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Direct Risk Aversion Evidence From Risky Prospects Valued Below Their Worst Outcome

Abstract
Why would people pay more for a $50 gift certificate than for the opportunity to receive a gift certificate worth either $50 or $100, with equal probability? This article examines three possible mechanisms for this recently documented *uncertainty effect* (UE): First, awareness of the better outcome may devalue the worse one. Second, the UE may have arisen in the original demonstration of this effect because participants misunderstood the instructions. Third, the UE may be due to direct risk aversion, that is, actual distaste for uncertainty. In Experiment 1, the UE was observed even though participants in the certainty condition were also aware of the better outcome; this result eliminates the first explanation. Experiment 2 shows that most participants understand the instructions used in the original study and that the UE is not caused by the few who do not. Overall, the experiments demonstrate that the UE is robust, large (prospects are valued at 65% of the value of the worse outcome), and widespread (at least 62% of participants exhibit it).

Keywords
judgment, decision making, scientific communication, fake data, data sharing, data posting

Disciplines
Other Communication | Other Psychology | Scholarly Publishing

Direct-Risk-Aversion:
Evidence from Risky Prospects Valued Below Their Worst Outcome

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Abstract

Why would people pay more for a $50 gift certificate than for the opportunity to receive either a $50 or a $100 gift certificate with equal probability? This paper examines three mechanisms for this recently documented "Uncertainty Effect" (UE): (i) awareness of the better outcome devalues the worse one, (ii) instructions in the original demonstration of the UE were misunderstood, and (iii) people exhibit direct-risk-aversion, that is, actual distaste for uncertainty. Experiment 1 documents the UE in a design where participants in the certainty condition were also aware of the better outcome, eliminating the first explanation. Experiment 2 shows that most participants understand the instruction and that the UE is not caused by the few who do not. Overall, the UE is proven robust, large (prospects are valued at 66% the value of their worst outcome) and widespread (at least 62% of participants exhibit it).

Author's note:
This paper was originally titled '*The Uncertainty Effect': In Fact the Effect of Uncertainty*. I thank Leif Nelson for valuable comments on the first draft of this manuscript, and both Isabel Swinburn and Daniela Lejtneker for efficient and professional support in the data collection process as managers of Wharton's Behavioral Lab (the data for this project were collected while the author was affiliated with the University of Pennsylvania).

Why are people risk averse? This question has received considerable attention by decision making researchers, both theoretical and empirical, going back at least to Bernoulli (1738). Despite the great number of theories that have been proposed to explain risk aversion, it is striking that the notion that people simply dislike uncertainty, that is, that uncertainty itself influences utility, is not part of any mainstream theory.[1]

Widely accepted risk aversion theories, including Expected Utility and Prospect Theory, arrive at risk aversion only indirectly, as a side-effect of how outcomes are valued and/or probabilities judged. In Expected Utility Theory, for instance, people are risk averse because they satiate from consumption and hence potential increases in wealth are valued less than potential decreases.

Despite important conceptual differences between Expected Utility and Prospect Theory, then, they share (together with all mainstream theories of risk aversion) the reliance on "indirect-risk-aversion." Importantly, all such theories makes the following falsifiable prediction: an individual cannot be so risk averse as to value a risky prospect less than the prospect's worst possible outcome.

A recent paper by (Gneezy, List, & Wu, 2006, henceforth GLW), however, obtained evidence that contradicted this consensual prediction. In several between participant studies they find that people are willing to pay less, on average, for a binary lottery than they are willing to pay for its worst outcome, a finding they coin the "Uncertainty Effect" (henceforth, UE). For example, they find that people are willing to pay an average of $26 for a $50 gift certificate for

[1] A small theoretical literature has considered the possibility of direct utility from risk, primarily to account for gambling (see e.g. Conlisk, 1993; Diecidue, Schmidt, & Wakker, 2004; Fishburn, 1980; Royden, Suppes, & Walsh, 1959).

Barnes and Noble, but only $16 for a lottery that pays either a $50 or a $100 gift certificate with equal probability.

Considering the potential importance of the findings by GLW, posing a direct challenge to the overarching paradigm currently used to understand risk aversion, in this paper I set out to distinguish among three possible causes behind them. The first and most interesting mechanism that may have lead to GLW's findings is that uncertainty enters directly into people's utility function, that people exhibit what I shall refer to as "direct-risk-aversion." The other two, to be discussed in some detail below, are (i) that awareness of the lotteries' high value outcome diminished the perceived value of the low-value one and hence of the lottery as a whole, and (ii) that respondents erroneously believed the lottery could result in a payment of $0.

In all of the multiple demonstrations of the Uncertainty Effect by GLW, participants evaluating lotteries were shown their two outcomes while those evaluating outcomes to be received with certainty were shown just one. This means that the manipulation of uncertainty was fully confounded with the number of outcomes presented to participants. As it turns out, this could -independently of uncertainty- explain the Uncertainty Effect.

Abundant research has examined the differences between evaluations performed on single vs. multiple items (e.g. Bazerman, Loewenstein, & White, 1992; Bazerman, Moore, Tenbrunsel, Wade-Benzoni, & Blount, 1999; Hsee, 1996, 1998; Hsee & Zhang, 2004; List, 2002), and (Hsee, Loewenstein, Blount, & Bazerman, 1999) for a review. Particularly relevant in this "joint vs. separate evaluation" literature is the finding that the willingness-to-pay (WTP) for low quality items drops when they are evaluated jointly with similar but superior ones. For example, Hsee (1996) reports that participants were willing to pay $24 for a dictionary with

10,000 words when they were evaluating just that dictionary, but only $19 if they were also evaluating a dictionary with 20,000 words.

The fact that the lottery includes a similar yet superior outcome, therefore, may diminish the perceived value of the worst outcome. This mechanism provides a plausible uncertainty-independent explanation for the Uncertainty Effect. Some patterns in the data obtained by GLW suggest that the use of separate evaluation influenced their results at least somewhat. For example, the median WTP to receive $100 and $200 in a year was the same amount: $50 (see table I in GLW); such inadequate sensitivity to changes on the quantity of the good being evaluated is typical of separate (but not joint) evaluations.

The experiments presented in this paper eliminated this confound by asking participants in the certainty condition to value both the low and the high value outcome, i.e. by conducting joint evaluations in both conditions.

Another possible cause behind the findings of GLW is that the lottery descriptions they employed did not unambiguously rule out a $0 payment. One of their lottery descriptions, for instance, was "*…a lottery that pays $50 or $100 with equal probability…*" (GLW, pp.1304). While the authors were referring to a lottery that would for certain pay one of these two outcomes, their description is consistent with a lottery that could result in a payment of $0, such as one paying $0 with 98% probability, and $50 or $100 each with 1% probability.[2]

The possibility that the findings by GLW were caused by participants' misunderstanding of the lottery has been put forward by two independent set of researchers, (Keren & Willemsen, Forthcoming) and (Ortmann, Prokosheva, Rydval, & Hertwig, 2008). To address this potential

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[2] In some experiments they used the description "*A lottery ticket that gives you a 50 percent chance at a $50 gift certificate, and a 50 percent chance at a $100 gift certificate*". This could be interpreted as consisting of two independent 50:50 draws, one for $50 and one for $100, making a $0 (and a $150) outcome possible.

explanation, Experiment 1 in this paper modified the lottery description to more definitely rule out a $0 payment, and Experiment 2 included comprehension questions about the lottery.

EXPERIMENT 1 – THE UNCERTAINTY EFFECT WITH JOINT EVALUATION

The design of experiment 1 makes two notable modifications to those conducted by GLW: participants in the certainty condition indicated their WTP for two rather than a single outcome, and the lottery description was modified slightly, seeking to eliminate the possibility that participants may believe a $0 payment is possible.

Method

Two hundred and seventy-nine participants, primarily University of Pennsylvania undergraduates, answered hypothetical willingness-to-pay questions as part of a series of surveys and experiments they completed in exchange of monetary payment at Wharton's Behavioral Lab.

The experiment consisted of a 6x2 between participant design, where six conditions presenting different pairs of low and high value items were crossed with whether participants indicated their WTP for each of the two items (certainty condition) or for the corresponding 50:50 lottery (uncertainty condition). Each participant evaluated only one item-pair under one elicitation mode.

The six item-pairs were constructed by combining gift certificates for Barnes and Noble (for $50 or $100), gift certificates for *Pod,* a high-end Asian Fusion restaurant located near the University of Pennsylvania (also for $50 or $100), and three-course meals, also at *Pod,* for either 2 or 4 people (see Table 1).

It is fundamental that participants in the certainty condition are aware of both items before indicating their WTP for the first one (otherwise the first elicitation would not be performed under joint evaluation). This was accomplished with the following instructions:

We are interested in how much you would be willing to pay for two different items. In particular we will ask you how much you would be willing to pay for <low-value-item> and for <high-value-item>.

*If you could only buy the <low-value-item>, what is the highest amount of money you would pay for it?*____
*If you could only buy the <high-value-item>, what is the highest amount of money you would pay for it?*____

As mentioned above, the lottery description was modified to reduce ambiguity as to the possibility of a $0 payment. In particular, it stated:

We are interested in how much you would be willing to pay for a lottery ticket that will for sure pay one of two possible rewards (both are equally likely).
It will either pay <low-value-item> or <high-value-item>.

*What is the highest amount of money you would pay for this lottery?*___

The study was part of a series of experiments completed by participants in individual cubicles with personal computers. Participants were assigned sequentially into conditions based on the order in which they signed-on to the experiment. Data was collected over several experimental sessions with condition assignment being randomized within sessions.

Results

Table 1 summarizes the results for Experiment 1. The Uncertainty Effect is observed both for the average and the median WTP for all six item-pairs. Four of the six differences in means are statistically significant at the 5% level, while two are marginally not significant at the 10% level. Four of the six Wilcoxon tests are significant at the 5% level and the remaining two are significant at the 10% level.

*** Table 1 ***

The ratio between the WTP for the lottery and the WTP for the low value item gives us an indication of how large the Uncertainty Effect is. The average ratio across the six item-pairs for the WTP means is 65%, indicating that participants were willing to pay 2/3 as much for the lotteries as they were willing to pay for their lowest possible outcome. The average ratio for the median WTP is a striking 38%.

It is worth noting that estimates of the Uncertainty Effect arising from central-tendency measures, such as mean or median valuation, are conservative. They are conservative because if some participants do not exhibit direct-risk-aversion, they will value the lottery above its low value outcome and hence cancel out, in central tendency measures, the low valuation of those who do exhibit direct-risk-aversion. In fact, even if a substantial (and statistically significant) share of participants exhibited the Uncertainty Effect, the *average* WTP for the lottery may be higher than the *average* WTP for the low outcome, if just a few participants value the lottery sufficiently above its low value outcome.

Although in Experiment 1 central tendency measures did exhibit the UE, it is nevertheless worth assessing how widespread it is across participants. This calculation is not entirely straightforward in the present setting because the design is between participants and hence only one of the two relevant valuations are observed for any given participant (i.e., we cannot simply count the number of participants giving a higher WTP for the low value item than for the lottery). We can, nevertheless, learn quite a bit by comparing the distributions of valuations across conditions.

Figure 1 plots the cumulative distribution of the WTP for the $50 Barnes and Noble gift certificate and for the 50:50 lottery for a $50 or $100 gift certificate as a demonstration. The figure shows -for instance- that for around 50% of participants the WTP for the lottery was less than $20, while not a single participant's WTP was lower than $20 for the $50 gift certificate; in other words, around half the participants valued the lottery less than the person who was willing to pay the least for its worst outcome. This pattern suggests that the UE is quite prevalent, and not driven by a few extreme responses.

Employing the distributions depicted in Figure 1 we can precisely estimate the share of participants who exhibited the UE, if we assume that the relative ranking of valuations across participants is constant across conditions, that is, if we assume that if a participant pays more for the low value item than another participant does, then she would also pay more for the lottery. This would mean that the person paying the most for the lottery is assumed to be the person paying the most for the low value item, the one paying the second highest amount for the lottery to be the second highest payer for the low-value item, and so on.

Under this assumption, the point at which both distributions cross is the share of people who are wiling to pay less for the lottery than for the low-value item. In Figure 1 the cumulative distributions cross at roughly 80%, suggesting that around 80% of participants exhibit the Uncertainty Effect. The crossing point for the other five item-pairs ranges between 70% and 80% (corresponding figures available from the author's website).

Figure 1

Considering that the assumption on which these estimates rest cannot be tested, I also estimated an alternative which assesses the *lowest* possible share of participants exhibiting the UE. To this end the matching of participants' between conditions is done in a manner that minimizes the total number of 'violations'.

To illustrate the procedure imagine a situation where there were three participants per condition, with the valuations of the lottery being $10, $20 & $30, and the valuations of the low value item being $15, $25 & 35. For expository purposes let's begin again with the assumption that the ranking of valuations is constant across conditions. Under such assumption 100% of participants exhibit the UE (since the lowest, median and highest valuation of the lottery are lower than the corresponding lowest, median and highest valuation of the low-value item).

In contrasts, the lowest possible share of participants exhibiting the UE is just 1/3. If the participant paying $35 for the low-value outcome was the one paying $10 for the lottery, and the ones paying $15 and $25 for the low-value outcome were willing to pay $20 & 30 for the lottery, then only one participant would exhibit the UE.

I conducted analogous calculations for the distributions of valuations for each of the six item-pairs. The *lower bound* on the share of participants exhibiting the UE ranged between 52% and 70% across the six pairs, with an overall-mean of 62%.

In sum, if we assume that the ranking of valuations of the lottery and the low-value item is the same across subjects between conditions, then the best estimate of the share of participants exhibiting the UE is about 80%. If we are not willing to make such an assumption, we can place the lower bound on such share at 62%.

The main findings from Experiment 1, then, are that the Uncertainty Effect: (i) is not caused (at least exclusively) by the fact that the lottery contains a superior outcome which may reduce the valuation of the low-value one, (ii) is large in magnitude, and (iii) is widespread across participants.

Study 2 will further address the possibility that people value the binary lottery less than its actual worst outcome not because of direct-risk-aversion, but because they incorrectly believe that the lottery may result in a $0 payoff.

EXPERIMENT 2 – DO PARTICIPANTS UNDERSTAND THE LOTTERY?

If participants in UE studies erroneously believe that, like in most lotteries, a $0 payoff is possible, it would no longer be surprising that they would pay less for the lottery than for the low value outcome. Working papers by Keren & Willemsen (2008) and by Ortmann et al. (2008) propose this is all that's behind the findings by GLW.

Both papers assess the impact of modifying instructions and/or the randomizing procedure behind the lottery on the prevalence of the UE. They both find that these modifications do (sometimes) attenuate and even eliminate the UE for the average valuation (though recall the previous discussion regarding the limitations of inferences about the Uncertainty Effect based on mean and median valuations). [3]

Keren & Willemsen, also find that a substantial share of participants erroneously answer a comprehension question about the lottery and that only for these participants is the UE observed. In particular, they asked: "*True/False: The lottery offered me, with 100% certainty, at least 50 euros in Book certificates,*" and found that only for the roughly 45% (on average across experiments) of participants answering *false* was WTP for the lottery lower than the WTP for the low value outcome. These results are consistent with the UE being driven by misunderstood instructions rather than by a direct distaste for uncertainty.

Their design and analysis contain two potential problems, however, both are addressed by Experiment 2 in this paper. The first is that their comprehension question may have itself been difficult to comprehend by participants. The second is that the comprehension question (and resulting participant exclusion) was performed only in the uncertainty condition, possibly

[3] Keren and Willemsen emphasize that in their experiments they employed coin flips –an intuitive randomization device- to describe the lotteries, but this is an unlikely explanation for the difference in results, as GLW also did (see appendixes 2 and 4 in GLW).

introducing bias by engaging in selective elimination of observations in only one of the two conditions being compared. It is hence possible that, despite their findings, the UE is fully caused by a direct distaste for uncertainty.

In light of this, Experiment 2 contains two alternative comprehension questions. In one condition participants were directly asked to state the lowest possible payoff of the lottery, providing a simple assessment of the share of participants who erroneously believed they could earn less than what the lottery actually could pay. In the other condition participants were instead asked the true/false question. In addition, in Experiment 2 all participants indicated their WTP both for an item to be obtained with certainty *and* for a lottery. By comparing the WTP for the sure-thing item across participants answering the comprehension questions correctly and incorrectly, we can estimate the statistical bias introduced by dropping observations only from the uncertainty condition.

Method

One hundred and ninety-six participants, primarily University of Pennsylvania undergraduates, participated in this study as part of a series of surveys and experiments. The experiment consisted of a simple two-condition between-participant design, where the comprehension question was systematically manipulated between participants. All questions were over hypothetical scenarios.

All participants begun by indicating their WTP, today, for $100 to be received in a year. They then all indicated their WTP for a 50:50 lottery that paid either a $50 Barnes and Noble gift certificate, or a $100 one (employing the lottery description from Experiment 1).

Participants were then asked one of two comprehension questions. Half the participants were asked: *"True/False: The lottery from the previous question offered me, with 100% certainty, at least $50 in Gift Certificates"* while the other half were asked "*What was the lowest possible payment the lottery could pay?*" and were presented with a multiple choice set of answers that included values between $0 and $250 in gift certificates, in steps of $25. Importantly, participants could no longer see the lottery description when they were asked the comprehension question.

Results

Table 2 summarizes the results from Experiment 2. Arguably the most important finding is that of the 97 participants assigned to the multiple choice question, 92% (n=89) correctly answered that $50 was the lowest possible payoff, and that not a single participant answered $0, the most relevant value associated with misunderstanding. Two of the remaining 8 participants answered $25, while the other six answered a number *greater* than $50. If anything, this suggests that participants who misunderstand the lottery *over*-estimate its worst outcome; more likely, rather than signaling lack of understanding of the lottery per-se, missing the comprehension question signals not having taken the task seriously enough.

It is worth, nevertheless, to assess the extent to which participants such as these ones may be behind the UE. Table 2 shows that the WTP for the lottery by the eight participants giving an erroneous answer to the comprehension question was in fact much lower (*M*=15.5) than among the 89 answering it correctly (*M*=31.1).

It is tempting to interpret this result as suggesting that misunderstood instructions do indeed play a role in the UE. Such interpretation of the difference in WTP for the lottery, however, relies on the assumption that participants who answer the lottery question correctly and incorrectly do not differ in their (reported) valuation of items to be received for certain.

This assumption, however, is contradicted by the results from Experiment 2. Participants giving an incorrect answer to the comprehension question *for the lottery* had also for *$100 to be received in one year* a dramatically lower WTP than did participants correctly answering the comprehension question (*M*=15.74 vs. *M*=57.98). This exemplifies the problems associated with comparing the conditional mean of participants in one treatment to the unconditional mean of participants in another.

The lower panel of Table 2 repeats the analyses just presented for participants assigned to the True/False question. A higher share of participants answered *false* to this comprehension question (21 out of 99, or 21.2%) than the 8.2% that missed the multiple choice one, a statistically significant difference $Z = 2.56$, $p = .011$. This is consistent with the proposition that the True/False question was itself difficult to understand, especially considering that an answer of $50 (or above) to the multiple choice question is logically equivalent to answering *true* for the True/False question.

As was the case for the multiple choice question, participants erroneously answering the True/False question gave a lower median response for the WTP for *$100 in a year* than did participants correctly answering the comprehension question (medians of $30 and $50 respectively). The mean WTPs do not show this pattern ($52.43 and $47.38 respectively); this is driven by two participants who answered *false* and gave a WTP of $200 (again, for $100 in a year). If only answers of $100 or less are considered (in both conditions), the same pattern is present: average WTP for *$100 in a year* is lower among participants answering the true/false question incorrectly (M = 33.11) than those answering correctly (M = 45.34).

Experiment 2, in sum, suggests that the mechanism behind the Uncertainty Effect is not the erroneous belief that lotteries may pay a counterfactually low outcome. It also highlights the importance of the conducting symmetric comprehension checks across conditions in order to avoid statistical bias caused by, for example, eliminating participants who do not take the task seriously only from one condition.

GENERAL DISCUSSION

The results from this paper suggest that the Uncertainty Effect, valuing a risky prospect below the value of its worst possible outcome, occurs as the consequence of people exhibiting what I have referred to as "direct-risk-aversion", that is, risk aversion which does not arise indirectly as a consequence of how people value outcomes or weight probabilities, but instead, directly from a literal distaste for uncertainty.

Importantly, the Uncertainty Effect is found to be quite large, with the average valuation of a lottery over two outcomes being just 65% of the average valuation of its lowest outcome, and widespread, with a lower bound on the percentage of participants exhibiting it being 62%.

While the notion of direct-risk-aversion has been considered before (within frameworks regarding the "utility from gambling", see footnote 1), it has not entered our mainstream understanding of risk aversive behavior. The robustness, magnitude and widespread nature of the Uncertainty Effect suggest this may be an important shortcoming in our current understanding of risky choice.

Future work on direct-risk-aversion should strive to make progress on two different directions. The first is in exploring its ability to account for real-world behaviors that are at odds with existing theories of risk. The popularity of insurance for small-stakes risks, such as warranties for electronics, low deductibles or mail-insurance, is one promising possibility. Both Expected Utility and Prospect Theory predict that people should not purchase insurance over small stakes risks, and yet these seem to be extremely popular. Direct-risk-aversion provides a plausible explanation.

The challenge, of course, is in avoiding the tautological argument of alluding to direct-risk-aversion to 'explain' otherwise puzzling risk averse behavior. This leads to the second direction in which future research on direct-risk-aversion could make important progress: understanding what determines the perceived riskiness of, and hence aversion to a given prospect.

It seems likely that factors that have previously thought to influence risky choice independently, such as familiarity (Song & Schwarz, 2008; Weber, Siebenmorgen, & Weber, 2005), emotions (Loewenstein, Weber, Hsee, & Welch, 2001), and ambiguity aversion (Ellsberg, 1961; Fox & Tversky, 1995), for example, all ultimately influence it by affecting the subjective sense of 'riskiness' of a prospect in turn influencing decisions via direct-risk-aversion. Research exploring this and related issues could reshape our understanding of decision making under uncertainty.

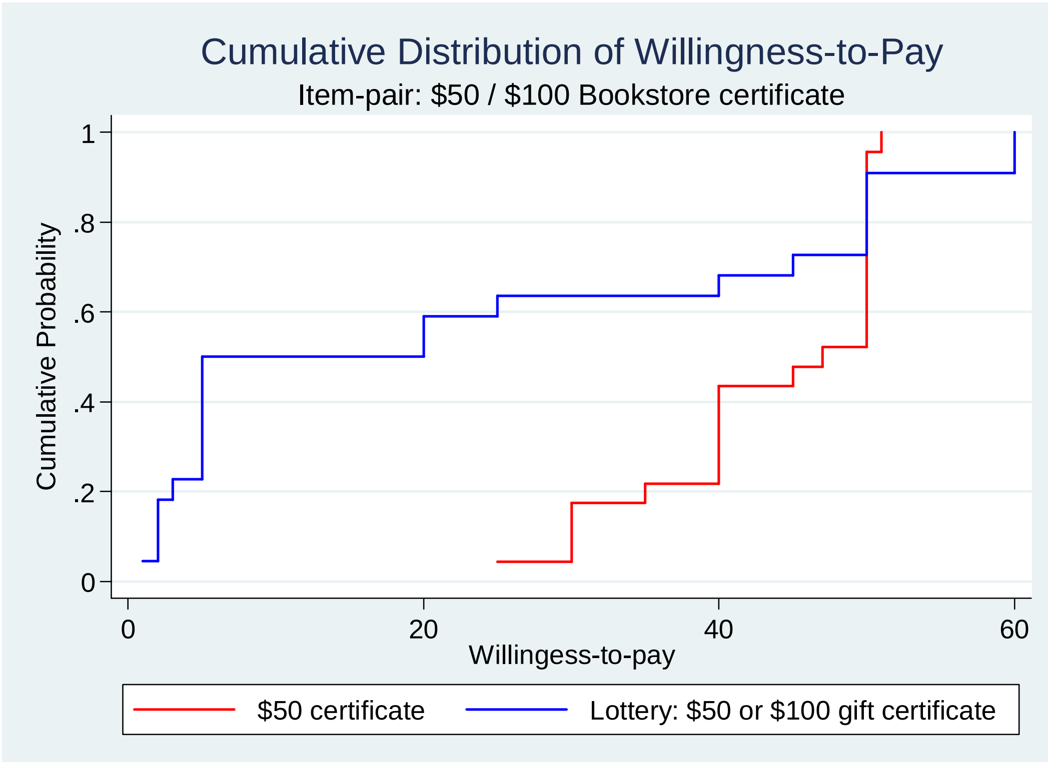
Table 1. Experiment 1 - Willingness-to-pay for binary lotteries and for their respective outcomes (between subjects)

High Value outcome	Low Value outcome		High Outcome	Low Outcome	Lottery	p-value of lottery vs. low outcome t-test/*Wilcoxon*	Observations (N) Certainty Condition	Observations (N) Uncertainty Condition
Bookstore: $100 certificate	Bookstore: $50 certificate	mean	84.2	43.2	23.2	<.001	23	22
		median	90	47	12.5	*.005*		
Restaurant: $100 certificate	Bookstore: $50 certificate	mean	67.6	34.5	25.7	.133	23	23
		median	65	30	15	*.065*		
Bookstore: $100 certificate	Restaurant: $50 certificate	mean	57.8	33.7	23.9	.104	23	23
		median	60	35	10	*.019*		
Restaurant: $100 certificate	Restaurant: $50 certificate	mean	78.5	40.8	25.1	.006	23	20
		median	80	45	20	*.005*		
Restaurant: free meal for four	Bookstore: $50 certificate	mean	91.0	35.6	24.5	.044	24	24
		median	100	40	12.5	*.086*		
Restaurant: free meal for four	Restaurant: free meal for two	mean	97.7	46.9	30.7	.016	24	23
		median	85	42.5	20	*.001*		

Table 2. Experiment 2 - Willingness-to-Pay by answer to comprehension questions

Willingness to Pay (WTP) for:	Receiving $100 in a year		Lottery $50/$100 gift certificate	
	Mean	Median	Mean	Median
Comprehension Question:				
Multiple choice				
Correct (N=89)	57.98	50	31.13	25
Incorrect (N=8)	15.75	10	15.50	10
Total (N=97)	54.50	50	29.84	25
True/False				
Correct (N=78)	47.38	50	28.24	25
Incorrect (N=21)	52.43	30	19.04	10
Total (N=99)	48.45	50	26.29	25

Figure 1



Cumulative Distribution of Willingness-to-Pay
Item-pair: $50 / $100 Bookstore certificate
Cumulative Probability
0
.2
.4
.6
.8
1
0
20
40
60
Willingess-to-pay
$50 certificate
Lottery: $50 or $100 gift certificate

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