Appendix A Supplementary Analysis

A.1 Results for r

	Dependent variable: r		
	display seq. I	display seq. II	full sample
FF	−0.149	−0.102	−0.125
	(0.118)	(0.122)	(0.085)
FT	−0.009	−0.056	−0.033
	(0.118)	(0.123)	(0.085)
TF	−0.162	−0.083	−0.126
	(0.120)	(0.123)	(0.086)
TT	0.016	0.046	0.030
	(0.120)	(0.121)	(0.085)
MPLb	0.241**	0.152	0.196**
	(0.121)	(0.126)	(0.087)
MPLc	−0.048	−0.083	−0.067
	(0.119)	(0.121)	(0.085)
MPLd	0.035	−0.288**	−0.131
	(0.119)	(0.121)	(0.085)
MPLe	0.228*	0.125	0.174**
	(0.120)	(0.122)	(0.086)
Constant	0.524***	0.508***	0.519***
	(0.111)	(0.114)	(0.080)
Observations	197	199	396
R^2	0.070	0.092	0.069
Adjusted R^2	0.030	0.054	0.050
Residual Std. Error	0.532 (df = 188)	0.546 (df = 190)	0.539 (df = 387)
F Statistic	1.763* (df = 8; 188)	2.410** (df = 8; 190)	3.595*** (df = 8; 387)

Table A.1: Specification as in Table 3 but with $\hat{r}$ as dependent variable

Diff	Seq. I	Seq. Ine	Seq. II	p-values
Text vs FF	0.103	0.055	0.048	0.26, 0.60, 0.65
Text vs FT	-0.012	0.033	0.121	0.88, 0.78, 0.26
Text vs TF	0.168*	0.332***	0.052	0.10, 0.00, 0.60
Text vs TT	-0.047	0.069	-0.024	0.61, 0.62, 0.78
Text vs all Graphical	0.053	0.05	0.077	0.44, 0.44, 0.36
MPLa vs MPLb	-0.19***	-	-0.11*	0.01, - , 0.09
MPLa vs MPLc	0.07**	-	0.05	0.05, - , 0.15
MPLa vs MPLd	0.01	-	0.28***	0.89, - , 0.00
MPLa vs MPLe	-0.21***	-	-0.09	0.00, - , 0.17

*** p<0.01, ** p<0.05, * p<0.1

Table A.2: Analogue of Table 5 for performance variable r, showing within subject difference (Text-Graphical and MPLa - MPLi). Column Seq. Ine excludes differences involving MPLe. The p-values are associated with the Diff=0 null hypothesis for the preceding three columns.

A.2 Other supplementary results

Table A.3 shows how many observations (we have n=47 at best in the current study) it would take to detect at the 5% level in 90% of samples with NOBS = n an effect of the empirical size and variability shown in the columns labeled mean and sd.

In Figure A.1, the two 5x5 blocks on the main diagonal are most relevant. Text has remarkably low correlation with any of the visual presentations for the s variable (.08 - .25), but even the different visual presentations are not very correlated (.11-.48). The MPL schedules have s-correlations in the .41-.69 range, and surprisingly schedule e has correlations well within that range. The r-correlations are a bit higher, but probably because their calculations exclude the NAs (e.g., multiple switches), which eliminates a lot of variation.

The off-diagonal 5x5 blocks correlate the r and s measures for the 5 visual displays with the corresponding measures for the 5 MPL schedules. These are of less intrinsic interest, and in any case are upward biased by including overlapping observations. E.g., an observation of s = 2, say, in the treatment MPLa-TT is counted in both vectors when MPLa is correlated with TT.

A.3 A conjecture on graphics

Math problems can be solved symbolically (e.g., with numbers) or using an approximate number system (ANS) in which quantities are represented as noisy mental magnitudes.

	Seq. I			Seq. II			Seq. Ine		
Treatment	mean	sd	n	mean	sd	n	mean	sd	n
FF	0.1	0.56	620	0.04	.65	3823	0.05	0.52	1877
FT	-0.012	0.54	38336	0.12	0.66	633	0.03	0.6	6746
TF	0.16	0.6	274	0.05	0.62	2917	0.33	0.55	60
TT	-0.04	0.55	2857	-0.02	0.58	11573	-0.06	0.63	1768
Graphical	0.05	0.44	1416	0.07	0.53	1023	0.09	0.47	478
MPLb	-0.19	0.43	104	-0.11	0.4	265			
MPLc	0.07	0.24	212	0.05	0.25	380			
MPLd	0.01	0.74	46276	0.285	0.64	107			
MPLe	-0.21	0.3	45	-0.09	0.39	401			
FF	0.51	2.4	466	0.14	2.13	4325	0.21	1.59	1165
FT	0.23	2.47	2356	0.17	2.51	4583	0.35	1.72	491
TF	0.57	2.46	387	0.40	2.13	586	0.96	1.64	62
TT	0.23	2.48	2372	0.08	2.07	12467	0.07	1.49	8522
Graphical	0.38	1.95	533	0.20	1.7	1493	0.4	1.36	240
MPLb	-0.19	1.59	1462	0.02	1.27	75667			
MPLc	1	1	22	1.06	1.22	28			
MPLd	0.06	1.27	8389	0.44	1.44	219			
MPLe	-2.82	1.3	5	-2.31	1.33	8			

Table A.3: Power tests for $\alpha = .05$ and power = 90%. First block reports results for $\hat{r}$ and second block reports results for s.

Park & Brannon (2013) conclude that ANS is a precursor to symbolic math, and report that training with visual representations of problems significantly improves symbolic math performance relative to symbolic training alone. In particular, subjects were trained to add or subtract large quantities of dots arranged in two arrays, without counting. When presented with follow up symbolic addition and subtraction problems, these subjects provided significantly more accurate answers than a control group with no ANS training. A subsequent treatment provided evidence that ANS training improved subsequent symbolic math performance relative to symbolic math training.

Thus we conjecture that visual representations of risky choice problems may impact preference elicitation if the expected value of a lottery is salient and visualization improves a subject's assessment of expected value. Many studies have demonstrated that subjects with lower numeracy exhibit greater small-stakes risk aversion (Benjamin *et al.* (2013); Cokely & Kelley (2009); Frederick (2005); Weller *et al.* (2013); Schley & Peters (2014)). Since these studies rely on symbolic rather than visual choice representations, it's plausible that reported small-stakes risk aversion has been, to some extent, a consequence of low-numeracy, and that

	FF	FT	text	TF	TT	MPLa	MPLb	MPLc	MPLd	MPLe
FF	0.821	0.613	0.438	0.425	0.653	0.663	0.694	0.765	0.688	0.634
FT	0.265	0.891	0.362	0.538	0.663	0.685	0.596	0.701	0.764	0.586
text	0.249	0.083	0.868	0.398	0.468	0.568	0.700	0.467	0.707	0.363
TF	0.154	0.229	0.198	0.912	0.428	0.579	0.579	0.727	0.552	0.765
TT	0.240	0.487	0.146	0.114	0.841	0.560	0.671	0.664	0.805	0.667
MPLa	0.576	0.610	0.312	0.467	0.438	1.000	0.540	0.740	0.604	0.569
MPLb	0.613	0.474	0.526	0.253	0.417	0.409	0.896	0.639	0.709	0.586
MPLc	0.494	0.531	0.392	0.621	0.555	0.704	0.481	1.000	0.682	0.690
MPLd	0.425	0.639	0.483	0.415	0.696	0.621	0.553	0.664	1.000	0.616
MPLe	0.394	0.465	0.301	0.582	0.515	0.512	0.428	0.665	0.609	1.000

Figure A.1: Rank Correlation between all treatments: r above the diagonal, s below diagonal, and r and s in the same treatment along the diagonal.

elicited responses may change with the use of visual lottery displays.

In investigating this conjecture in future work, it may be helpful to develop treatments intermediate between our TF and FF (which are ambiguous as to prize amounts) and TT and FT (which are explicit). Intermediate treatments (denoted I below) would not show prizes explicitly but would have a labelled height axes so that a subject could visually approximate the absolute prize sizes. Finding a difference between {TT, FT} and {TI, FI} would sharpen the argument for visual cortex effects, while finding a difference between {TI, FI} and {TF, FF} would support the argument for ambiguity effects.

Sequence	trial 1	trial 2	trial 3	trial 4	trial 5
1	Text-A	TF-C	FT-B	TT-E	FF-D
2	Text-B	TF-D	FT-C	TT-A	FF-E
3	Text-C	TF-A	FT-E	TT-D	FF-B
4	Text-D	TF-E	FT-A	TT-B	FF-C
5	Text-E	TF-B	FT-D	TT-C	FF-A
6	TF-A	Text-C	FF-B	FT-E	TT-D
7	TF-B	Text-D	FF-C	FT-A	TT-E
8	TF-C	Text-A	FF-E	FT-D	TT-B
9	TF-D	Text-E	FF-A	FT-B	TT-C
10	TF-E	Text-B	FF-D	FT-C	TT-A
11	FT-A	TT-C	Text-B	FF-E	TF-D
12	FT-B	TT-D	Text-C	FF-A	TF-E
13	FT-C	TT-A	Text-E	FF-D	TF-B
14	FT-D	TT-E	Text-A	FF-B	TF-C
15	FT-E	TT-B	Text-D	FF-C	TF-A
16	TT-A	FF-C	TF-B	Text-E	FT-D
17	TT-B	FF-D	TF-C	Text-A	FT-E
18	TT-C	FF-A	TF-E	Text-D	FT-B
19	TT-D	FF-E	TF-A	Text-B	FT-C
20	TT-E	FF-B	TF-D	Text-C	FT-A
21	FF-A	FT-C	TT-B	TF-E	Text-D
22	FF-B	FT-D	TT-C	TF-A	Text-E
23	FF-C	FT-A	TT-E	TF-D	Text-B
24	FF-D	FT-E	TT-A	TF-B	Text-C
25	FF-E	FT-B	TT-D	TF-C	Text-A

Figure A.2: Treatment sequences selected for experiment. Labels A-E correspond to MPL variants (MPLa-MPLe) and FT, TT, text, FF and TF denote the different graphical display treatments.

Appendix B Instructions

Welcome! You are about to participate in an experiment in the economics of decision-making. If you listen carefully and make good decisions, you could earn a considerable amount of money that will be paid to you in cash at the end of the experiment.

Please remain silent and do not look at other participants' screens. If you have any questions or need any assistance, please raise your hand and we will come to you. Do not attempt to use the computer for any other purpose than what is explicitly required by the experiment. This means you are not allowed to browse the Internet, check email, etc. If you interrupt the experiment by using your smart phone, talking, laughing, etc., you may be asked to leave and may not be paid. We expect and appreciate your cooperation today.

B.1 The Basic Idea

This experiment is composed of ten segments. In each of which you are asked to make a sequence of ten choices/decisions between two lotteries presented to you. Each decision is a paired choice between "Option A" and "Option B." In each segment you will make ten choices and record them by clicking the radio button next to the option you chose, A or B. To determine you payment, we will randomly pick one of the ten segments by rolling a ten-side die, we will then randomly select one of your ten choices within that segment by another roll of the ten-sided die. Final payment will be determined by the outcome of your chosen lottery, which will be determined by a third and final roll of a ten-sided die.

Before you start making your choices, please let me explain in more detail how these choices will affect your earnings. Here is a ten-sided die that will be used to determine payoffs; the faces are numbered from 1 to 10 (the "0" face of the die will serve as 10.) After you have made all of your choices, we will throw this die three times, once to select one of the ten segments to be used, a second time to determine one of the ten choices for that segment, and a third and final time to determine what your payoff is for the option you chose, A (left) or B (right), for the particular decision selected. Even though you will make ten decisions per segment, only one of these will end up affecting your earnings for that segment, but you will not know in advance which decision will be used.

A lottery is defined by probabilities and a set of payoffs associated with these probabilities. As shown in the example in figure B.1, you will be asked to choose between lottery A (on the left), which offers you a payoff of \$3 with probability 0.3 (30%) and a payoff of \$2.50 with probability 0.7 (70%), and lottery B (on the right), which offers you a payoff of \$4.82 with probability 0.3 (30%) and a payoff of \$0.10 with probability 0.7 (70%).

Again, in a given segment, you will face a list of ten pairs of lotteries. You must make one choice between the two displayed lotteries for each of the ten pairs in the list. Payment for the experiment will be based on the lotteries you choose. A random segment is picked and a random line will be chosen for payment by a roll of a die and payment will be determined for each subject by the outcome of the chosen lottery (also by a roll of a die) on the randomly selected line.

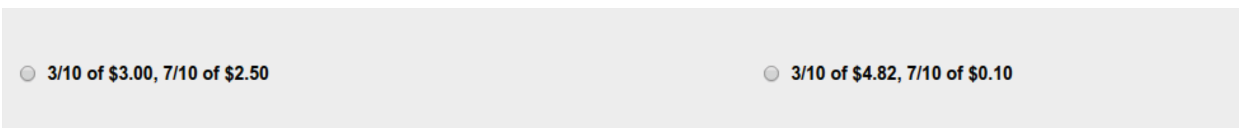

Figure B.1: Text Display

B.2 Display Types

B.2.1 text Only

The following example illustrates one of the displays you will be seeing in this experiment. In the text only display you will be facing a list of different lotteries of the same form as in B.1. As you can see the probabilities and payoffs are displayed in text. In this specific line the lottery on the left has payoffs \$3 with probability 0.3 (30%) and a payoff of \$2.50 with probability 0.7 (70%), and lottery B (on the right), which offers you a payoff of \$4.82 with probability 0.3 (30%) and a payoff of \$0.10 with probability 0.7 (70%). You are to choose one of the two lotteries on this line for payment.

B.2.2 Full graphics with payoff and probability in text

In this segment we combine a graphical and text representation of probabilities and payoffs. As demonstrated in figure B.2This display type will feature the probability of a given payoff in the size of the pie slice while the payoff is represented by the height of the pie slice. Therefore, a pie with two different (in color and volume) wedges represents each lottery; the size of a given wedge represents the probability while the height of the wedge represents the payoff. In order to get a full picture of the wedges you can rotate the pie graphs to the left and right by sliding your mouse over the figure (you don't need to click).

It's important to point out that both lotteries (A and B) are displayed on the same scale. This means that if a payoff in lottery A is \$2 and a payoff in lottery B is \$4, then the height of the \$4 payoff in lottery B is twice as high as the height of the \$2 payoff in lottery A. This is also true for payoffs in the same lottery. If lottery A pays $2 or 0.20$, then the height of the \$2 payoff will be ten times as high as the \$0.20 payoff in the same lottery.

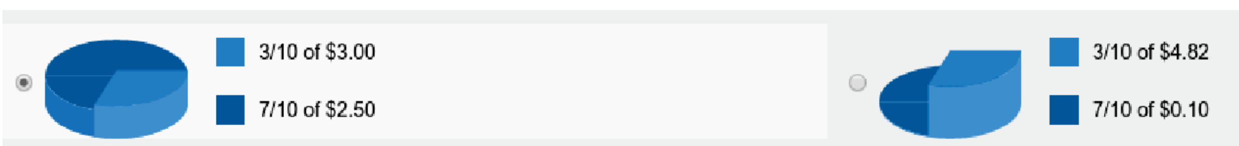

Figure B.2: TT Display: Graphical with text prize and probability

B.2.3 Full graphics with probability in text

This display type is similar to the full graphics with text. As you can see in figure B.3, the only difference is that now payoff is represented only in a graphical form (in the height of the pie slice), while the probabilities are display in text as well as graphically (in the size of the pie slice).

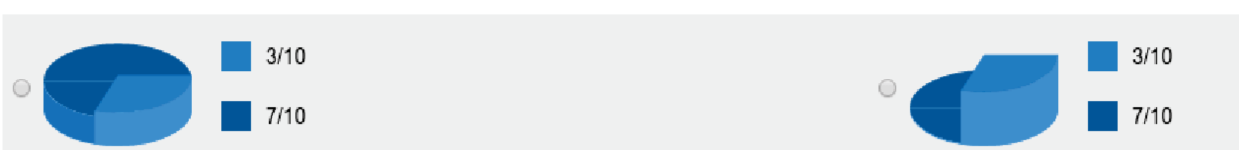

Figure B.3: TF Display: Graphical with text probability only

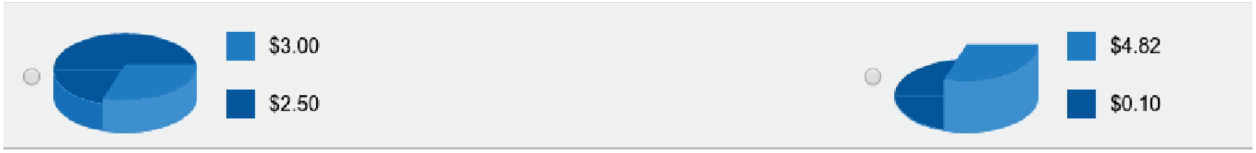

Figure B.4: FT Display: Graphical with text prize only

B.2.4 Full graphics with payoff in text

This display type is similar to the full graphics with text. The only difference is that now probabilities are represented only in a graphical form (in the size of the pie slice), while the payoffs are display in text as well as graphically (in the height of the pie slice).

B.2.5 Fully graphical

This segment removes all text from the list and represents the lotteries in a fully graphical manner. The lotteries are again displayed with the probabilities represented by the size of the pie slice and the payoffs represented by the height of the pie slice. There is no text displaying probabilities or payoffs. Each lottery is fully characterized by the height and size of the pie wedges.

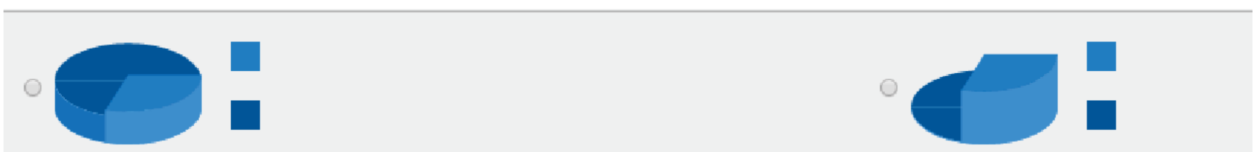

Figure B.5: FF Display: Graphical with no text

Are there any questions? Now you may begin making your choices. Please do not talk with anyone while we are doing this; raise your hand if you have a question.

Appendix C MPL variants

		Lottery A		Lottery B		Calculated		
Row	prob1	A-prize1	A-prize2	B-prize1	B-prize2	EV[A]-EV[B]	$\hat{r}$	$\hat{r}*$
1	0.1	4.00	0.25	2.15	1.75	-1.16	-1.87	-
2	0.2	4.00	0.25	2.15	1.75	-0.83	-1.05	-5.11
3	0.3	4.00	0.25	2.15	1.75	-0.49	-0.54	-2.76
4	0.4	4.00	0.25	2.15	1.75	-0.16	-0.16	-0.84
5	0.5	4.00	0.25	2.15	1.75	0.17	0.16	0.91
6	0.6	4.00	0.25	2.15	1.75	0.51	0.47	2.66
7	0.7	4.00	0.25	2.15	1.75	0.84	0.79	4.57
8	0.8	4.00	0.25	2.15	1.75	1.18	1.16	6.91
9	0.9	4.00	0.25	2.15	1.75	1.51	1.66	10.41
10	1	4.00	0.25	2.15	1.75	1.85	-	-

Table C.1: MPLb, a variation of the original Holt & Laury (2002) Multiple Price List where columns are switched with \$0.15 added to prize. The remaining columns show the difference in expected values of the two lotteries; the approximate solution $\hat{r}$ to the equation EU[A] = EU[B] at that row, where $U(x) = \frac{x^{1-r}}{1-r}$; and $\hat{r}*$ is the solution when \$7 is added to all prizes.

		Lottery A		Lottery B		Calculated		
Row	prob1	A-prize1	A-prize2	B-prize1	B-prize2	EV[A]-EV[B]	$\hat{r}$	$\hat{r}$*
1	1	1.95	1.55	3.80	0.05	-1.85	-	-
2	0.9	1.95	1.55	3.80	0.05	-1.51	1.23	10.16
3	0.8	1.95	1.55	3.80	0.05	-1.18	0.86	6.74
4	0.7	1.95	1.55	3.80	0.05	-0.84	0.62	4.47
5	0.6	1.95	1.55	3.80	0.05	-0.51	0.38	2.6
6	0.5	1.95	1.55	3.80	0.05	-0.17	0.13	0.88
7	0.4	1.95	1.55	3.80	0.05	0.16	-0.13	-0.82
8	0.3	1.95	1.55	3.80	0.05	0.49	-0.46	-2.70
9	0.2	1.95	1.55	3.80	0.05	0.83	-0.91	-
10	0.1	1.95	1.55	3.80	0.05	1.16	-1.65	-

Table C.2: MPLc, a variation of the original Holt & Laury (2002) Multiple Price List where the row order is reversed, top-to-bottom, and $0.05 is subtracted from all prizes.

		Lottery A		Lottery B		Calculated		
Row	prob1	A-prize1	A-prize2	B-prize1	B-prize2	EV[A]-EV[B]	$\hat{r}$	$\hat{r}$*
1	0.1	1.41	1.26	1.96	0.32	0.79	-	-
2	0.2	1.41	1.26	1.96	0.32	0.64	-2.87	-
3	0.3	1.41	1.26	1.96	0.32	0.49	-1.95	-
4	0.4	1.41	1.26	1.96	0.32	0.35	-1.26	-
5	0.5	1.41	1.26	1.96	0.32	0.20	-0.69	-5.01
6	0.6	1.41	1.26	1.96	0.32	0.05	-0.16	-1.20
7	0.7	1.41	1.26	1.96	0.32	-0.09	0.36	2.81
8	0.8	1.41	1.26	1.96	0.32	-0.24	0.95	7.55
9	0.9	1.41	1.26	1.96	0.32	-0.39	1.76	14.39
10	1	1.41	1.26	1.96	0.32	-0.54	-	-

Table C.3: MPLd, a variation of the original Holt & Laury (2002) Multiple Price List where we take the square root of all prizes.

		Lottery A		Lottery B		Calculated		
Row	prob1	A-prize1	A-prize2	B-prize1	B-prize2	EV[A]-EV[B]	$\hat{r}$	$\hat{r}$*
1	0.1	4	2.56	14.82	0.01	1.21	-0.35	-1.1
2	0.2	4	2.56	14.82	0.01	-0.12	0.02	0.08
3	0.3	4	2.56	14.82	0.01	-1.46	0.26	0.91
4	0.4	4	2.56	14.82	0.01	-2.79	0.42	1.61
5	0.5	4	2.56	14.82	0.01	-4.13	0.57	2.28
6	0.6	4	2.56	14.82	0.01	-5.47	0.70	2.96
7	0.7	4	2.56	14.82	0.01	-6.81	0.83	3.74
8	0.8	4	2.56	14.82	0.01	-8.14	0.98	4.73
9	0.9	4	2.56	14.82	0.01	-9.48	1.18	6.29
10	1	4	2.56	14.82	0.01	-10.82	-	-

Table C.4: MPLe, a variation of the original Holt & Laury (2002) Multiple Price List where we square all prizes.