

Saving Behavior and Cognitive Abilities: Supplementary Materials

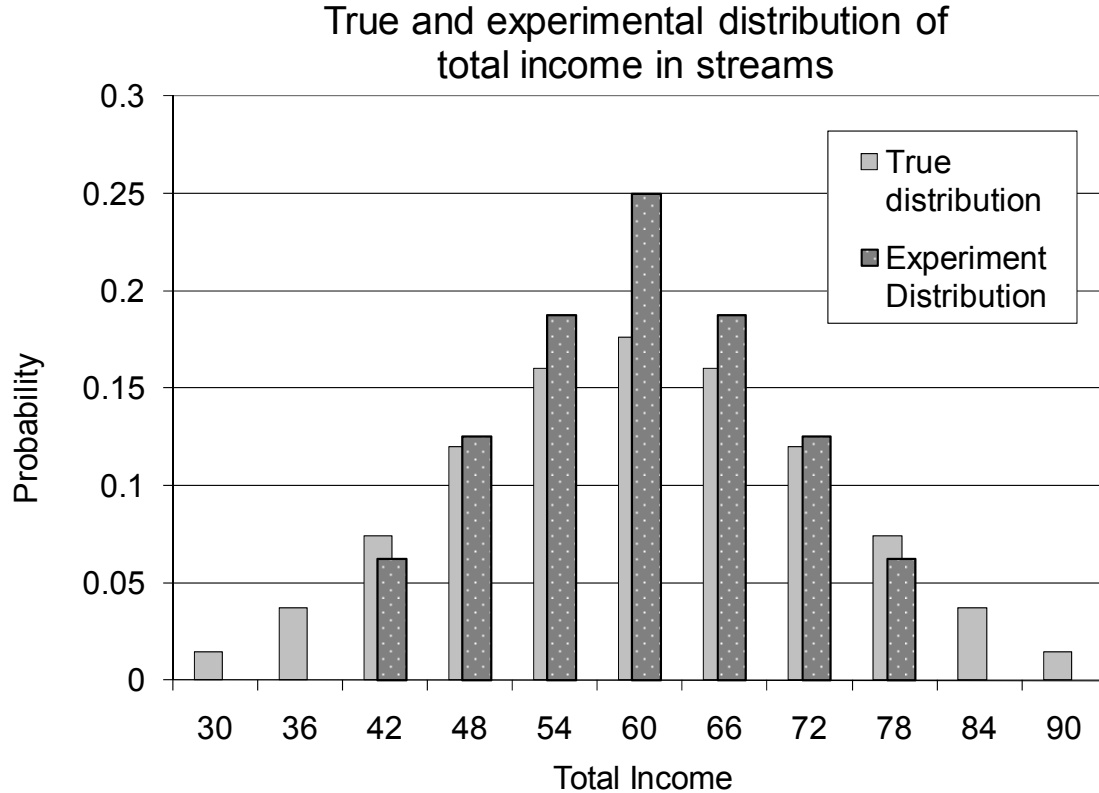
by

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Supplementary Material A: The Income Streams

The hard, moderate and easy sets of income streams (**H**, **M** and **E**) used in the experiment are not truly random since we pre-selected them in various ways. This appendix shows the extent to which these sets collectively resemble a random sample of truly random i.i.d. binomial sequences of length 20 with success probability $p = 0.5$ —the “advertised distribution.”

Let $\sum Y$ denote the total income in stream Y . The set size (16 streams) is the smallest discrete number of streams that can roughly approximate the actual sampling distribution of total income in streams drawn from the advertised distribution. The figure below shows this distribution along with the approximation of it that each of our sets create with 16 total streams. Our distribution truncates away about 0.12 total probability from the tails of the advertised distribution (and has noticeably more mass in the center), but otherwise resembles it.



Recall that we use 48 sequences of five income streams. Using a standard goodness-of-fit test (likelihood ratio chi-square, or G-test) against the null that a subject's five observed total income figures (in her five streams) come from the advertised distribution, just 1 (1,8,18) of our 48 subjects would reject that null at 5% (10%,25%,50%). Put differently, subjects' five observations of total income give them no more frequent reasons to reject the advertised income process than would five streams actually drawn from the advertised income process itself.

The "difficulty" of streams, which we systematically select for our three sets of streams, is related to the timing of income realizations. We also need to make sure that the resulting collection of streams have average time series properties resembling those actually drawn from the advertised distribution. We construct a special sample autocorrelation function to examine this, meant for relatively short sequences of i.i.d. Bernoulli draws. In this analysis we consider streams $Y = (y_1, y_2, \dots, y_t, \dots, y_T)$ as i.i.d. sequences of Bernoulli draws, where $p = \Pr(y_t = 1)$ is the probability that income is received, and $(1-p) = \Pr(y_t = 0)$ is the probability of no income.

Define a stream's sample mean and sample variance by

$$\hat{p} = \frac{1}{T} \sum_{t=1}^T y_t \quad \text{and} \quad \hat{v} = \frac{1}{T-1} \sum_{t=1}^T (y_t - \hat{p})^2$$

Under the null that the y_t are i.i.d. binomial random variables with common success probability p , we have

$$E(\hat{p}) = p, \quad \text{and} \quad E(\hat{v}) = \text{Var}(y_t) = p(1-p)$$

Define the sample autocovariance at lag k by

$$\hat{c}_k = \frac{1}{T-k} \sum_{t=k+1}^T (y_t - \hat{p})(y_{t-k} - \hat{p}).$$

Expand this:

$$\hat{c}_k = \frac{1}{T-k} \left\{ \sum_{t=k+1}^T y_t y_{t-k} - \frac{1}{T} \sum_{t=k+1}^T (y_t + y_{t-k}) \sum_{j=1}^T y_j + \sum_{t=k+1}^T \frac{1}{T^2} \left(\sum_{j=1}^T y_j \right)^2 \right\}, \text{ or}$$

$$\hat{c}_k = \frac{1}{T-k} \left\{ \sum_{t=k+1}^T y_t y_{t-k} - \frac{1}{T} \sum_{t=k+1}^T (y_t^2 + \sum_{j \neq t} y_t y_j) - \frac{1}{T} \sum_{t=k+1}^T (y_{t-k}^2 + \sum_{j \neq t-k} y_{t-k} y_j) + \frac{1}{T^2} \sum_{t=k+1}^T \sum_{j=1}^T (y_j^2 + \sum_{i \neq j} y_j y_i) \right\}.$$

Under the null that the y_t are i.i.d. binomial random variables with common success probability p , we have $E(y_t^2) = p \cdot 1 + (1-p) \cdot 0 = p \ \forall t$, and $E(y_t y_j) = p^2 \cdot 1 + (1-p^2) \cdot 0 = p^2 \ \forall t \neq j$. Substituting these, the expectation of the sample autocovariance under this null is

$$E(\hat{c}_k) = \frac{1}{T-k} \left\{ \sum_{t=k+1}^T p^2 - \frac{1}{T} \sum_{t=k+1}^T (p + \sum_{j \neq t} p^2) - \frac{1}{T} \sum_{t=k+1}^T (p + \sum_{j \neq t-k} p^2) + \frac{1}{T^2} \sum_{t=k+1}^T \sum_{j=1}^T (p + \sum_{i \neq j} p^2) \right\}, \text{ or}$$

$$E(\hat{c}_k) = \frac{1}{T-k} \left\{ (T-k)p^2 - 2 \frac{T-k}{T} (p + (T-1)p^2) + \frac{T-k}{T^2} T (p + (T-1)p^2) \right\}, \text{ or}$$

$$E(\hat{c}_k) = \frac{1}{T-k} \left\{ (T-k)p^2 - \frac{T-k}{T} (p + (T-1)p^2) \right\} = -\frac{p(1-p)}{T}$$

This shows that in finite samples, the sample autocovariance \hat{c}_k has a bias equal to the negative of the true variance divided by the sample size. The negative finite sample bias of autocorrelation coefficients in an i.i.d. sequence has long been known (e.g. Marriott and Pope 1954). Therefore, define an unbiased small-sample autocovariance estimator by

$$\hat{c}_k^u = \hat{c}_k + \hat{v}/T.$$

Then use the analogy principle to define this nonstandard sample autocorrelation function, designed to be centered on zero for small T i.i.d. Bernoulli sequences:

$$\hat{\rho}_k = \frac{\hat{c}_k^u}{\hat{v}} = \frac{\hat{c}_k + \hat{v}/T}{\hat{v}} = \frac{\hat{c}_k}{\hat{v}} + \frac{1}{T}.$$

We calculate the average value of this $\hat{\rho}_k$ across our experimental income streams, at lags k from 1 to 8. Recall that there are 48 streams, 16 in each of the hard, moderate and easy sets **H**, **M** and **E**, but that the streams in **M** are used three times as often as those in **H** or **E**. Therefore, each stream in **M** is counted three times, and the streams in **H** and **E** once, in calculating the average value of $\hat{\rho}_k$ across our streams. This is as if our experiment uses 80 streams in all. Therefore, we bootstrap the distribution of $\hat{\rho}_k$ using 10,000 samples of 80 truly random binomial streams with $T = 20$. The table below shows the actual average values of $\hat{\rho}_k$ across our experimental streams (in column 2), and the bootstrapped 95% confidence interval for these autocorrelations (last two columns). As can be seen, one of the eight autocorrelations falls outside its bootstrapped confidence interval (at lag $k = 3$), but the other seven do not. This seems reasonably representative of the advertised income process.

	Actual average autocorrelation over the experiment's streams	Bootstrapped 95% confidence interval for this average across truly random streams (10,000 samples)	
		lower	upper
$\hat{\rho}_1$	-0.0217	-0.0480	0.0477
$\hat{\rho}_2$	0.0186	-0.0488	0.0487
$\hat{\rho}_3$	-0.0572	-0.0500	0.0493
$\hat{\rho}_4$	0.0427	-0.0526	0.0532
$\hat{\rho}_5$	-0.0139	-0.0526	0.0532
$\hat{\rho}_6$	0.0521	-0.0576	0.0549
$\hat{\rho}_7$	-0.0293	-0.0584	0.0580
$\hat{\rho}_8$	-0.0576	-0.0611	0.0599

Supplementary Material B: Discarded Cognitive Tests

As mentioned in the text, we retained only two of five cognitive tests that were examined in the first two samples. The “Porteus Maze” (Porteus 1965) was one of these: It requires subjects to thread a pencil through mazes of increasing complexity without taking wrong turns. Some believe this test measures both planning ability and impulse control, both of which may be relevant to saving behavior. This test was a marginally significant predictor of saving performance in the first sample, but less significant than the Beta III subtests, so we discarded it and retained the Beta III subtests.

The family of tests known as “Raven Progressive Matrices” (Raven, Raven and Court 1998) are visual pattern induction tests, much like the “matrix reasoning” portion of the Beta III test. The Raven family is widely used in research on cognitive performance; these tests are regarded as measures of fluid intelligence (the ability to learn about and adapt to novel situations or tasks). We first tried Raven’s “Standard Progressive Matrices Plus” or SPM+, which has an extended sensitivity for distinguishing abilities in the upper 20% of the distribution of ability. This was a poor predictor of saving performance in our first sample and many of our subjects gave up on the last third of the problems in this test, suggesting that it was too difficult for most of them. Therefore, we administered the briefer and simpler “Standard Progressive Matrices” or SPM in the second sample. The SPM significantly explained variance in saving performance, but less effectively than the WM span test we also administered in the second sample. Therefore, we abandoned the Raven family of tests after the second sample and retained the WM span test.

Supplementary Material C: The Personality Scales

Subjects may vary in their intrinsic motivation to perform well in experimental tasks, whether or not extrinsic motivators (usually, performance-contingent cash payment) are used. This gives rise to interesting methodological questions examined elsewhere;¹ for our purposes, variation in intrinsic motivation could be a source of variance both in task performance and measured cognitive abilities (perhaps especially the latter, since we do not provide any extrinsic motivation for performance in them). Because of this, our first personality measure is an item-response-based measure of the intrinsic motivation to engage in effortful thought called “need for cognition” (Cacioppo et al. 1996), which is measured in the second, third and fourth samples.

Need for cognition is not cognitive ability. Some studies suggest that need for cognition correlates only modestly, if at all, with cognitive abilities (e.g., Cacioppo, Petty and Morris 1983), but we do not want to confuse cognitive abilities with the intrinsic motivation to engage in cognitively challenging tasks. Therefore, we select twelve of the eighteen items recommended by Cacioppo, Petty and Kao (1984) for the short version of their need for cognition scale to measure this personality characteristic in the second, third and fourth samples.²

Personality psychologists and clinicians have long regarded tendencies toward procrastination and impulsiveness as potentially interesting personality characteristics, and scales

¹ For instance, one may ask whether subjects’ ideas about what it means to “perform well,” and hence their goals, are the same as those of the experimenter, and whether extrinsic incentives are needed to better align their goals with the experimenter’s meaning of performance. This is an old, respectable view (Smith 1982) and many experimental tests of incentive effects are at least partially motivated by it (Camerer and Hogarth 1999). Even when the subject aims to do what the experimenter desires, there may be nontrivial interactions between extrinsic and intrinsic motivations that produce ironic results (Gneezy and Rustichini, 2000; McDaniel and Rutström 2001). Rydval (2003) discusses unanswered questions regarding interactions between cognitive capital, intrinsic motivation and extrinsic motivation in producing observed decisions.

² Examples of the twelve items used are “I would prefer complex to simple problems,” “Thinking is not my idea of fun” and “I find satisfaction in deliberating hard and for long hours.” The response “completely true” would be numerically coded as “4” (high Need for Cognition) for the first and third statements, and as “1” (low Need for Cognition) for the second statement. We deliberately omit items used by Cacioppo, Petty and Kao (1984) that seem to involve other personality characteristics of interest to us, using only twelve of their eighteen total items.

meant to measure these have a long history. At the same time, psychologists and behavioral economists argue that procrastination and impulsiveness are outcomes of fundamental properties of time preferences and/or the manner in which people weigh the present against the future when making choices over time (Ainslie 1975; Thaler and Shefrin 1981; O'Donoghue and Rabin 1999). Procrastination scales are known to correlate negatively with need for cognition (Ferrari 1992), so a significant relationship between need for cognition and saving performance might occur simply because need for cognition is an instrument for procrastination. Therefore, our survey includes twelve items from a contemporary procrastination scale (Tuckman 1991).³

Whiteside and Lynam (2001) review past measures of impulsiveness and argue that tendencies toward impulsive behavior actually arise from the interplay of several distinct personality characteristics. On the basis of a new study examining a very large number of items used to construct existing scales of impulsiveness, Whiteside and Lynam offer a new "impulsiveness inventory" comprised of four subscales they call premeditation, sensation-seeking, perseverance and urgency. In the second sample, we included the items used to measure the first two of these subscales which, according to Whiteside and Lynam, are both highly reliable, nearly orthogonal to one another, and somewhat correlated with the other two measures (urgency and perseverance). Premeditation explained no variance in saving performance in the second sample, but sensation-seeking did (though weakly). But to give these components of impulsiveness a good shot, we continued to measure them in the third and fourth samples, and also added the perseverance and urgency scale items to our survey for good measure.⁴

³ Examples of the twelve procrastination items are "I manage to find an excuse for not doing something," "I put the necessary time into even boring tasks, like studying" and "I am an incurable time waster." The response "completely true" would be numerically coded as "4" (high procrastination tendency) for the first and third statements, and as "1" (low procrastination tendency) for the second statement.

⁴ Examples of the eleven premeditation items are "I like to stop and think things over before I do them," "I don't like to start a project until I know exactly how to proceed" and "I tend to value and follow a rational, 'sensible' approach to things." Examples of the twelve sensation-seeking items are "I'll try anything once," "I quite enjoy taking risks"

Sensation-seeking is potentially interesting for reasons going beyond its contribution to impulsiveness. It is positively correlated with the willingness to take many kinds of risks (Zuckerman 1994) and has been found to explain risk-taking variance in some economics experiments (e.g., Eckel and Wilson 2004). Additionally, sensation-seeking is known to be positively correlated with need for cognition (Olson, Camp and Fuller 1984; Crowley and Hoyer 1989); therefore, including sensation-seeking in multivariate analyses could clarify the meaning of any significant effect of need for cognition in those analyses.

and “I sometimes like doing things that are a bit frightening.” Examples of the ten perseverance items are “I generally like to see things through to the end,” “Unfinished tasks really bother me” and “I am a productive person who always gets the job done.” Examples of the twelve urgency items are “I have trouble controlling my impulses,” “When I am upset I often act without thinking” and “In the heat of an argument, I will often say things that I later regret.”

Supplementary Materials D: Subject Instructions

If you have any questions about operating the computer (using the mouse, and so forth) at any time, contact the proctor immediately, and he or she will gladly answer any questions you may have.

This is a study of economic decision making. If you make good decisions, you can earn a considerable amount of money. The money comes from a grant, so don't worry about earning "too much." We want you to make good decisions and earn as much as you can, so read the instructions carefully and feel completely free to ask the proctor questions! Here is an outline of the decision task; later pages of these instructions will explain these things in greater detail.

1. You will play five separate "ROUNDS" of a "spending and saving game." You will be PAID according to your SCORE in each round; you can earn up to a maximum of \$7.00 in each round, for a maximum possible \$35.00 in all.
2. Each round contains twenty consecutive decision "PERIODS."
3. You will manage spending and saving of "experimental currency units," called "ecus" for short. You buy POINTS by spending ecus in each period; Your total points purchased over an entire round is your "SCORE" for that round.
4. ONLY at the beginning of the FIRST period of a round, you will receive 2 ecus for sure, as "starter savings" for the round.
5. In any period (including the first period), you MAY also receive an INCOME of 6 ecus. BUT it is equally likely that you will receive no income in any period. So you MAY wish to save ecus for future periods, rather than spending them all at once.
6. In each period, any income you receive is added to any SAVINGS you have, to give SAVINGS+INCOME. You then decide how much of this sum to spend on points in that period, and how much of the sum to save for future periods.
7. A table will be updated in each period as you receive income, buy points and decide how much to save. It will show everything that has occurred and everything you have done so far in a round, how many periods remain in a round, and your total points so far in the round.
8. When you finish a round, your total points purchased over that round are your SCORE. This will be compared to the score of a "poor" player and a "good" player. If you do better than the "poor" player, you earn some of the \$7.00 available for that round; to earn the full \$7.00, you have to do as well or better than the "good" player. This will be described in detail soon.
9. After you finish your five rounds of the saving and spending game, you will write ADVICE on how to play the spending and saving game.

Your total points over a round is your score for the round, and that determines your earnings. You purchase points during each round by spending ecus in each period. So, how do you receive ecus so that you can purchase points?

First, remember that you will get starting savings of 2 ecus at the very beginning of any round.

Second, you may receive 6 ecus of income in any period (including the first period when you also receive starting savings). However, whether you receive income or not is random. It is as if the computer flips a coin at the beginning of each period and only gives you 6 ecus when the coin comes up heads; if it comes up tails, the computer gives you zero ecus.

It is very important to understand that income is truly random. The computer will not “react” to any decisions you make. In fact, the computer is not really flipping coins at all. It simply reads a randomly determined sequence of income numbers (a sequence of 6 and 0) from a file on its hard drive. We actually flipped the coins long ago to make a lot of income sequences, and put those sequences in a file on the computer’s hard drive. The computer simply reads one of those sequences.

We are telling you this so that you don’t worry about the computer “punishing” or “rewarding” you for doing something “wrong” or “right.” The only thing the computer does with your decisions is record them in a file. It does not “look at” your decisions and then “decide” what to do next. Put another way, the computer is not “intelligent” and you are not “playing a game against it.” Put still a different way, your decisions so far in a round will have absolutely no effect on the likelihood of receiving income later in that round. Income is truly random.

The “Point purchasing table” below shows your opportunities for purchasing points by spending ecus in any period. This table will always be present on your screen when you are deciding how many ecus to spend in a period.

ecus you spend	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	≥16
total points purchased	0	26	51	65	77	89	101	104	107	110	111	112	113	114	115	116	116
incremental points purchased	0	26	25	14	12	12	12	3	3	3	1	1	1	1	1	1	0

Notice the following things about this table, and what it means to you:

1. The first row shows total ecus you might decide to spend in a period, from zero up to “16 or more” ecus. Notice that you waste ecus if you spend more than 15 ecus in a period, since you get no extra points by doing so.
2. The second row shows the total points you would purchase by spending the total ecus shown in the first row. Notice that the total points you purchase increases as you spend more ecus (up to 15 ecus).
3. The third row shows “extra” or “incremental” ecus you purchase as a result of spending each “extra” or “incremental” ecu in any period. Notice that this decreases as you spend more ecus (there will be more about this on the next screen).
4. Your ability to buy points (according to this table) is “refreshed” in every period. If for instance you spent 5 ecus in some period, that does NOT affect the way you use the table in the next period. In every period, the first ecu you decided to spend buys 26 points; the second ecu you decide to spend gives an extra 25 points for a total of 51 points for spending 2 ecus, and so on. How you use the table doesn’t depend on how many ecus you spent, or how many points you bought, in previous periods.

In summary, you have the opportunity to buy from zero to 116 points by spending from zero to 15 ecus in any period. This opportunity does not depend on how many points you purchased in past periods. Of course, you cannot take advantage of that opportunity unless you have ecus available, either from savings or any income you may (or may not) receive in a period.

It is helpful to see how many extra points you buy as you spend extra ecus in each period. Consider the table below. It is exactly the same as the table you saw on the previous page, except that the third row is empty.

You now will fill in the third row, according to the following instructions:

- If you spend 1 ecu you buy 26 points. Thus by spending 1 more ecu as compared to 0 ecus spent, you buy 26 more points. So, you should enter the number 26 in the space of the third row below 1.
- If you spend 2 ecus you buy 51 points. Thus the extra points purchased by spending 2 rather than 1 is $51 - 26 = 25$. So, you should enter 25 in the space below 2.
- Similarly, spending 3 ecus buys 65 points, while spending 2 ecus buys 51. So the extra points purchased by spending 3 rather than 2 is $65 - 51 = 14$. So you should enter 14 in the 'incremental points purchased' below 3.

Thus, each open space in the 'incremental points purchased' row is the difference between the 'total points purchased' shown above each open space and the 'total points purchased' shown for spending one less ecu.

Now, please fill in the rest of the open spaces.

If you have any trouble, please contact the experimenter and he or she will assist you.

ecus you spend	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	≥ 16
total points purchased	0	26	51	65	77	89	101	104	107	110	111	112	113	114	115	116	116
incremental points purchased	0																

[The computer tests the responses for mistakes. If any are detected, the software displays a "Please contact the experimenter to proceed" pop-up. The software locks up as well, requiring a password to proceed. So any error must be handled between the experimenter and the subject before proceeding.]

Good job! Now that you have completed the exercise, here is the complete point purchase table again. Once more, we want to point out one thing about it, which you should now be able to see clearly for yourself.

ecus you spend	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	≥16
total points purchased	0	26	51	65	77	89	101	104	107	110	111	112	113	114	115	116	116
incremental points purchased	0	26	25	14	12	12	12	3	3	3	1	1	1	1	1	1	0

Examine the “incremental points” row of the table—the one you just completed yourself in the exercise. Notice again that, as more and more extra ecus are spent in any one period, they buy fewer and fewer extra points in that period. To illustrate:

- For instance, the first ecu spent in any period would buy a relatively large number of points—26 points in fact.
- The fifth extra ecu spent in that same period would buy less than half as many extra points—just 12 extra, in fact.
- Finally, the tenth extra ecu spent in that same period would buy only 1 extra point.

Do you understand? If you do not understand, please contact the proctor and he or she will be very happy to help explain this to you. Remember, it is your total point purchases across all periods of a round that will determine how much of an available \$7.00 you can earn for that round. Full understanding of the point purchase table is quite helpful for doing well in the saving and spending game.

How the score in a round of the spending and saving game earns money.

Your chances to purchase points are partly determined by luck: You might get 6 ecus of income more or less often than what is expected on average, since income sequences are truly random. We determine your earnings in a way that neither "rewards" nor "punishes" you for good or bad luck of this sort. Instead, you are rewarded for doing **RELATIVELY WELL** with what you **HAPPEN TO GET**.

In each round, you will be "competing" against a "good" player and a "poor" player. These are not real players but "strategies" for playing the game. Both strategies are in the same position you are, as far as what they know about your income sequence and when they learn it. That is, these strategies do not get to "peek ahead" at future parts of the income sequence or otherwise "cheat" in any way.

The **GOOD PLAYER** has an excellent strategy. Sometimes participants do better than the "good" player does, but this is rare and, strictly speaking, it only happens by luck. A file in the computer contains the total points earned by the good player's strategy when it is applied to the income sequence you actually get in a round. We call this the **GOOD SCORE** for that round.

The **POOR PLAYER** has a poor strategy. It is not the worst imaginable strategy: It is possible to get a lower score than this strategy, but this is also rare. Again, a file in the computer contains the total points earned by the poor player's strategy when applied to the income sequence you actually get in a round. We call this the **POOR SCORE** for the round.

Basically, you earn at least some money by "coming in second:" that is, if your score exceeds the poor score, you earn at least some money. Additionally, the closer your score is to the good score, the more you earn. And if you happen to do as well or better than the good score, you earn the entire \$7.00 available for the round. To summarize, at the end of a round:

1. If **YOUR SCORE** is less than or equal to the **POOR SCORE**, then **YOU EARNING NOTHING**.
2. If **YOUR SCORE** is greater than or equal to the **GOOD SCORE**, then **YOU EARN \$7.00**.
3. If **YOUR SCORE** is between the **POOR SCORE** and the **GOOD SCORE** (this is most likely), then you earn a **PERCENTAGE** of \$7.00, determined as follows:

$$\text{PERCENTAGE} = 100 * (\text{YOUR SCORE} - \text{POOR SCORE}) / (\text{GOOD SCORE} - \text{POOR SCORE}).$$

Notice that this percentage increases as your score grows, and will be 100% if your score equals the good score. In other words, the closer you are to the good score (and the further above the poor score you are), the higher will be your earnings.

Now, let's look at three examples. These will be followed by an exercise to check your understanding.

How the score in a round of the spending and saving game earns money.

Example A.

Suppose that Your SCORE is 1200 points, the POOR SCORE is 600 points and the GOOD SCORE is 1800 points in some round. Notice that YOUR SCORE is halfway between the POOR and GOOD scores. It might not surprise you, then, that in this example, you will earn fifty percent of the available \$7.00. That is in fact right. Let's apply the formula:

$$\text{PERCENTAGE OF \$7.00} = 100 \cdot (\text{YOUR SCORE} - \text{POOR SCORE}) / (\text{GOOD SCORE} - \text{POOR SCORE})$$

$$(\text{YOUR SCORE} - \text{POOR SCORE}) = (1200 - 600) = 600; \text{ and,}$$

$$(\text{GOOD SCORE} - \text{POOR SCORE}) = (1800 - 600) = 1200; \text{ so then,}$$

$$\text{PERCENTAGE OF \$7.00} = 100 \cdot (1200 - 600) / (1800 - 600) = 100 \cdot (600/1200) = 100 \cdot (1/2) = 50\%$$

How the score in a round of the spending and saving game earns money.

Example B.

Suppose that Your SCORE is 1400 points, the POOR SCORE is 1200 points and the GOOD SCORE is 1800 points in some round. Notice that YOUR SCORE in this example is only one-third of the distance from the POOR SCORE to GOOD SCORE. It might not surprise you, then, that in this example, you will earn a third (or thirty-three percent) of the available \$7.00. That is in fact right. Let's apply the formula:

$$\text{PERCENTAGE OF } \$7.00 = 100 \cdot (\text{YOUR SCORE} - \text{POOR SCORE}) / (\text{GOOD SCORE} - \text{POOR SCORE})$$

$$(\text{YOUR SCORE} - \text{POOR SCORE}) = (1400 - 1200) = 200; \text{ and,}$$

$$(\text{GOOD SCORE} - \text{POOR SCORE}) = (1800 - 1200) = 600; \text{ so then,}$$

$$\text{PERCENTAGE OF } \$7.00 = 100 \cdot (1400 - 1200) / (1800 - 1200) = 100 \cdot (200/600) = 100 \cdot (1/3) = 33\%$$

How the score in a round of the spending and saving game earns money.

Example C.

Suppose that Your SCORE is 1350 points, the POOR SCORE is 400 points and the GOOD SCORE is 1400 points in some round. Notice that YOUR SCORE is very close to the GOOD SCORE (nineteen twentieths of the distance from the POOR SCORE to GOOD SCORE to be exact). It might not surprise you, then, that in this example, you will earn ninety-five percent of the available \$7.00. That is in fact right. Let's apply the formula:

$$\text{PERCENTAGE OF \$7.00} = 100 \cdot (\text{YOUR SCORE} - \text{POOR SCORE}) / (\text{GOOD SCORE} - \text{POOR SCORE})$$

$$(\text{YOUR SCORE} - \text{POOR SCORE}) = (1350 - 400) = 950; \text{ and,}$$

$$(\text{GOOD SCORE} - \text{POOR SCORE}) = (1400 - 400) = 1000; \text{ so then,}$$

$$\text{PERCENTAGE OF \$7.00} = 100 \cdot (1350 - 400) / (1400 - 400) = 100 \cdot (950/1000) = 100 \cdot (95/100) = 95\%$$

We will sometimes call this percentage, calculated as above, the PERCENT SCORE for a round. This percent score can be thought of as a measure of how well a person did in a round of the spending and saving game that doesn't depend so much on whether that person got a "lucky" or "unlucky" income sequence. This is why we use the percent score to determine your payment for a round of the spending and saving game.

You will not know what the GOOD SCORE and POOR SCORE are while you play a round. When you finish each round, the computer will display YOUR SCORE, the POOR SCORE and the GOOD SCORE, and will calculate the percent score for you and show how much of the available \$7.00 you earned for that round.

How the score in a round of the spending and saving game earns money.

Remember, after each round ends, the computer screen will show you YOUR SCORE, POOR SCORE, GOOD SCORE and your resulting PERCENTAGE OF \$7.00 for that round.

Let's perform one last exercise to cement your understanding of the scoring rules.

Here is the scenario:

YOUR SCORE for the round was 900 points.

The POOR SCORE for the round was 620 points.

The GOOD SCORE for the round was 1020 points.

Now, given those three numbers, and the calculator beside you, please calculate your PERCENTAGE OF 7.00 which you would earn in such a round. Here is the formula again for your convenience:

$$\text{PERCENTAGE OF } \$7.00 = 100 * (\text{YOUR SCORE} - \text{POOR SCORE}) / (\text{GOOD SCORE} - \text{POOR SCORE})$$

Percentage of \$7.00:

ENTER

Press 'Continue' after you have entered the value.

[The computer tests the response for mistakes. If any are detected, the software displays a "Please contact the experimenter to proceed" pop-up. The software locks up as well, requiring a password to proceed. So any error must be handled between the experimenter and the subject before proceeding.]

Just a few reminders before you begin:

1. You begin each round with 2 ecus of starting savings.
2. You receive an income of either 6 or zero ecus at the beginning of every period. Each is equally likely in any period, like a coin flip.
3. The total of your savings from the last period and whatever income you receive in a current period is the ecus you have available for spending and saving.
4. You spend ecus in each period to buy points. The sum of the points you have bought in all twenty periods of a round is your SCORE, and this determines your percentage of an available \$7.00 prize for that round. The more points you earn over each round, the higher your share of the available \$7.00 for that round.
5. Although you obviously carry saved ecus from a current period to the next period WITHIN any one round, you cannot carry saved ecus BETWEEN different rounds. Any ecus you have remaining at the end of the 20th and final period of each round are simply lost. You should always spend all of your remaining ecus in the 20th period of any round.

Please contact the experimenter so that you may begin playing the game.

Supplemental Materials E: References

Ainslie, G. 1975. Specious reward: A behavioral theory of impulsiveness and impulse control. Psychological Bulletin 82:463-496.

Cacioppo, J. T., R. E. Petty and K. J. Morris, K. J. 1983. Effects of need for cognition on message evaluation, recall, and persuasion. Journal of Personality and Social Psychology 45:805-818.

Cacioppo, John T., R. E. Petty and C. F. Kao. 1984. The efficient assessment of need for cognition. Journal of Personality Assessment 48:306-307.

Cacioppo, John T., R. E. Petty, Jeffrey A. Feinstein, and W. Blair G. Jarvis. 1996. Dispositional differences in cognitive motivation: the life and times of individuals varying in need for cognition. Psychological Bulletin 119(2):197-253.

Camerer, Colin F. and Robin M. Hogarth. 1999. The effects of financial incentives in experiments: A review and capital-labor-production framework. Journal of Risk and Uncertainty 19(1-3):7-42.

Crowley, A. E. and W. D. Hoyer. 1989. The relationship between need for cognition and other individual difference variables: A two-dimensional framework. Advances in Consumer Research 16:37-43.

Eckel, Catherine and Rick Wilson. 2004. Is trust a risky decision? Journal of Economic Behavior and Organization 55(4):447-65.

Ferrari, J. R. 1992. Psychometric validation of two procrastination inventories for adults: Arousal and avoidance measures. Journal of Psychopathology and Behavior Assessment 14:97-110.

Gneezy, Uri and Aldo Rustichini. 2000. Pay enough or don't pay at all. Quarterly Journal of Economics 115:791-810.

Marriott, F. H. C. and J. A. Pope. 1954. Bias in the estimation of autocorrelations. Biometrika 41:390-402.

McDaniel, Tanga M. and E. Elisabet Rutström. 2001. Decision making costs and problem solving performance. Experimental Economics 4:145-61.

O'Donoghue, Ted and Matthew Rabin. 1999. Doing it now or later. American Economic Review 89:103-124.

Olson, K., C. Camp and D. Fuller. 1984. Curiosity and need for cognition. Psychological Reports 54:71-74.

Porteus, Stanley D. 1965. Porteus Maze Tests: Fifty Years' Application. Palo Alto: Pacific Book Publishers.

Raven, J., Raven, J. C., & Court, J. H. 1998. Manual for Raven's Progressive Matrices and Vocabulary Scales. San Antonio, TX: The Psychological Corporation.

Rydval, Ondrej. 2003. The impact of financial incentives on task performance: The Role of cognitive abilities and intrinsic motivation. Prague, Czech Republic: CERGE-EI Discussion Paper 112.

Smith, Vernon L. 1982. Microeconomic systems as an experimental science. American Economic Review 72:923-55.

Thaler, R. H. and H. M. Shefrin. 1981. An economic theory of self-control. Journal of Political Economy 89:392-406.

Tuckman, B. W. 1991. The development and concurrent validity of the procrastination scale. Educational and Psychological Measurement 51:473-480.

Whiteside, Stephen P. and Donald R. Lynam. 2001. The five factor model and impulsivity: Using a structural model of personality to understand impulsivity. Personality and Individual Differences 30:669-689.

Zuckerman, M. 1994. Behavioural Expressions and Biosocial Bases of Sensation Seeking. Cambridge: Cambridge University Press.