How Individual Preferences Get Aggregated in Groups – An Experimental Study

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How individual preferences get aggregated in groups - An experimental study*

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Abstract

This paper experimentally investigates how individual preferences, through unrestricted deliberation, get aggregated into a group decision in two contexts: reciprocating gifts, and choosing between lotteries. In both contexts we find that median group members have a significant impact on the group decision, but particular other members also have some influence. Non-median members closer to the median tend to have more influence than other members. By investigating the same individual's influence in different groups, we find evidence for relative position in the group having a direct effect on influence. We do not find evidence that group choice exhibits a shift in a particular direction that is independent of member preferences and caused by the group decision context itself. We also find that group deliberation not only involves bargaining and compromise, but it also involves persuasion: preferences tend to shift towards the choice of the individual's previous group, especially for those with extreme individual preferences.

Keywords: group decision-making, role of deliberation, social influence

JEL Classification: C72, C92, H41

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1 Introduction

Many important decisions, in various contexts, are made by groups, such as committees, governing bodies, juries, business partners, teams, and families. Group decisions are typically preceded by deliberation among members, who enter the process with varying opinions and preferences. The expansion of democratic institutions and rapid progress in communication technology further highlight the prevalence of group decisions - in politics and business, among other facets of society - and the importance of investigating the process of such decisions (see also the discussion in Charness and Sutter, 2012).

This paper presents an experimental investigation of group decision-making in two settings that are stylized versions of important real-world decision problems: (i) choosing how much to reciprocate as the second mover in a sequential gift-exchange game (Brandts and Charness, 2004; Fehr, Kirchsteiger and Riedl, 1993), and (ii) choosing between (comparatively) safe and risky lotteries, using a version of the risk-preference elicitation questionnaire of Holt and Laury (2002). Gift-exchange games are often used as a stylized framework for employment relationships with incomplete labor contracts, in which the employee performance is not always enforceable (for example, see Brown, Falk and Fehr, 2004; Charness, 2004; Charness, Cobo-Reyes, Jiménez, Lacomba and Lagos, 2012; Fehr and Gächter, 1998; Fehr et al., 1993), while the lottery choice can be considered a simplified version of financial portfolio or investment decisions. For both of the tasks above, there is no clear normative criterion for evaluating the quality of decisions.[1] In the gift-exchange game, a group's chosen reciprocation level (conditional on the first-mover's gift) should depend on members' social preferences, while lottery choices should depend on members' risk preferences. Hence, in our experiments the main focus is how different preferences shape the group decision, through bargaining and/or persuasion.

[1] Such tasks are dubbed "non-intellective" by Laughlin (1980) and Laughlin and Ellis (1986). For recent experimental investigations of group decision-making with intellective tasks, see Blinder and Morgan (2005) and Cooper and Kagel (2005) and Kocher and Sutter (2005). Glaeser and Sunstein (2009) provide a related theoretical analysis.

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Experimental investigation of group decisions has long been a central research area in social psychology, and has recently attracted more attention in experimental economics.[2] A novel feature of our design is that before deliberation, we solicited each member's opinion on what she thought the group's choice should be. It was randomly determined whether the eventual group choice or one of the initial individual opinions were implemented, making the solicited initial opinions payoff-relevant. In either case, the implemented outcome applied to all members with respect to payoffs. Hence, the solicited opinions can be interpreted as the outcome for the group that the individual would have chosen before deliberation, as a dictator. Another distinguishing aspect of our experiment is that groups consist of five individuals, unlike most existing studies, which investigate three-person groups.[3] Five-person groups allow us to compare the influence of the extreme group members to the non-median members who are not at the extremes.

Our central empirical investigation regresses the group decision on the ordered individual decisions by the group members.[4] This regression provides a detailed picture of how a member's influence on the group decision

[2]The investigation of risk attitudes of groups versus individuals started with Stoner (1961). See also Teger and Pruitt (1967), Burnstein, Vinokur and Trope (1973), and Brown (1974). Recent papers in economics include Shupp and Williams (2008), Baker, Laury and Williams (2008) and Masclet, Colombier, Denant-Boemont and Loheac (2009). Groups' attitudes towards cooperation and reciprocity were first examined in the context of prisoner's dilemma games: see Pylyshyn, Agnew and Illingworth (1966), Wolosin, Sherman and Maynatt (1975), Lindskold, McElwain and Wayner (1977), Rabbie (1982), Insko, Schopler, Hoyle, Dardis and Graetz (1990), and Schopler and Insko (1992). Wildschut, Pinter, Vevea, Insko and Schopler (2003) provide a meta-analysis of the subject, while Charness, Rigotti and Rustichini (2007) is a more recent contribution in economics. Other treatments investigate centipede games (Bornstein, Kugler and Ziegelmeyer, 2004), ultimatum games (Bornstein and Yaniv, 1998; Robert and Carnevale, 1997) and dictator games (Cason and Mui, 1997; Luhan, Kocher and Sutter, 2009). Closest to our work is Kocher and Sutter (2007), who investigate gift exchange games similar to ours.

[3]Among the papers closest to our experimental design, Cason and Mui (1997) use two-person groups, while Luhan et al. (2009) use three-person groups.

[4]In the gift-exchange games, ordering is based on the extent of reciprocation of the first mover's gift. In the lottery choice problem, ordering is based on the frequency of choosing the safer (low-spread) lottery over the high-spread lottery in a list of lotteries with increasing odds of the higher outcome. In the main text we report results from OLS specifications, as the interpretation of regression coefficients is clearer in this case. In the Supplementary Appendix we also provide Tobit specifications and show that all our results qualitatively remain the same.

depends on her relative position within the group. In contrast, most of the existing literature focuses on comparing aggregate statistics of group and individual decisions.[5] Conceptually, our empirical methodology corresponds to the influential work of Davis (1973), who defines social decision schemes as mappings between individual preferences and the group decision.[6]

Although we find some differences in the gift-exchange and lottery-choice settings, the most important qualitative insights hold in both. First, we find that the coefficient of the constant is insignificant, and we cannot reject the hypothesis that the sum of the coefficients of members' individual decisions is one. This is consistent with the group decision being a convex combination of the members' decisions. A constant significantly different from zero would indicate a level shift in group decisions, suggesting that the group decision situation itself sways members' preferences in a particular direction, independently of initial opinions. Second, the median group member always has a significant effect on the group choice. However, some (but not all) of the other group members also have an impact on the group choice. In the gift-exchange context, the members immediately above and below the median have a significant impact, but the members at the extremes do not. In the lottery choice context, besides the median, the second least risk-averse and the most risk-averse group members seem to be influential. Overall, while there is a tendency for groups to ignore extreme individual opinions, the most risk-averse member has some influence on the group decision, possibly because the arguments that can be brought up to support

[5]For example, Teger and Pruitt (1967) and Myers and Arenson (1972) focus solely on comparing mean individual and mean group decisions. We are aware of four papers that examine the relationship between individual preferences and the group decision: Fiorina and Plott (1978), Corfman and Harlam (1998), Arora and Allenby (1999), and Zhang and Casari (2012). In the first three of the above papers preferences are exogenously imposed by the experimenter, essentially constructing pure bargaining situations. Zhang and Casari report on experiments in a lottery choice context, conducted in parallel to ours, in which subjects offer proposals to each other until an agreement is reached, where members' initial proposals are interpreted as their individual preferences. However, since initial proposals might reflect strategic considerations, they can easily differ from the choices of subjects if they were in a dictatorial position, that we solicit in our experiments.

[6]For a detailed discussion on how various social decision schemes affect the ways in which the distributions of group and individual choices might differ, see Kerr, MacCoun and Kramer (1996).

risk-averse choices are particularly persuasive.[7] In both settings we can reject the "mean hypothesis" that all members' opinions matter equally, and the "median hypothesis" that only the median member's opinion matters,[8] even though our results confirm that the median member has a significant influence.

The above analysis does not distinguish between the direct effect of relative positions within a group on the group choice and the effect of unobserved characteristics of individuals which may be correlated with their relative positions. We investigate this issue utilizing the experimental design feature that each subject participates in multiple groups and decisions. We compare three econometric models explaining the absolute difference between an individual's decision and the group decision. In the first one, the independent variables are relative positions of individuals in their group. In the second model we only allow subject-specific fixed effects to explain the difference between group and individual. Finally, in the third model we allow for both types of explanatory variables. We find that the first model has better explanatory power than the second one, and the combined third model improves explanatory power only by a modest amount relative to the first model. Controlling for individual fixed effects does not change significance and magnitude of the coefficients of relative position. A robust finding from these specifications is that being at either of the extreme relative positions significantly increases the difference between the group decision and the individual's decision, relative to the median member's difference to the group. At the same time, being at a non-median position next to the median does not increase the above difference significantly, relative to the median.

The above findings are also useful for interpreting aggregate level differences between individual and group choices. Consistent with earlier papers, we observe that groups on average reciprocate less than individuals in the

[7]The persuasive argument theory (Brown, 1974; Burnstein et al., 1973), which originated in social psychology, posits that deliberation drives group decisions in a particular direction because arguments in that direction are more persuasive. A related explanation is that people with certain preferences tend to be more persuasive than others (for example, more selfish individuals are also more aggressive in deliberation).

[8]The latter would hold theoretically under a simple majority voting rule provided preferences are single-peaked (see Moulin, 1980).

gift-exchange setting - standardly referred to as the "selfish shift." Our data suggests that this shift is not attributable to subjects behaving differently in groups,[9] or to arguments to be selfish being especially persuasive, as in the persuasive argument theory. The influences of the group members immediately next to the median roughly cancel each other out, and on average the group choice is very close to the median member's choice. The selfish shift arises mainly because the distribution of individual preferences is skewed: in particular the median member's preferred reciprocation level is below that of the mean.[10] For lottery choices, groups are on average more risk-averse than individuals. Although the most risk-averse member influences the group choice, she is not the main driver of this "cautious shift", as her influence is roughly cancelled out by that of the second least risk-averse member, and again on average the group choice is very close to the median. The cautious shift arises primarily because the median individual choice is more risk-averse than the mean one. This observation also suggests an explanation for why earlier experiments sometimes found cautious shifts, while others found risky shifts: namely, that for some types of lottery choice problems the median individual tends to be more risk-averse than the mean, while in other types the opposite holds.[11]

[9] An influential explanation in social psychology, the social comparison theory, argues that people behave fundamentally differently in group settings than individually (Levinger and Schneider, 1969). It posits that people are motivated both to perceive and to present themselves in a socially desirable way. To accomplish this, a person might react in a way that is closer to what he regards as the social norm than how he would act in isolation.

There are several other explanations of why people make decisions differently in groups, that apply to particular types of choices. The identifiability explanation (Wallach, Kogan and Bem, 1962, 1964) claims that people in group decisions act more selfishly because the other side's ability to assign personal responsibility is more limited. In the context of lottery choices, Eliaz, Ray and Razin (2005) point out that subjects who are not expected utility maximizers exhibit a group shift, because the decision problem associated with the possibility of being pivotal in a group's lottery choice decision differs from individually deciding on the lottery choice if the probability of being pivotal is less than 1.

[10] The observation that the distribution of attitudes towards reciprocity is skewed towards the selfish direction is made, for example, in Ledyard (1995), Palfrey and Prisbey (1997), Brandts and Schram (2001), Fischbacher, Gächter and Fehr (2001), and Ambrus and Pathak (2012).

[11] As Hong (1978) demonstrates, the cultural setting can also influence the direction of the shift.

In both of our settings, the variance of group choices is smaller than that of individual decisions, mainly because extreme member preferences tend to be curbed by groups. This suggests that, in the types of decision contexts we examine, delegating the decision to a committee can reduce the variability of outcomes, and reduce the likelihood of extreme outcomes.[12]

We also find evidence of social influence on opinions in our experiments, in that group choices affect the subsequent individual choices of subjects. In particular, individuals tend to adjust their individual choices in the direction of prior group decisions. Since individual decisions are submitted secretly, this effect is not due to social pressure. This suggests that the group decision process does not just involve bargaining and compromise, but also persuasion, i.e. members trying to change each others' opinions. We also find that the members who tend to change their opinions (in the direction of the previous group decision) are the extreme ones, hence deliberation leads to depolarization of opinions in the settings we examine. This finding suggests that social decision making, as in a deliberative democracy, could have an important role in preference formation, besides preference elicitation and aggregation.

An important feature of our experimental design is that group members can freely deliberate (face-to-face communication in a private room, with no experimenter present) and can select their own way to arrive at a group decision. This is motivated by the observation that for many real-world group decision problems, there is no externally-imposed decision mechanism (such as a voting rule), and there are no hard constraints on the amount of deliberation before the decision. This aspect is an important difference between our work and Goeree and Yariv (2011)'s recent experimental investigation of collective deliberation, in which different voting mechanisms (simple majority, two-thirds majority, and unanimity) are imposed.[13] In general, as

[12]In different contexts, particularly those in which groups are asked to form a political opinion, deliberation can lead to extremization of opinions (Manin, 2005; Sunstein, 2000, 2002), although it can also lead to depolarization of opinions (Burnstein, 1982; Ferguson and Vidmar, 1971).

[13]The experiments of Goeree and Yariv also differ from ours with regards to the decision tasks, as well as many aspects of experimental design (including the nature of communi-

there are some settings in which a decision rule is externally imposed and others in which there is no such constraint, we believe the investigation of both cases is warranted.

As shown recently by several papers (Charness and Jackson, 2009; Charness et al., 2007; Chen and Li, 2009; Sutter, 2009), individuals' decisions depend on whether its consequences only apply to them or to the entire group to which they belong.[14] Our main focus is not directly related to this effect, as we are interested in comparing initial individual opinions on what the group should choose to the group choice itself. Nevertheless, to compare this effect to the effects of preference aggregation, in one of our sessions we also solicited group members' choices before deliberation in a scenario in which the choice was only payoff-relevant for themselves (and all other group members received a constant payment independent of the choice). In this session it was randomly selected whether the group choice, or one of the individual-for-group choices, or one of the individual-for-individual choices got implemented.[15] Consistent with the existing literature, we find that individuals reciprocate less when deciding for the group than for only themselves, and are less risk-averse. In both of the examined settings, the magnitudes of these differences are similar to the differences between average individual-for-group choices and average group choices resulting from preference aggregation.

cation, which is impersonal in their experiments, via a computer network). Hence, our results are not directly comparable to theirs. For an earlier experimental investigation of group decision making with externally imposed voting rules, see Bower (1965).

[14]This is related to the in-group versus out-group sentiments theory in social psychology (Kramer, 1991; Tajfel, Billig, Bundy and Flament, 1971), which posits that subjects develop more other-regarding preferences toward their group members than towards subjects outside the group.

[15]Cason and Mui (1997) and Luhan et al. (2009) also solicit individual-for-individual decisions, besides group decisions, but they did not solicit individual-for-group decisions, which is the central component of our analysis. Furthermore, in these studies, individuals interact with individuals, and groups interact with groups, while the first-mover in our gift-exchange game is always an individual.

2 Experimental design and procedures

To explore how individual opinions are aggregated in groups, our experiment utilizes non-intellective decision making situations from the two main domains of economic experiments: strategic social interaction and non-strategic, individual decision making. We confront subjects with the choice of a second mover in a gift-exchange game, and with a list of binary lottery choice situations. As we elicit both individual and group choices from the same individuals over the same decision task for the group, our design allows us to observe the aggregation of individual choices to group decisions.

The first game featured in our experiments is structurally the same as the one in Brandts and Charness (2004), and following their terminology we refer to it as a gift-exchange game.[16] In our version of the game, a first mover and a second mover are each endowed with 10 tokens, which have monetary value. First, the first mover may send a gift of 0 to 10 tokens to the second mover. The amount is deducted from the first mover's account, but is tripled on the way before being awarded to the second mover. Then the second mover decides whether to send a gift of 0 to 10 tokens to the first mover under the same conditions: for each token sent, one token is deducted from the second mover's account, and triple the amount is added to the first mover's account. While the socially optimal behavior is to exchange maximal gifts, in the unique Nash equilibrium outcome neither player contributes any gift.

The typical experimental data on this game shows first movers trusting and a significant likelihood of reciprocation among second movers, yielding outcomes which are closer to the socially efficient one. Individuals differ both in their degrees of trust as well as in their pattern of reciprocation. In our experiment we concentrate on the latter, studying how individual reciprocal patterns to a diverse set of stimuli are aggregated to group behavior.

For the risk choice situation, we used a version of the risk preference elicitation questionnaire of Holt and Laury (2002). Subjects made ten choices between two lotteries, namely $p[\$11.50] \oplus (1-p)[\$0.30]$ vs. $p[\$6.00] \oplus (1-p)[\$4.80]$ with $p \in \{0, 0.1, 0.2, ..., 0.9\}$. Of this choice list, one lottery was

[16] The term gift-exchange game was introduced by Fehr et al. (1993). Gift-exchange games are similar in structure to trust games, and can be more generally classified as sequential social dilemma games.

randomly selected, the decision implemented and the corresponding lottery played out. Most lottery-choice experiments of this kind observe heterogeneous individual risk attitudes, with a majority of people being slightly to strongly risk averse.[17] Our experiment studies how these individual risk preferences are aggregated to a group risk attitude when the group has to make a decision that applies to all members.

The experimental sessions took place in 2008 and 2010 in the Computer Laboratory for Experimental Research at Harvard Business School. We conducted seven sessions with a total of 172 student subjects, each session comprising either 21, 26, or 36 participants, and lasting approximately one hour and thirty minutes.

The experiment was computerized using the z-Tree software (Fischbacher, 2007). After subjects arrived instructions were distributed.[18] An experimenter (the same in all sessions) led subjects through the instructions and answered open questions. Then, subjects were randomly assigned to be either one of 6 purely individual decision-makers, or to be a member of a group of 5 participants, by drawing a numbered card.

The six purely individual decision-makers stayed in the main lab and made n first-mover decisions in a row at the beginning of the experiment, without any feedback, with n equal to the number of groups in the session.[19] Afterwards they had to stay in the lab until the end of the session.

Group participants were led to small group rooms to make their decisions. For them, each session consisted of three phases. Between phases, the initial random assignment to the n groups g was reshuffled by assigning each group member i to her new group $g + i \pmod{n}$. During a phase groups

[17] A typical result observed in Holt and Laury (2002) lottery tasks is that some participants make non-monotonic/inconsistent choices, i.e. make more than one switch between the safe and risky lotteries when going down the ordered list of choices. As Holt and Laury (2002), we consider the total number of safe choices per lottery task as our outcome measure. Overall, we observe relatively little inconsistencies. While 3.1% of individual lottery tasks exhibit non-monotonic choices (5.4% of the very first tasks in a session), none of the observed group decisions was inconsistent.

[18] Instructions are included in the Supplementary Appendix.

[19] About half of first movers in our sessions did vary their offers, despite receiving no feedback between offers, while the other half didn't. Each decision of a single first mover was played against a different group.

stayed constant. In each phase, group members made decisions as second movers in two gift-exchange games (with two different first movers) and in one lottery task. In each game, after seeing the first mover's gift, group members first made individual decisions (i.e. their choice if they can dictate the group decision), and submitted their decisions secretly to a researcher conducting the experiment. Then they freely discussed and made a group decision. After all decisions in all three phases had been made, group members filled in a post-experimental questionnaire asking for demographic data and containing open questions for motivations of subjects' decisions.

At the end of the experiment all participants were paid in cash. Tokens for the gift-exchange game were converted to real money at a fixed exchange rate, plus subjects received an additional fixed show-up fee of \$10.[20] Group members earned the income from each gift-exchange game and from one randomly chosen of the three lottery questionnaire choices they were involved in. Subjects were told that for each of those choices with 50% probability one of the individual decisions would become the effective group choice, with equal probability allocated to every member's decision, and that in this case it would not be revealed which individual's decision was implemented. With the remaining 50% probability, the group's joint decision became the effective group choice.

In the last session, in addition to individuals' choices on behalf of the group, we also elicited individuals' choices on behalf of themselves. That is, if an individual-for-individual decision was randomly selected at the end of the experiment, then the corresponding choice would only be implemented for that individual, while the other four group members received a fixed payment of 15 tokens/\$5.50 for that choice. This allows us to test in a small sample whether individual-for-group choices differ substantially from individual-for-individual choices in our two settings. In this session, the 50% probability of individual choices to matter for payoff was split equally between individual-for-group and individual-for-individual choices.

[20]The exchange rate for gift-exchange games of \$0.10 per token was verbally announced at the beginning of sessions.

Overall, we collected five individual choices and one group choice for each of the 156 gift-exchange games and 78 ten-decision lottery tasks. In the last session, we collected an additional 90 individual-for-individual decisions for the gift-exchange game and 45 individual-for-individual decisions for lottery tasks.

3 Competing Hypotheses

We investigate situations in which five individuals first make an individual choice, and then jointly decide on a group choice, for the same decision problem. The main model can be generally written as:

$$y_{gt} = f(x_{i_1gt}, x_{i_2gt}, x_{i_3gt}, x_{i_4gt}, x_{i_5gt}, X_{gt})$$

where t stands for a time period (at which every group is associated with one particular decision problem), y_{gt} is group g's observed decision in period t, x_{igt} is the observed decision of individual i in the same period, and X_{gt} is a vector of characteristics of the decision situation. We will use $x_{gt}^{(j)}$ to refer to the jth lowest decision among the individuals in group g (in particular $x_{gt}^{(1)}$ referring to the lowest, and $x_{gt}^{(5)}$ referring to the highest decision).

For gift-exchange games, variable x_{igt} corresponds to member i's individual reciprocation decision to the first mover, relative to the first mover's offer.[21] Thus, $x_{gt}^{(1)}$ represents the reciprocation of the most selfish member, minus the first mover's offer, while $x_{gt}^{(5)}$ represents the reciprocation of the most generous member, minus the first mover's offer. In the lottery tasks, choices might be inconsistent in that individuals might switch more than once from the safe to the risky lottery (about 3% of our subjects do so), such that their "cutoff" is not well-defined. We follow Holt and Laury (2002) and use the total number of safe choices per lottery task as a measure of risk aversion. (Our results presented below would not be qualitatively different

[21] In the Supplementary Appendix we also present an alternative specification for gift-exchange games in which we do not normalize the reciprocation decisions by the first offer, and instead add the first offer as an additional control variable in the regressions. The results from this alternative specification are qualitatively the same.

when we used the position of the first switch to the risky lottery instead.) So for lottery choices, $x_{gt}^{(1)}$ equals the lowest number of safe choices in a group and corresponds to the most risk-loving group member, while $x_{gt}^{(5)}$ equals the number of safe choices of the most risk-averse group member.

We focus on models in which the group decision is a linear function of $(x_{igt})_{i=1,..,5}$:

$$y_{gt} = \alpha + \beta_1 x_{gt}^{(1)} + \beta_2 x_{gt}^{(2)} + \beta_3 x_{gt}^{(3)} + \beta_4 x_{gt}^{(4)} + \beta_5 x_{gt}^{(5)} + \epsilon_{gt}. \tag{1}$$

First we investigate whether there is a systematic shift between the group's decision and the individual decision. In particular, we test the hypothesis that $\alpha = 0$. Note that $\alpha \neq 0$ would imply that there is a difference between individual and group decisions that is independent of members' preferences.

Next, we investigate the hypothesis that the coefficients of individual decisions sum up to one:

$$\sum_{i=1}^{5} \beta_i = 1.$$

Note that $\alpha = 0$ and $\sum_{i=1}^{5} \beta_i = 1$ imply that the group decision is a convex combination of individual decisions, hence the coefficients of the latter can be interpreted as the weights of different members in shaping the group decision.

Next we examine the *mean hypothesis*, which implies that the group's decision is simply a function of the mean individual decision:

$$y_{gt} = \alpha + \beta \left(\frac{1}{5} \sum_{i=1}^{5} x_{gt}^{(i)} \right).$$

That is, the mean is a sufficient statistic for the group's decision. If $\beta = 1$, then the mean exactly predicts the component of the group decision that varies with individual preferences. In our econometric tests, we test whether we can reject the hypothesis that $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5$. The version of the mean hypothesis which further requires the mean to exactly predict the

group decision, what we call the *strong mean hypothesis*, involves tests of the hypothesis that $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \frac{1}{5}$.

A competing hypothesis, the *median hypothesis*, implies that the group's decision is a function of the median individual decision only, so that

$$y_{gt} = \alpha + \beta x_{gt}^{(3)}.$$

In our econometric tests, we estimate equation (1), and test whether we can reject the hypothesis that $\beta_1 = \beta_2 = \beta_4 = \beta_5 = 0$. The version of the hypothesis which further requires the median to exactly predict the group decision, what we call the *strong median hypothesis*, involves testing whether we can reject both $\beta_1 = \beta_2 = \beta_4 = \beta_5 = 0$ and $\beta_3 = 1$.

The last hypothesis, the *extreme-irrelevance hypothesis*, implies that extreme opinions are ignored in the group decision: $\beta_1 = \beta_5 = 0$.

4 Results

4.a Summary Statistics

The upper part of Table 1 lists averages of gift-exchange and lottery decisions at the individual and group level. We observe that on average, both individuals and groups reciprocate less as second movers than what they received from the first mover (the returned gifts, normalized by the received gifts, are negative), and are generally risk-averse. Compared to the mean individual decision, the median decision is less altruistic and more risk-averse. On average, group decisions are between the mean and median individual decisions, but closer to the median.

We use Datta and Satten (2008)'s signed-rank test for clustered data to compare our matched data on group means/medians and group decisions, with clustering at the session level.[22] For gift-exchange decisions, we find

[22]Due to our group rematching procedure, our data is clustered at the session level. The tests we use are similar to Wilcoxon signed-rank tests or Sign tests, but allow the distribution of pair-wise differences to differ between clusters. Details are given in Datta and Satten (2008). We are grateful to Tom Wilkening for providing us with an Excel macro implementation of the test. We obtain the same qualitative results when using session averages and traditional Wilcoxon signed-ranks tests.

that groups reciprocate less than the average member ($p = 0.035$), while there is no difference between group decisions and the median members' decisions ($p = 0.277$). For lottery decisions, we observe a similar pattern: group decisions are significantly more risk averse than the average of members' decisions ($p = 0.037$), but not different to the median member's decision ($p = 0.449$).

TABLE 1
AVERAGE CHOICES AT INDIVIDUAL AND GROUP LEVEL IN GIFT-EXCHANGE GAMES AND LOTTERY TASKS

	Gift-exchange decisions (Normalized amount returned)			Lottery decisions (Number of safe choices)		
	N	Avg	StdDev	N	Avg	StdDev
Individual	780	-3.86	3.70	390	6.31	1.30
Group Median	156	-4.21	3.34	78	6.44	0.73
Group	156	-4.31	3.29	78	6.41	0.86
Only last session						
Individual for individual	90	-2.29	2.71	45	6.56	1.16
Individual for group	90	-2.44	2.18	45	6.29	1.24

Standard deviations of group and individual choices are reported in columns 3 and 6 of rows 1 and 3 of Table 1, respectively. We find that the variance of group choices is smaller than the variance of individual decisions, for both decision tasks. To provide statistical corroboration for this observation, which controls for the clustering in our data, we calculate the variance of group and individual decisions for each session separately, and use these session data points in non-parametric Wilcoxon signed-ranks tests. The tests yield $p = 0.018$ for gift-exchange decisions and $p = 0.018$ for lottery decisions, allowing us to reject the Null hypothesis of equal variances of group and individual choices.[23]

[23]Traditional F tests for the homogeneity of variances, which ignore the clustering of data at session level and are based on all individual-group decision pairs, yield p-values of $p < 0.001$ for both gift-exchange and lottery tasks, rejecting the Null hypothesis of equality of variance of individual and group decisions.

The individual decisions considered above were taken on behalf of the group, such that the object and scope of the group and individual decisions were the same. In the last session, we elicited two types of individual decisions: individual-for-individual and individual-for-group. The lower part of Table 1 contains summary statistics for these two types of decisions in the last session. Individuals in this session give slightly less when deciding for the group rather than themselves (0.15 fewer tokens on average), but are slightly more risk-taking (0.27 fewer safe choices on average). Testing these differences statistically is difficult, since our independent unit of observation is the session.[24] In general, the magnitude of the difference between individual-for-individual and individual-for-group decisions is similar to the difference between individual-for-group and group decisions caused by preference aggregation.

4.b Main results

Table 2 reports the results of our main econometric specifications, regressing the group decision on the ordered individual decisions in the group. Models (1) and (3) represent the basic linear specifications, while Models (2) and (4) verify robustness with respect to including session-phase fixed effects into the model. [25]

In all models, the coefficient on the median member's choice, β_3, is positive and significant. In gift-exchange decisions, also the second highest and the fourth highest individual choice contribute to explaining the group choice, while the coefficients on the extreme individual choices β_1 and β_5 are insignificant. In lottery choices, on the other hand, the member one position less risk-averse than the median, as well as the most risk-averse member

[24] Wilcoxon signed-ranks tests, applied to the respective 15 very first (and thereby statistically independent) individual decisions for self and group in this session yield p-values of $p = 0.629$ and $p = 0.103$ for gift-exchange and lottery choices, respectively.

[25] Our hypotheses developed in Section 3 assume a linear structural model of how individual decisions are aggregated to group decisions. Thus, reporting OLS estimates and running post-estimation hypotheses tests on their results (see Table 3) is appropriate here. To test for robustness of our results, we ran the same models as Tobit specifications, and with absolute gifts rather than normalized gifts, including the first mover's offer as a control. The results are reported in the Supplementary Appendix in Tables 7 and 9. In general, all our results and conclusions are robust to the specification.

TABLE 2

OLS REGRESSIONS OF GROUP CHOICES ON INDIVIDUAL CHOICES

	Gift-exchange decisions (Normalized amount returned)		Lottery decisions (Number of safe choices)	
Model	(1)	(2)	(3)	(4)
Constant	-0.233	-0.164	-0.224	-0.930
	[0.244]	[0.229]	[0.671]	[1.090]
$x_{gt}^{(1)}$	0.031	0.021	0.062	0.034
	[0.069]	[0.070]	[0.044]	[0.117]
$x_{gt}^{(2)}$	0.347**	0.332**	0.348**	0.313
	[0.101]	[0.120]	[0.101]	[0.170]
$x_{gt}^{(3)}$	0.274*	0.343**	0.318*	0.525***
	[0.118]	[0.095]	[0.151]	[0.141]
$x_{gt}^{(4)}$	0.298**	0.342**	0.101	-0.03
	[0.099]	[0.110]	[0.123]	[0.125]
$x_{gt}^{(5)}$	0.062	0.014	0.206*	0.224**
	[0.042]	[0.093]	[0.089]	[0.067]
Session-Phase FE	N	Y	N	Y
N	156	156	78	78
R^2	0.771	0.811	0.505	0.618

Notes: *, **, *** denote significance at the 10%, 5%, and 1%-level, respectively. Standard errors are clustered at the experiment session level, and shown in brackets.

have a significant effect, besides the median member. When controlling for session-phase effects, the coefficient on $x_{gt}^{(5)}$ stays significant, while the coefficient on $x_{gt}^{(2)}$ just misses the 10%-level with a p-value of $p = 0.115$.[26]

Our results do not support the hypothesis of a level shift – in both models (1) and (3) we do not observe a significant constant α. Table 3 reports the results from post-estimation hypothesis tests which directly test the com-

[26]In Tobit versions of these analyses reported in Table 7 in the Supplementary Appendix, the coefficient of $x_{gt}^{(2)}$ is significant in model (4).

peting hypotheses in Section 3 for the four OLS models reported in Table 2. We reject both the weak and strong versions of the mean and the median hypotheses for all models: neither are all five individual choices equally important, nor is only the median important and none of the other individual decisions. Consistent with our finding that the constant is not significant in models (1) and (3), we cannot reject the complementary hypothesis that the coefficients on individual choices add up to 1 in any of our models. We also cannot reject the hypothesis that extreme choices do not matter, except for model (4) on lottery decisions which includes session-phase fixed effects.

TABLE 3
Results from post-estimation hypothesis tests, p-values

	Model			
Hypothesis	(1)	(2)	(3)	(4)
Weak mean	0.024**	0.051*	0.068*	0.061*
Strong mean	0.032**	<0.001***	0.075*	<0.001***
Weak median	0.004***	0.003***	0.016**	<0.001***
Strong median	0.005***	0.005***	<0.001***	<0.001***
Extreme-irrelevance	0.339	0.953	0.131	<0.001***
Convex combination	0.741	0.427	0.739	0.688

Note: *, **, *** denote significance at the 10%, 5%, and 1%-level, respectively.

4.c Order versus subject-specific effects

The results in the previous section establish that the median member, and certain other members have significant influence on the group decision. However, they do not rule out that there are unobserved individual characteristics, correlated with relative positions in groups, that determine how influential different members are with respect to the group decision. Since each individual participates in 6 (3) decisions in three different groups in our experiment, we can investigate this issue further, at the individual level.

Below we compare three empirical models, in all of which the dependent variable is the absolute difference between the group choice and an individual's choice (Δ_{gi}). In the first model we regress this variable on a set of independents indicating the relative position of the individual in the given

group. In the second model, we aim to explain the same dependent variable purely by subject-specific individual fixed effects. In the third model we allow both the relative position within the group and individual effects to influence the variable of interest. Formally, the models we investigate are:

$$\Delta_{gi} = \alpha + \beta_1 p_{gi}^{(1)} + \beta_2 p_{gi}^{(2)} + \beta_4 p_{gi}^{(4)} + \beta_5 p_{gi}^{(5)} + \epsilon_{gi}.$$

$$\Delta_{gi} = \alpha + \gamma_i + \epsilon_{gi}.$$

$$\Delta_{gi} = \alpha + \beta_1 p_{gi}^{(1)} + \beta_2 p_{gi}^{(2)} + \beta_4 p_{gi}^{(4)} + \beta_5 p_{gi}^{(5)} + \gamma_i + \epsilon_{gi}.$$

In the above regression equations, γ_i with $i \in \{1, ..., N\}$ represent subject fixed-effects, with the constraint $\sum_{i=1}^{N} \gamma_i = 0$. The independents $p_{gi}^{(k)}$ are variables indicating the (tie-weighted) relative position of individual i in group g. If individual i's position in the group is the unique kth lowest within the group, $p_{gi}^{(k)}$ takes the value of 1, while all $p_{gi}^{(k')}$ for $k' \neq k$ take the value 0. If individuals $i_{l_1}, ..., i_{l_m}$ are tied at positions $k, ..., k+m$ then all $p_{gi}^{(k)}$ for $k \in \{k, ..., k+m\}$ take the value $1/|\{k, ..., k+m\}|$ and all other $p_{gi}^{(k')}$ take the value of 0. Thus, for example, if an individual i is tied with another group member at the lowest value in the group, we would have $p_{gi}^{(1)} = 0.5, p_{gi}^{(2)} = 0.5, p_{gi}^{(3)} = 0, p_{gi}^{(4)} = 0, p_{gi}^{(5)} = 0$.

In our estimations, the indicator variable for the 3rd position (median) is omitted to avoid perfect multicollinearity, in the presence of the constant term. Given this, the constant α represents the average difference of the group choice from the median member. Coefficients β_1, β_2, β_4, β_5 represent how much further away from the group choice the individual decisions of individuals at positions 1, 2, 4, and 5 are. To return to our example of individual i tied with another group member at positions 1 and 2, the post-estimation prediction of the difference between the group and the individual choice of this subject according to the third model above would be the sum of constant, individual effect, and weighted average of position-effects 1 and 2, $\Delta_{gi} = \alpha + 0.5\beta_1 + 0.5\beta_2 + \gamma_i$.

TABLE 4

OLS REGRESSIONS OF DIFFERENCE BETWEEN INDIVIDUAL AND GROUP CHOICE

	Gift-exchange decisions			Lottery decisions		
Model	(1)	(2)	(3)	(4)	(5)	(6)
Constant	0.314	1.990***	0.391	0.124	0.923***	0.184
	[0.335]	[0.000]	[0.307]	[0.183]	[0.000]	[0.107]
$p_{gi}^{(1)}$	2.780***		2.615***	1.790***		1.630***
	[0.678]		[0.645]	[0.186]		[0.253]
$p_{gi}^{(2)}$	0.385		0.616	0.516*		0.298
	[0.349]		[0.374]	[0.236]		[0.249]
$p_{gi}^{(4)}$	0.911*		0.952*	0.225		0.266
	[0.426]		[0.431]	[0.245]		[0.247]
$p_{gi}^{(5)}$	4.305***		3.812***	1.465***		1.500***
	[0.477]		[0.464]	[0.137]		[0.172]
Subject FE	N	Y	Y	N	Y	Y
N	780	780	780	390	390	390
Adj. R^2	0.225	0.156	0.291	0.363	0.198	0.472

Notes: *, **, *** denote significance at the 10%, 5%, and 1%-level, respectively. Standard errors are clustered at the experiment session level, and shown in brackets. Subject fixed-effects are constrained in that their sum is equal to zero.

Table 4 summarises the results of our investigation, which are remarkably similar across our two domains of decisions, gift-exchange and lottery choices. Models (1) and (4) show the estimates from the first equation, which only includes order indicators. While being at positions 1 and 5 implies that the group decision is significantly further away from the individual's decision than from the median's decision, for positions 2 and 4 the difference is not significant or depends on the specification. In models (2) and (4), using only subject fixed-effects as explanatory variables of the difference between an individual's choice and the choice of her group (the second equation above),

we observe a drop in explanatory power. Adding these subject fixed-effects to the base model with order indicators (the third equation) increases the explanatory power only modestly, and has basically no effect on the size and significance of the order coefficients.

In sum, the relative position of an individual choice within a group seems to be the most important indicator of the individual's impact on the group's choice, and is particularly robust against controlling for possible (unobserved) individual characteristics which might additionally influence an individual's effect on the group choice.

4.d Social influence

Our experimental design allows us to study the effect of group decisions on subsequent decisions of the involved individuals. Subjects made two gift-exchange decisions and one lottery decision within the same group, before being rematched to another group in the next of three phases. Thus, for gift-exchange decisions, when looking at the first decision in a phase, the previous decision (in $t-1$) was made in a different group. For the second decision in a phase, however, the previous decision (in $t-1$) was made in the same group. The first two models presented in Table 5 regress the first and second individual choice in a phase, respectively, on the subject's own decisions in $t-1$ as well as the difference between the group's choice and the own choice in $t-1$. We find that the first individual choice in a phase is correlated with the own previous decision, but not with the group choice in the previous, different group. The second choice in a phase, however, is correlated both with the own previous choice and with the difference between group decision and own decision in the same group in $t-1$ (such that when the group decision was more generous than the own decision in $t-1$, the own decision becomes more generous in t).

A similar analysis for lottery decisions in provided in the third model in Table 5. We find that the current decision of an individual, besides being highly correlated with the own previous decision, is positively correlated with the difference between the previous group choice and previous own individual choice.

TABLE 5

OLS REGRESSIONS OF CURRENT INDIVIDUAL CHOICES ON CHOICES MADE BEFORE IN A DIFFERENT GROUP OR THE SAME GROUP

	Gift-exchange (Normalized amount returned)		Lottery (Nb safe choices)
Decision in phase	1st	2nd	
Constant	-1.295***	-1.717***	-0.130
	[0.329]	[0.395]	[0.157]
Own decision in t–1	0.734***	0.659***	1.022***
	[0.064]	[0.046]	[0.027]
Diff to Group in t–1	0.061	0.176***	0.393***
	[0.042]	[0.045]	[0.048]
N	260	260	260
R^2	0.478	0.338	0.679

Notes: For the first gift-exchange decision in a phase, and for all lottery decisions, decisions in t–1 were made in a different group. For the second gift-exchange decision in a phase, decisions in t–1 were made in the same group. *, **, *** denote significance at the 10%, 5%, and 1%-level, respectively. Standard errors are clustered at the experiment session level, and shown in brackets.

These results indicate the existence of social influence. In gift-exchange games, the previous group choice only has a significant effect when the group members stay together (that is, for the second gift-exchange situation within a phase).[27] However, the second individual gift-exchange decisions within a phase already incorporate the influence of the first group choice in the same phase, so this just means that the same group members do not have a further influence on each others' individual choices the second time around. The influence of the first group choice in a phase is permanent, in the sense that we do not observe a correction in the opposite direction when individuals part from their previous group members and get into new groups.

To explore whether group members at different positions are differently affected by the group choice in their subsequent decision, we run extended

[27]Tobit versions of these analyses yield the same results, see Table 10 in the Supplementary Appendix.

TABLE 6

OLS REGRESSIONS OF CURRENT INDIVIDUAL CHOICES ON CHOICES MADE BEFORE, CONDITIONAL ON PREVIOUS POSITION

	Gift-exchange 2nd decision in phase (Normalized amount returned)	Lottery (Nb safe choices)
Constant	-1.939***	0.012
	[0.406]	[0.342]
Own decision in t–1	0.665***	1.003***
	[0.04]	[0.052]
Was (1)	0.296*	0.312**
× Diff to Group in t–1	[0.146]	[0.121]
Was (2)	0.063	0.16
× Diff to Group in t–1	[0.194]	[0.103]
Was (3)	0.189	0.07
× Diff to Group in t–1	[0.115]	[0.102]
Was (4)	0.069	-0.305
× Diff to Group in t–1	[0.056]	[0.185]
Was (5)	0.024	0.566***
× Diff to Group in t–1	[0.102]	[0.111]
N	260	260
R^2	0.338	0.679

Notes: *, **, *** denote significance at the 10%, 5%, and 1%-level, respectively. Standard errors are clustered at the experiment session level, and shown in brackets.

versions of the models reported in Table 5, with results reported in Table 6. In particular, we interact the difference between an individuals' own choice in $t-1$ and the group choice in $t-1$ with a dummy indicating whether this person's individual choice was at position (1), (2), (3), (4), or (5) in the group in the previous decision situation. In other words, we estimate the effect of the group choice separately by position. For gift-exchange decisions, we find

that for second choices within a phase, there is only a significant effect for the least altruistic member, with this member's individual choice becoming less egoistic. For lottery choices, we find relatively strong significant effects for both the most risk-averse and the most risk-loving person, both of whom adjust their subsequent lottery task decision towards the previous group choice.

These results suggest that deliberation not only suppresses extreme opinions in the current decision, but that it also has a long-lasting effect by changing the opinions of extreme group members, bringing them closer to the median.

5 Conclusion

This paper investigates how groups come to an agreement through deliberation, and which group members have a significant influence on the group choice. We find that the member with the median opinion has the greatest influence on the choice, but there are members in both direction from the median who can also influence the choice. We observe that extreme opinions tend to be suppressed in group decision making. We also find evidence that persuasion is part of deliberation, as individual opinions tend to move towards previous group decisions the individuals participated in. This particularly holds for individuals with extreme opinions, implying that deliberation has a permanent depolarizing effect in the population. This is consistent with the idea behind deliberative democracy, in that deliberation, not merely voting, provides real authenticity to social choices.

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Supplementary Appendix

A Additional tables

The tables below provide robustness results for the estimations discussed in the paper.

- Table 7 shows results from Tobit estimations of the same models as displayed in Table 2.
- Table 8 shows results from post-estimation hypothesis tests on the Tobit models, paralleling those discussed in the main text and shown in Table 3.
- Table 9 shows results from OLS and Tobit regressions using absolute second-mover gifts (rather than normalized by first mover's gift) as dependent and independents.
- Finally, Table 10 replicates the results on social influence from Table 5 in Tobit models.

TABLE 7

ROBUSTNESS: TOBIT REGRESSIONS OF GROUP CHOICES ON INDIVIDUAL CHOICES

	Gift-exchange decisions (Normalized amount returned)		Lottery decisions (Number of safe choices)	
Model	(1)	(2)	(3)	(4)
Constant	-0.119	0.006	-0.224	-0.930
	[0.218]	[0.195]	[0.649]	[0.896]
$x_{gt}^{(1)}$	0.047	0.051	0.062	0.034
	[0.066]	[0.070]	[0.043]	[0.096]
$x_{gt}^{(2)}$	0.348***	0.340***	0.348***	0.313**
	[0.099]	[0.108]	[0.098]	[0.140]
$x_{gt}^{(3)}$	0.274**	0.331***	0.318**	0.525***
	[0.118]	[0.088]	[0.146]	[0.116]
$x_{gt}^{(4)}$	0.326***	0.381***	0.101	-0.030
	[0.112]	[0.116]	[0.119]	[0.102]
$x_{gt}^{(5)}$	0.066	0.028	0.206**	0.224***
	[0.056]	[0.095]	[0.086]	[0.055]
Session & Phase FE	N	Y	N	Y
N	156	156	78	78
Pseudo-R^2	0.280	0.320	0.279	0.382
L (Non) R Censored	11 (145) 0	11 (145) 0	0 (78) 0	0 (78) 0

Notes: *, **, *** denote significance at the 10%, 5%, and 1%-level, respectively. Standard errors are clustered at the experiment session level, and shown in brackets.

TABLE 8

ROBUSTNESS: RESULTS FROM POST-ESTIMATION HYPOTHESIS TESTS ON TOBIT MODELS REPORTED IN TABLE 7, P-VALUES

	Model			
Hypothesis	(1)	(2)	(3)	(4)
Weak mean	0.003***	0.013**	0.004***	0.004***
Strong mean	0.001***	<0.001***	0.004***	<0.001***
Weak median	<0.001***	<0.001***	<0.001***	<0.001***
Strong median	<0.001***	<0.001***	<0.001***	<0.001***
Extreme-irrelevance	0.356	0.764	0.050*	<0.001***
Convex combination	0.032**	0.025**	0.719	0.610

Note: *, **, *** denote significance at the 10%, 5%, and 1%-level, respectively.

TABLE 9

ROBUSTNESS: OLS AND TOBIT REGRESSIONS OF GROUP CHOICES ON INDIVIDUAL CHOICES IN GIFT-EXCHANGE GAMES, USING ABSOLUTE CHOICES (AMOUNT RETURNED OUT OF 10)

	OLS		Tobit	
Model	(1)	(2)	(3)	(4)
Constant	-0.426	0.884	-3.778***	-1.347
	[0.258]	[0.527]	[1.072]	[0.876]
$x_{gt}^{(1)}$	0.108	0.165	0.184	0.332
	[0.110]	[0.146]	[0.186]	[0.248]
$x_{gt}^{(2)}$	0.342**	0.328**	0.458**	0.347
	[0.102]	[0.122]	[0.209]	[0.224]
$x_{gt}^{(3)}$	0.266*	0.334**	0.218*	0.381***
	[0.123]	[0.103]	[0.130]	[0.110]
$x_{gt}^{(4)}$	0.289**	0.324**	0.654***	0.758***
	[0.099]	[0.107]	[0.146]	[0.149]
$x_{gt}^{(5)}$	0.072	0.021	0.178	0.096
	[0.042]	[0.095]	[0.110]	[0.149]
First-mover's gift	0.008	0.006	-0.017	-0.090
	[0.040]	[0.070]	[0.095]	[0.111]
Session-Phase FE	N	Y	N	Y
N	156	156	156	156
(Pseudo) R^2	0.772	0.817	0.304	0.375
L (Non) R Censored			71 (72) 13	71 (72) 13

Notes: *, **, *** denote significance at the 10%, 5%, and 1%-level, respectively. Standard errors are clustered at the experiment session level, and shown in brackets.

TABLE 10

ROBUSTNESS: TOBIT REGRESSIONS OF CURRENT INDIVIDUAL CHOICES ON CHOICES MADE BEFORE IN A DIFFERENT GROUP OR THE SAME GROUP

	Gift-exchange (Normalized amount returned)		Lottery (Nb safe choices)
Decision in phase	1st	2nd	
Constant	-1.305***	-1.742***	-0.13
	[0.341]	[0.439]	[0.156]
Own decision in t–1	0.768***	0.687***	1.022***
	[0.073]	[0.051]	[0.026]
Diff to Group in t–1	0.062	0.173***	0.393***
	[0.044]	[0.054]	[0.048]
N	260	260	260
Pseudo-R^2	0.111	0.074	0.3501
Left (Non) Right Censored	26 (233) 1	31 (358) 0	0 (260) 0

Note: See also notes to Table 5. *, **, *** denote significance at the 10%, 5%, and 1%-level, respectively. Standard errors are clustered at the experiment session level, and shown in brackets.