Online Appendix

A. Theoretical Derivations

A.1. Equivalence of coding rules

HWP have derived coding rules under three different performance objectives: one that maximizes expected financial gain, one that maximizes mutual information, and one that maximizes accuracy. In this section, we follow HWP and prove that, when the conditions in equation (9) of the main text

$$\begin{aligned} &(i)\ pX \text{ and } C \text{ are i.i.d.} \\ \text{and } &(ii)\ pX \text{ and } C \text{ are uniformly distributed} \end{aligned} \tag{A.1}$$

are satisfied, the three coding rules are equivalent. First, if the performance objective is to maximize expected financial gain, then the coding rules $\theta(X)$ and $\theta(C)$ in equations (5) and (6) of the main text come directly from HWP.

Next, if the performance objective is to maximize mutual information between a payoff (X or C) and its noisy signal (R_x or R_c), then HWP derive the following coding rules

$$\theta(X) = \left[\sin\left(\frac{\pi}{2}F(X)\right)\right]^2 \quad \text{and} \quad \theta(C) = \left[\sin\left(\frac{\pi}{2}F(C)\right)\right]^2, \tag{A.2}$$

where $F(X)$ and $F(C)$ are the cumulative distribution function of $f(X)$ and $f(C)$, respectively. When X and C are uniformly distributed, the coding rules in (A.2) reduce to equations (5) and (6). That is, maximizing mutual information and maximizing expected financial gain lead to the same coding rules. Finally, if the performance objective is to maximize accuracy—in the sense of choosing the option with the highest objective expected value—then, under the conditions in (A.1), we make two conjectures

$$\begin{aligned} &(i)\ \mathbb{E}[p\tilde{X}|R_x], \text{ viewed as a function of } R_x, \text{ and } \mathbb{E}[\tilde{C}|R_c], \text{ viewed as a function of } R_c, \\ &\text{are identical,} \\ &\text{and } (ii) \text{ the optimal coding rules are related: } \theta(X) = \theta(C = pX),\ \forall X \in [X_l, X_u]. \end{aligned} \tag{A.3}$$

We observe that maximizing accuracy is equivalent to minimizing the probability of error

$$\mathbb{P}\text{rob}_{error} \equiv \int_{C_l}^{C_u} dC \int_{X_l}^{X_u} \mathbb{P}\text{rob}\left(error|\theta(X), \theta(C)\right) \cdot f(X)f(C) \cdot dX, \tag{A.4}$$

where $\mathbb{P}\text{rob}(error|\theta(X), \theta(C))$ represents the probability that the DM chooses the option with the lower expected value observed by the econometrician. Given the two conjectures from (A.3), this probability of error equals the probability that $R_x - R_c$ and $\theta(X) - \theta(C)$ are of the opposite sign.

Combining (A.4) with the two conjectures, we observe that when n is large,

$$\begin{aligned}&\mathbb{P}\text{rob}(error|\theta(X),\theta(C))\\&=\mathbb{P}\text{rob}(error|\theta(Y),\theta(C))\approx\Phi\left(-\frac{|\theta(Y)-\theta(C)|}{\sqrt{\frac{\theta(Y)(1-\theta(Y)+\theta(C)(1-\theta(C)))}{n}}}\right),\end{aligned}\tag{A.5}$$

where $Y\equiv pX$, so Y and C are independently and identically distributed. Moreover, (A.4) can be written as

$$\begin{aligned}\mathbb{P}\text{rob}(error|\theta(X),\theta(C))&=\int_{C_l}^{C_u}dC\int_{X_l}^{X_u}f(X)f(C)\cdot\mathbb{P}\text{rob}\left(error|\theta(X),\theta(C)\right)\cdot dX\\&=\int_{C_l}^{C_u}dC\int_{C_l}^{C_u}f(Y)f(C)\cdot\mathbb{P}\text{rob}\left(error|\theta(Y),\theta(C)\right)\cdot dY.\end{aligned}\tag{A.6}$$

Given (A.6), the derivation of the optimal coding rules $\theta(X)$ and $\theta(C)$ follow directly from the Appendix of HWP; these coding rules are identical to those when the performance objective is to maximize mutual information. Given the coding rules, verifying the two conjectures from (A.3) is straightforward. ■

A.2. Theoretical prediction of efficient coding in Experiment 2

In this section, we prove an analytical result which justifies the claim that Experiment 2 in the main text targets a specific test of efficient coding, rather than a general test of noisy coding.

Proposition: Assume the design of Experiment 2. Further assume (i) pX and C are independently and identically coded, (ii) $f(R_x|X)$ is identical across the two experimental conditions (no efficient coding), and (iii) $f(R_c|C)$ is also identical across the two experimental conditions (no efficient coding). Then, for all values of X and C, $\mathbb{P}\text{rob}(\text{risk taking}|X,C)$ is identical across the two conditions.

Proof: Given assumption (i), $\mathbb{E}[p\tilde{X}|R_x]=\mathbb{E}[\tilde{C}|R_c]$ when $R_x=R_c$. It is easy to show that this function of R is increasing in R. As such, the probability of risk taking is

$$\begin{aligned}&\sum_{R_x=0}^{n}\sum_{R_c=0}^{n}\left(\mathbb{1}_{p\cdot\mathbb{E}[\tilde{X}|R_x]>\mathbb{E}[\tilde{C}|R_c]}\cdot f(R_x|X)\cdot f(R_c|C)+\mathbb{1}_{p\cdot\mathbb{E}[\tilde{X}|R_x]=\mathbb{E}[\tilde{C}|R_c]}\cdot\frac{1}{2}f(R_x|X)\cdot f(R_c|C)\right)\\&=\sum_{R_x=0}^{n}\sum_{R_c=0}^{n}\left(\mathbb{1}_{R_x>R_c}\cdot f(R_x|X)\cdot f(R_c|C)\right)+\sum_{R=0}^{n}\frac{1}{2}f(R|X)\cdot f(R|C).\end{aligned}\tag{A.7}$$

Given assumptions (ii) and (iii), the last line in (A.7) is identical across the two conditions. In other words, under assumption (i), any difference in risk taking for a given (X,C) across the two conditions serves as evidence that the likelihood functions, $f(R_x|X)$ and $f(R_c|C)$, respond endogenously to changes in the prior distribution (i.e., a violation of assumptions (ii) and (iii)). ■

B. Experimental Instructions and Pre-Registration Documents

B.1. Instructions for the risky choice task in Experiment 1

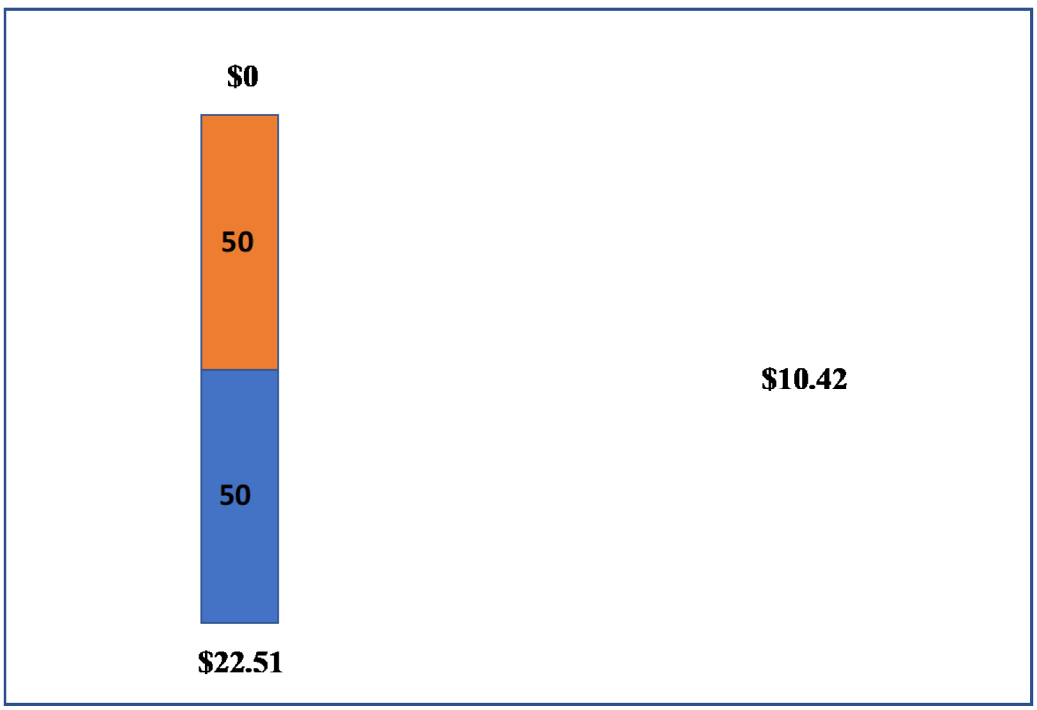
Experiment Instructions

Thank you for participating in this experiment. Before we begin, please turn off all cell phones and put all belongings away. For your participation, you have already earned $7, and you will have the opportunity to earn more money depending on your answers during the experiment.

The experiment consists of **two phases**. The instructions for Phase I are given below. After you go through Phase I, you will be given a new set of instructions for Phase II.

Phase I

In Phase 1 of the experiment, you will be asked to make a series of decisions about choosing a "risky gamble" or a "sure thing". The risky gamble will pay a positive amount with 50% chance, and $0 with 50% chance. The amount shown for the sure thing will be paid with 100% chance, if chosen. Below is an example screen from the experiment:



In the above example, the risky gamble is on the LEFT side of the screen and the sure thing is on the RIGHT side of the screen. The risky gamble pays $22.51 with 50% chance, and $0 with 50% chance. The sure thing pays $10.42 with 100% chance. For each question, you will be asked to select one of the two options for each question by pressing either the "z" key for the LEFT option or the "?" key for the RIGHT option. On some questions, the risky gamble will be on the LEFT, and other questions it will be on the RIGHT. **Phase I of the experiment is broken down into 12 parts, and each part contains 50 questions.**

At the end of the experiment (after both Phase I and Phase II are completed), one trial will be randomly selected, and you'll be paid according to your decision on that trial. For example, if the above trial was chosen, and you selected the sure thing you would be paid $10.42. If instead you chose the risky gamble, you'd be paid either $0 or $22.51, depending on which outcome the computer randomly selects. **Therefore, you should choose the option on each question that you prefer, since it may end up being the question that you are actually paid for.** Remember that all earnings for Phase I and Phase II will be added to your $7 show-up fee.

Before you begin Phase I, you will see a set of 10 practice trials so you can become familiar with the software and have a chance to ask any questions. These 10 practice trials will not count towards your actual payment.

When you are ready to begin the practice trials, press "Enter" on the computer ONCE. When you are finished with Phase I, please wait quietly and raise your hand. An experimenter will then come give you instructions for Phase II.

If you have any questions during the experiment, please raise your hand quietly.

B.2. Instructions for the perceptual choice task in Experiment 1

Phase II

In Phase II of the experiment, you will see a series of numbers and will be asked to classify whether each number is greater than or smaller than 65. If the number displayed is less than 65, press the "z" key. If the number displayed is greater than 65, press the "?" key. At the end of the experiment, you will be paid depending on the speed and accuracy of your classifications (in addition to your earnings from Phase I and the show-up fee). Specifically, you will be paid:

Payout = $ (15 x accuracy – 10 x avgseconds),

where "accuracy" is the percentage of trials where you correctly classified the number as larger or smaller than 65. "avgseconds" is the average amount of time it takes you to classify a number throughout the experiment, in seconds. For example, if you correctly classified the number on all trials and it took you 0.3 seconds to respond to each question, you would earn $(15 x 100% - 10 * 0.3) = $12.00. If instead you only classified 80% of the questions correctly and took 0.8 seconds to respond to each question, you would be paid $(15 x 70% - 10* 0.8) = $2.50. Therefore, you will make the most money by answering as quickly and as accurately as possible.

The experiment will be separated into sixteen parts, and each part will contain 50 trials. In between each part, you can take a short break, and then continue at your own pace.

When you are ready to begin Phase II, press "Enter" on the computer ONCE.

When you finish all sixteen parts, please quietly raise your hand and an experimenter will come give you payment instructions.

If you have any questions during the experiment, please raise your hand quietly.

B.3. Instructions for the risky choice task in Experiment 2

Welcome to the Experiment

Thank you for participating in this study!

Before we begin, please close all other applications. This study will last approximately 40 minutes.

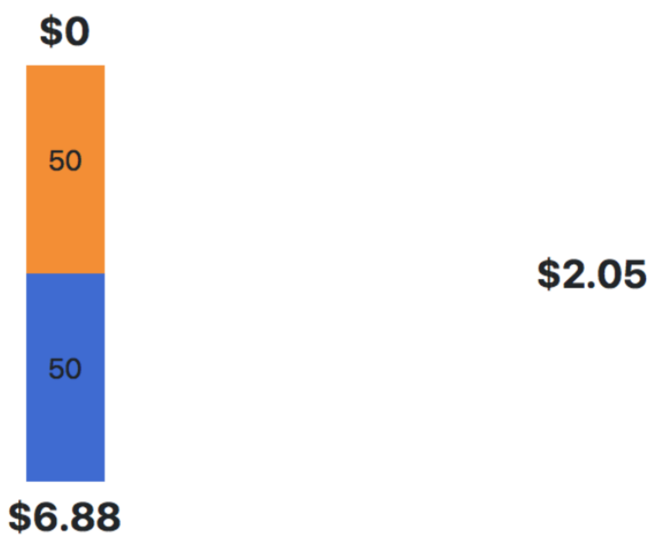
For completing the experiment, you will earn $6.50, and you will also have the opportunity to earn an additional **bonus payment** depending on your answers during the experiment.

Click **Next** to see the instructions.

Next

Instructions

In this experiment you will be asked to make a series of decisions about choosing a "risky gamble" or a "sure thing". The risky gamble will pay a positive amount with 50% chance, and $0 with 50% chance. The amount shown for the sure thing will be paid with 100% chance. Below is an example screenshot from the experiment:

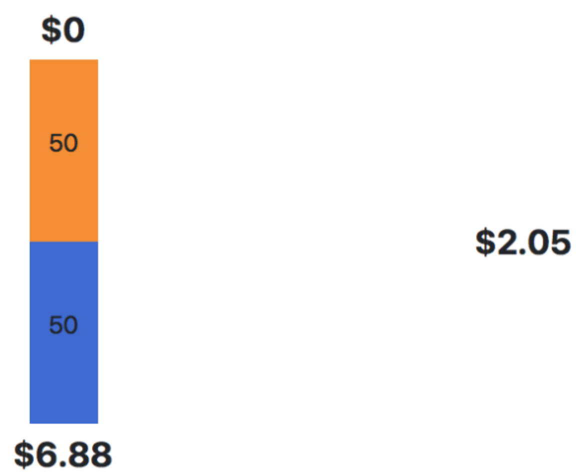


In the above example, the risky gamble is on the LEFT and the sure thing is on the RIGHT. The risky gamble pays $6.88 with 50% chance, and $0 with 50% chance. The sure thing pays $2.05 with 100% chance. For each question, you will be asked to select one of the two options by pressing either the "a" key for the LEFT option or the "k" key for the RIGHT option. For some questions, the risky gamble will be on the LEFT, and for the other questions it will be on the RIGHT. The dollar amounts will change on each question, so please pay attention to each question carefully.

Click **Next** to see how your bonus payment will be computed.

Next

Instructions



The experiment is broken down into 12 parts, for a total of 600 questions. At the end of the experiment, one question will be randomly selected by the computer, and **you'll be paid a bonus** according to your decision on that question. For example, if the above question was randomly chosen for the bonus question, and you selected the sure thing, you would be paid a **bonus** of $2.05. If instead you chose the risky gamble, you'd be paid a **bonus** of either $0 or $6.88, depending on which outcome the computer randomly selects.

You will have a 10-second time limit to make each choice. If you fail to enter a response within 10 seconds, the computer will randomly select a decision for you and it will advance to the next question. At the end of each part, you can take a short break.

Before you begin, you will go through a short comprehension check and two practice questions.

Click **Next** to start the comprehension check.

Next

Comprehension Check

Please answer each question to the best of your ability.

Question 1:

True or False: The possible dollar amounts you can win will change on every question.

- True
- False

Question 2:

True or False: One of the 600 questions will be randomly selected by the computer, and you will be paid a bonus depending on your answer to the randomly selected question.

- True
- False

When you have answered the above questions, press **Next** to begin the 2 practice questions.

Next

B.4. Pre-registration document for Experiment 1

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ASPREDICTED

EC Risk Taking and Numerical Comparison - Feb 2020 (#35331)

Created: 02/09/2020 11:09 PM (PT)
Shared: 07/17/2020 03:26 PM (PT)

This pre-registration is not yet public. This anonymized copy (without author names) was created by the author(s) to use during peer-review. A non-anonymized version (containing author names) will become publicly available only if an author makes it public. Until that happens the contents of this pre-registration are confidential.

---

1) Have any data been collected for this study already?

No, no data have been collected for this study yet.

2) What's the main question being asked or hypothesis being tested in this study?

We investigate whether human subjects make decisions about monetary lotteries and number comparisons in a manner that is consistent with theories of efficient coding.

3) Describe the key dependent variable(s) specifying how they will be measured.

There are two main tasks in the experiment. There is a "Risky choice" task in which subjects will choose between a risky option and a certain option. In this task, the dependent variable is the decision to choose the risky lottery. Second, there is a "Number classification" task in which the subject classifies whether a number is greater than or less than the number "65." In this task, the dependent variable is whether the subject accurately classified the number on a given trial. We will also collect response times for each trial and each task.

4) How many and which conditions will participants be assigned to?

In both tasks, subjects will be assigned to two conditions: a "high volatility" and a "low volatility" condition. "High" and "Low" refer to the volatility of the distribution from which monetary amounts or numerical quantities are drawn in each of the two tasks. We will randomize, at the subject level, whether the first condition is the "high" or "low" volatility condition; this enables us to test for both within and between subjects variation.

In the risky choice task, the high and low volatility distributions are uniform with the same mean, but the high volatility distribution has larger volatility. Each condition begins with 30 "initial adapt" trials, and for each condition we only analyze data after these "initial adapt" trials. Our main focus of analysis will be on 30 choice sets that are identical across conditions, which have the form (X, 0.5; 0, 0.5) vs. (C, 1). We call these "test trials," and the 30 different values of (X,C) are given by:

(17.30, 11.20)
(17.31, 9.62)
(17.32, 8.04)
(17.34, 8.75)
(17.38, 10.38)
(18.63, 8.79)
(18.64, 11.16)
(18.68, 9.61)
(18.68, 8.03)
(18.72, 10.44)
(19.96, 9.62)
(19.98, 8.01)
(19.99, 8.81)
(20.03, 10.4)
(20.04, 11.22)
(21.29, 8.82)
(21.3, 10.39)
(21.34, 11.23)
(21.34, 9.58)
(21.38, 8.00)
(22.62, 9.62)
(22.66, 8.79)
(22.67, 8.04)
(22.69, 11.21)
(22.71, 10.42)
(23.96, 9.55)
(23.97, 11.18)
(23.98, 10.37)

(23.98, 8.03)
(23.99, 8.84)

The design for the number classification task is nearly identical, except we use 60 "initial adapt" trials in each condition, and the test trials are the integers that fall in the support of the low volatility distribution, [56, 74].

5) Specify exactly which analyses you will conduct to examine the main question/hypothesis.
For each of the two tasks, we will test whether responses on test trials in the high volatility condition exhibit more noise compared to responses on test trials in the low volatility condition. Because responses are binary in both tasks, we will use logistic regressions where the main independent variables are X and C in the risky choice task and the main independent variable in the number classification task is (X-65). Between subjects tests will be conducted only on test trials in the first condition. Within subjects test will be conducted on all test trials, across conditions.

6) Describe exactly how outliers will be defined and handled, and your precise rule(s) for excluding observations.
We will exclude any subject who exhibits no variation in choice behavior in either of the two tasks.

7) How many observations will be collected or what will determine sample size? No need to justify decision, but be precise about exactly how the number will be determined.
We will collect N=150 subjects, where each subject completes the risky choice and number classification task.

8) Anything else you would like to pre-register? (e.g., secondary analyses, variables collected for exploratory purposes, unusual analyses planned?)
As an additional analysis, we will test for a correlation in behavior across the number comparison and risky choice tasks. We will also test whether response times are longer for more "difficult" decisions, and whether response times are longer on test trials in the high volatility condition.

B.5. *Pre-registration document for Experiment 2*

ASPREDICTED

Wharton CREDIBILITY LAB
UNIVERSITY *of* PENNSYLVANIA

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EC Risk Taking with Monotonic Priors - Within Subjects on Prolific (#58963)

Created: 02/21/2021 08:23 PM (PT)
Shared: 03/01/2021 05:56 PM (PT)

This pre-registration is not yet public. This anonymized copy (without author names) was created by the author(s) to use during peer-review. A non-anonymized version (containing author names) will become publicly available only if an author makes it public. Until that happens the contents of this pre-registration are confidential.

1) Have any data been collected for this study already?
No, no data have been collected for this study yet.

2) What's the main question being asked or hypothesis being tested in this study?
We hypothesize that the shape of the distribution from which risky payoffs are drawn affects a subject's level of risk taking, in a manner consistent with efficient coding.

3) Describe the key dependent variable(s) specifying how they will be measured.
Subjects will choose between a risky option and a certain option, where each choice set has the form (X, 0.5; 0, 0.5) vs (C, 1). The key dependent variable is the decision to choose the risky lottery; we will also collect response times for each decision.

4) How many and which conditions will participants be assigned to?
There will be two conditions, an "increasing" condition and a "decreasing" condition. In the increasing condition:

1) The payoff X will be drawn from a mixture of two uniform distributions: with probability 49/50, X will be drawn uniformly from [4.5, 8]; with probability 1/50, X will be drawn uniformly from [2, 4.5).

2) The payoff C will be drawn from a mixture of two uniform distributions: with probability 49/50, C will be drawn uniformly from [2.25, 4]; with probability 1/50, C will be drawn uniformly from [1, 2.25).

In the decreasing condition:

1) The payoff X will be drawn from a mixture of two uniform distributions: with probability 49/50, X will be drawn uniformly from [2, 5.5]; with probability 1/50, X will be drawn uniformly from (5.5, 8].

2) The payoff C will be drawn from a mixture of two uniform distributions: with probability 49/50, C will be drawn uniformly from [1, 2.75]; with probability 1/50, C will be drawn uniformly from (2.75, 4].

The design is within subjects, and the order of the two conditions is randomized across subjects. There are 300 trials in each condition, and we will insert 8 "common test trials" in each condition. The set of common test trials are the same across conditions, and the values of (X, C) for the 8 common test trials are given by:

(7.13, 2.70)
(7.26, 2.70)
(7.37, 2.70)
(7.49, 2.70)
(7.62, 2.70)
(7.76, 2.70)
(7.87, 2.70)
(7.99, 2.70)

The common test trials will be inserted on trials 90, 120, 150, 180, 210, 240, 270, and 300 of each condition. The order of the 8 common test trials is randomized across subjects and conditions.

5) Specify exactly which analyses you will conduct to examine the main question/hypothesis.
Our main analysis will be to compare the probability of choosing the risky lottery on the common test trials across the increasing and decreasing conditions. We therefore restrict our analysis to trials 90, 120, 150, 180, 210, 240, 270, 300 in each condition (for a total of 16 trials per subject). We will regress the probability of choosing the risky lottery on a condition dummy variable, which takes the value 1 if the trial belongs to the increasing condition, and 0 otherwise. Our main test is whether the estimated coefficient on the condition dummy variable is greater than zero.

6) Describe exactly how outliers will be defined and handled, and your precise rule(s) for excluding observations.
We will apply multiple rules for excluding observations, which we implement in the following order:

1) We will exclude any subject who fails to answer either of the two questions on a comprehension quiz, which will be given after the experimental instructions and before any risky choice decisions are made.

2) We will then exclude trials for which a subject fails to enter a response within the 10 second time limit.

3) We will then exclude subjects who exhibit sufficiently minimal variation in choice behavior on non-common test trials. That is, for those trials other than 90, 120, 150, 180, 210, 240, 270, and 300 in each condition, we compute the probability that each subject chooses the risky lottery. If this probability is strictly less than 2.5% or strictly greater than 97.5%, we exclude the subject.

4) We will then exclude any trial on which a subject responds in less than 0.5 seconds.

7) How many observations will be collected or what will determine sample size? No need to justify decision, but be precise about exactly how the number will be determined.
We will collect data on Prolific until we obtain N=200 subjects who have completed the experiment.

8) Anything else you would like to pre-register? (e.g., secondary analyses, variables collected for exploratory purposes, unusual analyses planned?)
N/A

C. Predictions of Alternative Models

C.1. Expectations-based reference points: Kőszegi and Rabin (2006, 2007)

We consider predictions of the model of expectations-based reference points as proposed by Kőszegi and Rabin (2006, 2007) (KR). In this model, the DM evaluates a lottery by comparing each of its individual outcomes to a (possibly stochastic) reference payoff. Specifically, suppose the DM expects the reference point distribution to be $G(r)$, and suppose the lottery F the DM evaluates has N potential outcomes, $x_1, x_2, \ldots, x_N$; outcome x_n is associated with probability p_n. Then, the utility of payoff x_n relative to the stochastic reference point G can be written as

$$v(x_n|G) = \int (x_n + \mu(x_n - r))dG(r), \tag{C.1}$$

where

$$\mu(y) = \begin{cases} \eta \cdot y & \text{if } y \geq 0 \\ (\eta\lambda) \cdot y & \text{if } y < 0 \end{cases}, \tag{C.2}$$

η measures the relative importance of the gain-loss utility, and λ measures the degree of loss aversion.

KR propose that expectations are given by the DM's rational expectations. As a first pass, one can assume that whenever the DM considers a lottery F, she views the lottery's payoff distribution as the reference point distribution, and thus the overall utility of F is $V(F|F) = \sum_{n=1}^{N} p_n v(x_n|F)$. KR denote such a reference point specification as the "choice acclimating personal equilibrium." Under this specification, the valuation of a lottery—and hence risk taking behavior—depends only on the payoff distribution of that particular lottery, which is held constant across different experimental conditions (in both Experiment 1 and Experiment 2). Thus, this specification of KR cannot explain our main experimental results.

C.2. Normalization models and decision-by-sampling models

We now examine normalization models and the decision-by-sampling (DbS) model, with an emphasis on how their predictions relate to our experiments. First, we examine the range normalization model of Rustichini et al. (2017). This model gives rise to the following probability of risk taking

$$\mathbb{P}\text{rob}(\textit{risk taking}|X, C) = \Phi\left(\frac{K_X t_X (X - X_l) - K_C t_C (C - C_l)}{\sqrt{\chi(K_X^2 t_X (X - X_l) + K_C^2 t_C (C - C_l))}}\right), \tag{C.3}$$

where $t_X = \overline{v}/(X_u - X_l)$ and $t_C = \overline{v}/(C_u - C_l)$. Here $\overline{v}$ and χ are parameters of coding capacity. Also, when $p(X_u - X_l) = C_u - C_l$, $K_X = K_C$. Equation (C.3) can be further simplified as

$$\mathbb{P}\text{rob}(\textit{risk taking}|X, C) = \Phi\left(\sqrt{\frac{\overline{v}}{\chi}} \cdot \frac{(X - X_l)/(X_u - X_l) - (C - C_l)/(C_u - C_l)}{\sqrt{(X - X_l)/(X_u - X_l) + (C - C_l)/(C_u - C_l)}}\right). \tag{C.4}$$

Panel A of Figure C.1 plots, for the two volatility conditions specified in Section III.A, the probability of choosing the risky lottery from equation (C.4). This result shows that models of efficient coding and models of range normalization both give rise to the main prediction from Experiment 1—that sensitivity to payoff values increases when the dispersion of potential values decreases.

[Place Figure C.1 about here]

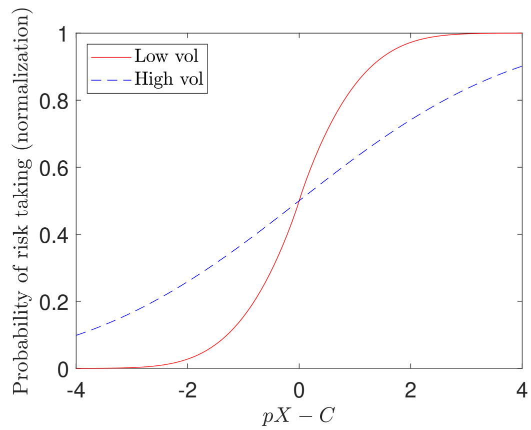
As mentioned in Section V.C, our results from Experiment 2 cannot be explained by range normalization models. It is plausible that another form of normalization could explain the results, although the model would need to operate through more than just the range of payoff values. For example, Louie et al. (2015) discuss a model of divisive normalization, in which the value of an option is normalized by a function—not just the range—of all past values. Depending on the functional form of normalization, which is a large degree of freedom, such a model could also explain the difference in average levels of risk taking we observe in Experiment 2.

Lastly, we turn to the decision-by-sampling model. As discussed in HWP, DbS implies the following coding rules under the resource constraints in HWP:

$$\theta(X) = F(X), \qquad \theta(C) = F(C). \tag{C.5}$$

Panel B of Figure C.1 shows that DbS also predicts that a given increase in X or a given decrease in C leads to a larger increase in risk taking when payoffs are drawn from the low volatility distribution, compared to the high volatility distribution (as in our Experiment 1). Moreover, DbS implies a higher demand for the risky lottery when risky payoffs are drawn from an increasing distribution, compared to a decreasing distribution (as in our Experiment 2). Thus, efficient coding and DbS generate qualitatively similar predictions. Indeed, Bhui and Gershman (2018) show that efficient coding can serve as a normative foundation for DbS.

Panel A



Panel B

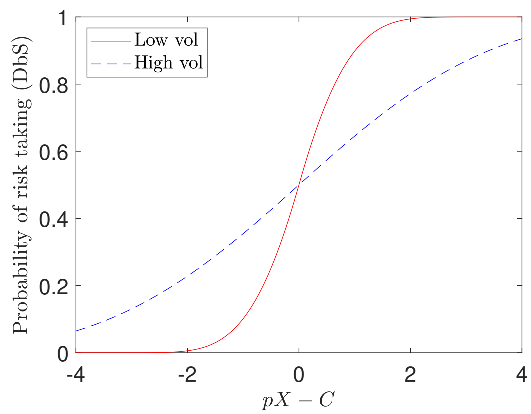


Figure C.1
Probability of choosing the risky lottery under alternative models

Panel A: the graph plots, for each of the two volatility environments (low volatility: $X_l = 16$, $X_u = 24$, $C_l = 8$, and $C_u = 12$; high volatility: $X_l = 8$, $X_u = 32$, $C_l = 4$, and $C_u = 16$), the probability of risk taking implied by the range normalization model of Rustichini et al. (2017). The prior distributions for X and C are uniform. The probability p for the risky lottery to pay X dollars is set to 0.5. The ratio $\overline{v}/\chi$ is set to 15; as in Rustichini et al. (2017), this ratio is a measure of coding capacity. Panel B: the graph plots, for each of the two volatility environments described above, the probability of risk taking implied by decision-by-sampling (Stewart et al., 2006; Bhui and Gershman, 2018). The capacity constraint parameter n is set to 10. In each panel and for each volatility environment, we draw X uniformly from [16, 24] and C uniformly from [8, 12]. We then compute, for a given X and C, the probability of risk taking. Finally, we aggregate these probabilities for each level of $pX - C$.

D. Additional Tables

Table D.1
Payoff values on the 30 common trials in Experiment 1

X	C	X	C
\$17.30	\$11.20	\$21.29	\$8.82
\$17.31	\$9.62	\$21.30	\$10.39
\$17.32	\$8.04	\$21.34	\$11.23
\$17.34	\$8.75	\$21.34	\$9.58
\$17.38	\$10.38	\$21.38	\$8.00
\$18.63	\$8.79	\$22.62	\$9.62
\$18.64	\$11.16	\$22.66	\$8.79
\$18.68	\$9.61	\$22.67	\$8.04
\$18.68	\$8.03	\$22.69	\$11.21
\$18.72	\$10.44	\$22.71	\$10.42
\$19.96	\$9.62	\$23.96	\$9.55
\$19.98	\$8.01	\$23.97	\$11.80
\$19.99	\$8.81	\$23.98	\$10.37
\$20.03	\$10.40	\$23.98	\$8.03
\$20.04	\$11.22	\$23.99	\$8.84

Notes. The table presents the payoff values that comprise the 30 common trials in the risky choice task of Experiment 1. The set of 30 common trials is presented to subjects once in each volatility condition; this amounts to a total of 60 test trials per subject. The order of the common trials is randomized at the subject-condition level.

Table D.2

Frequency of choosing the risky lottery in Experiment 1 using logistic regressions

	Between subjects tests		Within subject tests			
	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable: "Choose risky lottery"	Unrestricted sample	Restricted sample	Restricted sample	Restricted sample (w/out trials 301-450)	Restricted sample —low volatility first (w/out trials 301-450)	Restricted sample —high volatility first (w/out trials 301-450)
high	0.063	–0.051	–0.013	–0.088	0.507	–0.628
	(0.856)	(0.934)	(0.440)	(0.541)	(0.777)	(0.660)
X	0.332***	0.407***	0.331***	0.353***	0.407***	0.270***
	(0.039)	(0.041)	(0.027)	(0.029)	(0.041)	(0.040)
C	–0.825***	–0.987***	–0.830***	–0.894***	–0.987***	–0.749***
	(0.088)	(0.094)	(0.061)	(0.067)	(0.094)	(0.089)
$X \times high$	–0.108**	–0.171***	–0.058***	–0.111***	–0.150***	–0.034
	(0.049)	(0.051)	(0.020)	(0.027)	(0.033)	(0.035)
$C \times high$	0.222**	0.368***	0.117**	0.239***	0.263***	0.129*
	(0.108)	(0.114)	(0.048)	(0.057)	(0.071)	(0.077)
Constant	1.188	1.283	1.365***	1.512***	1.283	1.860***
	(0.754)	(0.848)	(0.486)	(0.584)	(0.850)	(0.639)
Observations	4,470	4,170	8,257	6,411	3,125	3,286

Notes. The table reports results from logistic regressions in which the dependent variable takes the value of one if the subject chooses the risky lottery, and zero otherwise. The dummy variable, *high*, takes the value of one if the trial belongs to the high volatility condition, and zero if it belongs to the low volatility condition. Data are pooled across all subjects and standard errors are clustered at the subject level. Only data from common trials are included. Standard errors are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table D.3
Payoff values on the 8 common trials in Experiment 2

X	C
\$7.13	\$2.70
\$7.26	\$2.70
\$7.37	\$2.70
\$7.49	\$2.70
\$7.62	\$2.70
\$7.76	\$2.70
\$7.87	\$2.70
\$7.99	\$2.70

Notes. The table presents the payoff values that comprise the 8 common trials in Experiment 2. The set of 8 common trials is presented to subjects once in each condition, on trials 90, 120, 150, 180, 210, 240, 270, and 300; this amounts to a total of 16 test trials per subject. The order of the common trials is randomized at the subject-condition level.

Table D.4

Frequency of choosing the risky lottery in Experiment 1: Comparison between early and late trials

	(1)	(2)	(3)
Dependent variable: "Choose risky lottery"	Trials 31-165	Trials 166-300	Trials 31-300
high	–0.007	0.012	–0.025
	(0.241)	(0.247)	(0.243)
X	0.077***	0.073***	0.075***
	(0.007)	(0.007)	(0.007)
C	–0.189***	–0.182***	–0.189***
	(0.013)	(0.016)	(0.013)
$X \times high$	–0.024***	–0.022**	–0.023**
	(0.009)	(0.009)	(0.010)
$C \times high$	0.054***	0.045**	0.054***
	(0.108)	(0.020)	(0.018)
second			–0.010
			(0.224)
$high \times second$			0.057
			(0.287)
$X \times second$			–0.002
			(0.008)
$C \times second$			0.007
			(0.014)
$X \times high \times second$			0.001
			(0.010)
$C \times high \times second$			–0.009
			(0.018)
Constant	0.755***	0.768***	0.790***
	(0.204)	(0.215)	(0.205)
Observations	2,147	2,023	4,170

Notes. The table reports results from the first condition of the risky choice task in Experiment 1. We present mixed effects linear regressions in which the dependent variable takes the value of one if the subject chooses the risky lottery, and zero otherwise. The dummy variable, *high*, takes the value of one if the trial belongs to the high volatility condition, and zero if it belongs to the low volatility condition. The dummy variable, *second*, takes the value of one if the trial belongs to the second half of the first condition (trials 166-300), and zero if it belongs to the first half (trials 31-165). Only data from common trials are included. There are random effects on the independent variables X, C, and the intercept. Standard errors of the fixed effect estimates are clustered at the subject level and reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.