10-2013

The "Play-Out" Effect and Preference Reversals: Evidence For Noisy Maximization

Joyce E. Berg
University of Iowa

John Dickhaut
Chapman University

Thomas A. Rietz
University of Iowa

Recommended Citation

Berg, Joyce E., John W. Dickhaut, and Thomas A. Rietz. "The "play-out" effect and preference reversals: Evidence for noisy maximization." *Journal of Economic Behavior & Organization* 94 (2013): 160-171.
DOI: 10.1016/j.jebo.2012.09.012

The "Play-Out" Effect and Preference Reversals: Evidence For Noisy Maximization

Comments

NOTICE: this is the author's version of a work that was accepted for publication in *Journal of Economic Behavior & Organization* . Changes resulting from the publishing process, such as peer review, editing, corrections, structural formatting, and other quality control mechanisms may not be reflected in this document. Changes may have been made to this work since it was submitted for publication. A definitive version was subsequently published in *Journal of Economic Behavior & Organization*, volume 94, in 2013. DOI: 10.1016/j.jebo.2012.09.012

The "Play-Out" Effect and Preference Reversals:

Evidence for Noisy Maximization*

by

Joyce E. Berg,** John W. Dickhaut and Thomas A. Rietz**

September 2012

Forthcoming in the Journal of Economic Behavior and Organization

Winner of the "Best Paper Award"
at
Experimental Economics, Accounting and Society:
A Conference in Memory of John Dickhaut
Chapman University
January 13-14, 2012

Corresponding Author: Thomas Rietz, Thomas-Rietz@uiowa.edu

Keywords: Preference Reversal, Risky Choice, Decision Making, Uncertainty

JEL Classification: C91, D81

---

* We thank the Economic Science Institute at Chapman University for financial support and the participants at "Experimental Economics, Accounting and Society: A Conference in Memory of John Dickhaut" for their insightful comments, especially Glenn Harrison, Elizabeth Hoffman, Charles Plott, Vernon Smith, Roman Sheremeta, Shyam Sunder and Nat Wilcox.
** Henry B. Tippie College of Business, University of Iowa, Iowa City, Iowa 52242.

The "Play-Out" Effect and Preference Reversals:

Evidence for Noisy Maximization

Abstract

In this paper, we document a "play-out" effect in preference reversal experiments. We compare data where preferences are elicited using (1) purely hypothetical gambles, (2) played-out, but unpaid gambles and (3) played-out gambles with truth-revealing monetary payments. We ask whether a model of stable preferences with random errors (e.g., expected utility with errors) can explain the data. The model is strongly rejected in data collected using purely hypothetical gambles. However, simply playing-out the gambles, even in the absence of payments, shifts the data pattern so that noisy maximization is no longer rejected. Inducing risk preferences using a lottery procedure, using monetary incentives or both shift the data pattern further so that noisy maximization achieves the best possible fit to the aggregate data. No model could fit the data better. We argue that play-out shifts the response pattern by inducing value because subjects can use outcomes to "keep score." Induction or monetary payments create stronger induced values, shifting the pattern further.

The “Play-Out” Effect and Preference Reversals:

Evidence for Noisy Maximization

> Money was never a big motivation for me, except as a way to keep score. The real excitement is playing the game.
>
> --Donald Trump, "Trump: Art of the Deal"

I. Introduction

Preference reversal data may call into question the economic assumption that subjects have a stable underlying preference function over gambles. In a typical preference reversal experiment, subjects indicate their preference for gambles using two different methods: (1) a direct “choice task” in which the subject indicates the preferred gamble from a pair of gambles directly indicating preference and (2) a “pricing task” in which the subject assigns values to the two gambles and the assigned values indicate preference. A preference reversal occurs when the indicated preferences in the two tasks are inconsistent. Reversal rates are high and appear to be impervious to incentives (Lichtenstein and Slovic (1971); Grether and Plott (1979)).

The existence of any reversals indicates that subjects are not perfect expected utility (EUT) optimizers. Strictly speaking, it would also violate non-expected utility (Non-EUT) preference functions that assume stable preferences across gambles (e.g., prospect theory). If reversals are the result of systematic deviations from stable preferences, it calls expected utility and many non-expected utility theories into serious question. However, reversals could also be the result of random (non-systematic) errors, especially if subjects do not have a strong preference across gambles. This is not as damaging to theories of stable preference. Modifying a stable preference function to incorporate random errors (something we term “noisy maximization” in Berg, Dickhaut and Rietz (2003)) would accommodate the data. In such a case, preferences do not actually reverse. Instead, reported preferences may be inconsistent because subjects make random errors.

Noisy maximization models are testable because they cannot explain all data patterns. When the difference in preferences indicated by the two tasks is large and there are systematic reversal patterns, the model fails. Such is the case in Lichtenstein and Slovic (1971) and several replications where subjects declare preferences over hypothetical gambles. In this paper, we show that hypothetical gamble data does not tell the entire story. Using data gathered in Berg, Dickhaut and Rietz (2010) surveying near replications of Lichtenstein and Slovic, a detailed analysis of procedures and new experiments, we uncover a previously undocumented effect in preference reversal data. When the gambles are purely hypothetical (gambles are not played-out or paid-out), the data is inconsistent with noisy maximization – the differences in preferences declared in pricing and choice tasks simply cannot be accommodated by stable preferences and random errors.[1] However, playing-out the gambles, even without paying subjects based on outcomes, shifts the pattern of responses. Noisy maximization is no longer rejected. We argue that this "play-out" effect arises because subjects can effectively "keep score" with the outcomes. This results in a weak form of induced value.[2]

We also document a preference effect. Playing-out the gambles followed by a played-out, but unpaid, risk preference induction lottery (a la Berg, Daley, Dickhaut and O'Brien (1986)) shifts the response pattern further: Noisy maximization not only fits the data, but fits the data as well as any model possibly could in the sense that it maximizes the global likelihood function of the aggregate data. Playing-out allows subjects to keep score and risk preference induction strengthens players' preferences. These two effects result in more systematically consistent revealed preferences across gambles.

We also document an additional "payment" (incentives) effect. Paying subjects based on outcomes (which requires play-out), also shifts the pattern. Again, noisy maximization generally fits the data as well as any model could. Finally, comparing data where we induce preferences under a play-out only design (with no monetary incentives tied to outcomes) and in a play-out/payment design (with monetary incentives), we show an incentive effect. Risk preferences estimated from prices move in the direction of induced risk preference in play-out only data, but are even closer with monetary incentives.

The key to our results is considering the entire pattern of responses instead of focusing only on reversal rates. In prior research (Berg, Dickhaut and Rietz (2010)), we summarize research replicating Lichtenstein and Slovic (1971). Reversal rates range from 22% to 54%. Reversal rates are somewhat lower when subjects reveal preference through played-out gambles with payments based on truth-revealing payment methods, but rates remain high and the effect of incentives is only marginally significant (p-value = 0.0893). However, there is a significant change in the <u>pattern</u> of reversals. Replications without outcome contingent payments largely accord with Lichtenstein and Slovic's (1971) finding – a model of stable preferences expressed

[1] We are not the first to point this out. See, for example Lichtenstein and Slovic's (1971) two-error-rate model analysis.

[2] The idea is similar to Hsee, Yu, Zhang and Zhang (2003), who argue that money, experimental currency units, points, or whatever the experimental medium of exchange is, becomes the objective of subjects. Subjects engage in "medium maximization" as a way of keeping score in the experiment even if the medium has no direct value. Consistent with this, Camerer and Hogarth (1999) observe that, sometimes, subject behavior accords with economic theory even without monetary payments.

with random error cannot explain the declared preference data. In contrast, truth revealing, monetary incentives typically result in patterns that are consistent with noisy maximization. Berg, Dickhaut and Rietz (2010) conclude that "incentives can generate more economically consistent behavior" presumably because the incentive structure creates a clearly defined objective function consistent with Smith's (1976) idea of induced value.

In related research on the preference effect (Berg, Dickhaut and Rietz (2003)), we show that inducing risk preferences can have a strong impact on the pattern of preference reversals as well. Commonly the gambles in preference reversal research have similar average payoffs but differ significantly in variance. One gamble, the "p-bet," has a high probably of a relatively low payoff and a low variance. The other, the "$-bet," has a low probability of a relatively high payoff and a high variance. Inducing risk aversion (risk seeking) creates a strong preferences for the p-bet ($-bet). This reduces reversal rates overall and makes the pattern consistent with noisy maximization. Berg, Dickhaut and Rietz (2003) argue that the risk preference induction mechanism creates stronger preferences across gambles than simple induced value.

Here, we argue that a combination of three effects drives more coherent patterns in preference reversal data:

1. A "payment" effect: Subjects behave more coherently when being paid in a truth revealing manner based on outcomes. This is Smith's (1976) traditional, monetary induced value theory in context.
2. A "preference" effect: Subjects behave more coherently when a lottery mechanism is used to induce stronger preferences across gambles. Berg, Dickhaut and Rietz (2003) document this in experiments where subjects are paid based on outcomes. Here, we document the preference effect in sessions where outcomes are determined, but there are no subject payments tied to the outcomes.
3. A previously undocumented "play-out" effect: Subjects behave more coherently when gambles are played-out, even when subjects are not paid based on the outcomes.

Of course, to pay subjects based on outcomes, at least one outcome must be determined by playing it out. As a result, prior research confounds the play-out and payment effects. Here, we disentangle them and find an independent play-out effect.

Figure 1: Timeline for a Perference Reversal Experiment

The subject chooses between gambles in pairs (3 pairs)	→	The subject states selling prices for each gamble (12 gambles)	→	The subject chooses between gambles in pairs (3 pairs)

II. Preference Reversal

A. Preference Reversal Tasks

In typical preference reversal research,[3] subjects evaluate pairs of gambles. The two gambles in a pair have approximately the same expected value, but differ in variance. One gamble, the "P-bet," has a high probability of winning a low amount while the other, the "$-bet," has a low probability of winning a large amount. The timeline for the typical subject in a preference reversal experiment (for example, Lichtenstein and Slovic (1971)) given in Figure 1.

First, three pairs are presented to the subject who must state which gamble in each pair is preferred. Then, the subject values each individual gamble. Finally, the last three pairs are presented to the subject.

For each subject, the data on each gamble pair include the subject's choice between the two gambles and the valuations (typically prices) of each gamble. Each observation is either consistent (i.e., the gamble chosen in the choice task is the same as the gamble that is priced higher) or it represents a "reversal" because the chosen gamble and the highest price gamble are inconsistent. Figure 2 shows a typical pattern of data from a preference reversal experiment (specifically Lichtenstein and Slovic's (1971) Experiment 1). In Cell a, the P-Bet is both chosen and priced higher and, in Cell d, the $-Bet is both chosen and priced higher. These two cells represent consistent rankings. Cells b and c represent reversals with the P-Bet chosen but the $-Bet priced higher (Cell b) or the $-Bet chosen with the P-Bet priced higher (Cell c). The reversal rate is (b+c)/(a+b+c+d) = (441+32)/(88+441+32+477) = 0.456 = 45.6%. Lichtenstein and Slovic (1971) show that their pattern of reversals is inconsistent with a model of stable underlying preference revealed with random error (i.e., "noisy maximization").

[3] Including the experiments run for this paper and in Berg, Dickhaut and Rietz (2003).

Figure 2: Typical pattern of Preference Reversal Responses (from Lichtenstein and Slovic, 1971, Experiment 1, 1038 observations)

	P-bet priced higher	$-bet priced higher
P-bet chosen	Cell a 88 8.48%	Cell b 441 42.49%
$-bet chosen	Cell c 32 3.08%	Cell d 477 45.95%

B. The Noisy Maximization (Two-Error-Rate) Model

Lichtenstein and Slovic's (1971) "two-error-rate" model assumes that (1) individual subjects have stable preferences across gambles but (2) preferences are revealed with random error where the error rates can differ across tasks. Tasks do not affect preferences nor do preferences affect error rates. This would be the case if subjects maximized expected utility or another stable preference function with errors. Berg, Dickhaut and Rietz ((2003) and (2010)) examine whether this model of "noisy maximization" fits the data when truth-revealing incentives are used in preference reversal experiments. In this paper, we ask whether playing-out the gambles alone has a similar effect.

To parameterize the model, let "*q*" represent the percentage of subjects who prefer the P-bet, "*r*" represent the error rate in the choice task (rate at which the non-preferred gamble is chosen) and "*s*" represent the error rate in the pricing task (rate at which the non-preferred gamble is valued higher). If we assume that errors in the choice task and the pricing task are random and independent (that is, making an error in the choice task does not affect the probability of making an error in the pricing task), then the pattern of observations generated in a preference reversal experiment should conform to Figure 3, where *a*, *b*, *c* and *d* represent the percentage of observations that fall into each cell.

Figure 3: Two Error Rate Model

	P-bet Priced Higher	$-bet Priced Higher
P-bet Chosen	$(q)(1-r)(1-s) + (1-q)(r)(s)$ a	b $(q)(1-r)(s) + (1-q)(r)(1-s)$
$-bet Chosen	c $(q)(r)(1-s) + (1-q)(1-r)(s)$	d $(q)(r)(s) + (1-q)(1-r)(1-s)$

where:
q = percentage of subjects whose underlying preference ordering ranks the P-bet higher
r = error rate in the paired-choice task
s = error rate in the pricing task

If behavior is explained by the two-error rate model, then these proportions are also functions of *q*, *r* and *s* as defined in Figure 3. When solutions exist for *q*, *r* and *s* that match the observed frequencies, these solutions are the maximum likelihood estimates of the parameters.[4] In fact, they would constitute a "best fit" model in the sense that these estimates maximize the global likelihood function of the aggregate data. These estimates are:[5]

$$\hat{q}(1-\hat{q}) = \frac{ad-bc}{(a+d)-(b+c)}, \tag{1}$$

$$\hat{r} = \frac{a+b-\hat{q}}{1-2\hat{q}}, \text{ and} \tag{2}$$

$$\hat{s} = \frac{a+c-\hat{q}}{1-2\hat{q}}. \tag{3}$$

Notice that the two error rate model cannot always be parameterized to fit the data. In particular, equation (1) may not have a real solution. If $\hat{q}$ = 0.5, there is no solution for $\hat{r}$ or $\hat{s}$. Other estimates of $\hat{q}$, $\hat{r}$ or $\hat{s}$ may fall outside the valid 0 to 1 range. Whether the two-error-rate model can be parameterized to fit the data and, if not, whether restrictions imposed by the two error rate model are significant is one factor we use to determine whether play-out and/or payment affect behavior in preference reversal experiments.

---

[4] See Berg, Dickhaut and Rietz (2010) for details.
[5] Due to the quadratic form, there are two equivalent sets of parameters that satisfy these equations because *q* and 1-*q* are interchangeable. The resulting estimates of *r* and *s* are each one minus the original estimate. We do not take a stand on which set of estimates is "correct" because it is irrelevant to the likelihood function (both sets give the same likelihood) and, hence, to the likelihood ratio tests discussed below. We let the data choose which set we display in the tables by minimizing the sum of the error rates *r* and *s*.

III. Play-out, Payment and Preference Induction in Preference Reversal Experiments

Lichtenstein and Slovic (1971) and Berg, Dickhaut and Rietz (2010) show that the data from the Lichtenstein and Slovic (1971) experiment differs significantly from a data pattern that could be explained by noisy maximization. This result is due to the overall pattern of choices as measured by conditional reversal rates (the reversal rate in one task conditional on the choice(s) in the other task), not simply the overall reversal rate. Results that are inconsistent with noisy maximization are generally the case in other preference reversal experiments when subjects are not paid based on the outcomes of their decisions. Here, we replicate this result in a new experiment. We also show that, in data from experiments where subjects are paid in a truth-revealing manner, reversals remain. However, the data accords with noisy maximization. This holds for Grether and Plott (1979) experiment 1b, most of the experiments in the literature and on data aggregated across experiments.

In Berg, Dickhaut and Rietz (2003), we study how inducing risk preferences (using the Berg, Daley, Dickhaut and O'Brien (1986) lottery procedure) affects behavior. Again, the pattern accords with noisy maximization. In addition, creating a strong preference across gambles using risk preference induction can decrease the overall reversal rate.

All experiments in the literature to date use one of two incentive schemes: (1) the gambles are played-out and subjects receive outcome contingent payments or (2) the gambles are not played-out and subjects do not receive outcome contingent payments. Note that providing outcomes-based payments and playing-out gambles are completely confounded. In the experiments with payments, the outcomes can be used to "keep score." In the experiment without incentives, there is no way to keep score. Could it be that the change in behavior is not driven by payments per se, but rather by playing-out the gambles and allowing subjects to keep score through observing the outcomes? We present results showing that play-out does affect behavior, even when there are no truth-revealing incentive payments. However, payments also have an effect, creating an even more coherent response pattern. Both matter.

IV. Experimental Procedures and Data

We compare three sources of data:

(1) aggregated outcomes from the prior research that replicated Lichtenstein and Slovic (1971) with and without incentive payments as reported in Berg, Dickhaut and Rietz (2010),

(2) individual experiments reported in Lichtenstein and Slovic (1971), Grether and Plott (1979) and Berg, Dickhaut and Rietz (2003), and

(3) new experiments.

Table 1: Design

Play Treatment	Induction Treatment	Incentives Treatment: No Incentives Tied to Gamble Outcomes	Incentives Treatment: Incentives Tied to Gamble Outcomes
Gambles Not Played	Native Preferences	NP-N-NI	
Gambles Played and Outcomes Revealed	Native Preferences	P-N-NI	P-N-I
	Induced Risk Averse	P-RA-NI	P-RA-I
	Induced Risk Neutral	P-RN-NI	P-RN-I
	Induced Risk Seeking	P-RS-NI	P-RS-I

The prior research allows us to benchmark our results and place them in context. Our new experiments use essentially the same design and instructions as used in Berg, Dickhaut and Rietz (2003). Modifications to the instructions depend on the treatment as discussed below.

Treatment variables across experiments include:

(1) whether subjects are paid based on experimental outcomes (which requires that gambles be played-out);

(2) whether subjects have risk preferences induced using the binary lottery procedure (which requires that gambles and lotteries be played-out);

(3) whether the gambles are actually played-out (this necessarily occurs when there are outcome-contingent incentive payments, but can be present or not when there are no outcome-based payments).

This leads to the design shown in Table 1. Cells in Table 1 are labelled NP or P to indicate whether gambles are Not Played-out or Played-out; N, RA, RN or RS to indicate Native preferences, induced Risk Averse, induced Risk Neutral or induced Risk Seeking preferences; and NI or I to indicate No (monetary) Incentives tied to gamble outcomes or (monetary) Incentives tied to gamble outcomes.

For data in cell P-N-I (gambles played-out, native preferences, and monetary incentives tied to gamble outcomes), we use aggregate data from the literature as reported in Berg, Dickhaut and Rietz (2010) (labelled "Lit. Agg.") and Grether and Plott's (1979) Experiment 1b (labelled G&P1b) as a benchmark data set. For data in cell NP-N-NI (gambles not played-out, native preferences, no monetary incentives tied to gamble outcomes), we use aggregate data from the literature as reported in Berg, Dickhaut and Rietz (2010) (labelled "Lit. Agg.") and Lichtenstein and Slovic's (1971) Experiment 1 (labelled L&S1) as a benchmark data set. For data in the other cells with monetary incentives tied to gamble outcomes, we use the experiments from Berg, Dickhaut and Rietz (2003) (labelled BDR-RA, BDR-RN and BDR-RS). Finally, for data in all of the cells with no incentives tied to gamble outcomes, we run new experiments for this

Table 2: P-bet Preferences and Reversal Rates across Treatments

Incentives Category	Data Set	Obs.	Avg. Pref. For the P-bet According to Choices (a+b)/(a+b+c+d)	Avg. Pref. For the P-bet According to Prices (a+c)/(a+b+c+d)	Difference Between P-bet Preference Measures	Reversal Rate (b+c)/(a+b+c+d)
NP-N-NI	Lit. Agg.	4644	0.524	0.318	0.206	0.409
NP-N-NI	L&S1	1038	0.510	0.116	0.394	0.456
NP-N-NI	New	134	0.672	0.396	0.276	0.410
P-N-NI	New	141	0.603	0.496	0.106	0.390
P-RA-NI	New	158	0.703	0.570	0.133	0.399
P-RN-NI	New	156	0.564	0.513	0.051	0.462
P-RS-NI	New	157	0.299	0.433	0.134	0.401
P-N-I	Lit. Agg.	3185	0.411	0.284	0.127	0.362
P-N-I	G&P1b	262	0.363	0.183	0.179	0.347
P-RA-I	BDR-RA	275	0.927	0.880	0.047	0.164
P-RN-I	BDR-RN	244	0.553	0.590	0.037	0.365
P-RS-I	BDR-RS	247	0.146	0.324	0.178	0.372

paper (this creates a new replication in cell NP-N-NI). Instructions for the existing experiments can be found in the original papers. The appendix contains instructions for the new experiments.

V. Results

C. Aggregate Results

Table 2 presents summary data across treatments. The first three rows (labeled NP) are all treatments in which gambles were not played-out. The other rows (rows 4-12) are all treatments in which gambles were played-out. As discussed in the prior research (ranging from Grether and Plott (1979) to Berg, Dickhaut and Rietz (2010)), reversal rates themselves are largely unaffected by the payment treatment. The lone significant exception is a drop in the reversal rate in treatment P-RA-I, where the gambles are played-out, and subjects are paid based on outcomes under induced risk aversion.

While there is no obvious effect on the level of reversals, Table 2 reveals that there is an effect on the percentage of times the P-bet is preferred in the choice and pricing tasks. Large differences in preferences between the two tasks occur when there are no outcome-based incentives and the gambles are not played-out. In Lichtenstein and Slovic (1971), subjects are much more likely to prefer the P-bet in the choice tasks than in the pricing task (the differenct between the tasks is 0.394). Our replication shows the same result (the difference is 0.276).

In contrast, revealed preference for the P-bet is more similar across tasks when the gambles are played-out, whether or not there are outcome-based incentives. Berg, Dickhaut and Rietz (2010), document this effect when subjects are paid (and by construction, gambles are played-

Table 3: Conditional Reversal Rates Across Treatments

			Conditional (on Choice) Reversal Rates			Conditional (on Pricing) Reversal Rates		
Incentives Category	Data Set	Obs.	P-bet (b/(a+b))	$-bet (c/(c+d))	Difference	P-bet (c/(a+c))	$-bet (b/(b+d))	Difference
NP-N-NI	Lit. Agg.	4644	0.586	0.213	0.374	0.318	0.451	-0.133
NP-N-NI	L&S1	1038	0.834	0.063	0.771	0.267	0.480	-0.214
NP-N-NI	New	134	0.511	0.205	0.307	0.170	0.568	-0.398
P-N-NI	New	141	0.412	0.357	0.055	0.286	0.493	-0.207
P-RA-NI	New	158	0.378	0.447	-0.068	0.233	0.618	-0.384
P-RN-NI	New	156	0.455	0.471	-0.016	0.400	0.526	-0.126
P-RS-NI	New	157	0.447	0.382	0.065	0.618	0.236	0.382
P-N-I	Lit. Agg.	3185	0.595	0.199	0.396	0.414	0.342	0.072
P-N-I	G&P1b	262	0.726	0.132	0.595	0.322	0.458	-0.136
P-RA-I	BDR-RA	275	0.114	0.800	-0.686	0.066	0.879	-0.813
P-RN-I	BDR-RN	244	0.296	0.450	-0.153	0.340	0.400	-0.060
P-RS-I	BDR-RS	247	0.667	0.322	0.344	0.850	0.144	0.706

out). However, our new experiments reveal that just playing-out the bets reduces the difference between tasks. The difference in P-bet preference across tasks is smaller when the gambles are played-out (P-N-NI) than when they are not played-out (NP-N-NI), even though subjects do not receive truth-revealing monetary incentives.

Table 3 shows the conditional reversal rates. In Berg, Dickhaut and Rietz (2003) and (2010), we argue that the pattern of conditional reversal rates under induced risk preferences is consistent with noisy maximization models with error correction.

Consider the data under risk averse preferences (Incentives Category P-RA-I). Subjects should be risk averse. If they “err” in the choice task, by choosing the $-bet (inconsistent with risk aversion), the reversal rate should be high if they correct the “error” in the pricing task. On the other hand, the reversal rate should be low if they choose the P-bet. Similarly, if they err in the pricing task, by pricing the $-bet higher, the reversal rate should be high if they correct the error in the choice task. The rate should be low if they price the P-bet higher. This is exactly the data pattern we observe. Subjects who choose the P-bet reverse 11.4% of the time in the pricing task. Subjects who price the P-bet higher reverse 6.6% of the time in the choice task. In contrast, consistent with error correction, the reversal rates skyrocket if the subjects choose the $-Bet (80.0% of the time) or price the $-Bet higher (87.9% of the time).

Though somewhat weaker, the opposite pattern holds for risk seeking preferences (Incentives Category P-RS-I). Under risk neutral preferences and native preferences, there is no strong pattern in the conditional reversal rate. This is consistent with relatively risk neutral subjects and random errors.

Table 4: Estimates of the Two-Error-Rate Model Across Treatments

Incentives Category	Data Set	Obs.	Two–Error-Rate Model: Estimates q	r	s	LR Test Stat
NP-N-NI	Lit. Agg.	4644	0.318	0.409	0.000	74.65*
NP-N-NI	L&S1	1038	0.116	0.456	0.000	20.42*
NP-N-NI	New	134	0.396	0.410	0.000	22.36*
P-N-NI	New	141	0.603	0.000	0.390	0.425
P-RA-NI	New	158	0.764	0.116	0.368	Equal
P-RN-NI	New	156	0.603	0.190	0.438	Equal
P-RS-NI	New	157	0.239	0.115	0.372	Equal
P-N-I	Lit. Agg.	3185	0.236	0.331	0.091	Equal
P-N-I	G&P1b	262	0.122	0.318	0.080	Equal
P-RA-I	BDR-RA	275	0.991	0.065	0.113	Equal
P-RN-I	BDR-RN	244	0.633	0.300	0.162	Equal
P-RS-I	BDR-RS	247	0.005	0.142	0.322	Equal

While the differences are considerably smaller, they remain under induced preferences even when the subjects are not paid. Under induced risk aversion without outcome-based incentives (Incentives Category P-RA-NI), the $-bet conditional reversal rates exceed the P-bet conditional reversal rates. Under induced risk seeking without outcome-based incentives (Incentives Category P-RS-NI), the P-bet conditional reversal rates exceed the $-bet conditional reversal rates.

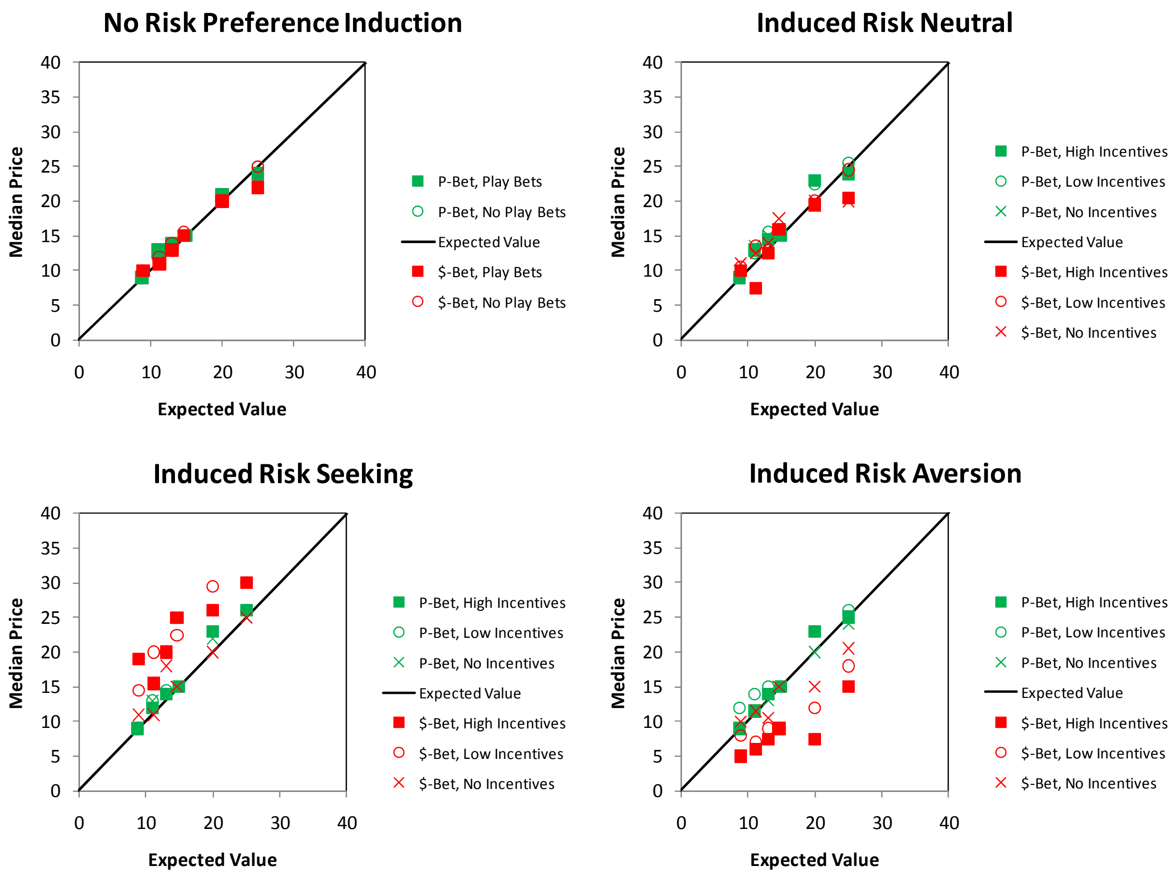
The two-error-rate model allows us to ask precisely whether behavior is consistent with noisy maximization. Table 4 shows these estimates from the aggregate data in each incentives category. Just playing-out the gambles clearly has an effect. When gambles are not played-out, (Incentives Category NP-N-NI), the two error rate model cannot accommodate the data. This occurs across individual experiments in the existing literature, on average in the existing literature, and in our new experiment.

When gambles are played-out, the two-error-rate model fits the data exactly in all but one case, and in that case, the difference is insignificant. Estimates of the preferences for the P-bet (q) are highest under induced risk aversion (Incentives Categories P-RA-NI and P-RA-I) and nearly 1 when subjects are paid based on outcomes (Incentives Category P-RA-I). Estimates of the preferences for the P-bet (q) are lowest under induced risk seeking (Incentives Categories P-RS-NI and P-RS-I) and nearly 0 when subjects are paid based on outcomes (Incentives Category P-RS-I).

In summary, our aggregate results show that:

1. Playing-out the gambles (that is, allowing subjects to keep score) generates more economically consistent behavior.

Figure 4: Average Prices of Bets by Treatment



2. Risk preference induction generates more economically consistent behavior while generating behavior consistent with the induced preferences.
3. The choice patterns are most consistent when subjects are paid based on outcomes.

D. Analysis of Individual Prices

We also ask whether the play-out effect appears in individual pricing decisions. Here, we study the data from the six treatments in Berg, Dickhaut and Rietz (2003) and the three new data sets that use identical gambles, instructions and risk preference induction procedures. The only difference in procedures is that, in the sessions run for this paper, subjects are paid a flat participation fee rather than receiving outcome-contingent payments. In all cases, risk preferences are induced using Berg, Daley, Dickhaut and O'Brien's (1986) lottery procedure with an induced utility function of $U(w) = e^{\gamma w}$, where w is the payoff from a task and γ=-0.11 for risk averse, γ=0 for risk neutral and γ=0.11 for risk seeking preferences.[6]

[6] See Berg, Dickhaut and Rietz (2003) for details.

Table 5: Gambles and Certainty Equivalents

Pair	Type	Probability of Winning	Points if Win	Points If Lose	Expected Points (Risk Neutral Certainty Equivalent)	Risk Averse Certainty Equivalent	Risk Loving Certainty Equivalent
1	P	35/36	9	2	8.81	8.71	8.86
	$	11/36	27	1	8.94	4.09	17.33
2	P	33/36	14	2	13.00	12.13	13.43
	$	9/36	40	4	13.00	6.56	27.90
3	P	32/36	15	14	14.89	14.88	14.89
	$	12/36	36	4	14.67	7.55	26.54
4	P	30/36	23	5	20.00	16.52	21.59
	$	18/36	40	0	20.00	6.19	33.81
5	P	27/36	26	22	25.00	24.82	25.15
	$	18/36	39	11	25.00	16.89	33.11
6	P	29/36	13	3	11.06	10.01	11.74
	$	7/36	37	5	11.22	6.90	23.16

Under risk averse, risk neutral and risk seeking induced preferences, prices for individual gambles should be successively higher in theory. Figure 4 shows average prices for each gamble under each treatment. The $-bet (riskier bet) in each pair is graphed in red while the P-bet (less risky bet) in each pair is graphed in green. The upper left graph shows prices when preferences are not induced. Regardless of whether the gambles are played-out or not, the prices of gambles within a pair align closely. This is consistent with subjects' native risk preference being approximately risk neutral.

The upper right graph shows some divergence under induced risk neutral preferences, possibly because of noise introduced by the risk preference induction procedure. But, again subjects are approximately risk neutral.

The bottom two graphs show increasing divergence under induced risk seeking (left) and risk averse (right) preferences. As expected, under induced risk seeking preferences, valuations generally exceed expected values and $-bet (riskier) prices exceed p-bet (less risky) prices. Also as expected, under induced risk averse preferences, valuations are generally lower than expected values and p-bet (less risky) prices exceed $-bet (riskier) prices. Recall that the gambles are played-out in all but the upper left graph in Figure 4. As seen by comparing the incentives and no incentives treatments, simply playing the gamble makes subject behavior conform to the noisy maximization model. However, effects appear stronger for incentives treatments than no-incentives treatments.

Under induction, we can compute the theoretical certainty equivalent for each gamble as:

Table 6: Deviations from Induced Certainty Equivalents by Risk Preference Induction Treatment and Incentives Levels

Risk Preference Induction Treatment	Item	Incentives Treatment High	Low	None	Kruskal-Wallis Tests of Incentives Effects	
	Observations	288	276	360		
	Mean	2.0656	3.5078	4.0927	$\chi 2$ Statistic	18.005***
Averse	Std. Dev.	6.0237	6.4361	7.8432	d.o.f.	2
	Robust T-Stat.#	3.56***	5.21***	4.89***	p-value	0.0001
	p-value	0.002	0.000	0.000		
	Observations	312	288	360		
	Mean	1.3905	1.4896	2.0236	$\chi 2$ Statistic	6.202**
Neutral	Std. Dev.	7.4993	5.9743	6.6652	d.o.f.	2.0000
	Robust T-Stat. #	1.88*	2.21**	4.32***	p-value	0.0450
	p-value	0.0720	0.0380	0.0000		
	Observations	264	288	348		
	Mean	-1.967	-2.033	-3.983	$\chi 2$ Statistic	6.976**
Seeking	Std. Dev.	9.611	9.569	8.674	d.o.f.	2
	Robust T-Stat. #	-1.70	-2.44**	-6.32***	p-value	0.0306
	p-value	0.104	0.0230	0.0000		

#Clustered by subject.
*Significant at the 90% level of confidence.
*Significant at the 95% level of confidence.
*Significant at the 99% level of confidence.

$$CE=\frac{\ln(p_h e^{\gamma h}+(1-p_h)e^{\gamma l})}{\gamma}, \qquad (4)$$

where CE is the certainty equivalent, h is the high payoff, l is the low payoff and p_h is the probability of the high payoff. This provides a benchmark value for each gamble under each risk preference. Table 5 (reproduced from Berg, Dickhaut and Rietz (2003)) presents the gambles and certainty equivalents for these data sets. The certainty equivalents tell us what prices should be if subjects maximize expected utility under the risk preference induction technique. We can compare this to actual prices. Alternatively, we can estimate the risk aversion parameter displayed in a particular subject's prices using non-linear regression by setting gamma to minimize the squared deviation between (4) and the actual prices submitted by that subject across the twelve gambles.

Table 6 shows the deviations of prices from certainty equivalents for each treatment. On average, induced risk averse subjects over price gambles. There is a significant incentive effect. The overpricing is most severe with no outcomes based incentives and least severe under high incentives levels. Induced risk neutral subjects also tend to over price gambles. Again, there is a significant incentive effect with the most severe (and most significant) over pricing under no incentives and the least severe (and least significant) over pricing under high incentives. Without incentives, induced risk seeking subjects under price gambles. Again, there

Table 7: Individual Risk Aversion Parameter Estimates by Risk Preference Induction Treatment and Incentives Levels

Risk Preference Induction Treatment	Item	Incentives Treatment: High	Low	None	Kruskal-Wallis Tests of Incentives Effects	
Averse	Observations	24	23	20		
	Median	-0.0743	-0.0463	-0.0134	χ2 Statistic	16.033***
	Inter-quartile Range	0.0619	0.0454	0.0686	d.o.f.	2
	Sign Rank Test Statistic#	2.029**	3.315***	3.527***	p-value	0.0003
	p-value	0.0425	0.0009	0.004		
Neutral	Observations	26	24	30		
	Median	-0.0020	0.0062	0.0118	χ2 Statistic	1.825
	Inter-quartile Range	0.0645	0.0497	0.0198	d.o.f.	2.0000
	Sign Rank Test Statistic#	0.317	0.914	2.808***	p-value	0.4015
	p-value	0.7509	0.3606	0.0050		
Seeking	Observations	22	24	29		
	Median	0.0479	0.0577	0.0311	χ2 Statistic	2.883
	Inter-quartile Range	0.0832	0.0753	0.0976	d.o.f.	2
	Sign Rank Test Statistic#	-2.808***	-4.000***	-3.925***	p-value	0.2366
	p-value	0.0050	0.0001	0.0001		

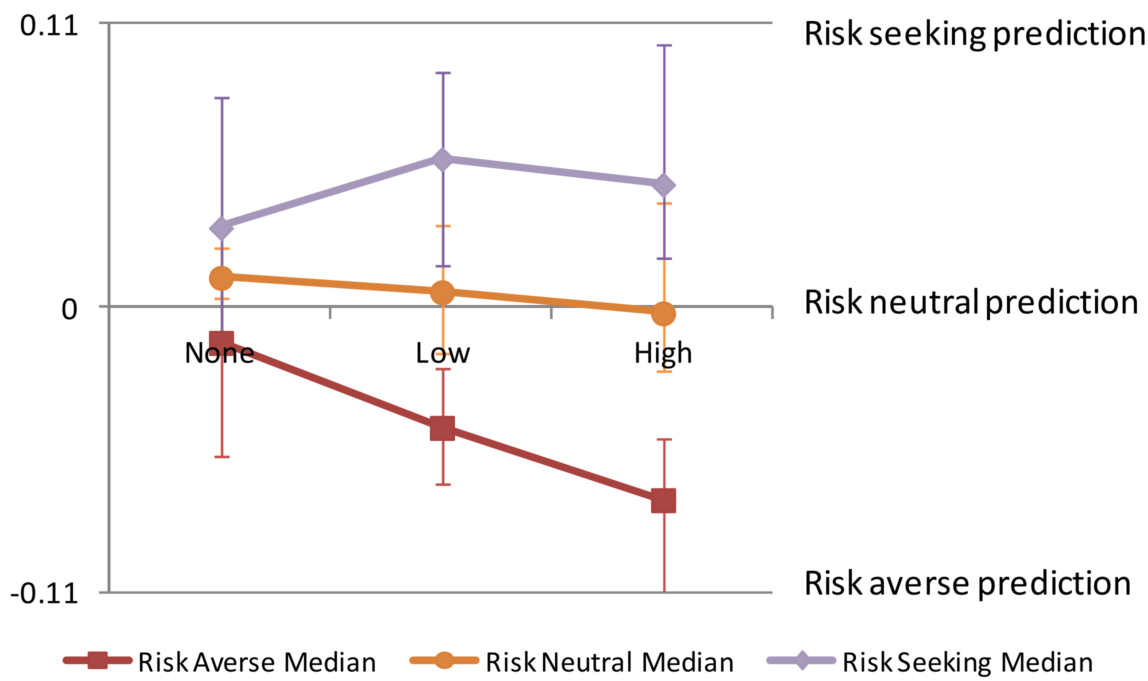
#Sign rank test statistics measure whether the median estimated risk aversion parameter differs from the predictions of -0.11, 0 and 0.11 for risk averse, neutral and seeking induced preferences, respectively.
*Significant at the 90% level of confidence.
*Significant at the 95% level of confidence.
*Significant at the 99% level of confidence.

is a significant incentive effect. The magnitude of the under pricing falls with incentives and the significance of the under pricing disappears under high incentives. However, notice that often the standard deviation of prices relative to certainty equivalent goes up with incentives. Overall, prices move closer to theoretical predictions as incentives increase even though incentives may not necessarily eliminate noise. This is why reversal rates may not fall with incentives even though prices are more coherent on average.

Table 7 shows, for each treatment, median estimates of the risk aversion parameter estimated using non-linear regression. For all subjects, the non-linear regressions converged. For most subjects, it converged to reasonable estimates. However, a few produce estimates that are clearly outliers (e.g., if a subject prices several gambles above (below) the maximum (minimum) possible payoff, the estimate may show extreme risk seeking (aversion)). Because of these outliers, we use medians as our measure of central tendency and non-parametric sign-rank and Kruskal-Wallis tests for deviations from predictions and incentives effects.

Median estimates of the risk aversion parameter are all negative for risk aversion (as predicted), but fall short of the predicted level of -0.11. There is a significant incentive effect, with high incentives created more risk averse estimates which are closer to the predicted level.

Figure 5: Medians and Inter-Quartile Ranges of Estimated Risk Aversion Parameters by Treatment



The median induced risk neutral subject without incentives displays a positive (risk seeking) preference parameter. However, when subjects are paid, the medians do not differ significantly from zero. Median induced risk seeking subjects all have positive estimated risk preference parameters (as predicted) but they fall short of the predicted value of 0.11. With increasing incentives, the inter-quartile range does not necessarily fall. As a result, risk preference induction moves subjects in the right direction but not as far as predicted by theory. When there is an incentives effect, higher incentives push behavior closer to predictions. But again, in this context, incentives do not necessarily reduce noise.

Figure 5 shows the median estimated risk aversion parameter and inter-quartile ranges under each treatment. While risk averse parameters are always lower and risk seeking parameters are always higher than risk neutral (as predicted), the differences are small and the inter-quartile ranges overlap without incentives (labeled "none"). As incentives increase, the median estimated values remain close to zero (as predicted) for induced risk neutral preferences. They fall dramatically for risk averse induced preferences (as predicted). They rise and level off for risk seeking induced preferences. These effects are significant as shown by the following median regression:

$$\hat{\gamma}_i = \underset{(2.00^{**})}{0.0118} \underset{(-1.05)}{-0.0050} \times \begin{pmatrix} \text{Incentives} \\ \text{Category} \end{pmatrix} + \underset{(2.06^{***})}{0.0219} \times \begin{pmatrix} \text{Risk} \\ \text{Seeking} \\ \text{Dummy} \end{pmatrix} + \underset{(1.96^{*})}{0.0134} \times \begin{pmatrix} \text{Risk} \\ \text{Seeking} \\ \text{Dummy} \end{pmatrix} \times \begin{pmatrix} \text{Incentives} \\ \text{Category} \end{pmatrix} - \underset{(-3.48^{***})}{0.0291} \times \begin{pmatrix} \text{Risk} \\ \text{Averse} \\ \text{Dummy} \end{pmatrix} - \underset{(-3.57^{***})}{0.0241} \times \begin{pmatrix} \text{Risk} \\ \text{Averse} \\ \text{Dummy} \end{pmatrix} \times \begin{pmatrix} \text{Incentives} \\ \text{Category} \end{pmatrix} + \varepsilon_i, \tag{5}$$

where the incentives category is a category defined as 0 for no incentives, 1 for low incentives and 2 for high incentives; risk seeking and risk averse dummies are 1 under the appropriate risk preference induction treatments; numbers in parentheses are z-statistics; "***" denotes significance at the 99.9% level of confidence, "**" denotes significance at the 99% level of confidence and "*" denotes significance at the 90% level of confidence.

Without incentives, but playing-out the gambles, subjects appear slightly risk seeking under induced risk neutrality (intercept>0). Inducing risk aversion or risk seeking affects the estimated risk preference parameter significantly in the predicted direction even without incentives (significance on both dummy variables alone with the appropriate signs). Increasing incentives has little effect under induced risk neutrality. Increasing incentives moves estimated risk aversion parameters closer to their predicted values (significance on the interaction terms with the appropriate signs).

VI. Discussion

If subjects reverse preferences systematically depending on how preferences are elicited (e.g., through choice or pricing tasks), it presents serious challenges for economic theory. On the other hand, if subjects have stable preferences, but reveal them with random errors, economic theory simply needs to be extended to allow for errors in revelation. That is, we may need to think of economic agents as "noisy maximizers" instead of strict expected utility maximizers. If this is the case, preference reversal is actually a misnomer. Errors only cause the appearance of reversal.

Previous evidence documenting systematic preference reversals is based on stated preferences over purely hypothetical gambles. Monetary incentives can shift the pattern of the data, making it consistent with noisy maximization. However, previous preference reversal studies documenting incentive effects all confound incentive payments and playing-out gambles. In this paper, we introduce new experimental treatments that allow us to tease apart the effect of truth-revealing incentives from the effect of providing a "score keeping" mechanism through playing-out gambles. This allows us to identify three separate effects that drive data to be more consistent with the stable preference with errors (noisy maximization) model:

1. A monetary incentive “payout effect” that we first documented in Berg, Dickhaut and Rietz (2010). When subjects are paid based on the outcomes of the gambles in a truth revealing manner, noisy maximization fits the aggregate data as well as any model could. Apparent reversal rates may still be high because, as the data suggests, subjects do not have strong preferences across the gambles.
2. A “preference effect” that we first documented in Berg, Dickhaut and Rietz (2003). When subject risk preferences are induced using a lottery procedure, noisy maximization again fits the data as well as any model could. Revealed preferences consistently shift in the direction predicted by the induced utility function and reversal rates fall. Here, we document the effect even when subjects are not paid based on the outcomes.
3. A new “play-out effect.” When gambles are played-out, even when subjects are not paid based on outcomes, revealed preferences do not differ significantly from noisy maximization. Again, risk preference induction (with play-out, but no payments) leads to data where noisy maximization fits as well as any model could.

Our play-out effect is related to the differences between declared versus revealed preferences (see, for example, Ben-Akiva, et al. (1994)) where survey responses differ from actual behavior. Hypothetical gambles effectively elicit stated preferences, which reverse in a systematic manner. Played-out gambles with outcome contingent payments reveal preferences that appear stable, but are revealed with error. Data under played-out, but unpaid, gambles appears similar to the revealed preference data. This shows the importance of the play-out effect in generating more economically consistent data. It also suggests that the common practice of running a multi-stage experiment and randomly selecting a single stage for play-out and payoffs ex post may weaken incentives.[7]

Our results are also related to the literature on incentives effects. While play-out alone has a significant effect, incentives and higher incentives under induced incentives drive behavior closer to that predicted by the induced incentives. While the play-out effect is new, the payment effect is consistent with Jamal and Sunder’s (1991) observation that payments are not necessary for convergence in double oral auction markets, but do make the results more reliable. It is also consistent with Camerer and Hogarth’s (1999) survey observation that incentives often reduce noise.

[7] We note that, in our data, we play-out every choice, gamble and induction lottery after each choice. Even though Grether and Plott (1979) follow pay based on one randomly selected outcome ex post in their experiment 1b, their data is nevertheless consistent with the noisy maximization.

Finally, our results are consistent with Donald Trump's observation about money being a score keeping mechanism to determine the winner. It is consistent with subjects having a utility of winning (see, for example, Rietz (1993) or Sheremeta (2010)) and needing to play-out the gambles to determine whether they "won." It explains why simple mechanisms, such as publishing "employee of the month" could have an effect on behavior even when there is no noticeable incentive tied to the designation. It also helps explain how competitions among groups can have incentives when there are no explicit prizes except "bragging rights."

VII. Bibliography

Ben-Akiva, M., et al. "Combining Revealed and Stated Preferences Data." *Marketing Letters* 5, no. 4 (1994): 335-350.

Berg, Joyce E., John W Dickhaut, and Thomas A. Rietz. "Preference Reversals and Induced Risk Preferences: Evidence for Noisy Maximization." *Journal of Risk and Uncertainty* 27, no. 2 (2003): 139-170.

Berg, Joyce E., John W. Dickhaut, and Thomas A Rietz. "Preference Reversals: The Impact of Truth-Revealing Monetary Incentives." *Games and Economic Behavior* 68, no. 2 (2010): 443-468.

Berg, Joyce E., Lane A. Daley, John W. Dickhaut, and John R. O'Brien. "Controlling Preferences for Lotteries on Units of Experimental Exchange." *Quarterly Journal of Economics* 101 (1986): 281-306.

Camerer, Colin F., and Robim M. Hogarth. "The Effects of Financial Incentives in Experiments: A Review and Capital-Labor-Production Framework." *Journal of Risk and Uncertainty* 19, no. 1 (1999): 7-42.

Cammerer, Colin F., and Robin M. Hogarth. "The Effects of Financial Incentives in Experiments: A Review and CapitalLlabor-Production Framework." *Journal of Risk and Uncertainty* 19, no. (1-3) (1999): 7-42.

Grether, David M., and Charles R. Plott. "Economic theory of Choice and the Preference Reversal Phenomenon." *The American Economic Review* 69, no. 4 (1979): 623-638.

Hsee, Christopher K., Fang Yu, Jiao Zhang, and Yan Zhang. "Medium Maximization." *Journal of Consumer Research*, no. 30 (2003): 1-14.

Jamal, Karim, and Shyam Sunder. "Money vs. Gaming: Effects of Salient Monetary Payments in Double Oral Auctions." *Organizational Behavior and Human Decision Processes* 49, no. 1 (1991): 151-166.

Lichtenstein, Sarah, and Paul Slovic. "Response-induced Reversals of Preference in Gambling: An Extended Replication in Las Vegas." *Journal of Experimental Psychology* 101, no. 1 (1973): 16-20.

Lichtenstein, Sarah, and Paul Slovic. "Reversals of Preference between Bids and Choices in Gambling Decisions." *Journal of Experimental Psychology* 89, no. 1 (1971): 46-55.

Rietz, Thomas A. "Implementing and Testing Risk Preference Induction Mechanisms in Experimental Sealed Bid Auctions." *Journal of Risk and Uncertainty* 7, no. 3 (1993): 199-213.

Sheremeta, Roman M. "Experimental Comparison of Multi-Stage and One-Stage Contests." *Games and Economic Behavior* 68, no. 2 (2010): 731-747.

Smith, Vernon L. "Experimental Economics: Induced Value Theory." *American Economic Review* 66, no. 2 (1976): 274-279.

Appendix: Instructions

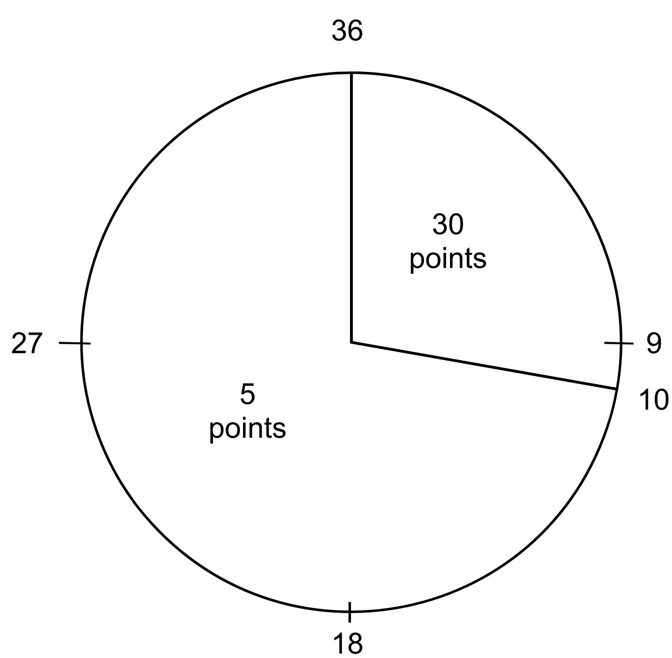
VIII. A. Instructions for NP-N-NI (Not-Played-Out, Native Preferences, No Incentives)

Instructions

This is an experiment in individual decision making. At the end of the experiment, you will receive your $5 show up fee and a flat fee of an additional $15 for participation in the experiment. These are the only payments you will receive for participating.

As a participant in this experiment, you will make decisions. There are 18 decision items in this experiment.

Each decision you make will involve one or more bets. These bets will be indicated by pie charts as shown below. The point areas in each bet correspond to a hypothetical draw from a bingo cage that contains 36 red balls numbered 1, 2, …, 36. The ball drawn would determine the point outcome of the bet. For example, suppose you were playing the bet below. If the red ball drawn was less than <u>or equal to</u> 10, you would receive 30 points. If the red ball drawn was greater than 10, you would receive 5 points.



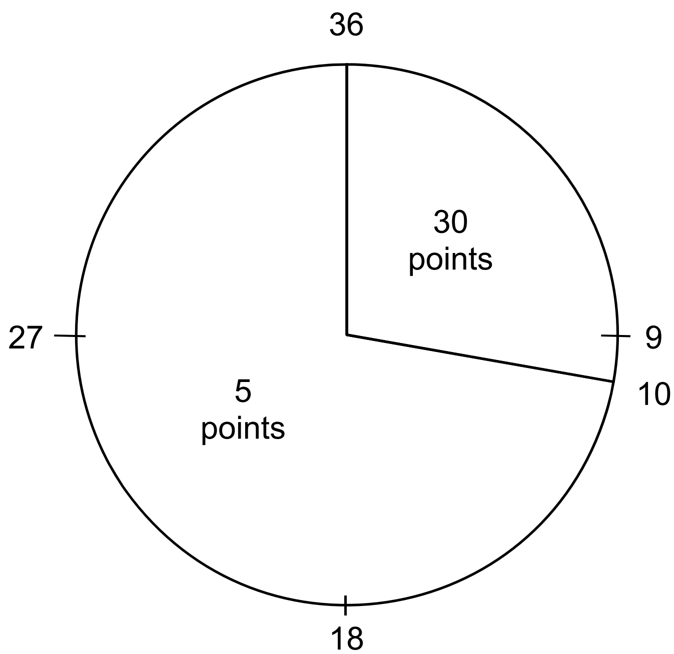
Part 1:

In this part you will be asked to consider several pairs of bets. For each pair you should indicate which bet you would prefer to play or indicate that you are indifferent between them.

Part 2:

In this part you are given several opportunities make decisions. For each bet you must indicate the smallest number of points for which you would give up the opportunity to play the bet.

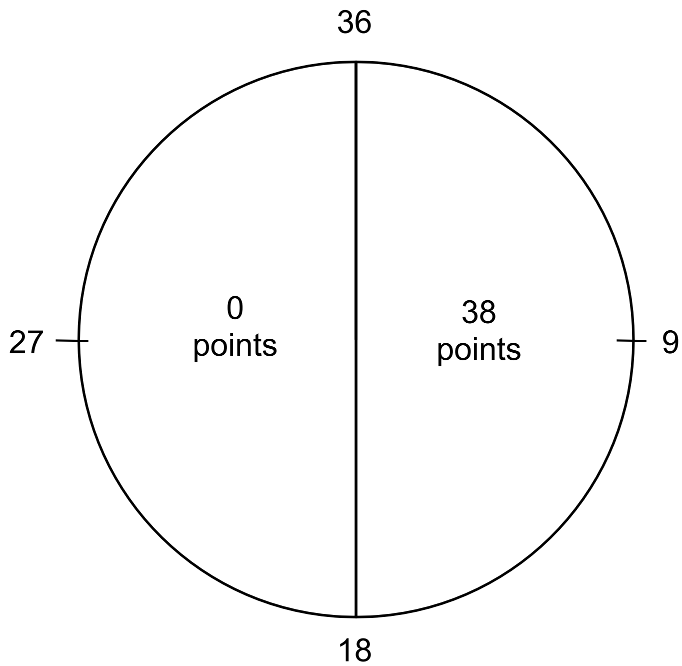
Practice Item 1: Suppose you have the opportunity to play the bet shown below. What is the smallest number of points for which you would give up this opportunity?



Decision _____ .

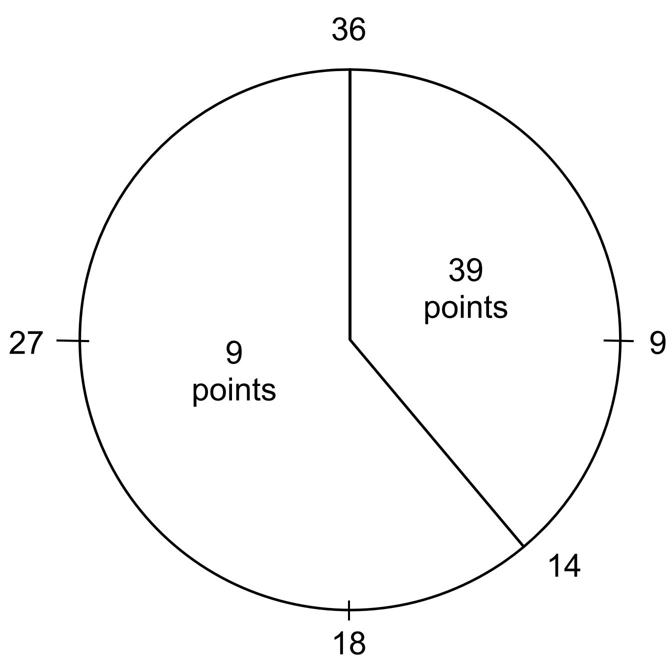
Stop here and wait for the experimenter to tell you to go on to the next practice item.

Practice Item 2: Suppose you have the opportunity to play the bet shown below. What is the smallest number of points for which you would give up this opportunity?



Decision ____.

Practice Item 3: Suppose you have the opportunity to play the bet shown below. What is the smallest number of points for which you would give up this opportunity?



Decision ____.

Part 3:

This part is exactly like Part 1. You will be asked to consider several pairs of bets, and for each pair you should indicate which bet you would prefer to play or indicate that you are indifferent between them.

Instructions for P-N-NI (Play, Native Preferences, No Incentives)

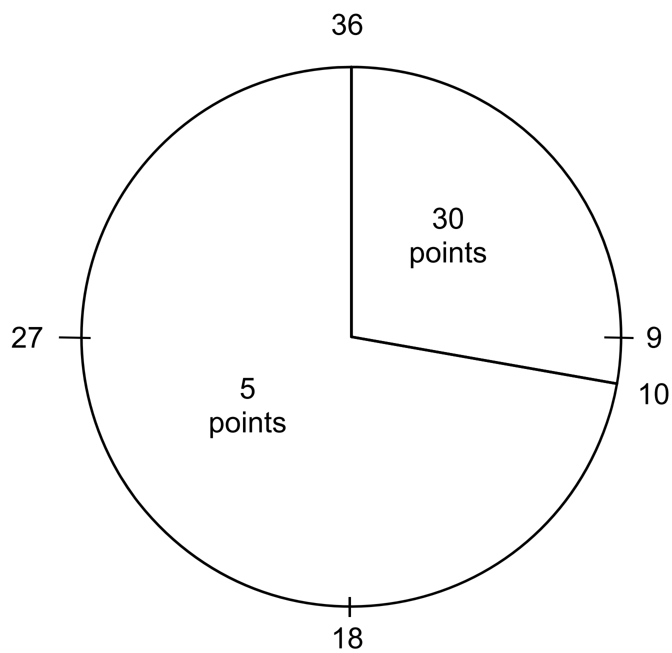
Instructions

This is an experiment in individual decision making. At the end of the experiment, you will receive your $5 show up fee and a flat fee of an additional $15 for participation in the experiment. These are the only payments you will receive for participating.

As a participant in this experiment, you will receive points for making decisions. There are 18 decision items in this experiment.

Each decision you make will involve one or more bets. These bets will be indicated by pie charts as shown below. When a bet is played, one ball will be drawn from a bingo cage that contains 36 red balls numbered 1, 2, …, 36. The ball drawn determines the point outcome of the bet. For example, suppose you are playing the bet below. If the red ball drawn was less than or equal to 10, you would receive 30 points. If the red ball drawn was greater than 10, you would receive 5 points.

Now let's use the bet shown below as a practice item.



The number that the experimenter drew from the cage of red balls is _____.

This means that I would receive ____ points as a result of this bet.

Part 1:

In this part you will be asked to consider several pairs of bets. For each pair you should indicate which bet you prefer to play or indicate that you are indifferent between them. After each decision, you will have an opportunity to using the following procedure:

1. The bet you indicate as preferred will be played and you will receive the points indicated by its outcome. If you check "Indifferent" the bet you play will be determined by a coin toss.

Part 2:

In this part you are given several opportunities to play bets to obtain points. For each bet you must indicate the smallest number of points for which you would give up the opportunity to play the bet.

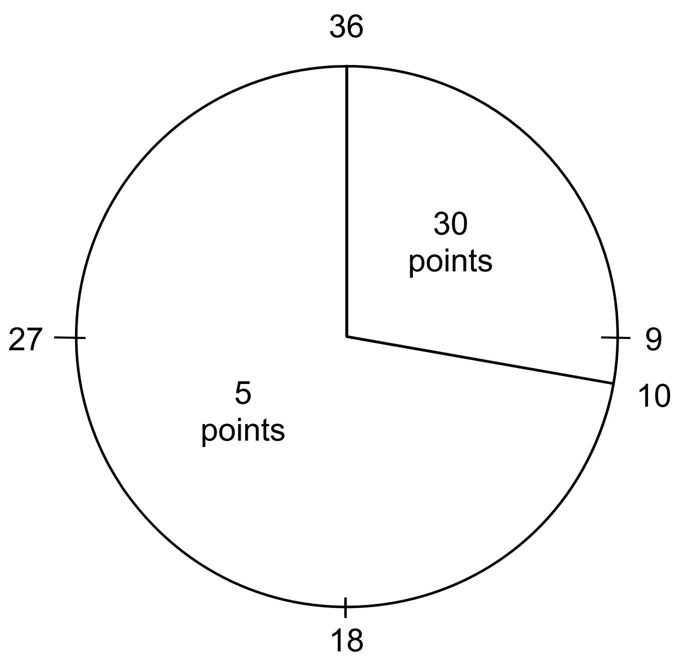
After each decision, you will have an opportunity to receive points using the following procedure:

1. A ball will be drawn from a bingo cage containing 41 green balls numbered 0,1,2,…,40. If the number on this green ball is less than <u>or equal to</u> the number you have specified, you will keep the bet and play it. You will receive the points indicated by the outcome of the bet. If the number on the green ball is greater than the number you have specified, you will give up the bet and in exchange receive the points equal to the number on the <u>ball</u>.

It is in your best interest to be accurate; that is, the best thing you can do is be honest. If the number of points you state is too high or too low, then you are passing up opportunities that you prefer. For example, suppose you would be willing to give up the bet for 20 points but instead you say that the lowest amount for which you would give it up is 30 points. If the green ball drawn at random is between the two (for example 25) you would be forced to play the bet even though you would rather have given it up for 25 points.

On the other hand, suppose that you would give it up for 20 points but not for less, but instead you state your amount as 10 points. If the green ball drawn at random is between the two (for example 15) you would be forced to give up the bet for 15 points even though at that amount you would prefer to play it.

<u>Practice Item 1:</u> Suppose you have the opportunity to play the bet shown below. What is the <u>smallest</u> number of points for which you would give up this opportunity?



Decision _____ .

In order which results from this decision, you need to know two things:

(1) The ball drawn from the cage of green balls.

(2) The ball drawn from the cage of red balls.

The two examples in this practice item fix these draws so that you can concentrate on how your decision and the results of the draws will determine your points.

<u>Example 1:</u> Use your decision in the Practice Item 1 and suppose the green ball drawn at random is 2.

The number on the green ball is a) greater than my indicated amount.

b) less than or equal to my indicated amount.

Therefore, I would a) receive points equal to the number on the ball and not play the bet.

b) play the bet and receive points according to its outcome.

Will you be playing the bet? ____ (yes/no) If your answer is YES, you will need to know the outcome of the bet before you can determine the points you receive. If your answer is

NO, you do not need to know the outcome of the bet to determine the points received.

Suppose the red ball drawn to determine the outcome of the bet was 18.

Based on my point decision above, and the results of the draws from the bingo cages, the number of points I would have is _____.

Complete the next part only if you would have been playing the bet to receive points.

Suppose the red ball drawn to determine the outcome of the bet was 10 instead of 18.

Based on my point decision above, and the results of the draws from the bingo cages, the number of points I would have is _____.

Stop here and wait for the experimenter to tell you to go on to Example 2.

<u>Example 2:</u> Now use your decision in the Practice Item 1 and suppose instead that the green ball drawn at random is 38.

The number on the green ball is a) greater than my indicated amount.

b) less than or equal to my indicated amount.

Therefore, I would a) receive points equal to the number on the ball and not play the bet.

b) play the bet and receive points according to its outcome.

Will you be playing the bet? ____ (yes/no) If your answer is YES, you will need to know the outcome of the bet before you can determine the points you receive. If your answer is NO, you do not need to know the outcome of the bet to determine the points received.

Suppose the red ball drawn to determine the outcome of the bet was 18.

Based on my point decision above, and the results of the draws from the bingo cages, the number of points I would have is _____.

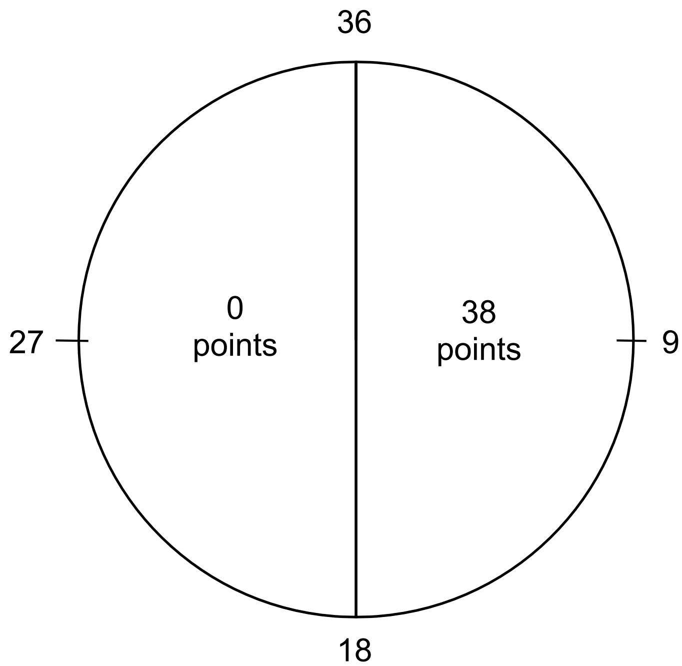
Complete the next part only if you would have been playing the bet to receive points.

Suppose the red ball drawn to determine the outcome of the bet was 10 instead of 18.

Based on my point decision above, and the results of the draws from the bingo cages, the number of points I would have is _____.

Stop here and wait for the experimenter to tell you to go on to the next practice item.

Practice Item 2: Suppose you have the opportunity to play the bet shown below. What is the smallest number of points for which you would give up this opportunity?



Decision ____.

The green ball drawn at random is ____ .

The number on this green ball is a) greater than my indicated amount.

b) less than or equal to my indicated amount.

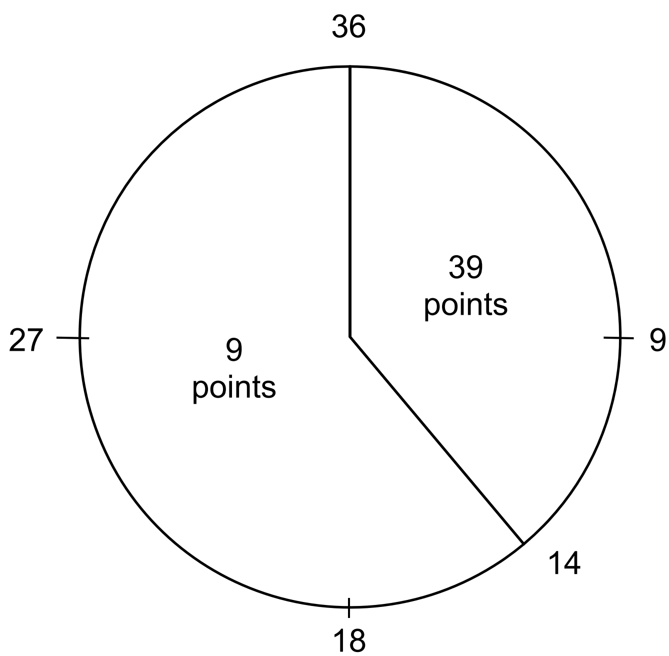
Therefore, I would a) receive points equal to the number on the ball and not play the bet.

b) play the bet and receive points according to the outcome.

The red ball drawn to determine the outcome of the bet was ____.

Based on my decision above, and the results of the draws from the bingo cages, the number of points I would have is _____.

Practice Item 3: Suppose you have the opportunity to play the bet shown below. What is the smallest number of points for which you would give up this opportunity?



Decision ____.

The green ball drawn at random is ____ .

The number on this green ball is a) greater than my indicated amount.
b) less than or equal to my indicated amount.

Therefore, I would a) receive points equal to the number on the ball and not play the bet.
b) play the bet and receive points according to the outcome.

The red ball drawn to determine the outcome of the bet was ____.

<u>Part 3:</u>

This part is exactly like Part 1. You will be asked to consider several pairs of bets, and for each pair you should indicate which bet you prefer to play or indicate that you are indifferent between them. After each decision, you will then have an opportunity receive points using the following procedure:

1. The bet you indicate as preferred will be played and you will receive the points indicated by its outcome. If you check "Indifferent" the bet you play will be determined by a coin toss.

IX. B. Instructions for P-RA/RN/RS-NI (Play-Out, Induced Preferences, No Incentives)

Instructions

This is an experiment in individual decision making. At the end of the experiment, you will receive your $5 show up fee and a flat fee of an additional $15 for participation in the experiment. These are the only payments you will receive for participating.

As a participant in this experiment, you will have opportunities to play for eighteen "prizes." "Prizes" in this experiment have no value, however your objective in this experiment is to win as many prizes as possible. Whether or not you receive a particular prize will be determined by spinning the spinner on your prize wheel. If the spinner stops in the area designated as the WIN area on your prize wheel, then you will receive the prize. If the spinner stops in the area outside the WIN area, then you will receive nothing.

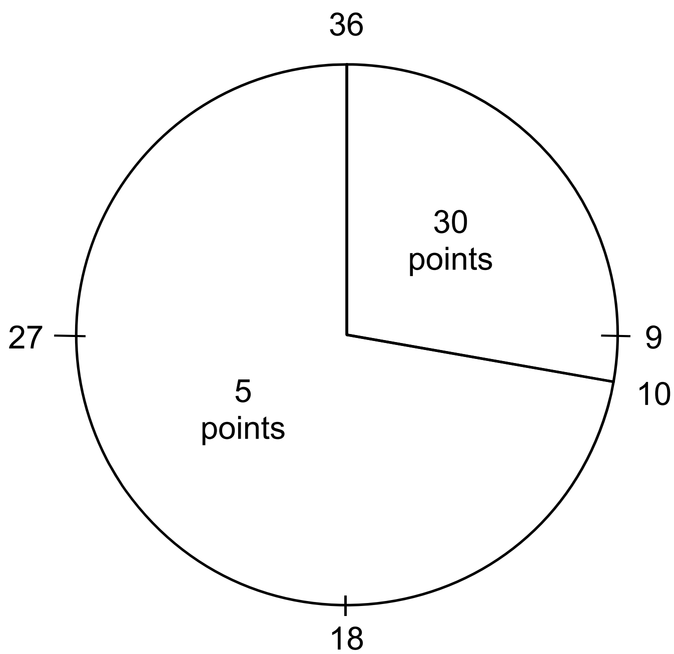
For example, suppose the WIN area of your prize wheel is designated as 0 through 5. Then, if the spinner stops on a number <u>less than or equal to</u> 5, you will receive the prize. If the spinner stops on a number greater than 5, you will receive nothing. Although the WIN area on your prize wheel will vary, it will always be determined by starting at zero and moving clockwise.

Now suppose that the WIN area on your prize wheel is designated as 0 through 30. Please spin the spinner to determine whether you would have received the prize or not.

So far, you have discovered that a spin on your prize wheel will determine whether or not you receive a prize. However, you need to know how the WIN area on your prize wheel is determined before you can complete the experiment. The markings on the circumference of your prize wheel denote points, and you will receive points for making decisions. There are 18 decision items in this experiment. When a decision is made, the WIN area on your prize wheel will be designated as the area between 0 and the number of points you receive as a result of the decision. Then the spinner on your prize wheel will be spun to determine whether you receive the prize. Points do <u>not</u> accumulate from decision to decision.

Each decision you make will involve one or more bets. These bets will be indicated by pie charts as shown below. When a bet is played, one ball will be drawn from a bingo cage that contains 36 red balls numbered 1, 2, …, 36. The ball drawn determines the point outcome of the bet. This point outcome will designate the upper boundary of the WIN area on your prize wheel. For example, suppose you are playing the bet below. If the red ball drawn was less than <u>or equal to</u> 10, you would receive 30 points. If the red ball drawn was greater than 10, you would receive 5 points.

Now let's use the bet shown below as a practice item.



The number that the experimenter drew from the cage of red balls is _____.

This means that I would receive ____ points as a result of this bet.

Therefore the WIN area on my prize wheel is designated as 0 through _____.

Now, spin the spinner. As a result of my spin I would have received

PRIZE / NOTHING (circle the correct word).

Part 1:

In this part you will be asked to consider several pairs of bets. For each pair you should indicate which bet you prefer to play or indicate that you are indifferent between them. After each decision, you will have an opportunity to play for a prize using the following procedure:

1. The bet you indicate as preferred will be played and you will receive the points indicated by its outcome. If you check "Indifferent" the bet you play will be determined by a coin toss.
2. The WIN area of your prize wheel will be designated as the area from 0 through the number of points which you have received. You will spin the spinner to determine whether you win the prize.

Part 2:

In this part you are given several opportunities to play bets to obtain points. For each bet you must indicate the smallest number of points for which you would give up the opportunity to play the bet.

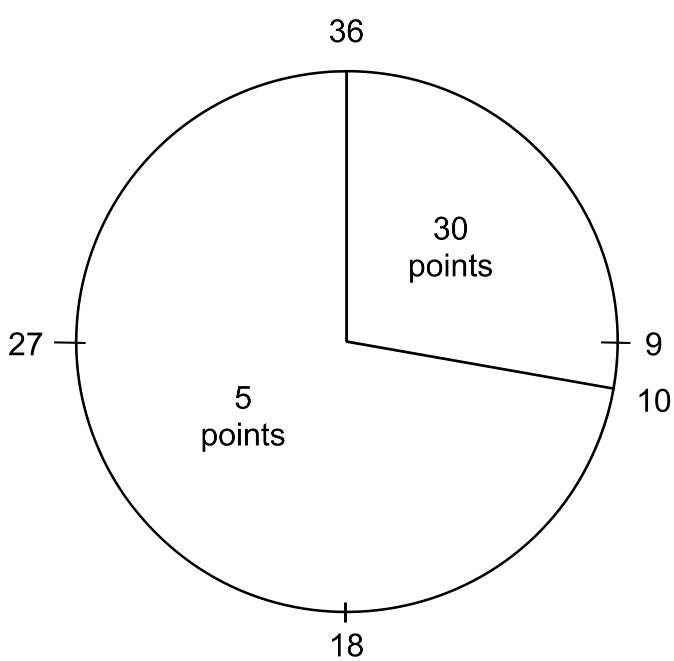
After each decision, you will have an opportunity to play for a prize using the following procedure:

1. A ball will be drawn from a bingo cage containing 41 green balls numbered 0,1,2,…,40. If the number on this green ball is less than <u>or equal to</u> the number you have specified, you will keep the bet and play it. You will receive the points indicated by the outcome of the bet. If the number on the green ball is greater than the number you have specified, you will give up the bet and in exchange receive the points equal to the number on the <u>ball</u>.
2. The WIN area of your prize wheel will be designated as the area from 0 through the number of points which you have received. You will spin the spinner to determine whether you win the prize.

It is in your best interest to be accurate; that is, the best thing you can do is be honest. If the number of points you state is too high or too low, then you are passing up opportunities that you prefer. For example, suppose you would be willing to give up the bet for 20 points but instead you say that the lowest amount for which you would give it up is 30 points. If the green ball drawn at random is between the two (for example 25) you would be forced to play the bet even though you would rather have given it up for 25 points.

On the other hand, suppose that you would give it up for 20 points but not for less, but instead you state your amount as 10 points. If the green ball drawn at random is between the two (for example 15) you would be forced to give up the bet for 15 points even though at that amount you would prefer to play it.

<u>Practice Item 1:</u> Suppose you have the opportunity to play the bet shown below. What is the <u>smallest</u> number of points for which you would give up this opportunity? Remember that the WIN area on your prize wheel will be designated as the area from 0 through the number of points you receive as a result of your decision.



Decision _____ .

In order to determine the WIN area on your prize wheel which results from this decision, you need to know two things:

(1) The ball drawn from the cage of green balls.

(2) The ball drawn from the cage of red balls.

The two examples in this practice item fix these draws so that you can concentrate on how your decision and the results of the draws will determine your WIN area.

<u>Example 1:</u> Use your decision in the Practice Item 1 and suppose the green ball drawn at random is 2.

The number on the green ball is a) greater than my indicated amount.

b) less than or equal to my indicated amount.

Therefore, I would a) receive points equal to the number on the ball and not play the bet.

b) play the bet and receive points according to its outcome.

Will you be playing the bet? ____ (yes/no) If your answer is YES, you will need to know the outcome of the bet before you can determine the WIN area of your prize wheel. If your answer is NO, you do not need to know the outcome of the bet to determine the WIN area. Suppose the red ball drawn to determine the outcome of the bet was 18.

Based on my point decision above, and the results of the draws from the bingo cages, the number of points I would have is _____.

This means that the WIN area of my prize wheel would cover the numbers 0 through _____.

If the spinner stopped on the number 5, I would (circle the correct words) win / not win the prize.

If the spinner stopped on the number 40, I would (circle the correct words) win / not win the prize.

Complete this page only if you would have been playing the bet to receive points.

Suppose the red ball drawn to determine the outcome of the bet was 10 instead of 18.

Based on my point decision above, and the results of the draws from the bingo cages, the number of points I would have is _____.

This means that the WIN area of my prize wheel would cover the numbers 0 through _____.

If the spinner stopped on the number 5, I would (circle the correct words) win / not win the prize.

If the spinner stopped on the number 40, I would (circle the correct words) win / not win the prize.

Stop here and wait for the experimenter to tell you to go on to Example 2.

<u>Example 2:</u> Now use your decision in the Practice Item 1 and suppose instead that the green ball drawn at random is 38.

The number on the green ball is a) greater than my indicated amount.

b) less than or equal to my indicated amount.

Therefore, I would a) receive points equal to the number on the ball and not play the bet.

b) play the bet and receive points according to its outcome.

Will you be playing the bet? ____ (yes/no) If your answer is YES, you will need to know the outcome of the bet before you can determine the WIN area of your prize wheel. If your answer is NO, you do not need to know the outcome of the bet to determine the WIN area. Suppose the red ball drawn to determine the outcome of the bet was 18.

Based on my point decision above, and the results of the draws from the bingo cages, the number of points I would have is _____.

This means that the WIN area of my prize wheel would cover the numbers 0 through _____.

If the spinner stopped on the number 5, I would (circle the correct words) win / not win the prize.

If the spinner stopped on the number 40, I would (circle the correct words) win / not win the prize.

Complete this page only if you would have been playing the bet to receive points.

Suppose the red ball drawn to determine the outcome of the bet was 10 instead of 18.

Based on my point decision above, and the results of the draws from the bingo cages, the number of points I would have is _____.

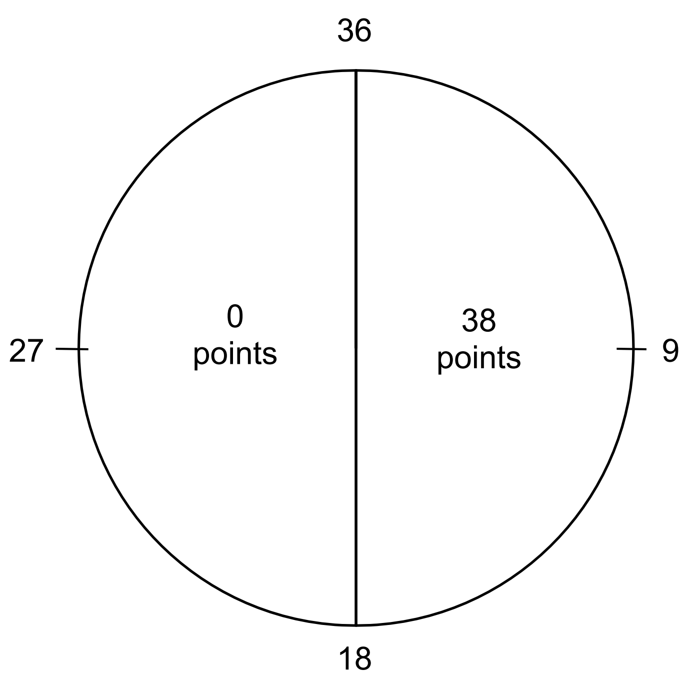
This means that the WIN area of my prize wheel would cover the numbers 0 through _____.

If the spinner stopped on the number 5, I would (circle the correct words) win / not win the prize.

If the spinner stopped on the number 40, I would (circle the correct words) win / not win the prize.

Stop here and wait for the experimenter to tell you to go on to the next practice item.

<u>Practice Item 2:</u> Suppose you have the opportunity to play the bet shown below. What is the <u>smallest</u> number of points for which you would give up this opportunity? Remember that the WIN area on your prize wheel will be designated as the area from 0 through the number of points you receive as a result of your decision.



Decision ____.

The green ball drawn at random is ____ .

The number on this green ball is a) greater than my indicated amount.

b) less than or equal to my indicated amount.

Therefore, I would a) receive points equal to the number on the ball and not play the bet.

b) play the bet and receive points according to the outcome.

The red ball drawn to determine the outcome of the bet was ____.

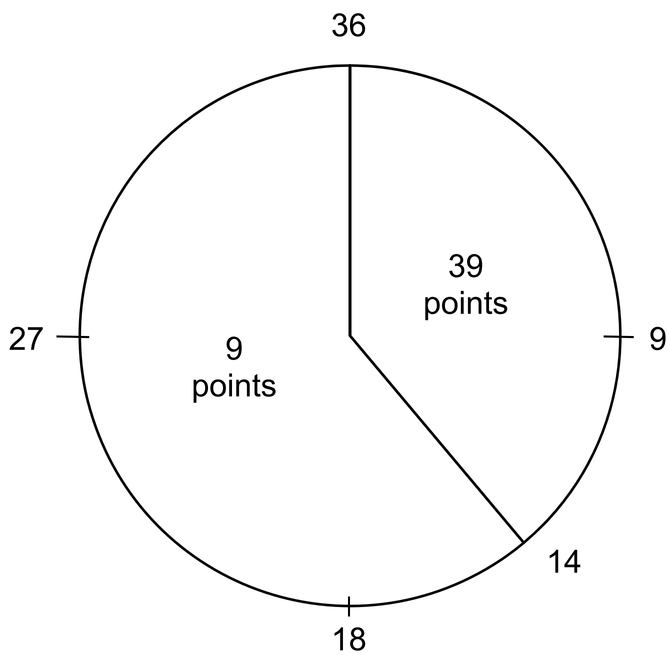
Based on my decision above, and the results of the draws from the bingo cages, the number of points I would have is _____.

This means that the WIN area of my prize wheel would cover the numbers 0 through _____,

My spinner stopped on the number ____.

Therefore I would have (circle the correct words) won / not won the prize.

Practice Item 3: Suppose you have the opportunity to play the bet shown below. What is the smallest number of points for which you would give up this opportunity? Remember that the WIN area on your prize wheel will be designated as the area from 0 through the number of points you receive as a result of your decision.



Decision ____.

The green ball drawn at random is ____ .

The number on this green ball is a) greater than my indicated amount.

b) less than or equal to my indicated amount.

Therefore, I would a) receive points equal to the number on the ball and not play the bet.

b) play the bet and receive points according to the outcome.

The red ball drawn to determine the outcome of the bet was ____.

Based on my decision above, and the results of the draws from the bingo cages, the number of points I would have is _____.

This means that the WIN area of my prize wheel would cover the numbers 0 through _____,

My spinner stopped on the number ____.

Therefore I would have (circle the correct words) won / not won the prize.

Part 3:

This part is exactly like Part 1. You will be asked to consider several pairs of bets, and for each pair you should indicate which bet you prefer to play or indicate that you are indifferent between them. After each decision, you will then have an opportunity to play for a prize using the following procedure:

1. The bet you indicate as preferred will be played and you will receive the points indicated by its outcome. If you check "Indifferent" the bet you play will be determined by a coin toss.
2. The WIN area of your prize wheel will be designated as the area from 0 through the number of points which you have received. You will spin the spinner to determine whether you win the prize.