Loss Aversion and Sunk Cost Sensitivity in All-pay Auctions for Charity: Experimental Evidence*

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Abstract

All-pay auctions have demonstrated an extraordinary ability at raising money for charity. One mechanism in particular is the war of attrition, which frequently generates revenue well beyond what is theoretically predicted with rational bidders. However, what motivates the behavioral response in bidders remains unclear. By imposing charity auction incentives in the laboratory, this paper uses controlled experiments to consider the effects of loss aversion and sunk cost sensitivity on bidders' willingness to contribute. The results indicate that revenues in incremental bidding mechanisms, such as the war of attrition, rely heavily on bidders who are sunk cost sensitive. It is shown this behavioral response can be easily curbed with a commitment device which drastically lowers contributions below theoretical predictions. A separate behavioral response due to loss aversion is found in the sealed-bid first-price all-pay auction, which reduces bidders' willingness to contribute. These findings help explain the inconsistencies in revenues from previous all-pay auction studies and indicate a mechanism preference based on the distribution of these behavioral characteristics.

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Many non-profit organizations today are finding charity auction events helpful in reaching their fund-raising goals. This strategy is with merit, as much of the theoretical and empirical literature on charity auctions demonstrate they are superior revenue-raising mechanisms over alternative methods, such as raffles and voluntary contributions. Moreover, charitable organizations can create fund-raising opportunities by taking donations lacking mission-oriented value and converting them into cash. For instance, a human rights organization recently raised over $600,000 through a winner-pay auction when Apple CEO Tim Cook agreed to have a coffee date with the highest bidder.

Attention has focused recently on all-pay auctions, which are mechanisms that collect revenue from all those who submitted a positive bid, regardless of who wins. It has been shown all-pay auctions possess properties that generate expected revenues greater than that of more traditional, winner-pay auctions (cf. Goeree et al. 2005; Engers and McManus 2007). However, the empirical evidence for the all-pay advantage is certainly mixed. In field studies, Carpenter et al. (2008) and Onderstal et al. (2013) find that first-price all-pay auctions under-perform relative to the first-price winner-pay in the former and the voluntary contribution mechanism (VCM) in the latter. Both of these studies conclude a lack of participation as the source of the shortfall. On the other hand, Carpenter et al. (2014) found the all-pay auction to raise more revenue than the first-price winner-pay and the second-price winner-pay in a laboratory setting. In addition, their paper also introduced a promising all-pay mechanism called the "bucket" auction, which is a variation of the war of attrition. This is a time-based incremental bidding mechanism equivalent to a second-price all-pay auction, and it raised one and a half times more revenue than the first-price all-pay auction - and well beyond what was theoretically predicted.

To better understand when all-pay mechanisms are successful, this paper investigates the first-price all-pay auction and the war of attrition to ask two questions. First, how do mechanism-specific characteristics (e.g., incremental vs. sealed bid bidding) affect bidders' contributions? Second, how do bidder-specific characteristics (e.g., loss aversion and sunk cost sensitivity) affect bidder contributions and thus revenue? A theoretical model is provided to underpin the predictions of contributions from rational agents, while the experiments highlight the behavioral tendencies of subjects in a controlled environment. The results indicate incremental bidding mechanisms, such as in the war of attrition, can be advantageous when bidders are sufficiently sunk cost sensitive. However, they underperform when those bidders are absent or when provided with a commitment device which limits their ability to bid. Finally, a separate behavioral response from loss averse bidders is present in the sealed bid first-price all-pay auction, which is shown to reduce their willingness to contribute. Ultimately, a charity's preference over which all-pay auction to run depends on the distribution of bidders who are sensitive to losses and sunk costs, with the preference being the first-price all-pay auction when bidders are relatively rational.

The paper proceeds as follows: Section 1 provides an overview of the relevant literature for charity auctions; Section 2 presents a theoretical model of rational bidder behavior for the war of attrition and the first-price all-pay auction and establishes hypotheses to be experimentally tested; Section 3 describes the laboratory experiments conducted to test the hypotheses from Section 2; Section 4 presents the results from the experiments and summarizes the statistical evidence for (against) the hypotheses in Section 2; Section 5 provides concluding remarks.

1 All-pay Auction Mechanisms for Charity

Under the standard theoretical assumptions, auction bids are larger when the revenue goes to charity than when it is for profit. This 'charity premium' is the result of assuming 1) bidders receive a public good benefit from auction revenues (Goeree et al. 2005), and 2) that bidders experience 'warm glow' from personally contributing to the charity (Engers and McManus 2007). Empirically, Elfenbein and McManus (2010) compared over two thousand charity and for-profit auctions on eBay, finding that items linked to charity raised 6% more revenue on average. In a similar field experiment, Popkowski and Rothkopf (2010) find bid levels increase by more than 40% in online charity auctions compared to otherwise identical for-profit auctions.

Perhaps more importantly, the expected revenue from charity auctions can vary by mechanism under these assumptions - a violation of the revenue equivalence theorem. As a result, the choice of auction mechanism becomes a particularly important consideration. It has been shown that all-pay auctions outperform winner-pay auctions when there is a sufficient number of bidders.[1] The intuition of this rank-ordering of revenue in winner-pay and all-pay auctions rests on solving a type of free-rider problem. Goeree et al. (2005) explains that bidders in winner-pay auctions are confronted with the trade-off of winning the auction (and claiming the value of some prize less their bid) and free-riding on the benefits generated from another's winning bid. However, this trade-off is attenuated with all-pay auctions. Furthermore, Goeree et al. (2005) demonstrates this trade-off is best managed by a last-price all-pay auction, in which the highest bidder wins and pays the lowest bid submitted. In a laboratory study on last-price

[1] See Morgan (2000), Morgan and Sefton (2000), Goeree et al. (2005), Engers and McManus (2007), Isaac et al. (2008) and Carpenter et al. (2014) for a comparison of all-pay mechanisms to other mechanisms.

all-pay auctions for charity, Damianov and Peeters (2015) suggests these predictions require a sufficient number of bidders to hold.

Given that several studies have demonstrated the performances of all-pay mechanisms are sensitive to the level of competition (i.e. participation), fundraisers may prefer a mechanism that does rely on bids from many potential bidders. A relatively new mechanism introduced in Carpenter et al. (2014) called the "bucket" auction has the promise of harnessing the theoretical benefits of all-pay auctions without its success requiring much at all of participation. The bucket auction is a sequential-move war of attrition, a contest in which n bidders vie for one of $k < n$ prizes by expending resources at a constant rate through time. The contest persists until $n - k$ bidders choose to exit the contest, thus making it equivalent to a $(k+1)^{\text{th}}$-price all-pay auction. Standard wars of attrition have the important property of "instant exit," in which all but $k+1$ participants exit without expending any resources (Bulow and Klemperer 1999). By imposing a charity auction environment to the war of attrition, Carpenter et al. (2014) shows that this mechanism can generate equivalent expected revenues from $k+1$ bidders, while the sealed-bid alternatives require positive contributions from all n bidders. For example, in the case where there is one prize ($k = 1$), only two bidders are required to generate expected revenue equal to that of a second-price all-pay auction.

In addition to concentrating contributions to fewer bidders, the war of attrition has shown to raise revenue well beyond what is theoretically predicted in a charity setting, and simultaneously overshadowing the performances of other mechanisms. In Carpenter et al. (2014), the war of attrition raised two and a half times more revenue than the next best winner-pay mechanism and one and a half times more revenue than the first-price all-pay auction. While there is limited evidence to aid in comparison, there has been a stark difference in the level of competition reported from a laboratory study in non-charity wars of attrition. Notably, Höerisch and Kirchkamp (2007) find wars of attrition under-perform relative to theoretical predictions. The substantial empirical difference gives rise to behavioral considerations for what makes the war of attrition so inconsistent.[2] Carpenter et al. (2014) reports that bidders who were sunk cost sensitive or competitive (or both) were willing to compete longer in the war of attrition relative to those who were not. One explanation for this finding, which is independent of any

[2]A few studies of the war of attrition in specific environments have also been conducted. For instance, Bilodeau et al. (2004) studies the willingness of individuals with heterogeneous preferences to be the provider of a public good in what they call the *volunteer's dilemma*. Their paper reports the willingness to provide the good matches the comparative static predictions. Oprea et al. (2012) studies the war of attrition in an industrial organizational context, in which two firms compete in an unsustainable duopoly. Their paper finds the degree of competition to be very close to the point predictions in their model.

incentive-based features of the auction and will be explored further in this paper, is the appeal of the sequential, time-based bidding method in the war of attrition.

Given these behavioral considerations, if bidders recognize they are prone to over-bidding then providing them with a commitment device that limits their ability to bid will cause a decrease in contributions. On the other hand, it may be possible to artificially elevate contributions in a sealed-bid mechanism, such as the first-price all-pay auction, by adopting the time-based bidding properties in the war of attrition. Both of these ideas will be explored using controlled experiments.

In the next section, a theoretical framework outlines predictions over rational contribution strategies in the first-price all-pay auctions and the war of attrition. This design will provide the benchmark used to evaluate the effects of mechanism variants on bidders' willingness to contribute.

2 Theoretical Motivation

Two all-pay auction mechanisms are explored theoretically in this paper, the sequential-move war of attrition (WoA) and the first-price all-pay auction (FPAP). In each auction mechanism it is assumed there are $n \geq 2$ risk-neutral bidders looking to claim a single item with a pure common value v. Complete information regarding n and v is assumed. Following Engers and McManus (2007) on charity auction characteristics, it is assumed that bidders receive two constant marginal benefits from auction revenue. The first benefit α measures the indirect benefit a bidder receives from each unit of revenue raised. This benefit is independent of which bidder generates the revenue. The second benefit γ measures the benefit a bidder receives from personally contributing a unit of revenue to the auction, which is motivated by the notion that bidders receive "warm glow" benefits from supporting the charity.

Due to the loss of revenue equivalence in a charity setting, isolating the effects that mechanism characteristics have on contributions requires special consideration. In this effort, variations of the WoA and FPAP are explored in a way so that changing bidding rules, such as incremental vs. lump-sum bidding, become revenue neutral. In the FPAP, Baye et al. (1996) is paired with the charity preferences assumed here, which establishes the unique symmetric mixed strategy equilibrium over contributions. The traditional sealed-bid format is then modified such that pre-committed contributions are revealed in an incremental, turn-based manner (as described in Figure 1 below), which mimics the WoA without changing the incentives of the

FPAP. This variation will be explored experimentally.

In the WoA, Markov-perfect equilibria are explored to best capture the sequential-move nature of this auction. Charity characteristics are applied to a model in the vein of Augenblick (2016). To measure the extent to which contributions are motivated by sunk cost sensitivities, a variation of the WoA allows bidders to set a personal maximum contribution before the auction begins. This, too, is a revenue-neutral variation that is explored through experimentation.

Analysis begins with bidders pursuing rational strategies according to the incentives of each mechanism. While there exist several asymmetric equilibria within each mechanism, focus is given primarily to symmetric equilibria.

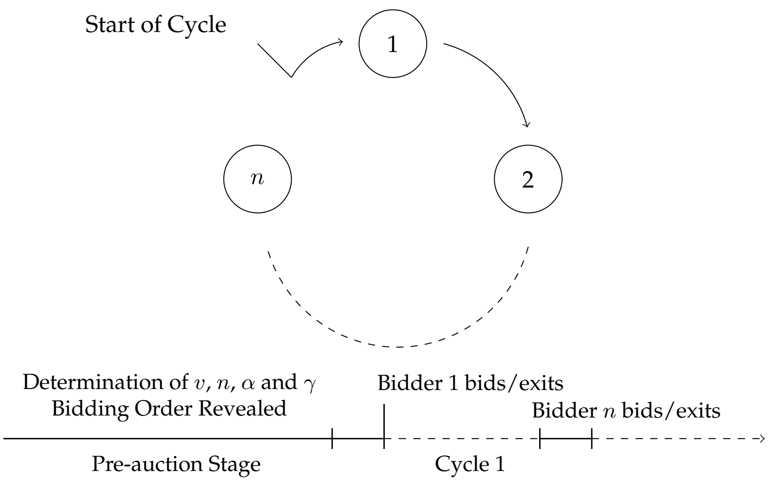
2.1 The Sequential-move War of Attrition

The two stages of this sequential-move war of attrition are described below.

Nature: the pure common value of the item v, the number of potential bidders n, and the constant marginal benefits to revenue (α and γ) are exogenously determined. Bidders are randomly assigned to a bidding sequence.

Auction Stage: the auction begins and bidders choose to bid or exit sequentially in the pre-determined order. Bidding has a monetary cost of c in each cycle, and exiting is permanent. The auctioneer cycles through bidders until one bidder remains, and this bidder claims the prize.

Figure 1: Sequential-move War of Attrition



For simplicity, attention is given primarily to Markov-perfect equilibria. This is a refinement to the subgame perfect equilibrium concept in which players employ 'memoryless' strategies conditioned only by the current state of the game (Maskin and Tirole 2001).[3] In the symmetric case, strategies involve each of the n bidders remaining to choose to bid (and stay in the auction) with probability p_n. Therefore, each bidder exits with probability $1-p_n$. Equilibrium bidding strategies are identified via backward induction in the final subgame where $n=2$ bidders remain. The expected return to bidding with probability p_2 is balanced with the expected benefit from exiting such that

$$\begin{aligned} p_2[\alpha c] + (1-p_2)[v] - (1-\alpha-\gamma)c &= 0 \\ \Rightarrow p_2 &= \frac{v-(1-\alpha-\gamma)c}{v-\alpha c} \end{aligned} \tag{1}$$

On the left side of (1) we see the expected return to bidding has three terms. The first term is the benefit received when the other remaining bidder bids (αc) with probability p_2. The second term is the return from the other remaining bidder exiting with probability $1-p_2$, in which case the item is claimed. The final term is the cost to the bidder for bidding, adjusted by α and γ, which the bidder pays regardless of the other bidder's action. On the right side of (1) is the expected return to exiting, which is equal to zero due to the flow of auction externalities ending, the prize being awarded to the other bidder, and incurring no bid expenditure. To ensure the marginal benefits of bidding do not outweigh the marginal cost of bidding it is assumed $1-2\alpha-\gamma>0$. Importantly, the resulting bidding strategy for any bidding cycle t leads all bidders in cycle $t-1$ indifferent between bidding and exiting, making continuation profits equal to zero and imposing the same mixed bidding strategy in all cycles $\{1,...,t-1\}$.

In the final subgame this model closely resembles Augenblick (2016), which studies Markov-perfect equilibria in for-profit penny auctions. However, an important difference is the systematic removal of bidders who exit within the war of attrition, which does not occur in penny auctions. As a result, the equilibrium bidding strategies in these models deviate for $n>2$. To demonstrate, attention moves to the strategies for the $n=3$ subgame. The expected return from bidding can be summarized as

$$p_3\left\{(1-p_3)[\alpha c] + p_3[2\alpha c]\right\} + (1-p_3)\left\{(1-p_2)[v] + p_2[\alpha c]\right\} - (1-\alpha-\gamma)c.$$

[3]Another natural way to model wars of attrition is establishing a perfect-Bayesian equilibrium by following Bulow and Klemperer (1999) when bidders' valuations are distributed. The sequential-move nature of this model makes the continuous model in Bulow and Klemperer (1999) an imperfect approximation. However, it will be demonstrated that many characteristics are shared between the models.

By induction, continuation profits are equal to zero and again are omitted. Unlike the $n = 2$ subgame, there is a positive return associated with not bidding. This is due to the positive externality from others' contributions (α) in the $n = 2$ subgame, and in expectation is equal to $\alpha c \frac{p_2}{1-p_2}$ which in equilibrium is $\alpha \frac{v-(1-\alpha-\gamma)c}{1-2\alpha-\gamma}$. Given the expected payout of competing in the $n = 2$ subgame is zero, analysis begins by assuming $p_3 = 0$ and checking for the incentive a bidder has to deviate. This leads to the relation of the expected return to bidding and the expected externality from exiting such that

$$(1 - p_2)[v] + p_2[\alpha c] - (1 - \alpha - \gamma)c \leq \alpha c \frac{p_2}{1 - p_2}. \tag{2}$$

A simplification and rearrangement of (2) in equilibrium yields $\alpha \frac{v-(1-\alpha-\gamma)c}{1-2\alpha-\gamma} \geq 0$, which is true by assumption. Thus, there is no case in which bidders use a symmetric strategy involving $p_3 > 0$. By induction, this applies to all p_n for $n > 2$. As a result the auction outcomes are fully characterized by the final subgame with two bidders. This is the basis of bidding strategies and expected revenue, π_{WoA}, in the sequential-move war of attrition for charity.

Sequential-move War of Attrition Outcomes: There exists a Markov-perfect equilibrium in which bidders' strategies and expected auction revenue are described by

$$\begin{aligned} p_n &= \begin{cases} \frac{v-(1-\alpha-\gamma)c}{v-\alpha c} & \text{if } n = 2 \\ 0 & \text{if } n > 2, \end{cases} \\ E[\pi_{\text{WoA}}] &= \frac{v - (1 - \alpha - \gamma)c}{1 - 2\alpha - \gamma}. \end{aligned} \tag{3}$$

To better understand the mechanism-specific effect the war of attrition has on bidders, two revenue-equivalent treatments of this auction will be studied experimentally. These versions of the auction are called *Unconstrained* and *Self-constrained*, and they are described below.

> The *Unconstrained* treatment is a standard war of attrition in which all bidding and exiting decisions are made during the auction.
>
> The *Self-constrained* treatment gives bidders the ability to limit their contributions by choosing, before the auction begins, a maximum number of bids they can make.

The self-imposed constraint in the *Self-constrained* treatment should have no effect on rational bidders, which leads to Rational Hypothesis 1.

Rational Hypothesis 1: Both the *Unconstrained* and *Self-constrained* WoA mechanisms will generate an expected revenue of $\frac{v-(1-\alpha-\gamma)c}{1-2\alpha-\gamma}$.

However, these mechanism treatments may have varying effects on bidders with a sunk cost bias. If this bias is present, then our expectation would be that sunk cost sensitive bidders should be more likely to win in the *Unconstrained* mechanism treatment, relative to those who are not sunk cost sensitive. However, if these bidders are sufficiently sophisticated in their understanding of their bias, then this difference in winning should disappear in the *Self-constrained* mechanism treatment. This is the basis of Behavioral Hypothesis 1.

Behavioral Hypothesis 1: In the *Unconstrained* mechanism treatment, sunk cost sensitive bidders will win auctions more frequently those who are not sunk cost sensitive. In the *Self-constrained* mechanism treatment, sunk cost sensitive bidders will win auctions with the same frequency as those who are not sunk cost sensitive.

2.2 The First-price All-pay Auction

From Baye et al. (1996) it is known there is a unique symmetric equilibrium in mixed strategies for pure common value first-price all-pay auctions with complete information. Let F define the cumulative distribution over bids with density f. By marrying charity-based preferences to this environment, we establish a bidder's expected payout from a bid of x as

$$\int_0^x v\, dF(x)^{n-1} - (1-\alpha-\gamma)x + \alpha(n-1)\int_0^{\bar{z}} zf(z)dz \tag{4}$$

This first term in (4) is the value of the prize v weighted by the probability a bid of x wins the auction. The second term is the adjusted cost of bidding x, and the third term is the positive externalities accrued from the $n-1$ other bidders' bids. As noted in Engers and McManus (2007), a bidder's contribution is not influenced by the expected contributions from other bidders. To ensure a bidder maximizes their expected return according to their bid, the first-order condition is established for (4) and the resulting differential equation is solved for $F(x)$. This yields bidding strategies and expected revenue, π_{AP}, in the first-price all-pay auction for charity.

First-price All-pay Auction Outcomes: There is a unique symmetric mixed strategy Nash equilibrium in which bidders' strategies and expected auction revenue are described by

$$\begin{aligned} F(x) &= \left((1-\alpha-\gamma)\frac{x}{v}\right)^{\frac{1}{n-1}}, \\ E[\pi_{\mathrm{AP}}] &= \frac{v}{1-\alpha-\gamma}. \end{aligned} \tag{5}$$

Two revenue equivalent methods of implementing this mechanism will be explored experimentally. These mechanism treatments are called *Sealed-bid* and *Incremental Revelation*, and they are described below.

> The *Sealed-bid* treatment is a standard auction format in which bids are privately and simultaneously submitted, and the winner is revealed immediately.
>
> The *Incremental Revelation* treatment is a modification of the *Sealed-bid* treatment in which bidders submit their bids privately and simultaneously, but then reveal their bids incrementally *a la* the war of attrition.

These versions of the first-price all-pay auctions are revenue equivalent among rational bidders, and this leads to Rational Hypothesis 2.

Rational Hypothesis 2: Both *sealed-bid* and *incremental revelation* FPAP mechanisms will generate revenue of $\frac{v}{1-\alpha-\gamma}$ in expectation.

However, the design of these mechanisms may motivate different behavioral biases. For those bidders who are loss averse, the *Sealed-bid* mechanism may suppress or encourage contribution levels since the perception of loss is relatively large and instantaneous. For instance, in an experimental study, Ernst and Thöni (2013) finds bids in a for-profit version of the *Sealed-bid* mechanism presented here leads to a distribution over bids where relatively small and large bids were over-represented, as compared to rational bidders. On the other hand, the *Incremental Revelation* mechanism may limit this effect by way of presenting losses incrementally. Additionally, the *Incremental Revelation* mechanism may invoke a behavioral reaction among sunk cost sensitive bidders, as it mimics the bidding process in a war of attrition. This is the basis of Behavioral Hypothesis 2.

Behavioral Hypothesis 2: In the *Sealed-bid* mechanism treatment, loss averse bidders will make contributions that are different from those who are not loss averse and bidders who are sunk cost sensitive will make contributions that are not different from those who are not sunk cost sensitive. In the *Incremental Revelation* mechanism treatment, loss averse bidders will make contributions that are not different from those who are not loss averse, and bidders who are sunk cost sensitive will make contributions different that those who are not sunk cost sensitive.

The following section outlines the experimental design utilized to compare the stated hypotheses against empirical tests.

3 Experiment Design

In this study, a total of 96 subjects were recruited to participate in one of eight sessions. Using a between-subjects design, sessions were equally split to test four charity auction settings: two involving a first-price all-pay auction, and two involving a sequential-move war of attrition. The variations explored within each mechanism are outlined in Table 1. Both mechanisms included a standard protocol, called the *Benchmark*, and a modified protocol, called the *Variant*. In the first-price all-pay auction, the *Benchmark* was a sealed-bid protocol where bidders simultaneously submitted contributions and winners and losers were simultaneously revealed. In the *Variant*, bidders again chose sealed-bid contributions simultaneously, however they revealed their bids sequentially in fifty cent increments. The sequence order of revelation was randomly determined. In the war of attrition, bidders were also randomly assigned to a sequence order for bidding, and each bid cost fifty cents. In the *Benchmark* mechanism, each bidder chose to bid or exit without constraint. However, in the *Variant* mechanism each bidder was given the opportunity to set a maximum contribution for themselves before the auction began.

Sessions took place in a behavioral research laboratory at a large American university in groups of twelve subjects. Subjects were seated at partitioned computer workstations to ensure private decision-making and given computerized instructions about the experiment, at which point they were allowed to ask procedural and clarifying questions.[4] The entire experiment lasted approximately eighty minutes, and subjects earned $20.95 on average.

The instructions explained the experiment consisted of two phases. In Phase 1, subjects were given multiple opportunities to complete a task and earn cash. This task consisted of counting how many numbers (0-9) there were in a series of 120 random characters that included both

[4]Instructions for a treatment of the war of attrition can be found in the appendix. All sessions were computerized and programmed using z-Tree (Fischbacher 2007).

Table 1: Session Variations by Mechanism

Mechanism	**Benchmark**	**Variant**
First-price All-pay	*Sealed-bid*	*Incremental Revelation*
War of Attrition	*Unconstrained*	*Self-constrained*

digits (0-9) and letters (A-Z) within 60 seconds. Each of the 120 characters was equally likely to be one of the 36 alphanumeric characters. If the subject reported the correct number or was off by at most 3 in absolute value then they received $2, otherwise they received nothing. Table 2 is an example of one such task.[5] A relatively large margin of error was allowed in this task because its purpose was principally to avoid risk seeking behavior that may occur with unearned endowments. Subjects were given eight opportunities to complete this task for a maximum possible endowment of $16, though they were not informed on the number of opportunities they would have. 94 of the 96 subjects earned either $14 or $16 in Phase 1 while the remaining two subjects earned $10 and $12. Average endowments across sessions varied from $15.33 to $15.83.

Table 2: Effort Task Example

8	3	P	2	M	9	L	K	V	5	W	9	G	5	2	X	M	E	G	P
6	E	Y	R	4	D	S	S	9	L	V	X	3	Q	S	M	O	H	B	A
R	9	Y	Y	P	2	4	A	V	0	D	R	L	Z	X	8	3	A	L	J
7	Q	7	M	I	2	D	Z	V	6	W	Z	U	P	L	2	G	P	Q	J
F	N	N	L	Y	J	N	N	G	D	X	J	L	Q	7	5	4	T	F	Q
V	R	H	R	D	8	R	0	7	C	G	P	P	X	3	L	C	X	9	0

In Phase 2, subjects were given multiple opportunities to participate in auctions using the money they earned in Phase 1. Though the auction mechanism varied by session, the prize for winning the auction was always a fictitious item worth $10. There were ten periods of Phase 2 in which bidders were randomly matched in two bidder auctions for a total of 60 auctions per session.[6] The computer placed the twelve subjects for a given session into groups of four, and randomly rematched within that fixed group. This allowed for sufficient randomness to avoid collusion, and also allowed for the isolation of dynamic session effects (Fréchette 2012). This is summarized in Table 3.

To maintain a fixed financial position across auctions, bidders' endowments were set to the

[5]This example has 32 numbers in it. If the subject reported 29, 30, 31, 32, 33, 34 or 35 then they earned $2.

[6]In this experiment, the two bidder auctions were always followed by ten periods of six bidder auctions. However, due to the likely impact of order effects, the analysis in this paper focuses entirely on the first set of auctions (the two bidder auctions).

Table 3: Session Groups for Auctions

Auction Rematching by Period				
Auctions	Bidders per Auction	Groups of		
1-10	2	4	4	4

amount they earned in Phase 1 regardless of previous auction outcomes. To further aid in the simulation of the one-shot nature of the theory, subjects were paid according to a randomly selected auction from Phase 2. As a result, a subject's final earnings consisted of their cumulative earnings from Phase 1, one randomly selected auction in Phase 2, and a show up payment of \$5.

In accord with the theoretical assumptions, two constant marginal benefits were induced in the auction to simulate a charity setting. The particular parameters for these marginal benefits were chosen to be the same as Carpenter et al. (2014) to aid in the comparison to previous studies. The first marginal benefit $\alpha = 0.1$ is the indirect benefit associated to the revenue generated by the auction. In the experiment, subjects were informed that for every dollar of revenue generated, each of them would receive \$0.10. The second marginal benefit $\gamma = 0.05$ is the "warm glow" from personally contributing to the auction. As a result, for each dollar a bidder personally contributed, they received \$0.05.

After each auction, bidders were shown a break down of their earnings, which consisted of 1) their auction contribution, 2) the outcome of the auction (claimed the item or not), 3) the total revenue generated by the auction and their indirect benefit earnings from revenue (α), and 4) the money returned from their own contributions (γ). Table 4 outlines the theoretical predictions over revenue for the parameters of this experiment.

Table 4: Revenue Predictions with Rational Bidders by Mechanism (in \$)

Experimental Parameters			
$v = \$10$	$\alpha = 0.1$	$\gamma = 0.05$	
Predictions of Average Contributions by Treatment			
First-price All-pay		*War of Attrition*	
Sealed-bid	5.88	Unconstrained	6.38
Incremental Revelation	5.88	Self-constrained	6.38

Following Phase 2, subjects were asked to answer survey questions regarding their experience in the auction as well as questions regarding hypothetical scenarios that could address their susceptibility to the sunk cost fallacy and loss aversion.[7] These questions are included in the instructions found in the appendix.

The next section reports the experimental results of this study.

4 Experimental Results

4.1 Bidder Characteristics

Analysis begins with the summary of bidder characteristics, which were measured through survey responses collected at the end of each session. Four questions in this survey provide the basis of subjects' loss aversion and sunk cost sensitivity, which are summarized in Table 5. To identify sunk cost sensitivity, subjects were presented with two hypothetical scenarios involving sunk costs. In the first scenario, the subject had lost a movie ticket and asked if they'd be willing to buy another. In the second, the subject was asked if they'd forego the deposit on a weekend trip after learning there was a preferred alternative trip at the same time. If both answers indicated a sunk cost sensitivity, then that subject was coded as sunk cost sensitive. In Table 5 we see there is a consistent estimate of 25% to 29% of bidders as being sunk cost sensitive across mechanisms.

Table 5: Summary of Bidder Characteristics

Mean Scale Response				
	First-price All-pay		War of Attrition	
	Sealed-bid	*Incremental Revelation*	*Self-constrained*	*Unconstrained*
Sunk Cost Sensitive (0-1)	0.29	0.29	0.25	0.29
Loss Sensitivity				
Financial Loss (1-5)	4.29	4.00	4.04	4.33
General Loss (1-5)	3.79	3.75	3.79	3.75
Combined (2-10)	8.08	7.75	7.83	8.08
Subjects	24	24	24	24

[7]Many of the survey questions came from Carpenter (2010), some of which were slightly modified for regional context purposes.

Two questions regarding loss aversion were asked, one on whether they tend to worry about losses in financial situations and another on their tendency to worry about losses in general. Their responses were coded from 1 to 5, with 1 being "Strongly Disagree" and 5 being "Strongly Agree." The average responses across mechanisms are relatively similar with values ranging from 4 to 4.33 for financial losses and 3.75 to 3.79 for general losses. These two measures of loss aversion were combined for each subject to create an aggregate measure that ranged from 2 to 10. Standard deviations for the combined measure ranged from 1.14 to 1.99 across mechanisms. All analysis with respect to loss aversion utilizes this combined measure.

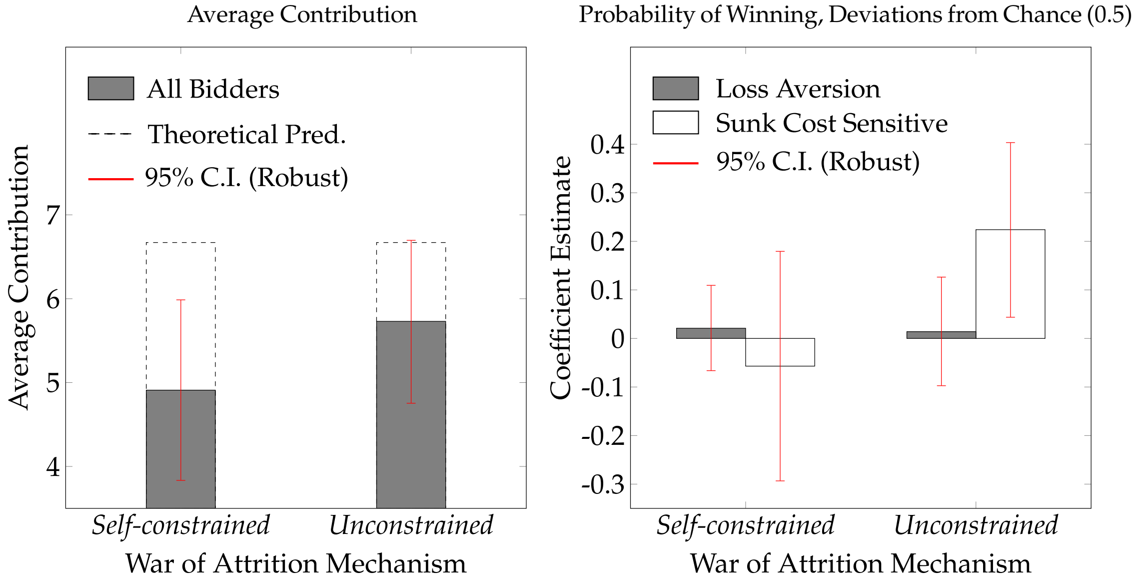
4.2 Bidder Contributions in the War of Attrition

The average bidder contribution in each of the war of attrition mechanisms is reported in the left panel of Figure 2 with 95% confidence intervals calculated using robust standard errors clustered at the subject level.[8] The average contribution of 5.73 in the *Unconstrained* treatment, a standard implementation of a war of attrition, is nearly statistically significantly less than the theoretically predicted contribution of 6.67 at the five percent level ($p<0.057$). Using a separate treatment to test whether bidders contribute more than they would prefer (according to their pre-auction preferences) due to their sunk cost sensitivity, the *Self-constrained* mechanism treatment allows bidders to preset a maximum contribution before the auction begins. In this mechanism, contributions dropped significantly below theoretical predictions ($p<0.003$) to an average of 4.91. This average contribution is approximately 26% below the expected theoretical contribution of 6.67.

Since the winner's willingness to contribute is censored by the losing bidder's contribution in the war of attrition, analysis turns to the probability of winning the auction to further understand the behavioral bias effects of sunk cost sensitivity and loss aversion. The OLS estimates on the probability of winning based on loss sensitivity and sunk cost sensitivity are reported in the right panel of Figure 2. In this figure we see the probability of winning an auction in the *Unconstrained* mechanism is statistically significantly greater for bidders who are sunk cost sensitive ($p<0.021$). Moreover, relatively loss averse bidders are no more likely to outlast the other bidder ($p<0.793$), compared to those who are not loss averse. In the *Self-constrained* mechanism,

[8]Clustering standard errors at the group level, as described in Table 3, would have been the preferred method of accounting for the repeated interactions in the experiment. However, with only eight groups per treatment, clustering at this level would provide a poor approximation of the critical values needed to reject a null hypotheses. Clustering at the subject level accounts for the correlation of errors while providing 24 clusters per treatment. See Cameron and Miller (2015).

Figure 2: Contributions and Probability of Winning in the War of Attrition



neither sunk cost sensitive bidders nor relatively loss averse bidders are statistically more likely to win auctions. When the results in both panels of Figure 2 are taken together, they suggest that the revenue performance of the standard war of attrition is buoyed by sunk cost sensitive bidders. Furthermore, the ability for the war of attrition to raise revenue at the expected level with two bidders is rather tenuous.

The nonlinear effects of a bidder's behavioral biases and their dynamic session effects are reported in a logit estimate in Table 6. The parameter estimates and marginal effects on Loss Aversion and Sunk Cost Sensitive measure the impact of these behavioral biases, while Last 5 Periods is a dummy variable indicating whether the auction was in the first half or second half of the experiment. Each behavioral bias is interacted with Last 5 Periods.

Beginning with the *Unconstrained* mechanism, the likelihood of a bidder winning an auction when they are sunk cost sensitive increase substantially. According to the estimated marginal effect they are 30.5% more likely to win the auction, and this result is significant at the one percent level. Interestingly, when bidders are capable of limiting their contributions before the auction begins, as in the *Self-constrained* mechanism, sunk cost sensitive bidders are no longer any more likely to win the auction than those who are not sunk cost sensitive. As with the OLS estimates in Figure 2, these results suggest that sunk cost sensitive bidders are somewhat sophisticated in their understanding of this sensitivity and plan for it accordingly.

Table 6: Logit Estimate on Winning the War of Attrition

DV: Winning the War of Attrition (1=Win)				
	Mechanism			
	Self-constrained		*Unconstrained*	
	Coefficients	Marginal Effects	Coefficients	Marginal Effects
Loss Aversion	0.097	0.024	0.054	0.013
	(0.166)	(0.041)	(0.245)	(0.058)
Sunk Cost Sensitive	-0.196	-0.049	1.280***	0.305***
	(0.714)	(0.177)	(0.461)	(0.101)
Last 5 Periods	0.246	0.061	0.093	0.022
	(1.138)	(0.283)	(1.855)	(0.442)
× Loss Aversion	-0.021	-0.005	0.012	0.003
	(0.148)	(0.037)	(0.209)	(0.050)
× Sunk Cost Sensitive	-0.067	-0.017	-0.701	-0.167
	(1.133)	(0.281)	(0.532)	(0.126)
Constant	-0.777		-0.791	
	(1.403)		(1.945)	
Observations	240		240	

Notes: ***, **, and * indicate significance at the 1%, 5% and 10% level, respectively. Robust standard errors are reported in parentheses.

To further explore the effects sunk cost sensitive bidders have on auction outcomes, OLS estimates over contributions are reported in Table 7. Here, a bidder's behavioral biases are interacted with those of the other bidder.

Across both auction mechanisms, the only statistically significant parameter is the interaction of bidders' sunk cost sensitivity. When two sunk cost sensitive bidders were paired in the *Unconstrained* mechanism, revenues increased by approximately 13.3%, as compared to when neither bidder is sunk cost sensitive. Conversely, when two sunk cost sensitive bidders were paired in the *Self-constrained* mechanism, revenues decreases by approximately 39.3%. These results give strong evidence that auction revenue in the war of attrition can be increased by introducing multiple bidders who are sunk cost sensitive. However, it also demonstrates that sunk cost sensitive bidders recognize their own tendency to occasionally contribute more than their pre-auction preferences would allow. As a result, we find this large decrease in contributions in the *Self-constrained* mechanism when both bidders are sunk cost sensitive.

Table 7: OLS Estimate on Contributions in the War of Attrition

DV: Bidder Contribution		
	Mechanism	
	Self-constrained	*Unconstrained*
Loss Aversion	-0.068	2.529
	(0.848)	(2.485)
Other's Loss Aversion	0.027	2.947
	(0.894)	(2.135)
Loss Aversion × Other's Loss Aversion	0.036	-0.355
	(0.125)	(0.277)
Sunk Cost Sensitivity	0.102	-1.181
	(1.269)	(1.338)
Other's Sunk Cost Sensitivity	1.394	-1.821
	(1.167)	(1.264)
Sunk Cost Sensitivity × Other's Sunk Cost Sensitivity	-4.507***	4.276**
	(1.529)	(1.902)
Last 5 Periods	-0.759	-7.762
	(1.548)	(5.433)
× Loss Aversion	0.220	0.906
	(0.202)	(0.658)
× Sunk Cost Sensitive	2.522*	-0.887
	(1.428)	(1.431)
Constant	2.082	-14.599
	(5.856)	(19.173)
Observations	240	240

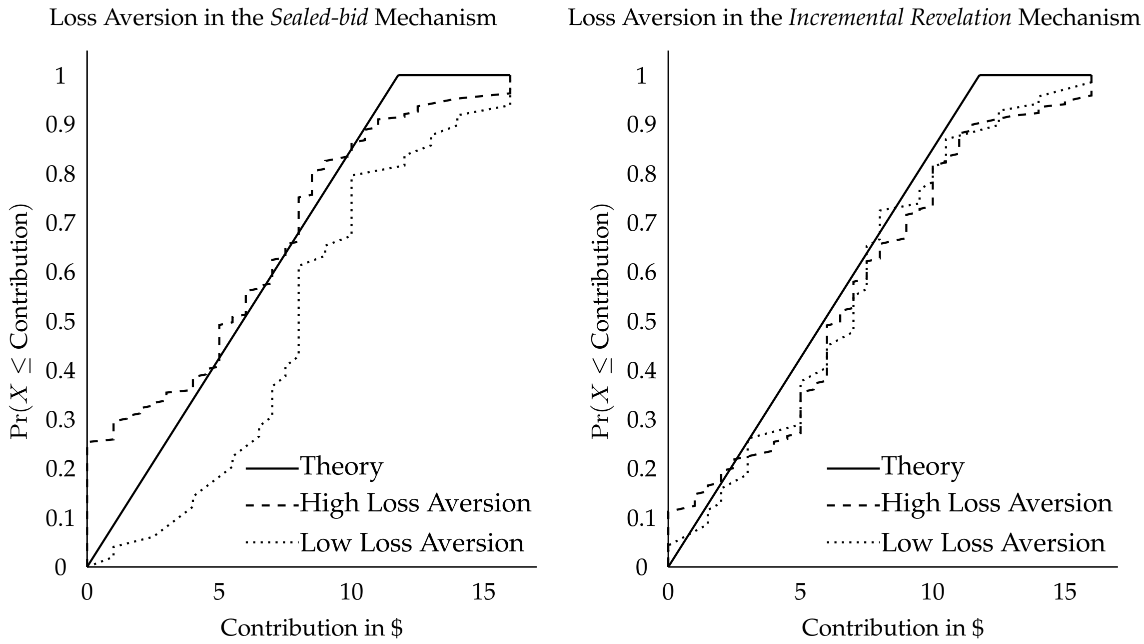
Notes: ***, **, and * indicate significance at the 1%, 5% and 10% level, respectively. Robust standard errors are reported in parentheses.

Experimental Result 1: Sunk cost sensitive bidders are willing to contribute more in the war of attrition, and thus win auctions more frequently. However, if given a commitment device that constrains their ability to bid, contributions and winning rates drop significantly. These results suggest that sunk cost sensitive bidders bid beyond their pre-auction preferences and support Behavioral Hypothesis 1.

4.3 Bidder Contributions in the First-price All-pay Auction

The distributions of bidder contributions in the first-price all-pay auctions are compared in Figure 3. Theoretical predictions over contributions are represented by solid lines, and experimental results are broken down by bidders' degree of loss aversion. For ease of visual comparison, contributions from those with a loss aversion response above the 50th percentile are labeled High Loss Aversion and are represented by a dashed line. All remaining contributions (i.e. at or below the 50th percentile) are labeled Low Loss Aversion and represented by a dotted line.

Figure 3: CDFs of Bidder Contributions in First-price All-pay Auctions



The left panel of Figure 3 shows that the contribution distribution for those with a low loss aversion response first order stochastically dominates the contribution distribution for those with a high loss aversion response in the *Sealed-bid* mechanism. Comparing these empirical distributions with a chi-square goodness of fit test suggests these distributions are not the same ($p < 0.001$) and that increases in loss aversion reduces the willingness of bidders to make large contributions at the same rate as those who are not loss averse. Moreover, those with low loss aversion responses make larger contributions than what is predicted theoretically ($p < 0.001$), while those with high loss aversion responses do not ($p < 0.884$). The right panel of Figure 3 shows that contributions closely follow the theoretical prediction for both low and high loss aversion bidders in the *Incremental Revelation* mechanism. A chi-square goodness of fit test finds no statistical difference between these empirical distributions ($p < 0.998$), and neither low loss aversion bidders' nor high loss aversion bidders' contribution distributions differ from the theoretically predicted distribution ($p < 0.659$ and $p < 0.241$, respectively).

Table 8 reports a broader investigation of the bidders' characteristics on their contributions in the first-price all-pay auctions through OLS estimates with robust standard errors clustering observations at the subject level. Without controlling for dynamic session effects, the first estimation in Table 8 for the *Sealed-bid* mechanism indicates that loss averse bidders submit statistically smaller bids at the five percent level. Controlling for dynamic session effects by including a dummy on an observation being in the latter half of the experiment, and interacting this dummy with the behavioral measures, does not change the statistical significance nor the magnitude of this effect. This effect size is quite large. A bidder in the 25$^{\text{th}}$ percentile of loss aversion bids 69% above the equilibrium bid on average, while a bidder in the 75$^{\text{th}}$ percentile of loss aversion bids 26% below the equilibrium bid on average. Finally, this estimate finds there is no evidence that bidders vary their contributions with experience, regardless of their sunk cost sensitivity or loss aversion.

Table 8: OLS Estimates on Contributions in the All-pay Auction

DV: Bidder Contribution				
	Mechanism			
	Sealed-bid		*Incremental Revelation*	
Loss Aversion (2-10)	-0.838**	-0.933**	0.117	0.441
	(0.356)	(0.431)	(0.224)	(0.261)
Sunk Cost Sensitive (0-1)	0.154	0.845	-2.308*	-2.124
	(1.587)	(1.790)	(1.269)	(1.372)
Last 5 Periods (0-1)		-1.784		5.970***
		(3.223)		(1.970)
× Loss Aversion		0.190		-0.648**
		(0.420)		(0.290)
× Sunk Cost Sensitive		-1.381		-0.367
		(2.221)		(1.259)
Constant	12.772***	13.664***	6.463***	3.478*
	(2.678)	(3.441)	(1.642)	(1.852)
Observations	240	240	240	240

Notes: ***, **, and * indicate significance at the 1%, 5% and 10% level, respectively. Robust standard errors are reported in parentheses.

In the *Incremental Revelation* mechanism, not controlling for dynamic session effects, as reported in the first estimate, indicates that loss aversion does not impact a bidder's willingness to contribute. There is marginal evidence at the ten percent level in this estimate that sunk cost sensitivity lowers a bidder's average contribution. However, after controlling for dynamic session effects, the second estimate shows bidders who are not loss averse bid more with experience, while those who are loss averse bid less with experience. This result suggests that bidders who are loss averse need experience to internalize the aggregate costs of participating in this mechanism. The effect by this estimate is also large, as a bidder in the 25$^{\text{th}}$ percentile of loss aversion contributes approximately 17% above the expected theoretical contribution on average, and a bidder in the 75$^{\text{th}}$ percentile of loss aversion bids approximately 49% below the expected theoretical contribution on average. As with the *Sealed-bid* mechanism estimates, this estimate suggests a bidder's sunk cost sensitivity does not have an effect on their average contribution.

The results reported here suggest that bidders evaluate losses differently between the two mechanisms, which in turn influences their willingness to contribute. As laid out in Behavioral Hypothesis 2, in the *Sealed-bid* mechanism, payouts are revealed nearly instantly and bidders experience gains and losses simultaneously. However, in the *Incremental Revelation* mechanism, bidders are put through a process of discovery in which they experience their losses while evaluating their chances of winning as other bidders exit. The first experience leads one to imagine that an aversion to losses weigh heavily on bidders, while the second experience may be attenuated by the mechanism design.

Experimental Result 2: Loss averse bidders submitted smaller contributions on average in the *Sealed-bid* mechanism, as compared to those who were not loss averse. When contributions were revealed in a manner that mimicked the war of attrition via the *Incremental Revelation* mechanism, loss averse bidders submitted smaller contributions on average with more experience. However, there is no strong evidence that sunk cost sensitivity affected bidder behavior. These results partially support Behavioral Hypothesis 2.

5 Conclusion

This paper adds to a growing literature on the ability of all-pay auctions to raise money for charity. The theoretical literature on charity auction design uniformly touts the superior fundraising capacity of all-pay auctions, as they reduce the free-riding associated with winner-pay auctions. However, this paper provides empirical evidence of all-pay auctions' sensitivity in generating charitable contributions as predicted. In this study, the inconsistency in revenue has largely been traced back to a unwillingness to fully participate due to behavioral concerns over losses.

By studying the first-price all-pay auction and the sequential-move war of attrition, the results of this study indicate that bidders face distinguishable concerns over losses and these concerns ultimately lead to different mechanism performances. Bidders in the first-price all-pay face gains and losses simultaneously and all at once, which for some elicits an aversion to contribute as theoretically predicted. On the other hand, bidders in the war of attrition experience losses slowly over an extended period of time through a process of discovering an auction winner, which leads sunk cost sensitive bidders to contribute more. The absence of sunk cost sensitive bidders or the presence of a commitment device to prevent over-bidding is linked to drastically reduced contributions and thus fails to generate the revenues predicted by theory.

Finally, this study helps guide organizations in their use of all-pay mechanisms by providing a ranking of their performances according to the distribution of sunk cost sensitive and loss averse bidders. In particular, the war of attrition may be a powerful revenue raiser when there are several bidders who are susceptible to sunk costs. However, in the absence of these behavioral responses, a first-price all-pay auction with an incremental revelation of one's bid may provide a more stable source of revenue that is close to theoretical predictions. Future studies can further aid organizations in this area by identifying relevant characteristics correlated with such behavioral tendencies.

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6 Appendix

6.1 Subject Directions for the War of Attrition

Welcome! You have already earned $5 for showing up on time. It is important that you read these instructions carefully and understand them, so that you can make good decisions, and potentially make a considerable amount of money today.

If you have any questions during the experiment, please raise your hand, and an experimenter will come to assist you. Otherwise, please do not talk or communicate with anyone.

Overview:

This experiment has two phases, each of which involves a repeated activity.

> Phase 1: In this phase all participants here today will have multiple opportunities to complete a task. Each time you complete the task successfully you will earn $2. If you do not complete the task successfully you will earn $0.
>
> Phase 2: In this phase all participants here today will have multiple opportunities to participate in an auction. The item being auctioned is a fictitious item worth $10. At first, each of you will be randomly and anonymously matched with one other bidder (participant in this experiment) for each auction. Later, each of you will be randomly and anonymously matched with five other bidders for each auction. However, only one of you may claim the $10 item in a given auction.

Phase 1: The Task

Instructions for the task are as follows:

You will be shown a sequence of 120 random characters consisting of numbers (0-9) and letters (A-Z). The task is to count how many numbers (0-9) there are in the 120 characters. You will have 60 seconds to complete this task and report the number to the computer.

If you count how many numbers are in the sequence correctly within 3 then you will receive $2. In other words, you can be off by at most 3 (over or under) and still receive $2.

To the left is an example of the task in Phase 1 [shown on screen]. Take a moment to see what this task is like. (The "REPORT" button does not work right now because this is just an example.)

Hint: in this example there are [actual] numbers. If you had reported [actual-3], [actual-2], [actual-1], [actual], [actual+1], [actual+2] or [actual+3] you would have received $2.

Note that zeros (0) and Os look very similar. Because the example here was randomly generated, it may or may not have zeros or Os.

Phase 2: The Auction

In Phase 2 you will have the opportunity to participate in auctions using the money you earned in Phase 1.

To participate in an auction you must have Tokens. Tokens can be purchased, using the money you earned in Phase 1, for $0.50 each *before the auction begins*. You cannot buy more tokens than you can afford, and you cannot buy tokens once the auction begins.

Bidders will take turns Bidding (i.e. contributing) their Tokens, one Token at a time. The last bidder to Bid a Token will claim the auctioned item, which is a fictitious item worth $10.

If at any point you prefer to not Bid, you may choose to Exit, and forfeit the auction. If you choose to Exit you will not claim the item. A bidder can claim the item only if they are the last to Bid (at least one) Token. If, when the auction ends, you have Tokens left over, these Tokens will be redeemed for $0.25 each.

Important Aspects of this Auction:

1. Each auction you will be randomly and anonymously matched with 1 or 5 other participants for the auction. So, you will never know who the other bidders are.

2. No one will ever know how many Tokens you buy, and you will not know how many Tokens other bidders buy.

3. Tokens are purchased at the beginning of each auction only, and cannot be transferred from one auction to the next.

4. One of you will be randomly chosen to start bidding. This will be revealed after all bidders have bought their Tokens and has nothing to do with how many Tokens were purchased.

5. You may choose to buy 0 Tokens at no cost, if you like.

6. If no one chooses to Bid a Token, then no one will claim the item.

7. If only one bidder chooses to buy Tokens, then that bidder will claim the item by bidding their first Token.

Bidders' endowments will be reset to the amount they earned in Phase 1 at the beginning of each new auction. As a result, the decision to participate in an auction does not impact a bidder's ability to participate in future auctions.

Important Aspects of this Auction:

Furthermore, in these auctions we will be simulating charity auctions. Charity auctions are different in two ways, *both of which will impact how much money you earn*. These two ways are outlined here:

1. In charity auctions, bidders often receive benefits from how much revenue is raised (i.e. how many Tokens are contributed by all bidders combined).

2. Bidders often feel good for contributing to a charity.

The auction raises revenue through the total value of Tokens that were Bid by everyone in the auction and the unredeemable value of unused Tokens.

Because bidders often receive benefits from the total revenue raised, for every $1 the auction raises in revenue the bidders in that auction will receive $0.10 each. *Example: if all bidders combined contribute $15 to the auction, then each of them would receive $1.50 at the end of the auction.*

Because individual bidders feel good for contributing to charity, for every $1 you personally contribute to the auction, you will receive $0.05. *Example: if you contribute $6 to the auction (i.e. 12 Tokens), then you would receive $0.30 at the end of the auction on top of any money received because of the total amount raised.*

Summary of the Auction

To recap, in each auction of Phase 2 you will be placed in an auction where,

1. Each period you will be randomly and anonymously paired with one or five other participants(s) for the auction. So, you will never know the other bidders.

2. All bidders will privately buy Tokens for the auction using the money earned in Phase 1.

3. One bidder will be randomly chosen to start bidding.

4. The last person to contribute a Token will claim the fictitious item worth $10.
5. Each of you, regardless of winning or losing the auction, will earn an additional $0.10 for each $1 of revenue generated by all bidders.
6. Each of you, regardless of winning or losing the auction, will earn an additional $0.05 for each $1 personally contributed to the auction.

As mentioned earlier, there will be many opportunities for you to participate in an auction. At the end of the experiment, the computer will choose one of these auctions randomly. Your payment for Phase 2 will be based on the outcome of this one randomly selected auction.

Almost Ready to Begin

Your total earnings for today's experiment will consist of your cumulative earnings from Phase 1, your earnings from one randomly selected auction in Phase 2, and your $5 show up payment for coming on time. So:

Total Earnings =

Phase 1 Earnings +

Phase 2 Earnings +

Show Up Payment ($5)

If you have any questions you would like to ask at this point, please raise your hand. Otherwise, you will now go through a series of comprehension questions to make sure you understand the experiment. After everyone has correctly answered these questions, there will be one practice auction, then Phase 1 will begin.

Comprehension Questions

1. **True or False:** The other bidders in my auction are the same every period.
   (a) True.
   (b) False. [A: Bidders are randomly assigned to auctions each time.]
2. **True or False:** You must buy Tokens for every auction.
   (a) True.

(b) False. [A: You can choose to not participate in an auction by not buying any Tokens.]

3. **True or False:** You won't know who will bid first when you buy your Tokens.

   (a) True. [A: Bidders will buy Tokens, then one bidder will be randomly selected to start bidding.]

   (b) False.

4. **True or False:** If you choose not to buy any Tokens you cannot win the auction, but you will not use any money you earned in Phase 1.

   (a) True. [A: If you don't buy any Tokens, you cannot win the auction and you will not use any money you earned in Phase 1.]

   (b) False.

5. **True or False:** Your earnings for Phase 2 will be based on one randomly selected auction.

   (a) True. [A: One auction will be randomly selected, and the outcome of this auction will determine your earnings for Phase 2.]

   (b) False.

[At the beginning of Period 11]

The number of bidders in each auction has increased to 6! Bidders are still randomly assigned to auctions. (Everything else about the auction is the same.)

6.2 Exit Survey

The experiment is now over. Thank you for participating! Below, there are a few questions that will help us understand the decisions you've made in this experiment. Please give them your full consideration.

How difficult did you find this auction?

Very Easy	Easy	Moderate	Hard	Very Hard
☐	☐	☐	☐	☐

Briefly, explain what your strategy was for bidding. [open response]

How many auctions have you participated in over the last 2 years (including online auctions like eBay)? [numerical response]

How fair is this auction to bidders?

Very Unfair	Unfair	Neither Fair Nor Unfair	Fair	Very Fair
☐	☐	☐	☐	☐

If present at a charity auction like this in the future, how likely would you be to participate?

Very Unlikely	Unlikely	Neither Likely Nor Unlikely	Likely	Very Likely
☐	☐	☐	☐	☐

We would like to ask you a few questions about your preferences and attitudes. Please try to answer these as accurately as possible.

In general, do you see yourself as someone who is willing to take risks?

Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree
☐	☐	☐	☐	☐

Financially, do you see yourself as someone who is willing to take risks?

Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree
☐	☐	☐	☐	☐

In general, when you are faced with an uncertain situation, do you worry a lot about possible losses?

Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree
☐	☐	☐	☐	☐

In financial situations, when you are faced with an uncertain situation, do you worry a lot about possible losses?

Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree
☐	☐	☐	☐	☐

In general, how competitive are you?

Not at All	Usually I Am Not	Undecided	Usually I Am	Very Competitive
☐	☐	☐	☐	☐

We would like to ask you a few hypothetical questions. Please try to answer these as accurately as possible.

Imagine that you've decided to see a movie in town and have purchased a $10 ticket. As you're waiting outside the theater for a friend to join you, you discover that you've lost the ticket. The seats are not marked and the ticket cannot be recovered because the person who sold it doesn't remember you. Would you buy another $10 ticket? [Response: Yes or No]

Imagine that a month ago, you and a friend made a nonrefundable $100 deposit on a hotel room in New Orleans for the coming weekend. Since the reservation was made, however, the two of you have been invited to spend the same weekend at another friend's cabin in Colorado. You'd both prefer to spend the weekend at the cabin but if you don't go to New Orleans, the $100 deposit will be lost. Would you still go to New Orleans? [Response: Yes or No]