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Self-serving interpretations of ambiguity in other-regarding behavior ☆

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ABSTRACT

We demonstrate that people can adopt a favorable view of ambiguous risks relative to ones with known probabilities, contrary to the usual attitude of ambiguity aversion, when doing so permits justification for unfair behavior. We use binary dictator games involving a choice between a relatively equitable allocation and an "unfair" allocation that is both less generous and makes the recipient's payment dependent on a $p = 0.5$ lottery. Dictators choose the unfair option more frequently when the recipient's allocation depends on an ambiguous lottery than on a lottery with a known probability — even though the objective distributions of outcomes are identical under the two kinds of lotteries. Dictators' estimates of the expected value of the recipients' allocations are inflated under ambiguity, indicating that dictators form self-serving beliefs about ambiguity. Finally, increased unfair behavior under ambiguity is extinguished when dictators are constrained by their own initial unmotivated, and negative, attitudes towards ambiguity.

1. Self-serving interpretations of ambiguity in other-regarding behavior

Suppose a manager must decide whether to layoff an employee in order to cut costs. If she does so, it will increase the manager's bonus. However, the employee may find it difficult to find another job and it will take time to do so, meaning that the employee will suffer harm if the layoff occurs. This decision involves the kind of tradeoff that social scientists often study between self-interest and the welfare of others. Considerable research — which we review below — suggests that people regularly exhibit positive concern for others' welfare.

Now, compare a situation where the employee faces a $p = 0.5$ likelihood of finding work in the next six months with a situation in which less information is known about the job market: the probability is somewhere between 0 and 1, with all probabilities equally likely (i.e., $p \sim U[0, 1]$). This distinction is often studied as the difference between "risk" and "ambiguity" (or "Knightian" uncertainty). Considerable research on ambiguity aversion — also reviewed below — suggests that the employee would prefer to be laid off in the market with the known 0.5 probability than in the one characterized by ambiguity. Thus, if the worker's preferences matter positively to the manager in the layoff decision, the layoff should be *less* likely to occur in the ambiguous case.

In this paper, we argue that the situation with less precise probability allows the manager a greater degree of self-serving bias about the likely consequences for the employee. In the case with an ambiguous probability, it is plausibly much easier for the manager to convince herself that the employees will be able to find work quickly (i.e., that the actual probability

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is higher than 0.5) and that, therefore, enacting the layoff is not that harmful. Such biased reasoning is not possible in the case where the probability is known to be 0.5.[1]

Using an experiment that re-creates the key features of the above situation, we find more self-interested behavior and more self-servingly biased beliefs when the consequences of decisions are ambiguous than when they involve known risk. That is, we find that people considering tradeoffs between self-interest and others' welfare can adopt favorable views of ambiguity in order to behave more selfishly (and unfairly). We demonstrate the self-serving adoption of a favorable view of ambiguity by eliciting subjective expectations of outcomes, with an incentive for accuracy.

Thus, in applying our findings to the case of the manager considering a layoff, we demonstrate that: (a) she will convince herself that the ambiguous job market is more favorable than it actually is and will thus be more likely to fire the employee when the consequences involve ambiguity instead of known risk, and (b) she will report that the employee has a higher probability of finding a new job when the job market is ambiguous.

Additionally, we explore a mechanism for preventing the adaptation of these self-serving beliefs. We demonstrate that such a self-serving favorable view of ambiguity — and the accompanying increase in self-regarding behavior — can be extinguished by using participants' own initial, and negative, attitudes towards ambiguity when their own earnings are at stake in order to constrain their subsequent beliefs. In the case of the manager, this is analogous to her first considering whether she would prefer to be unemployed in an ambiguous or unambiguous job market. This prevents her from subsequently adopting a favorable view of ambiguity in order to justify the layoff.

2. Review of relevant literature

People often sacrifice personal gain for others' welfare (Kahneman et al., 1986; Dawes and Thaler, 1988; Andreoni and Miller, 2002), a result most strongly demonstrated in the well-known laboratory dictator game, in which one participant shares wealth with another despite the absence of any extrinsic incentives for doing so (Forsythe et al., 1994; see also Camerer, 2003). The extent of this regularity has led many researchers to model such social concern as a preference for fairness or pro-social outcomes (Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000; Charness and Rabin, 2002; Engelmann and Strobel, 2004; Benabou and Tirole, 2006).

People are also generally averse to lotteries about which they possess less precise information on the distribution of outcomes (often referred to as "ambiguous" lotteries),[2] even when such lotteries have objectively identical distributions to lotteries with "known" or "simple" risk. Thus, people prefer to bet on a lottery involving 10 red and 10 blue chips over betting on either color in a lottery involving an unknown combination of 20 red and blue chips, and are often willing to pay a premium for the unambiguous lottery (Curley and Yates, 1989; see also Sarin and Weber, 1993; Ho et al., 2002; Hsu et al., 2005). In fact, such "ambiguity aversion" is referred to as one of the most prominent violations of expected utility theory (Camerer and Weber, 1992),[3] and has led to models in which the value of (or expectation of favorable outcomes in) gambles involving ambiguity is lower than when distributions are defined more precisely (Smith, 1969; Einhorn and Hogarth, 1986; Sarin and Wakker, 1998; Schmeidler, 1989; Ghirardato and Marinacci, 2002).

To summarize the above two lines of research: in contexts pitting self-interest against social concerns people typically place value on the latter, and in contexts involving ambiguous random processes people typically exhibit ambiguity aversion. In the case of our motivating example, ambiguity aversion implies that the employee would suffer greater disutility from being laid off in the market with ambiguous consequences than when the probability is known, and pro-sociality implies that the manager should therefore be less willing to fire the employee under ambiguity than known risk.

However, in this paper we show that the combination of the two contexts produces a surprising reversal of the two underlying phenomena. More precisely, in choices that pit self-interest against others' welfare — as in the example at the beginning of our paper — ambiguity becomes attractive when it can justify self-interested and unfair behavior. We find that more self-interested choices are made when the consequences for others involve ambiguous probabilities about which less is known than when they involve known probabilities — even though, objectively, the ambiguous and known random processes are identical.

Our work is the first to concretely demonstrate that people adopt favorable views of ambiguous risk in order to behave self-interestedly. We do so by directly measuring subjective beliefs, with incentives for accuracy, and by demonstrating that it is these modified beliefs that drive increased self-interested choice. Moreover, we further demonstrate that these positive

[1] There are other contexts in which subjective beliefs can be self-servingly biased in the pursuit of self-interest. For example, a manager deciding whether to adopt a profit-maximizing strategy that might harm the environment could adopt a favorable view of the likely consequences under ambiguity. Similarly, an elected official deciding whether or not to take a bribe could adopt a favorable view of the harmful effects on society when the likelihood of negative consequences is less precisely defined. Finally, mortgage brokers who are motivated to sell loans might find it easy to adopt a favorable view of an applicant's creditworthiness.

[2] There is some debate regarding whether "ambiguity" is the correct term to describe random processes about which there is less precise information — compared to, for instance, "vagueness" (e.g., Budescu et al., 1988) or using the terms "risk" and "uncertainty" to label the distinction (Epstein, 1999). We adopt the term "ambiguity" following the majority of the literature (see Ellsberg, 1961).

[3] There are a few situations in which ambiguity is preferred. Curley and Yates (1989) found ambiguity seeking at low probabilities. Heath and Tversky (1991) found that when people feel confident they prefer to bet on their judgment over a lottery with a probability equal to their confidence, which reflects a preference for the inherently more ambiguous option.

attitudes towards ambiguity can be prevented by using participants' own initial, negative attitudes towards ambiguity to constrain their subsequent beliefs and behavior.

Our results are important for three principal reasons. First, we provide an important caveat to the belief that people are genuinely other-regarding or pro-social when they choose to help others in situations like the dictator game. We find that our participants find an excuse not to behave pro-socially by developing self-serving subjective beliefs to justify self-interested behavior. Our results suggest that self-interest, coupled with a desire to maintain the perception of behaving fairly, is a more likely motivator of behavior. The results support other work that suggests fair or pro-social behavior is diminished when people are given the opportunity to act selfishly without forming negative self-perceptions (Rabin, 1995; Konow, 2000; Murnigham et al., 2001; Dana et al., 2006) or being perceived negatively by others (Lazear et al., 2006; Dana et al., 2007).

Second, we demonstrate that under certain conditions, attitudes towards ambiguity are malleable, based on what an individual wants to believe. Considerable evidence from psychology suggests that individuals tend to process information and arrive at conclusions in a manner influenced by what they *want* to hold true (see Kunda, 1990 for a review of "motivated reasoning").[4] Bargaining and allocation decisions can also be influenced by "self-serving biases" that influence perceptions of fairness (Messick and Sentis, 1979; Babcock et al., 1995, 1996; Wade-Benzoni et al., 1996; Diekmann et al., 1997; Konow, 2000. However, unlike this previous work, in which individuals are self-serving in their perceptions of what is fair, we demonstrate that people can be self-serving in their beliefs about what is likely to happen as a consequence of their decisions. Our participants, who are motivated by self-interest to believe that the lotteries for the recipient are more attractive than they actually are, find it easier to do so with less precise information about the distributions of outcomes under ambiguity.

Third, we demonstrate how the interaction of "regularities" in social science can produce reversals of the underlying phenomena, thus yielding valuable insights. For instance, research on ambiguity aversion and on other-regarding concerns would predict that the manager in our motivating example would be less likely to lay off the employees in the case with ambiguity. However, our research reveals that the self-serving malleability of attitudes towards ambiguity produces the opposite outcome. Understanding when, and how, such interactions of attitudes occur is important for predicting the behavior of economic agents. Moreover, our finding that participants' initial — and unmotivated — attitudes can be used to constrain their subsequent behavior yields an important prescription for how to limit people's ability to engage in self-serving belief manipulation when it comes at the expense of social outcomes.

A few previous studies suggest that when people are faced with tradeoffs between self-interest and fairness, they may capitalize on uncertainty in order to behave self-interestedly. For example, Schweitzer and Hsee (2002) found that participants gave more deceitful and self-interested advice to another, concerning an unknown value, when the range of their private information about the true value was wide compared to when it was narrow. Dana et al. (2007) found that dictators chose to remain ignorant about consequences of their decisions for a recipient — even when this information was freely available — in order to behave self-interestedly. However, none of these studies elicits participants' beliefs of the distributions over uncertain outcomes, as we do, to test whether subjective beliefs actually change in order to justify the increased self-interested behavior. Moreover, we are the first to show how to prevent people from capitalizing on uncertainty to justify self-interested decisions, using only their own previous attitudes. Finally, unlike in the above research, the degree of uncertainty in our experiment is objectively unchanged.

3. Theoretical framework and hypotheses

Our study directly examines the influence of favorably-biased perceptions of subjective uncertainty on fair behavior. We manipulate uncertainty through the distinction between simple (known) risk and ambiguity, which increases *subjective* uncertainty by decreasing the knowledge of the precise probability distribution that determines outcomes. In what follows, we present a simple model to describe the choice environment in our experiment. This model also captures key elements of the example at the beginning of the paper — one individual (the manager) faces a personally beneficial choice that harms another individual (the employee), and where the degree of harm involves varying subjective uncertainty (the likelihood of finding a job is either known ($p = 0.5$) or unknown ($p \sim U[0, 1]$). We use this model to develop our main hypothesis.

We consider a situation in which two individuals, A (the manager) and B (the employee), are both influenced by A's choice between two actions ($x \in \{0, 1\}$), where one action (firing the employee, $x = 1$) benefits A personally, while the other (not firing, $x = 0$) is socially desirable in that it benefits B. Both individuals receive payoffs resulting from the action by A. In addition, B's payoffs may depend on the outcome of a binary lottery ($L \in \{0, 1\}$), corresponding to whether the employee finds work ($L = 1$), which occurs with probability p, or does not find work ($L = 0$) with probability $(1 - p)$.

Denote the individuals' respective payoffs from the action choice and the lottery by $\pi_A(x, L)$ and $\pi_B(x, L)$. A's payoffs are uninfluenced by the lottery (i.e., $\pi_A(x, 0) = \pi_A(x, 1)$ for either value of x) and B's payoffs only depend on the lottery when A chooses $x = 1$ (i.e. $\pi_B(0, 0) = \pi_B(0, 1)$). We use $\pi_A(x, \cdot)$ and $\pi_B(0, \cdot)$ to refer to cases in which payoffs are uninfluenced by the lottery.

[4] Relatedly, people maintain higher perceptions of their own abilities or quality under greater ambiguity (e.g., Dunning, 1999; Klein, 2001; Santos-Pinto and Sobel, 2005; Klein et al., 2006).

Table 1
Payoffs for each allocation decision.

Allocation decision	Other-regarding choice ($x=0$)		Self-interested choice ($x=1$)	
	Payoff to self (π_A)	Payoff to other (π_B)	Payoff to self (π_A)	Payoff to other (π_B)
1	\$2.00	\$1.75	\$3.00	Lottery: ($\frac{1}{2}$, \$0.50)
2	\$2.00	\$1.50	\$2.25	Lottery: ($\frac{1}{2}$, \$1.00)
3	\$1.00	\$0.75	\$1.50	Lottery: ($\frac{1}{2}$, \$0.50)
4	\$1.50	\$1.00	\$2.25	Lottery: ($\frac{1}{2}$, \$0.50)

We allow $x=0$ to represent the other-regarding choice and $x=1$ the self-interested choice by assuming that $\pi_A(0,\cdot) < \pi_A(1,\cdot)$ and that $\pi_B(0,\cdot) > \pi_B(1,1) > \pi_B(1,0) = 0$.[5] Therefore, as in the example at the beginning of this paper, A increases her own payoff by choosing $x=1$, but this lowers B's payoff and makes it dependent on a lottery.

Assume that A's utility is given by

$$U_A = \pi_A(x,\cdot) + \beta\pi_B(x,L), \tag{1}$$

where $0 \leqslant \beta \leqslant 1$ represents A's concern for B's payoff. If $\tilde{p}$ is A's subjective probability for lottery L, then a subjective expected utility maximizing individual A will chose $x=1$ if and only if

$$\pi_A(0,\cdot) + \beta\pi_B(0,\cdot) \leqslant \pi_A(1,\cdot) + \tilde{p}\beta\pi_B(1,1). \tag{2}$$

Now consider two individuals, A_1 and A_2, with identical other-regarding preferences ($\beta_1 = \beta_2$). Assume that they each face the above decision problem, but that their subjective probabilities for lottery L, $\tilde{p}_1$ and $\tilde{p}_2$, may differ. The following proposition follows immediately:

Proposition. *Consider two individuals, A_1 and A_2, with identical other-regarding preferences ($\beta_1 = \beta_2$), then $x_1 = 0$ and $x_2 = 1$ only if $\tilde{p}_1 < \tilde{p}_2$.*

This states that if two equally other-regarding individuals faced with the same decision behave differently, with one choosing $x=0$ and the other $x=1$, then the individual choosing self-interestedly must have a higher subjective probability for the lottery.

Our experiment tests the above relationship between beliefs and behavior, using lotteries that are objectively identical ($p=0.5$ in all cases). We predict that participants, who want to maximize their own wealth but also want to believe they are behaving fairly, will self-servingly adopt a higher subjective probability for lottery L when the lottery is described as "ambiguous." Thus, under ambiguity, more participants will choose self-interestedly and will demonstrate increased subjective expected values for lotteries that determine payoffs for the recipient.

However, we also predict that such self-servingly biased perceptions of ambiguity will be influenced by whether participants have an incentive to view ambiguity favorably and by their own previously developed attitudes towards ambiguity. Therefore, neither participants who make hypothetical choices without real consequences nor participants who previously express preferences between ambiguity and simple risk (and are therefore constrained in how favorably they can view ambiguity) will demonstrate increased self-interested behavior under ambiguity.

Hypothesis. Participants will behave more self-interestedly and will reveal higher subjective expected values for lotteries when the consequences for the other party involve ambiguity instead of simple risk. These relationships will not occur with hypothetical stakes or with previously constrained attitudes.

4. Experimental design

We conducted an experiment to test the above hypothesis. As in the model, participants in our experiment made binary choices involving stochastic payoffs for the other party. Our treatments varied whether the random process involved *ambiguity* or *simple risk*, whether the choices involved *real* or *hypothetical* consequences, and whether participants' attitudes were *unconstrained* or *constrained* by previously expressed attitudes towards ambiguity. All treatments were implemented in a between-subjects design. Table A.1 in Appendix A describes the procedures, in sequence, for our experiment.

[5] To ensure that $x=0$ is socially desirable under criteria other than inequality aversion or altruism (such as the joint payoff for A and B, Engelmann and Strobel, 2004), our experiment makes the joint payoffs to $x=0$ higher than for $x=1$.

4.1. Choices and estimates

In all treatments, participants made four choices involving a tradeoff between self-interest and fairness as described by the model (see Table 1). We modified the standard dictator game to a binary choice with a potentially uncertain outcome for the recipient, as described in the model and in our motivating example. In this modified game, one participant in each pair (the dictator) chose between a "self-interested" allocation ($x = 1$) and an "other-regarding" allocation ($x = 0$) for herself and an anonymous other participant.

These choices were made both by the dictators (for real consequences) and by the recipients (for hypothetical consequences).[6] Following these four choices, all participants (including recipients) estimated the expected value to the other party of their four allocation choices. All participants received a monetary incentive for accuracy ($1 for providing an estimate within $0.10 of the actual expected value).

4.2. Lotteries

Each session involved lotteries with either known (simple risk) or unknown (ambiguity) probabilities. For simple risk lotteries, a chip was drawn from a bag containing precisely 10 red and 10 blue chips (i.e., $p = 0.5$ for each color). For ambiguous lotteries, the bag contained unknown numbers of red and blue chips, totaling 20 chips; the composition was determined by a random draw from 0 to 20, with uniform probability, prior to the experiment ($p \sim U[0, 1]$). This procedure has been used in previous experiments to operationalize ambiguity (e.g., Yates and Zukowski, 1976; Sarin and Weber, 1993; Fox and Tversky, 1995; Charness and Gneezy, 2003; Rustichini et al., 2005). Although the ambiguous lottery might appear subjectively more uncertain than the lottery involving simple risk, the two lotteries are normatively identical: the probability of drawing either a red or a blue chip is 0.5 in both cases.

At the beginning of each session, instructions informed participants that they would make decisions involving lotteries. The instructions explained the distinction between the simple risk lottery (termed "Lottery 1") and the ambiguous lottery (termed "Lottery 2").[7] Lotteries were implemented using bags containing red and blue poker chips (each dictator decided which color they wanted to correspond to a win). The contents of Lottery 2 were determined independently every time the lottery was played by selecting a new random number. Participants were then told which kind of lottery would be used in their session.

We now first described the procedures in for the Unconstrained Treatment, where we expect a positive relationship between ambiguity and self-interested behavior. We then describe how procedures differed for the Constrained Treatment, in which we used dictator's own previous attitudes towards ambiguity to attempt to limit their ability to view ambiguity favorably.

4.3. Unconstrained Treatment

Participants were randomly assigned to the role "A" or "B" and paired with a participant in the opposite role. Participants were assured that their identity and the identity of the person with whom they were paired would be anonymous. Role A participants made decisions with consequences for themselves and for their matched Role B participant. Role B participants made similar decisions, but their decisions were hypothetical and did not impact outcomes or payoffs (participants knew this). A's and B's were moved to opposite sides of the room following role assignment.

Each participant made the four choices in Table 1. The labels "self-interested" and "other-regarding" were not used; instead the choices were presented neutrally, as follows:

*Please select **one** of the following*:
__ *You receive **$2** for certain and the person you are matched with receives **$1.75** for certain*
OR
__ *You receive **$3** for certain and the person you are matched with wins **$0.50** if a winning chip is drawn in his/her lottery*

All participants received a stack of four sheets, each containing one of the decisions in Table 1. We counterbalanced the order of decisions; roughly one half of participants in each condition received the decisions in the inverse order. Participants were told to go through the sheets one by one, and not to return to previous sheets.

[6] We elicited the hypothetical choices from recipients as a way to test our hypothesis that favorable subjective beliefs for ambiguity would not occur if participants were not motivated to view ambiguity favorably. It should be noted that the recipients who make hypothetical dictator decisions might have other motivations that drive their decisions. For example, they may behave differently due to their randomly-assigned disadvantageous position. Thus, these are not exactly the same as purely hypothetical dictators who serve no other role in the experiment. However, our focus is on whether their behavior changes between ambiguity and simple risk, and there is little reason to believe that these other motivations would interact with ambiguity.

[7] Even though we used a between-subjects design where each session made decisions under either ambiguity or simple risk, we described both lotteries to each session based on evidence that ambiguity is only perceived in a comparative context (Fox and Tversky, 1995).

The experimenter collected these sheets and distributed another response sheet, which asked *all* participants to estimate the expected dollar amount that the recipient of the previous four choices (real or hypothetical) would receive after the resolution of any lotteries.[8] They were told that for an estimate within \$0.10 of the actual expected value they would receive \$1. Finally, to measure attitudes towards ambiguity, all participants were asked to decide between playing Lottery 1 or 2 for the chance to win \$5 for themselves (and to chose a winning color in the lottery). They were informed that one person would be selected at random to play this lottery at the end of the session.

All lotteries were then resolved sequentially by drawing either a red or blue chip out of a bag. For each lottery, a new bag was used and the result was announced publicly. Participants were then paid privately, in cash.[9] One participant stayed behind to play the additional \$5 lottery.

4.4. Constrained Treatment

The Constrained Treatment was identical to the Unconstrained Treatment, except that participants first made individual decisions involving risk and ambiguity, with no conflict between self-interest and fairness. These decisions were made prior to participants having any knowledge of the binary dictator game. Our hypothesis is that eliciting subjects' own attitudes towards ambiguity will constrain their ability to subsequently view ambiguity favorably when making the binary dictator choices.

After the explanation of lotteries at the beginning of the experiment, participants each made four decisions involving lotteries for themselves. Participants made these decisions under either simple risk or ambiguity (between-subjects). These decisions serve as a control to ensure that participants are not naturally ambiguity-loving for the stakes and probabilities associated with the allocations in the binary dictator game.[10]

Participants in the Constrained Treatment then made another single choice in which they expressed a preference either for simple risk or ambiguity. This choice was intended to establish participants' unmotivated and negative attitudes towards ambiguity. Participants chose which kind of lottery (1 or 2) they would like to play for the chance to win \$5 and were informed that one participant would be randomly selected at the end of the session to play the lottery. (Participants in the Unconstrained Treatment also made this choice, but at the end of the experiment.)

The Constrained Treatment then proceeded identically to the Unconstrained Treatment, beginning with random assignment to the role of A (dictator) or B (recipient) and instructions for the binary dictator game.[11]

4.5. Participants

Participants were recruited from a subject pool of undergraduate students taking business courses at Carnegie Mellon University. They received extra credit in one class in exchange for participation in an hour-long experiment. In addition, participants received their cash earnings privately at the end of the experiment. For the Unconstrained Treatment, we used 89 pairs of A and B participants (43 under simple risk, 46 under ambiguity), while in the Constrained Treatment, we used 58 pairs (29 under simple risk, 29 under ambiguity). Thus, a total of 294 participants participated in the experiment.

5. Results

Our primary variables of interest are the four allocation choices made by participants ($X_i = \{x_i^j\colon\ j = 1, \ldots, 4\}$) and participants' subjective estimates of the expected value of the total allocation (real or hypothetical) to the other party across the four decisions:

[8] We explicitly asked participants for the "expected value." The exact instructions were as follows: "Think back over the choices you have just made. What is the dollar amount that best reflects the amount that **the participant you are matched with** will receive **in total** for all 4 choices? That is, what is the total expected value of your choices for the participant you are matched with? This is the best guess that one could make about the amount that the participant will take home at the end of the experiment given that it may depend on lotteries with uncertain outcomes." We chose to ask for a single number rather than four separate numbers because we thought the latter might impose additional demands on subjects' memory (they would have to remember not just the four expected values, but also to which choices they corresponded). Also, for the purposes for having an estimate of how well dictators believe they had treated the recipient, asking for this single number seems appropriate. (In footnote 14 we discuss problems with an earlier wording of the question.)

[9] Prior to payment, participants filled out a brief questionnaire asking them to rate the fairness of their own choices and how fair they viewed themselves in general. We thought that dictators who made decisions under ambiguity might view self-interested allocations as less unfair. Previous versions of this paper found moderate support for this hypothesis. However, after collecting additional data, this result did not replicate and thus, we excluded the analysis.

[10] The decisions involved exactly the same kinds of lotteries (Lottery 1 or Lottery 2) as those used in the dictator decisions. Each decision was between a lottery for a small amount (\$1) and the equivalent expected value with certainty (\$0.50). Subjects choices were similar between simple risk and ambiguity (67% chose the lottery in each condition). Thus, we can reject the possible confound that, for this level of stakes and probability, the ambiguous lotteries are more attractive than those involving simple risk.

[11] People in the Constrained Treatment have opportunities to earn money in the experiment before they make dictator game decisions, meaning that their (expected) wealth may be slightly higher than that of subjects in the Unconstrained Treatment. However, the contrast of interest for our study is not a direct comparison between the Constrained and Unconstrained Treatments, but rather a comparison of ambiguity versus simple risk within the two conditions. Any influence of wealth effects would likely influence the Constrained condition for both ambiguity and simple risk, and would do so equally.

Table 2
Frequencies of self-interested choices by treatment (proportion of $x_i^j = 1$).

	Real (A participants)		Hypothetical (B participants)	
	Unconstrained	Constrained	Unconstrained	Constrained
Ambiguity	135/184 (73%)	69/116 (59%)	112/184 (61%)	70/116 (60%)
Simple risk	101/172 (59%)	73/116 (63%)	103/172 (60%)	62/116 (53%)
	$z = 2.92$ $p < 0.01$	$z = 0.54$ $p = 0.59$	$z = 0.19$ $p = 0.85$	$z = 1.06$ $p = 0.29$

Table 3
Probit regressions of behavior by treatments.

	Dependent variable: self-interested choice (x_i)			
	Real (A participant)		Hypothetical (B participant)	
	Unconstrained	Constrained	Unconstrained	Constrained
Ambiguity (= 1)	0.572** (0.277)	−0.043 (0.610)	0.028 (0.319)	0.320 (0.524)
Choice 1	−0.734*** (0.247)	−1.004*** (0.366)	−0.435* (0.241)	−0.712** (0.332)
Choice 2	−1.399*** (0.260)	−1.926*** (0.419)	−1.067*** (0.249)	−0.888*** (0.337)
Choice 3	−0.314 (0.250)	−0.495 (0.357)	−0.253 (0.241)	−0.547* (0.327)
Constant	0.956*** (0.260)	1.576*** (0.514)	0.864*** (0.282)	0.720* (0.431)
Observations (subjects)	356 (89)	232 (58)	356 (89)	232 (58)
Log likelihood	−191.78	−112.02	−202.92	−124.23

Notes. Participant random effects. Standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$, two-tailed.

$$\tilde{E}_i[\pi_B|X_i] = \sum_{j=1}^{4}(1 - x_i^j)\pi_B^j(0,\cdot) + x_i^j\tilde{p}_i^j\pi_B^j(1,1). \tag{3}$$

We compare a participant's estimate to the actual expected value of the allocation to the other party ($E_i[\pi_B|X_i]$) − which is the same as in the equation above, but with the actual probability for each lottery (p^j) in place of the subjective probability ($\tilde{p}_i^j$). For each individual participant, we construct a measure of estimate bias:

$$\text{Bias}[\tilde{E}_i] = \tilde{E}_i[\pi_B|X_i] - E_i[\pi_B|X_i] = \sum_{j=1}^{4} x_i^j\left(\tilde{p}_i^j - p^j\right)\pi_B^j(1,1). \tag{4}$$

Recall that our main hypothesis can be summarized as follows: ambiguity will lead to more self-interested (and unfair) choices and greater estimate bias relative to simple risk, only for Real choices made by Unconstrained dictators.

5.1. Choices

Table 2 presents, for each treatment, the frequency of self-interested ($x = 1$) choices made by participants. The results support our hypothesis. Unconstrained-Real participants choosing under ambiguity chose the self-regarding option 73% of the time (an average of 2.93 out of 4 choices). This frequency was higher than in *all* other conditions. Most relevant for our hypothesis, the frequency of unfair choices was lower for Unconstrained-Real participants under simple risk (59%, or 2.35 of 4 choices) and this difference is statistically significant. Moreover, there is no statistically significant difference in the proportions of self-interested choices between ambiguity and simple risk in any of the other conditions. The proportion of self-interested choices in the top left cell in Table 2 (Real-Unconstrained-ambiguity) is significantly higher than in any other cell ($p < 0.06$ in one instance, $p < 0.02$ in all others).

Table 3 reports probit regressions, with participant random effects, testing the effect of ambiguity on choice. We include binary variables for three of the four choices made by subjects (see Table 1, choice 4 is the excluded category). Again, we see that ambiguity only produces significantly more self-interested behavior for Real-Unconstrained participants.[12]

[12] The coefficients and statistical significance for ambiguity are similar if we exclude the binary variables for choice or if we omit random effects and instead cluster standard errors by participant.

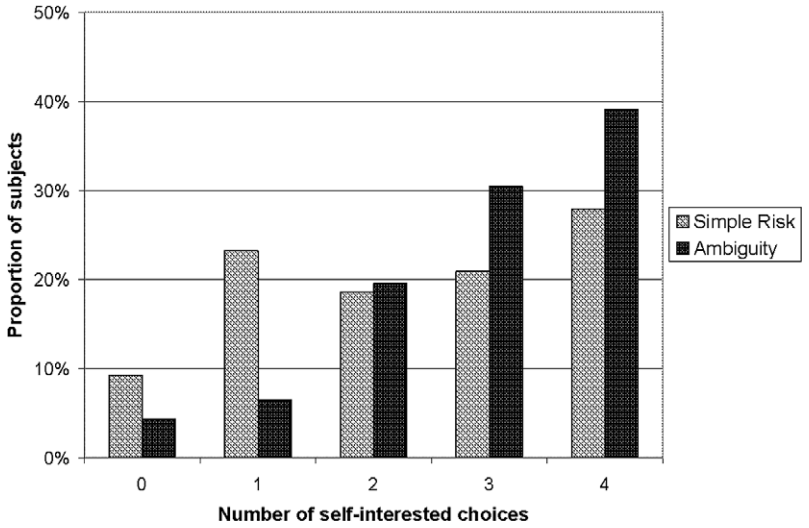

Fig. 1. Distributions of self-interested choices in Real-Unconstrained treatment.

Table 4
Summary of estimate bias by condition.

		Real (A participant)		Hypothetical (B participant)	
		Unconstrained	Constrained	Unconstrained	Constrained
Ambiguity	Mean	\$0.89	\$0.20	\$0.44	\$0.40
	(Std. Err.)	(\$0.24)	(\$0.24)	(\$0.24)	(\$0.37)
	Median	\$0.55	\$0.25	\$0.25	\$0.00
	N	46	29	46	29
Simple risk	Mean	\$0.29	\$0.23	\$0.51	\$0.28
	(Std. Err.)	(\$0.21)	(\$0.35)	(\$0.22)	(\$0.35)
	Median	\$0.38	\$0.00	\$0.25	\$0.38
	N	38	29	38	28
		$t_{82} = 1.78$	$t_{56} = 0.08$	$t_{82} = 0.21$	$t_{56} = 0.22$
		$p = 0.08$	$p = 0.94$	$p = 0.84$	$p = 0.83$

While we observe, as predicted, significantly more self-interested choices for Real-Unconstrained dictators under ambiguity than under simple risk, there is no significant difference in behavior between ambiguity and simple risk for any of the other conditions. Hypothetical (B participant) choices do not differ significantly between ambiguity and simple risk, which is consistent with our hypothesis that ambiguity is only used to justify self-interested decisions only when one is motivated by self-interest. Similarly, there is no difference in self-interested behavior between ambiguity and simple risk for Constrained-Real dictators. This is also consistent with our hypothesis, indicating that dictators cannot adopt a favorable view of ambiguity once they have previously expressed a personal preference for simple risk over ambiguity, when making decisions that affect only themselves.

Fig. 1 presents the number of self-interested choices (out of four) made by Real-Unconstrained participants under simple risk and ambiguity. More participants chose self-interestedly zero or one times under simple risk (33%) than under ambiguity (11%), while more choose self-interestedly three or four times under ambiguity (70%) than under simple risk (49%). A non-parametric Wilcoxon rank-sum test reveals the distributions of participant behavior differ significantly ($z = 2.05$, $p = 0.04$).[13]

5.2. Estimate bias

Turning to bias in estimates of the expected value of the allocation, Table 4 and Fig. 2 reveal a pattern consistent with our hypothesis.[14] On average, Unconstrained-Real participants under ambiguity overestimated the expected value the total

[13] The distributions do not differ significantly for any of the other conditions (Real-Constrained: $z = 0.11$, $p = 0.91$; Hypothetical-Unconstrained: $z = 0.24$, $p = 0.81$; Hypothetical-Constrained: $z = 0.59$, $p = 0.56$).

[14] In the first session we conducted (simple risk-Unconstrained; 5 participants in each role), estimates were very low. We realized that participants were providing the average expected earnings per choice rather than the expected earnings summed across all four choices. We changed the instruction wording for the remaining sessions to be more precise. To avoid making comparisons across wording formats, we omit these responses. Since the mean

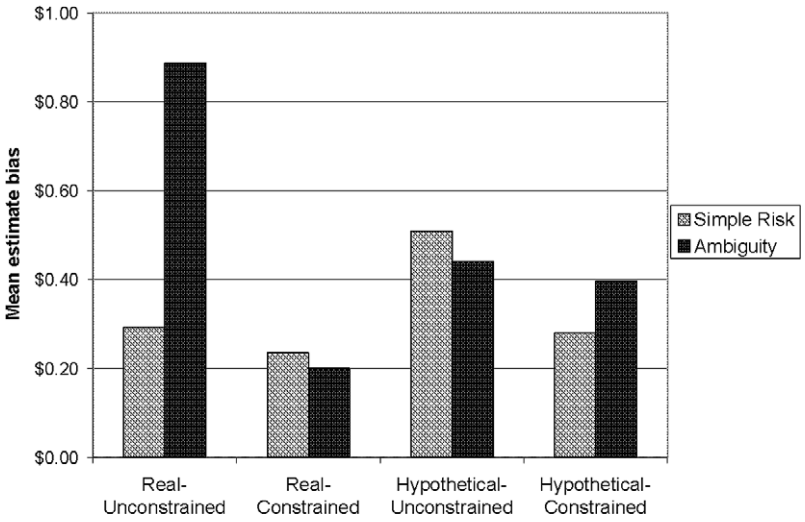

Fig. 2. Mean estimate bias by condition.

allocation to the recipient by \$0.89, which is higher than the mean estimate bias of \$0.29 under simple risk.[15] This difference in estimate bias is significant at $p = 0.08$. In no other condition is there a statistically significant difference in estimate bias between ambiguity and simple risk. Moreover the mean (median) estimate bias under ambiguity for Real-Unconstrained participants is higher than the mean (median) estimate bias in any other condition.

The results support our main hypothesis of increased self-interested behavior and positively biased estimates of generosity when consequences for the other party are ambiguous. Participants chose the self-regarding option more frequently under ambiguity than under simple risk and they overestimated the expected value of the allocation to the recipient. However, when participants were not motivated to view ambiguity favorably (i.e., recipients who made hypothetical choices) or when participants' attitudes were constrained by their own previously formed-beliefs,[16] we find no relationship between ambiguity and either increased unfair behavior or favorably biased expectations.

5.3. Additional analysis

Our hypothesis is based on the idea that biased subjective probabilities under ambiguity — when stakes are real and participants' attitudes are unconstrained — lead to increased self-interested behavior. Thus, it is not ambiguity *per se* that should produce a change in behavior, but rather the bias in subjective beliefs should be what drives the change in behavior.

Table 5 explores the relationship between behavior and estimate bias in the Real-Unconstrained condition. The first regression replicates the first regression in Table 3, demonstrating a relationship between ambiguity and self-interested behavior, using only participants for whom we have estimate data (see footnote 14). The second regression demonstrates that self-interested behavior is also positively and significantly related to estimate bias. The final regression demonstrates that the relationship between estimate bias and self-interested behavior is much stronger than that of ambiguity alone. While a comparison between models 1 and 3 reveals that including estimate bias significantly improves the model's fit ($\chi^2(1) = 25.03$, $p < 0.001$), the same is not true for the inclusion of ambiguity in a comparison of models 2 and 3 ($\chi^2(1) = 1.95$). Thus, these results indicate that the effect of ambiguity on behavior operates primarily through biased subjective beliefs, as we predicted.

Finally, if participants in the Real-Unconstrained condition really developed self-serving subjective probabilities for the lotteries under ambiguity, we might expect our treatment effect to persist into the lottery choice that each participant made later in the experiment, between the two kinds of lotteries, for the chance to win \$5 for themselves. Considering only Real-Unconstrained participants, we find that only 5 of 42 (12%) of those who had earlier made binary dictator choices under

underestimation among dictators in this group was \$1.33, including their responses would dramatically strengthen the significance of the comparison in the direction we hypothesized. We also omit the estimate of one recipient who gave an estimate of \$14, which is well above the possible maximum value of the allocation to the recipient (\$5) and over 3 standard deviations above the next highest estimate. Again, since this participant was in the simple risk-Constrained condition, where we predict ambiguity would not produce higher estimates than simple risk, including this estimate would strengthen support for our hypothesis. Note also that this is the only outlier under the revised instructions, suggesting that subjects generally understood the estimation task.

[15] If we break down the estimate bias in the Real-Unconstrained Treatment by the number of self-interested choices made by that participant, the estimate bias is higher under ambiguity than under simple risk in all cases, except for participants who made zero self-interested choices.

[16] As we expected, a majority of participants in the Constrained condition exhibited ambiguity aversion in the initial choice between lotteries (85 of 116, or 73%, preferred the simple risk lottery; significantly different from 50% using a binomial test ($p < 0.01$, one-tailed)).

Table 5
Probit regressions of behavior in Real-Unconstrained Treatment.

	Dependent variable: self-interested choice (x_i)		
	(1)	(2)	(3)
Ambiguity (= 1)	0.608** (0.287)		0.334 (0.239)
Estimate bias		0.472*** (0.091)	0.449*** (0.090)
Choice 1	−0.795*** (0.259)	−0.771*** (0.258)	−0.770*** (0.257)
Choice 2	−1.457*** (0.272)	−1.434*** (0.271)	−1.426*** (0.271)
Choice 3	−0.448* (0.261)	−0.461* (0.258)	−0.462* (0.257)
Constant	0.988*** (0.276)	1.026*** (0.222)	0.849*** (0.247)
Observations (subjects)	336 (84)	336 (84)	336 (84)
Log likelihood	−180.09	−167.60	−166.64

Notes. Participant random effects. Standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$, two-tailed.

simple risk chose to play the ambiguous lottery for themselves, consistent with ambiguity aversion.[17] However, the ambiguous lottery was preferred by a much larger proportion of participants who had previously made binary dictator decisions with Ambiguous consequences (16 of 46, 35%). This difference is statistically significant ($z = 2.51$, $p = 0.01$, two-tailed). Thus, the effect of our ambiguity vs. simple risk treatment has lasting consequences on participants' attitudes towards the two kinds of lotteries.

6. Conclusion

We present evidence that people develop positive and self-serving attitudes towards ambiguity when doing so allows them to behave self-interestedly at another's expense. That is, people view ambiguity as favorable when it allows them to believe what they are doing to others is "not that bad." Participants are more likely to give low-paying lotteries to others when these lotteries involve ambiguity compared to simple risk, and they subsequently treat these lotteries as more attractive, reflected by higher estimates of the lotteries' expected value and by increased willingness to bet on an ambiguous lottery with their own money at stake.

We demonstrate that the effects of ambiguity on behavior operate mostly through participants' biased subjective beliefs. First, we show that the change in behavior due to ambiguity is accompanied by an increase in the subjective valuations of lotteries given to the other party. It is these modified beliefs, rather than the use of ambiguous lotteries *per se*, that drive the change in behavior. Moreover, we show that constraining participants' ability to manipulate their beliefs, using their own, previously acknowledged, natural attitudes towards ambiguity, eliminates the relationship between ambiguity and self-interested behavior.[18]

The majority of previous research on ambiguity indicates that people interpret ambiguity unfavorably. Our results indicate that how people interpret ambiguity is more complicated and context-dependent. In contexts where there exists a strong motivation to view ambiguity favorably, people will adopt a more favorable view if they are unconstrained by other factors, such as their own previous attitudes. Thus, people's overall attitudes towards ambiguity may be more accurately described by "ambiguity distortion" rather than ambiguity aversion.[19]

Our findings are also consistent with previous evidence suggesting that people will engage in "moral wiggling," seizing justifications to behave self-interestedly without explicitly appearing so to themselves or others (see Dana et al., 2007). In this paper, we show that ambiguity about decision consequences presents just such a justification.

Our research has implications for many economic contexts. Individuals regularly face choices pitting self-interest against the welfare of others, and such decisions in the real world often involve uncertainty about the resulting consequences. We show here that the degree of subjective uncertainty exerts a strong influence on the resulting behavior in the direction of self-interest.

[17] One participant did not answer this question.

[18] The results of the Constrained Treatment also help to rule out the possibility that the bias in estimates is driven by a simple *post hoc* justification or an excuse for selfish choices, rather than the actual belief in the favorability of ambiguous lotteries. If the observed bias in expectations merely reflected excuses for selfish choices, there is no reason why dictators should not give these excuses after the adoption of an unfavorable view of ambiguity in the Constrained Treatment. Yet, dictators do not show this bias in the Constrained Treatment.

[19] An interesting question raised by our research is whether similar patterns could arise for how people treat simple risk versus certainty when they are the consequence for another of one's actions. We demonstrate here that increased subjective uncertainty can give rise to self-serving perceptions of the consequences to another of our behavior. Therefore, one might also see similar patterns when what we do impacts another either with certainty (e.g., a $1 loss) or with risk (a 0.5 probability of a $2 loss). "Dictators" in such environments might view the latter more favorably because it allows greater flexibility in subjective beliefs.

Appendix A

Table A.1
Sequence of experimental procedures.

Unconstrained Treatment	Constrained Treatment
Lotteries	Lotteries
• Description of two kinds of lotteries: simple risk ("Lottery 1") and ambiguity ("Lottery 2") • Participants told which lottery will be used in experiment	• Description of two kinds of lotteries: simple risk ("Lottery 1") and ambiguity ("Lottery 2") • Participants told which lottery will be used in experiment
	Choices involving risk
	• Description of choices between a lottery and certainty equivalent (Table 2) • All participants make 4 choices
	Ambiguity attitude: Choice of Lottery 1 vs. Lottery 2 for \$5 (one participant selected at end of experiment to play)
Dictator choices (X_i)	*Dictator choices* (X_i)
• Description of binary dictator game (Table 1) • A participants make 4 real choices • B participants make 4 hypothetical choices	• Description of binary dictator game (Table 1) • A participants make 4 real choices • B participants make 4 hypothetical choices
Estimates of expected payoff to recipient based on own (real or hypothetical) choices ($\tilde{E}_i[\pi_B \mid X_i]$)	*Estimates* of expected payoff to recipient based on own (real or hypothetical) choices ($\tilde{E}_i[\pi_B \mid X_i]$)
Ambiguity attitude: Choice of Lottery 1 vs. Lottery 2 for \$5 (one participant selected at end of experiment to play)	
Resolution of all lotteries and payment	Resolution of all lotteries and payment

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