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HOW INDIVIDUAL PREFERENCES ARE AGGREGATED IN GROUPS: AN EXPERIMENTAL STUDY*

Attila Ambrus[†], Ben Greiner[‡] and Parag A. Pathak[§]

ABSTRACT

This paper experimentally investigates how individual preferences, through unrestricted deliberation, are 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 the median is not the only influential group member. 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. These results are consistent with predictions from a spatial model of dynamic bargaining determining group choices. We also find that group deliberation involves bargaining and compromise as well as 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 the related 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.

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

¹Such tasks are dubbed "non-intellective" by Laughlin (1980) and Laughlin and Ellis (1986). For recent experimental investigations of group decision-making with intellectual 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.

²The 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), Lindsfold, 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.

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 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 is motivated by the influential work of Davis (1973), who defines social decision schemes as mappings between individual preferences and the group decision.⁶ To provide a more formal conceptual framework, and generate testable predictions, we propose a one-dimensional version of the random-proposer spatial bargaining game analyzed in Banks and Duggan (2000). We show that the model generates similar predictions both for the case of simple majority rule and unanimity rule. In particular, the expected group decision is a convex combination of individual opinions, and depending on the level of patience, it can span the range between the mean individual opinion (in the case of low levels of patience) and the median individual opinion (in the case of high levels of patience). In general, the model predicts that relative position within the group matters in how much influence the individual has on the group decision, and in particular members closer to the median member have more influence than extreme group members.

Our empirical findings confirm most of these predictions, in both the gift-exchange and lottery-choice settings. 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

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

⁴In 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.

⁵For 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.

⁶For 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).

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 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 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

⁷The 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).

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

⁹An 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.

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

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 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-

¹⁰The 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).

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

¹²In 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).

thirds majority, and unanimity) are imposed.¹³ In general, as 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 their 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.

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

¹³The 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 communication, 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).

¹⁴This 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.

¹⁵Cason 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.

¹⁶The 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.

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 extend trust and there is a significant likelihood of reciprocation among second movers, yielding outcomes that 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 $p \in \{0, 0.1, 0.2, \dots, 0.9\}$. Of this choice list, one lottery was 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 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

¹⁷A 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 inconsistency. 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.

¹⁸Instructions are included in the Supplementary Appendix.

¹⁹About 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.

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.

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 THEORETICAL BACKGROUND

To embed our experimental investigation in a conceptual framework, we propose a stylized theoretical model of the group decision-making situation. In particular, we consider a bargaining game, in which different members have different ideal points, and members prefer the group decision to be as close as possible to their own ideal point, and that agreements are reached sooner rather than later.²¹ We also consider the possibility that interacting with members with different ideal points can subsequently change the ideal point of a subject, as discussed at the end of this section.

The model below, like all formal models of bargaining, is stylized, and we do not think that it literally describes how negotiations occur in group decision-making. Nevertheless, it yields a set of

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

²¹Although the time horizon of group discussions in our experiments was much shorter than in most real world negotiations (where they can take days, or months), subjects showed signs of not wanting to stay in the lab and participate in discussions for too long. Even though we did not impose any time restriction, no group discussion lasted longer than 10 minutes.

predictions that we can test in a reduced-form econometric analysis.

Formally, our analysis is based on a 1-dimensional version of the spatial bargaining model analyzed in Banks and Duggan (2000).²² In particular, we consider a dynamic game in which in every period a proposer is selected randomly and independently, and she makes a proposal from a one-dimensional choice set. If the proposal is accepted, the group decision becomes the proposal, and the game ends. Otherwise the game proceeds to the next period.

In the simplest version of the model, players' ideal points are commonly known, and acceptance of a proposal requires a simple majority. Later we show that the predictions generated from this model extend, in weaker forms, to versions of the model in which ideal points are private information, and when accepting a proposal requires unanimity.

Formally, consider a 5-player dynamic bargaining game, in which at each period ($t = 0, 1, 2, \dots$) the proposer is chosen i.i.d., with each of the five players chosen with probability $1/5$. A proposer must propose an action on $[0, 1]$. Player i 's type, or ideal point, is $x_i \in [0, 1]$, and her payoff when an agreement y is reached at period t is $\delta^t(1 - (x_i - y)^2)$, where $\delta \in (0, 1)$ is a common discount factor. Assume $0 \leq x_1 \leq x_2 \leq x_3 \leq x_4 \leq x_5 \leq 1$. After an offer is made, players announce sequentially, in a random order, whether they accept or reject the offer. The proposal is accepted if and only if at least 3 group members accept.²³

Our assumption of a 1-dimensional state space corresponds to the existence of a natural ordering of choices in both types of decision problems featured in our experiments (amount to be reciprocated in the gift-exchange game, and the switching point from safe to risky lotteries in lottery choices). We assume a continuum of choices for analytical convenience only: the qualitative predictions of the model remain the same if the set of possible action choices is a finite subset of the unit interval.

We focus on stationary subgame-perfect equilibria (SSPE) of the game, that is, subgame-perfect equilibria (SPE) in which players' proposal strategies and acceptance rules do not change over time. While there is a severe multiplicity of SPE for general discount factors in a game like above, as we show below, SSPE is unique, generating sharp predictions for how the group decision depends on various parameters of the model. Furthermore, there are several recent papers that provide micro-foundations for selecting Markov perfect equilibria (equivalent to SSPE in our context) in sequential-move games.²⁴

In this game, for any specification of ideal points and the discount factor, SSPE is unique, and it is characterized by a compact set of acceptable proposals $A \subseteq [0, 1]$, of which x_3 is an interior point (relative to $[0, 1]$). When given the opportunity, each player proposes the point of A closest to her ideal point. This implies that the median player always proposes her ideal point. Other players either propose their ideal points (if included in A) or the closest boundary point of A .

²²The model of Banks and Duggan (2000) is an adaptation of the seminal multilateral bargaining model of Baron and Ferejohn (1989) to settings with non-transferrable utilities.

²³Sequentiality of responses ensures that there is no potential coordination issue among players in accepting a proposal: if it is in a majority's interest that the proposal is accepted, then the proposal does get accepted in a subgame-perfect equilibrium. This can be established in general using standard backward induction arguments.

²⁴See Bhaskar and Vega-Redondo (2002) and Bhaskar, Mailath and Morris (2013) for general classes of asynchronous-move games, and Ambrus and Lu (forthcoming) in the context of dynamic bargaining.

To demonstrate how the set of acceptable proposals depends on the discount factor, it is useful to look at a concrete example with the following ideal points: $x_1 = .1$, $x_2 = .2$, $x_3 = .4$, $x_4 = .7$, $x_5 = 1$.

In this example, $\delta \leq \frac{160}{221}$ implies that the acceptance set is the whole unit interval, and that player i proposes $y_i = x_i$ for all i . In particular, any proposal to the left of the (next round) expected proposal (the average proposal over all five players) is preferred by players 1, 2 and 3 to rejecting the proposal and waiting for a randomly drawn new proposer in the subsequent round. Similarly, any proposal to the right of the expected proposal is preferred by players 3, 4 and 5 to letting the game pass to the subsequent round. For $\delta \in (\frac{160}{221}, \frac{65}{67}]$ players 1-4 can still propose their ideal points, but player 5, whose ideal point is the furthest away from the median, has to propose the right boundary of A .²⁵ Next, for $\delta \in (\frac{65}{67}, \frac{120}{121}]$, only the median player and player 2, who is the closest non-median player to the median, can propose their ideal points.²⁶ Lastly, for $\delta \in (\frac{120}{121}, 1)$, A becomes $[\cdot 4 - \sqrt{\frac{5(1-\delta)}{5-4\delta}}, \cdot 4 + \sqrt{\frac{5(1-\delta)}{5-4\delta}}]$, and only the median player can propose her ideal point. Players 1 and 2 propose the left boundary of A , while players 4 and 5 propose the right boundary of A . Acceptance set A shrinks to x_3 as $\delta \rightarrow 1$.

The qualitative features of this example extend to any specification of our model, as summarized in the theorem below. The proof is in the Appendix, and it explicitly solves for the unique SSPE in every region of parameter values.²⁷

Theorem 1: In a bargaining game with publicly known ideal points and plurality decision rule, SSPE is unique. For any set of ideal points, the set of acceptable proposals A monotonically decreases in δ , it converges to the whole choice set as $\delta \rightarrow 0$, and it converges to the median ideal point as $\delta \rightarrow 1$.

The proof in the Appendix also reveals that for generic specifications of ideal points – when the median is not an extreme point of the choice set – for low enough δ in fact $A = [0, 1]$ and hence all players can propose their ideal points. Conversely, for high enough δ only players with ideal point equal to the median can propose their ideal points. This means that if players are impatient enough, then the expected action chosen by the group is equal to the mean of the ideal points, while if players are very patient then the expected group choice is very close to the median ideal point. In general, the equilibrium prediction of the model for the expected group decision, for different levels of patience, spans a range between the mean and median ideal point. For intermediate levels of patience only players closer to the median can propose their ideal points, and player 2 (the less extreme member to the left of the median) is more likely to influence the expected group decision than player 1 (the left extreme member). Similarly, player 4 is more likely to influence the group decision than player 5. In short, the prediction is that if players are not very patient then non-median members' ideal points

²⁵Acceptance set A becomes $[\max\{0, 0.4 - \sqrt{\frac{5(1-\delta)+.22\delta}{5-\delta}}\}, 0.4 + \sqrt{\frac{5(1-\delta)+.22\delta}{5-\delta}}]$.

²⁶Acceptance set A becomes $[0.4 - \sqrt{\frac{5(1-\delta)+.04\delta}{5-3\delta}}, 0.4 + \sqrt{\frac{5(1-\delta)+.04\delta}{5-3\delta}}]$.

²⁷The result on convergence to the median when players become patient also follows from Theorem 5 of Banks and Duggan (2000).

can also affect the expected group decision, but extreme members' ideal points are less likely to be influential than the ideal points of non-median members next to the median.²⁸

The above analysis assumes that the ideal points of group members are known at the beginning of the bargaining game. In the experiments, we kept the individual decisions preceding the group discussion private information. Therefore, taken literally, the above model implicitly assumes that members truthfully reveal their ideal points to each other before they start bargaining. This can be the case for example when there are costs associated with lying or misrepresenting one's true preferences. If, however, subjects are strategic, then we have a bargaining game with multi-sided asymmetric information. Such games are notoriously difficult to analyze, and they tend to have a severe multiplicity of equilibria.²⁹ Nevertheless, below we show that some of the qualitative features carry over to situations in which ideal points are privately known, and players are strategic in reporting their ideal points.

To formally analyze situations like above, we modify the previous model in two ways (besides assuming that ideal points are private information). First, we augment the game with one round of cheap talk before bargaining, in which members simultaneously and publicly announce ideal points. Second, here we assume that the set of possible action choices, and hence the set of possible types of players, is a finite subset of $(0, 1)$.³⁰ Assume that the distribution of types are iid across members, with distribution function F allocating positive probability to each possible type. The next result shows that for both very impatient, and for very patient players, there exist sequential equilibria in which players truthfully announce their types at the beginning of the game, and then bargain the same way as in the game with publicly known ideal points. In particular, this results in all members proposing their ideal points when the discount factor is low enough (hence the expected group decision is the mean ideal point), and all members proposing the median ideal point when the discount factor is high enough. Moreover, the above outcome is the unique equilibrium outcome with low levels of patience, although such uniqueness does not hold for high levels of patience.

Theorem 2: In a bargaining game with private ideal points and simple majority rule, preceded by a round of cheap talk, for low enough discount factors there is a sequential equilibrium in which members announce their types truthfully, and then all members propose their ideal points in the bargaining phase. Moreover, all sequential equilibria are outcome-equivalent to the equilibrium above. Conversely, for high enough discount factors there is a sequential equilibrium in which members announce their types truthfully, and then all members propose the median announced ideal point in the bargaining phase.

²⁸When applying the model directly to the groups we observe in our experiment and predicting group choices from individual preferences, and then regressing those predictions on the individual choices using an OLS model (as we do in our main empirical analysis reported below), we find exactly the discussed pyramid shape in coefficients on ordered individual opinions, the steepness of which is moderated by δ . In addition, all linear regressions have $R^2 > 0.99$, indicating that a linear approximation is able to capture the model's predictions almost perfectly (non-linear components of the model only play a minor role).

²⁹See for example Fudenberg and Tirole (1983) and Cramton (1984, 1992).

³⁰In our abstract bargaining model, endpoints 0 and 1 do not have inherent meanings, therefore it is not restrictive to exclude them from the finite type space. The important assumption we need for the theorem below is that even the most extreme types accept each others' ideal points when the level of patience is low enough. Alternatively, we could allow for types 0 and 1 and slightly modify the utility function instead.

In both versions of the model above, it is assumed that groups use simple majority rule to get to an agreement. However, similar results hold, with some caveats in the case of very patient players, when the group adopts some supermajority rule or unanimity as decision criterion. In a Supplementary Appendix we report a full analysis of the unanimity rule case. Similar to the case of simple majority, the acceptance set in an SSPE converges to the set of all possible choices as $\delta \rightarrow 0$ (and hence when members are very impatient, all of them can propose their ideal points), it monotonically decreases with δ , and converges to a single action choice as $\delta \rightarrow 1$. The difference is that in general the latter limit point is between the mean and the median ideal point under unanimity, although with the restriction that the median is equidistant to the two extreme ideal points, the limit point is exactly the median.³¹

Summarizing the predictions of the bargaining model above:

- (i) the group decision is a convex combination of individual decisions;
- (ii) if players are very impatient then the expected group decision is close to the mean individual decision;
- (iii) if players are very patient then the expected group decision is close to the median individual decision;
- (iv) for intermediate levels of patience, the further a member is from the median, the less effect she has in expectation on the group decision.

Lastly, our model can be extended to incorporate the possibility of persuasion, in particular others in the group persuading a member to change her ideal point (as opposed to just agreeing upon a compromise). Note that since the tasks in our experiments are not intellectual, persuasion in our context does not involve transmission of hard information as in standard economic models of persuasion (see, for example, Grossman and Hart, 1980, Milgrom and Roberts, 1986, or more recently, Kamenica and Gentzkow, 2011), and hence has to include a psychological component, as in Cialdini and Goldstein (2004) and Cooper and Rege (2011). There are two straightforward ways to incorporate this into our theoretical framework. One possibility is that it is the group decision itself that persuades members to change their ideal points, presumably towards the group decision. Formally, the shifted ideal point is: $\hat{x}_i = g^i(x_i, y - x_i)$, where x_i is the member's ideal point before the group decision, and $y - x_i$ is the difference between the group decision and the original ideal point, with $g_1^i, g_2^i \geq 0$. The function determining the shifted ideal point is indexed by the member's position in the group, allowing for relative position within the group influencing the magnitude of the shift. In this case persuasion does not directly affect the analysis of the current group decision process, instead the outcome of the decision process changes the ideal points subjects start out with in the next group decision problem. Another possibility is that persuasion happens during communication among group members, before

³¹Note that this condition does not restrict x_2 and x_3 to be the same distance from the median, and therefore for specifications satisfying the restriction the median typically differs from the mean.

the bargaining stage. The formal analysis of this game is as before, with the caveat that the relevant ideal points in the bargaining stage are not the originals, but the ideal points after persuasion. In this case, the effect of an individual’s original ideal point on the eventual group decision measures both the individual’s capacity to affect others’ ideal points through persuasion as well as the individual’s leverage to influence the expected outcome of the resulting bargaining game.

4 COMPETING HYPOTHESES

Our stylized model motivates a number of competing hypotheses for the experiment. 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. Our main empirical 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 j th 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.³² 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 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 $(x_{igt})_{i=1,\dots,5}$:

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

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.

³²In 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.

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: $\beta_1 = \beta_5 = 0$.

5 RESULTS

5.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.³³ For gift-exchange decisions, we find 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			Lottery decisions		
	(Normalized amount returned)			(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
<i>Only last session</i>						
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.³⁴

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

³³Due 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.

³⁴Traditional 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.

differences statistically is difficult, since our independent unit of observation is the session.³⁵ 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.

5.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.³⁶

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 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 $p = 0.115$.³⁷

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 competing hypotheses in Section 4 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.

5.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

³⁵Wilcoxon 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.

³⁶Our hypotheses developed in Section 4 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.

³⁷In Tobit versions of these analyses reported in Table 7 in the Supplementary Appendix, the coefficient of $x_{gt}^{(2)}$ is significant in model (4).

TABLE 2
OLS REGRESSIONS OF GROUP CHOICES ON INDIVIDUAL CHOICES

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

TABLE 3
RESULTS FROM POST-ESTIMATION HYPOTHESIS TESTS, P-VALUES

Hypothesis	Model			
	(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.

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 $i \in \{1, \dots, N\}$ represent subject fixed-effects, with the constraint $\sum_{i=1}^N \gamma_i = 0$. The variables $p_{gi}^{(k)}$ indicate the (tie-weighted) relative position of individual i in group g . If individual i 's position in the group is the unique k th 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}, \dots, i_{l_m} are tied at positions $k, \dots, k+m$ then all $p_{gi}^{(k)}$ for $k \in \{k, \dots, k+m\}$ take the value $1/|\{k, \dots, k+m\}|$ 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 $\beta_1, \beta_2, \beta_4, \beta_5$ 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 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

TABLE 4

OLS REGRESSIONS OF DIFFERENCE BETWEEN INDIVIDUAL AND GROUP CHOICE						
Model	Gift-exchange decisions			Lottery decisions		
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	0.314 [0.335]	1.990*** [0.000]	0.391 [0.307]	0.124 [0.183]	0.923*** [0.000]	0.184 [0.107]
$p_{gi}^{(1)}$	2.780*** [0.678]		2.615*** [0.645]	1.790*** [0.186]		1.630*** [0.253]
$p_{gi}^{(2)}$	0.385 [0.349]		0.616 [0.374]	0.516* [0.236]		0.298 [0.249]
$p_{gi}^{(4)}$	0.911* [0.426]		0.952* [0.431]	0.225 [0.245]		0.266 [0.247]
$p_{gi}^{(5)}$	4.305*** [0.477]		3.812*** [0.464]	1.465*** [0.137]		1.500*** [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.

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.

5.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).

TABLE 5
OLS REGRESSIONS OF CURRENT INDIVIDUAL CHOICES ON CHOICES MADE BEFORE IN A DIFFERENT GROUP OR THE SAME GROUP

Decision in phase	Gift-exchange (Normalized amount returned)		Lottery (Nb safe choices)
	1st	2nd	
Constant	-1.295*** [0.329]	-1.717*** [0.395]	-0.130 [0.157]
Own decision in t-1	0.734*** [0.064]	0.659*** [0.046]	1.022*** [0.027]
Diff to Group in t-1	0.061 [0.042]	0.176*** [0.045]	0.393*** [0.048]
N	260	390	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.

A similar analysis for lottery decisions is 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.

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).³⁸ 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.

³⁸Tobit 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*** [0.406]	0.012 [0.342]
Own decision in $t-1$	0.665*** [0.04]	1.003*** [0.052]
Was (1) × Diff to Group in $t-1$	0.296* [0.146]	0.312** [0.121]
Was (2) × Diff to Group in $t-1$	0.063 [0.194]	0.16 [0.103]
Was (3) × Diff to Group in $t-1$	0.189 [0.115]	0.07 [0.102]
Was (4) × Diff to Group in $t-1$	0.069 [0.056]	-0.305 [0.185]
Was (5) × Diff to Group in $t-1$	0.024 [0.102]	0.566*** [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.

To explore whether group members at different positions are differently affected by the group choice in their subsequent decision, we run extended versions of the models reported in Table 5, with results reported in Table 6. In particular, we interact the difference between an individual's 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.

6 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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APPENDIX

Theorem 1: In a bargaining game with publicly known ideal points and plurality decision rule, SSPE is unique. For any set of ideal points, the set of acceptable proposals A monotonically decreases in δ , it converges to the whole choice set as $\delta \rightarrow 0$, and it converges to the median ideal point as $\delta \rightarrow 1$.

Proof: Let y_i denote member i 's proposal, and define the following:

$$\lambda_1 \equiv \arg \min_{i \in \{1,2,4,5\}} |x_i - x_3|$$

$$\lambda_{k+1} \equiv \arg \min_{i \in \{1,2,4,5\} \setminus \{\lambda_1, \dots, \lambda_k\}} |x_i - x_3|$$

Thus, $|x_{\lambda_1} - x_3| \leq |x_{\lambda_2} - x_3| \leq |x_{\lambda_3} - x_3| \leq |x_{\lambda_4} - x_3|$, so that player λ_k is the non-median player whose ideal point is the k -th closest (among non-median players) to that of the median player.

First, Theorem 1 of Banks and Duggan (2000) implies that there is no delay in SSPE (along the equilibrium path all proposals are accepted).

Next, note that in any SSPE, the acceptable proposals are exactly those that are acceptable to player 3. This follows because for all players, in any SSPE, the expected continuation value if there is no agreement in the current round depends only on the expectation and the variance of the proposal in the next round. Let the expectation of the proposal in the SSPE be \bar{y} . Since the variance affects all players' payoffs the same way, the difference in expected continuation payoffs across players only depends on the distance between ideal points and \bar{y} . This means that if a proposal y is preferred by player 3 to no agreement in the current round and $y \leq \bar{y}$ then players 1 and 2 also prefer it. Conversely, if a proposal y is preferred by player 3 to no agreement in the current round and $y > \bar{y}$ then players 4 and 5 also prefer it.

Because payoffs are quasi-concave, in any SSPE, the set of proposals acceptable to player 3 is a convex interval. Moreover, this interval contains x_3 , the action that yields the highest possible payoff to player 3. Given this, we need to consider the following cases:

Case (i): the acceptance set contains x_3 , but does not contain any other player's ideal point.

The incentive compatibility condition to lure player 3 is

$$v \geq \delta(4v + 1)/5$$

Letting v denote player 3's payoff and setting $y = x_{\lambda_1}$ gives the bound on δ :

$$\delta > \frac{5(1 - (x_{\lambda_1} - x_3)^2)}{5 - 4(x_{\lambda_1} - x_3)^2}.$$

Then, given the above inequality holds,

$$y_1 = y_2 = x_3 - \sqrt{\frac{5(1-\delta)}{5-4\delta}}, \quad y_3 = x_3, \quad y_4 = y_5 = x_3 + \sqrt{\frac{5(1-\delta)}{5-4\delta}}.$$

This candidate equilibrium cannot exist for $\delta \leq \frac{5(1-(x_{\lambda_1}-x_3)^2)}{5-4(x_{\lambda_1}-x_3)^2}$. In this case, $|x_3 - x_{\lambda_1}| \leq \sqrt{\frac{5(1-\delta)}{5-4\delta}}$, so that x_{λ_1} is in the acceptance set given above (making it suboptimal for player λ_1 to propose anything other than x_{λ_1}).

Case (ii): the acceptance set contains two consecutive players' ideal points, including x_3 .

The incentive compatibility condition to lure player 3 is

$$v \geq \delta(3v + 2 - (x_{\lambda_1} - x_3)^2)/5$$

Setting the payoff of the median voter equal to v and setting $y = x_{\lambda_2}$ gives the next bound on δ :

$$\frac{5(1 - (x_{\lambda_2} - x_3)^2)}{5 - (x_{\lambda_1} - x_3)^2 - 3(x_{\lambda_2} - x_3)^2} < \delta \leq \frac{5(1 - (x_{\lambda_1} - x_3)^2)}{5 - 4(x_{\lambda_1} - x_3)^2}.$$

Then, given the above inequality holds,

$$y_3 = x_3, \quad y_{\lambda_k} = \begin{cases} x_{\lambda_k} & \text{if } k = 1 \\ x_3 - \sqrt{\frac{5(1-\delta) + \delta(x_{\lambda_1} - x_3)^2}{5 - 3\delta}} & \text{if } k > 1, \lambda_k < 3 \\ x_3 + \sqrt{\frac{5(1-\delta) + \delta(x_{\lambda_1} - x_3)^2}{5 - 3\delta}} & \text{if } k > 1, \lambda_k > 3 \end{cases}$$

This candidate equilibrium cannot exist for $\delta < \frac{5(1-(x_{\lambda_2}-x_3)^2)}{5-(x_{\lambda_1}-x_3)^2-3(x_{\lambda_2}-x_3)^2}$. In this case, $|x_3 - x_{\lambda_2}| < \sqrt{\frac{5(1-\delta)+\delta(x_{\lambda_1}-x_3)^2}{5-3\delta}}$, so that x_{λ_2} is strictly between x_3 and the prescribed proposal given above. Consequently, player λ_2 's ideal point x_{λ_2} would be accepted if proposed, so it would then be suboptimal for player λ_2 to propose anything other than x_{λ_2} .

This candidate equilibrium cannot exist for $\delta > \frac{5(1-(x_{\lambda_1}-x_3)^2)}{5-4(x_{\lambda_1}-x_3)^2}$ either. In this case, $1 - (x_3 - x_{\lambda_1})^2 < \delta \left[5 - (x_3 - x_{\lambda_1})^2 - \sum_{i \neq \lambda_1} (x_3 - y_i)^2 \right] / 5$, where the y_i 's are the proposals given above, so that $y_{\lambda_1} = x_{\lambda_1}$ is not incentive compatible with respect to player 3. Consequently, player 3 would reject x_{λ_1} so that it would be suboptimal for player λ_1 to propose x_{λ_1} .

Case (iii): the acceptance set contains three consecutive players' ideal points, including x_3 .

The incentive compatibility condition to lure player 3 is

$$v \geq \delta(2v + 3 - (x_{\lambda_1} - x_3)^2 - (x_{\lambda_2} - x_3)^2)/5$$

Setting the payoff of the median voter equal to v and setting $y = x_{\lambda_3}$ gives the next bound on δ :

$$\frac{5(1 - (x_{\lambda_3} - x_3)^2)}{5 - (x_{\lambda_1} - x_3)^2 - (x_{\lambda_2} - x_3)^2 - 2(x_{\lambda_3} - x_3)^2} < \delta \leq \frac{5(1 - (x_{\lambda_2} - x_3)^2)}{5 - (x_{\lambda_1} - x_3)^2 - 3(x_{\lambda_2} - x_3)^2}.$$

Then, given the above inequality holds,

$$y_3 = x_3, \quad y_{\lambda_k} = \begin{cases} x_{\lambda_k} & \text{if } k \leq 2 \\ x_3 - \sqrt{\frac{5(1-\delta) + \delta[(x_{\lambda_1} - x_3)^2 + (x_{\lambda_2} - x_3)^2]}{5 - 2\delta}} & \text{if } k > 2, \lambda_k < 3 \\ x_3 + \sqrt{\frac{5(1-\delta) + \delta[(x_{\lambda_1} - x_3)^2 + (x_{\lambda_2} - x_3)^2]}{5 - 2\delta}} & \text{if } k > 2, \lambda_k > 3 \end{cases}$$

This candidate equilibrium cannot exist for $\delta < \frac{5(1 - (x_{\lambda_3} - x_3)^2)}{5 - (x_{\lambda_1} - x_3)^2 - (x_{\lambda_2} - x_3)^2 - 2(x_{\lambda_3} - x_3)^2}$. In this case, $|x_3 - x_{\lambda_3}| < \sqrt{\frac{5(1-\delta) + \delta[(x_{\lambda_1} - x_3)^2 + (x_{\lambda_2} - x_3)^2]}{5 - 2\delta}}$, so that x_{λ_3} is strictly between x_3 and the prescribed proposal given above. Consequently, player λ_3 's ideal point x_{λ_3} would be accepted if proposed, so it would then be suboptimal for player λ_3 to propose anything other than x_{λ_3} .

This candidate equilibrium cannot exist for $\delta > \frac{5(1 - (x_{\lambda_2} - x_3)^2)}{5 - (x_{\lambda_1} - x_3)^2 - 3(x_{\lambda_2} - x_3)^2}$ either. In this case, $1 - (x_3 - x_{\lambda_2})^2 < \delta \left[5 - (x_3 - x_{\lambda_2})^2 - \sum_{i \neq \lambda_2} (x_3 - y_i)^2 \right] / 5$, where the y_i 's are the proposals given above, so that $y_{\lambda_2} = x_{\lambda_2}$ is not incentive compatible with respect to player 3. Consequently, player 3 would reject x_{λ_2} so that it would be suboptimal for player λ_2 to propose x_{λ_2} .

Case (iv): the acceptance set contains four consecutive players' ideal points, including x_3 .

The incentive compatibility condition to lure player 3 is

$$v \geq \delta(v + 4 - (x_{\lambda_1} - x_3)^2 - (x_{\lambda_2} - x_3)^2 - (x_{\lambda_3} - x_3)^2) / 5$$

Setting the payoff of player 3 equal to v and setting $y = x_{\lambda_4}$ gives the next bound on δ :

$$\frac{5(1 - (x_{\lambda_4} - x_3)^2)}{5 - \sum_{i=1}^5 (x_i - x_3)^2} < \delta \leq \frac{5(1 - (x_{\lambda_3} - x_3)^2)}{5 - (x_{\lambda_1} - x_3)^2 - (x_{\lambda_2} - x_3)^2 - 2(x_{\lambda_3} - x_3)^2}.$$

Then, given the above inequality holds,

$$y_3 = x_3, \quad y_{\lambda_k} = \begin{cases} x_{\lambda_k} & \text{if } k \leq 3 \\ x_3 - \sqrt{\frac{5(1-\delta) + \delta[(x_{\lambda_1} - x_3)^2 + (x_{\lambda_2} - x_3)^2 + (x_{\lambda_3} - x_3)^2]}{5 - \delta}} & \text{if } k = 4, \lambda_4 < 3 \\ x_3 + \sqrt{\frac{5(1-\delta) + \delta[(x_{\lambda_1} - x_3)^2 + (x_{\lambda_2} - x_3)^2 + (x_{\lambda_3} - x_3)^2]}{5 - \delta}} & \text{if } k = 4, \lambda_4 > 3 \end{cases}$$

This candidate equilibrium cannot exist for $\delta < \frac{5(1-(x_{\lambda_4}-x_3)^2)}{5-\sum_{i=1}^5(x_i-x_3)^2}$. In this case, $|x_3 - x_{\lambda_4}| < \sqrt{\frac{5(1-\delta)+\delta[(x_{\lambda_1}-x_3)^2+(x_{\lambda_2}-x_3)^2+(x_{\lambda_3}-x_3)^2]}{5-\delta}}$, so that x_{λ_4} is strictly between x_3 and the prescribed proposal given above. Consequently, player λ_4 's ideal point x_{λ_4} would be accepted if proposed, so it would then be suboptimal for player λ_4 to propose anything other than x_{λ_4} .

This candidate equilibrium cannot exist for $\delta > 5\frac{(1-(x_{\lambda_3}-x_3)^2)}{5-(x_{\lambda_1}-x_3)^2-(x_{\lambda_2}-x_3)^2-2(x_{\lambda_3}-x_3)^2}$ either. In this case, $1 - (x_3 - x_{\lambda_3})^2 < \delta \left[5 - (x_3 - x_{\lambda_3})^2 - \sum_{i \neq \lambda_3} (x_3 - y_i)^2 \right] / 5$, where the y_i 's are the proposals given above, so that $y_{\lambda_3} = x_{\lambda_3}$ is not incentive compatible with respect to player 3. Consequently, player 3 would reject x_{λ_3} so that it would be suboptimal for player λ_3 to propose x_{λ_3} .

Case (v): all members propose their ideal points.

Given

$$\delta \leq \frac{5(1 - (x_{\lambda_4} - x_3)^2)}{5 - \sum_{i=1}^5 (x_i - x_3)^2},$$

we have

$$y_i = x_i \text{ for all } i.$$

This candidate equilibrium cannot exist for $\delta > \frac{5(1-(x_{\lambda_4}-x_3)^2)}{5-\sum_{i=1}^5(x_i-x_3)^2}$. In this case, $1 - (x_3 - x_{\lambda_4})^2 < \delta \sum (1 - (x_3 - y_i)^2) / 5$, where the y_i 's are the proposals given above, so that $y_4 = x_{\lambda_4}$ is no incentive compatible to player 3. Consequently, it would be suboptimal for player λ_4 to propose x_{λ_4} .

This concludes the analysis of possible cases. Since $\lambda_1, \dots, \lambda_4$ are not restricted to be strictly positive, the above analysis also covers parameter values when multiple players' ideal points are at the median position. Relatedly, for some ideal point configurations, only some of the above cases apply. For example, if there are two players with ideal points exactly at the median, then the set of δ for which exactly one player proposes her ideal point is empty: for any $\delta \in (0, 1)$ at least the two median players can propose their ideal points in SSPE.

Since the regions of discount factors for which different types of equilibria (cases (i)-(v)) apply partition $(0, 1)$ for any (x_1, \dots, x_5) , SSPE is always unique. The above characterization of the unique SSPE also implies all of the other claims in the statement of the theorem. ■

Theorem 2: In a bargaining game with private ideal points and simple majority rule, preceded by a round of cheap talk, for low enough discount factors there is a sequential equilibrium in which members announce their types truthfully, and then all members propose their ideal points in the bargaining phase. Moreover, all sequential equilibria are outcome-equivalent to the equilibrium above. Conversely, for high enough discount factors there is a sequential equilibrium in which members announce their types truthfully, and then all members propose the median announced ideal point in the bargaining phase.

Proof: Let $a_1 < \dots < a_N$ be the set of possible actions and player types. Define $\Delta \equiv \min_i (a_{i+1} - a_i)$.

Consider first the continuation game on the equilibrium path following the reporting stage. Note that player 3's continuation payoff at any stage, in case of no agreement, is δ , as according to the candidate equilibrium profile all players propose x_3 subsequently. Therefore $\delta \geq 1 - \Delta^2$ implies that player 3 rejects any proposal other than x_3 . Moreover, any proposal $y < x_3$ gets rejected by players 4 and 5, and any proposal $y > x_3$ gets rejected by players 1 and 2. Conversely, a proposal $y = x_3$ gets accepted by any player i , since it yields a payoff of $1 - (x_i - x_3)^2 > 0$, which is strictly larger than the continuation payoff $\delta(1 - (x_i - x_3)^2)$. This also implies that any player i strictly prefers proposing x_3 to any other proposal.

Now we consider the stage in which players report their valuations. Suppose a player with true ideal point x_i reports $x'_i \neq x_i$, and consider each of the possible cases: (a) misreporting leads other players to believe the median ideal point is not x_i , when in fact it is x_i , (b) misreporting leads other players to believe the median ideal point is not x_j , when in fact it is $x_j \neq x_i$, (c) misreporting has no effect on other players' beliefs regarding the median ideal point.

For case (a), misreporting strictly decreases player i 's payoff because other players will no longer propose player i 's ideal point if recognized in the first period. Therefore no matter how the game proceeds thereafter, player i is strictly worse than if other players were to propose the true median of x_i in the first period.

For case (b), other players' beliefs regarding the median ideal point can only be affected by player i misreporting if x_j is strictly between x_i and x'_i . Therefore, the perceived median, \tilde{x}_j is further from player i 's ideal point than the true median: $|\tilde{x}_j - x_i| > |x_j - x_i|$. Consequently, other players (if recognized) propose \tilde{x}_j , which gives player i a strictly worse payoff regardless of whether or not the proposal is accepted than the payoff if other players propose (and accept) x_j , as in the truthful equilibrium.

For case (c), player i 's payoff is not affected by the deviation.

Therefore, player i cannot profit from misreporting in any of the three cases, and is strictly hurt by misreporting in cases (a) and (b). Moreover, for any x_i , player i 's ex-ante expectation of x_i being the true median ideal point is nonzero for a finite type space with independently distributed types. The likelihood of strictly hurting oneself by misreporting is strictly positive for any x_i . Thus, truth-telling is the unique optimal action in the reporting stage. ■