correspond to the different options that your group may choose. In the example above, you could choose option A, B, C, D, E, or F. Each option contains a series of marks corresponding to the colored beads. For example, Option C has a mark for the color red only while Option D has marks for both red and yellow. Alternatively note that Yellow beads are present in Options A, D and E.

For each task your group must choose only one option by circling the letter of your choice with the provided pen. Do not add any other marks on the page; just indicate your selected option by circling it. If you make a mistake or wish to change your response, please raise your hand and inform an experimenter. Circling multiple options or making additional marks without informing an experimenter may result in a loss of compensation.

After your group has selected an option for each task, please close your booklet. You may then complete the brief survey individually.

Once everyone has finished, a volunteer will pick a number at random to determine which of the 18 tasks will be used to determine your payment. Note that even though you are making 18 decisions, only one randomly chosen task will affect your payment.

First the container will be filled with 100 colored beads according to the "#" column of the selected task. Then one bead will be randomly drawn from the container. If the option your group chose for the selected task does not have a ✓ mark for the color of the bead drawn, every member of your group will leave with their $5 participation payment. However, if your group's chosen option does have a ✓mark for the color of the bead drawn, you will each receive an additional $20, making your total earnings $25.

Below is an example. Suppose the following task was randomly selected and the group had chosen Option F by marking it as shown below.

TASK

BEADS	#	OPTIONS Circle the letter option of your choice.					
		A	B	C	D	E	[✓ F]
Red	10			✓	✓		✓
Orange	30		✓			✓	✓
Yellow	60	✓			✓	✓	

If an orange bead is drawn from the container, then everyone in this group as well as everyone in any other group who chose Option F would be paid the $5 participation payment plus $20 (for a total of $25 each). Also every member of groups that chose Options B and E would receive the $20 (for a total of $25) since they contain a mark for orange. Members of groups that selected options A, C, or D would only receive the $5 participation payment.

After the drawing, a researcher will come to you to verify what you have earned. The researcher will give you a claim slip that you can use to collect your payment as you leave. When called, you will hand the claim slip to a researcher who will ask you to sign a receipt in exchange for your money. You will then drop your response booklet, survey, and blue ink pen in a large box. This process is designed to ensure that no one, including the researchers, can ever know the responses of any individual.

If you have any questions about the experiment, please ask now.

Otherwise, please wait quietly until you are taken to a room to complete the response booklet. Once there, you may open your group's response booklet and begin with Task 1. Keep in mind that you cannot go backwards through the booklet and should not skip around. Once you complete the booklet, close it and begin the survey. Please do not go back to the booklet once it has been closed.

Instructions for Non-Collaborative Group Treatment

You will receive $5 for participating in this experiment and completing a brief survey. You can also earn an additional sum of money based on performance in the experiment. The experiment consists of 18 tasks. You will be given a booklet containing the 18 tasks, and each task is on a separate page in the booklet.

You will be put into a group of three, but each of you will complete the task booklet individually. Group members will be randomly chosen. At the end of the experiment, the task booklet of one member of your group will be randomly selected and their decision will be used to determine the payoff for everyone in your group. It is important that you make the choices in the order in which they are presented in the experiment booklet. That is, you must complete the tasks in order, and once you complete a task you cannot go back to it. Please do not go back to any previous pages.

Each task requires the completion of a response form on which you will make a choice from a set of options appearing in a table such as the one below. In each task, you will select one of the options.

TASK

BEADS	#	OPTIONS Circle the letter option of your choice.					
		A	B	C	D	E	F
Red	10			✓	✓		✓
Orange	30		✓			✓	✓
Yellow	60	✓			✓	✓	

There will be a container of colored beads and one bead will be randomly drawn from the container at the end of the experiment. A volunteer will conduct the drawing in front of you. The column “BEADS” will list the colors of beads in the container and the column “#” will list the number of beads of each color in the container. There will always be a total of 100 beads. Thus according to the above table the container will have 10 Red beads, 30 Orange beads and 60 Yellow beads adding up to a 100 beads. The chance that a particular color will be drawn is the number of beads of that color/100. In this example, there is a 30/100 = 30% chance that an orange bead will be drawn.

Under the “Options” heading will be a set of letters. The letters correspond to the different options that you may choose. In the example above, you could choose option A, B, C, D, E, or F. Each option contains a series of marks corresponding to the colored beads. For example, Option C has a mark for the color red only while Option D has marks for both red and yellow. Alternatively note that Yellow beads are present in Options A, D and E.

For each task you must choose only one option by circling the letter of your choice with the provided pen. Do not add any other marks on the page; just indicate your selected option by circling it. If you make a mistake or wish to change your response, please raise your hand and inform an experimenter. Circling multiple options or making additional marks without informing an experimenter may result in a loss of compensation.

After you have selected an option for each task, please close your booklet. You may then complete the brief survey individually.

Once everyone has finished, a volunteer will randomly determine which one group member's booklet will be used. In other words decisions made by one person in the group will determine the payoffs of all the others in the group. The volunteer will also pick a number at random to determine which of the 18 tasks will be used to determine your payment. Note that even though you are making 18 decisions, only one randomly chosen task will affect your payment.

First the container will be filled with 100 colored beads according to the "#" column of the selected task. Then one bead will be randomly drawn from the container. If the option your group chose for the selected task does not have a ✓ mark for the color of the bead drawn, every member of your group will leave with their $5 participation payment. However, if your group's chosen option does have a ✓mark for the color of the bead drawn, you will all receive an additional $20, making your total earnings $25.

Below is an example. Suppose the following task was randomly selected and the group had chosen Option F by marking it as shown below.

TASK

BEADS	#	OPTIONS Circle the letter option of your choice.					
		A	B	C	D	E	[✓ F]
Red	10			✓	✓		✓
Orange	30		✓			✓	✓
Yellow	60	✓			✓	✓	

If an orange bead is drawn from the container, then everyone in this group as well as everyone in any other group who chose Option F would be paid the $5 participation payment plus $20 (for a total of $25 each). Also every member of groups that chose Options B and E would receive the $20 (for a total of $25) since they contain a mark for orange. Members of groups that selected options A, C, or D would only receive the $5 participation payment.

After the drawing, a researcher will come to you to verify what you have earned. The researcher will give you a claim slip that you can use to collect your payment as you leave. When called, you will hand the claim slip to a researcher who will ask you to sign a receipt in exchange for your money. You will then drop your response booklet, survey, and blue ink pen in a large box. This process is designed to ensure that no one, including the researchers, can ever know the responses of any individual.

If you have any questions about the experiment, please ask now.

Otherwise, please wait quietly until you are taken to a room to complete the response booklet. Once there, you may open your group's response booklet and begin with Task 1. Keep in mind that you cannot go backwards through the booklet and should not skip around. Once you complete the booklet, close it and begin the survey. Please do not go back to the booklet once it has been closed.