Mathematics self-confidence and the “prepayment effect” in riskless choices*

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Abstract

We replicate and extend a simple riskless choice experiment reported recently by Hochman et al. (2014) as supporting loss aversion for money. Participants select from among sets of standard playing cards, with values defined by a simple formula. In some sessions, participants are given a prepayment associated with some of the cards, which need not be the earnings-maximizing ones. We replicate the results of Hochman et al., but find the effect of prepayment is significantly modulated by the instructions; instructions which more explicitly link payments and choices eliminate the effect. Participants who have been in many economics experiments before do not choose differently than those who are relative novices. However, we find that a self-reported measure of confidence in mathematics is a strong predictor of maximization rates. These results are more consistent with a preference for defaults when evaluating alternatives requires cognitive effort.

JEL Classifications: C91; D83

Keywords: loss aversion; prepayment; replication; mathematics self-confidence; lab rats.

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1 Introduction

A stylized fact of behavioural economics is that individuals dislike losses more than they like equivalent gains. The endowment effect (e.g. Kahneman et al., 1990), status quo bias (e.g. Kahneman et al., 1991), and the sunk cost fallacy (Thaler, 1999) can be attributed loss aversion. The endowment effect was first observed by Kahneman et al. (1990), who observed that participants were reluctant to sell a mug given to them by the experimenter at the beginning of the experiment.

Evidence is mixed on whether the endowment effect extends to money, as opposed to other goods.[1] Kahneman et al. did not find evidence of the effect when they used tokens instead of mugs. In contrast, Hochman et al. (2014) (henceforth HAA) present an experiment in which, when, individuals are prepaid a certain amount of money they are unwilling to give it up even when the amount they could earn is greater. HAA interpret this result as supporting loss aversion in money, in a very strong form, in that the choice task involves no objective risk. HAA label this the "prepayment effect," and conduct a series of experiments using different tasks to support their interpretation.

We study in more detail the first of the experimental environments reported in HAA. There are seven tasks. In each task, participants are presented with a tableau of four standard playing cards, from which they must choose one. To each card is attached a monetary value, which depends on both the suit and the rank of the card. Their key manipulation is the timing of payments. In the prepayment treatment, participants receive an up-front payment corresponding to the value of the 5 cards which are spades in the tableaux.

We replicate the basic result of HAA using the original instructions, finding a qualitatively similar effect when using the prepayment protocol. We then extend the analysis in two directions. We first consider whether individual characteristics can explain non-maximizing behavior. We find that confidence in mathematical abilities is a strong predictor. We estimate the magnitude of the effect of mathematical self-confidence on maximizing choice frequencies to be as large as or larger than the effect of the HAA prepayment treatment. In contrast, experience in experiments does not have a significant effect. We also consider an alternative presentation of the instructions, which is designed to strengthen the link between the prepayment and choices; we find that the prepayment effect disappears under the re-explained task. Maximization rates therefore depend sensitively on a number of factors, both in the experimental protocol and the characteristics of individual participants.

The HAA task is a typical economic decision-making experiment. The task is simple, but artificial; it is not based directly on a game or other interaction participants experience outside the laboratory. The artificial environment, combined with the extra "theatre" of prepayment, could

[1] For a lengthier discussion see Hochman et al. (2014).

generate a treatment effect among participants unfamiliar with laboratory experiments. Experience has been shown to have an effect in, for example, public goods games (e.g. Conte et al., 2014) and allocation games (Matthey and Regner, 2013). Participants with prior experience also have self-selected into coming back to the laboratory. Abeler and Nosenzo (2014) have studied self-selection into participant pools and report that interest in monetary rewards appears strongly to drive participation. Both channels would suggest experienced participants would be more likely to maximize earnings.

The decision tasks and games which constitute a substantial fraction of the experimental economic literature frequently require participants to undertake some sort of mathematical computations. It is not uncommon for formulas to appear in participant instructions, or on-screen in the choice interface. It has been noted (Pajares and Miller, 1994) that many adults dislike and avoid math, even those who are competent at calculation. This has been ascribed to a combination of math anxiety and low confidence (self-efficacy). Ashcraft (2002) observes effects of math anxiety even on simple whole-number arithmetic problems. In HAA the prepayment effect only appeared when the values of cards were not presented on-screen, requiring participants to do mental arithmetic to determine the earnings-maximizing card.

This paper is organised as follows. Section 2 presents the experimental design and hypotheses. Our results are presented in Section 3. Section 4 contains a concluding discussion.

2 Experimental Design and Hypotheses

Our experiment replicates and extends the design of HAA. Participants view a series of tableaux consisting of four playing cards, from which one must be chosen. Cards are assigned values according to the rank of the card, and the suit. For cards which are spades, the value of the card is 25p times the rank of the card. There are 5 spades cards in the deck, from ace to five. For all other suits, the value is 10p times the rank of the card.[2] Aces have rank one, so the ace of spades is worth 25p and other aces are worth 10p. The rank of jacks, queens, and kings are 11, 12, and 13, respectively.

There are a total of seven sets of cards, which are presented in the same order for each participant.[3] Choices in all treatments are made without feedback.[4] The baseline condition, **Base**, is a standard post-payment setup: participants make all seven choices, then see a summary screen which recaps the decisions and tabulates their earnings. They are then dismissed one-by-one to the payment station and receive their payments in private before departing the laboratory. Treatment

[2]HAA value the cards at 25 cents and 10 cents times the rank of the card, respectively. At prevailing exchange rates at the time of our experiment, this means our stakes were 50 to 60 percent higher than HAA.

[3]The seven sets of cards are provided in Appendix C.

[4]See Appendix B for screenshots of the decision interface.

Σ£ implements HAA's prepayment treatment. Each participant is given £3.75 in cash at their station prior to making their choices. Participants are told this amount is the sum value of the five spades cards which will appear among the seven sets. After all seven choices are made, the summary screen appears; this screen tabulates separately the values of the cards chosen, as well as the value of any spade cards not chosen. Participants are then dismissed one-by-one to the payment station to settle payments in private. We carefully kept to the prepayment framing, in that, for any spades not chosen, we took back coins from the participant, and then gave them different coins for the cards actually chosen; that is, we did not integrate the two payments into a net payment.[5]

Hypothesis 1 *Participants will choose the earnings-maximizing card more often in **Base** than **Σ£**, consistent with the data reported by HAA.*

HAA attribute the difference in maximization rate between **Base** and **Σ£** to prepayment. There are (at least) two other differences between the treatments. In **Σ£**, in order to explain the significance of the £3.75 received in advance of decisions, the instructions included the following language;

> We have placed the cards ace through five of spades in the deck randomly ... The value of the five spades (ace through five) equals a total of three pounds and seventy-five cents: one plus two plus three plus four plus five is fifteen times 25p i.e. three pounds and seventy five pence. We will give you this amount up front.

No parallel language exists in **Base**; the total value of spades is not pointed out to participants explicitly. To identify whether the mere mention of the value of spades might call attention to spades, or otherwise create a reference point, we conduct treatment **Σ**, in which we retain postpayment, but include the language mentioning the total value of spades.

Hypothesis 2 *Participants will maximize less frequently in **Σ** than in **Base**; mentioning the value of spades will result in fewer maximizing choices.*

A second difference between **Base** and **Σ£** is the length and complexity of the instructions. Describing the prepayment protocol necessarily makes instructions longer, as there are more steps to explain to participants. To check on the robustness of the prepayment effect to alternate but equivalent ways of explaining the mechanism, we replace some of the text from the HAA originals. Specifically, at the end of their instructions, HAA state

> At the end of the game, if you have not selected all spades, we will pay you for the cards you have selected, and you will refund us money for the spades you have not selected.

[5] As all decisions were made by this point in the session, this bit of theatre could not affect results; nevertheless we wanted to be careful to maintain the framing throughout the session.

	Information on total value	Advance payment	Alternate instructions	Replicates HAA?
Base	No	No	—	**Yes**
Σ	**Yes**	No	—	No
Σ**£**	**Yes**	**Yes**	No	**Yes**
Σ**£**$\mathcal{I}$	**Yes**	**Yes**	**Yes**	No

Table 1: Summary of experimental design

In designing alternative phrasing, HAA report on results from follow-on experiments which they interpret as indicating that an explicit linkage between amounts of money and choices of particular cards is important for the effect. In our treatment Σ**£**$\mathcal{I}$, we therefore replace the above sentence with the following text designed to highlight that linkage:

> For each set of four playing cards, there are three possible scenarios:
>
> - There is not a spade among the four cards. Then, at the end of the session, you will receive a payment for that set equal to the value of the card you select.
> - There is a spade among the four cards, but you select a different card. Then, at the end of the session, you will pay us back from your up front payment an amount equal to the value of the spade, and you will receive a payment from us equal to the value of the card you did select.
> - There is a spade among the four cards, and you select the spade. Then, because you have already received payment for that spade card in your up front payment, you will not pay us back anything for that set, nor will you receive any additional payment for that set.

Hypothesis 3 *The treatment effect is robust to instructions; the maximization rates will be comparable in* Σ**£** *and* Σ**£**$\mathcal{I}$.

We are also interested in how the prepayment effect is distributed across the population. Is it that all participants are more likely to choose non-maximizing cards when a prepayment protocol is in effect, or are some segments of the population more likely to be influenced by the treatment?

To identify the possible role of experience with experiments, we conducted a stratified recruiting strategy. We defined "experienced" participants as those who had participated at least 10 times previously in experimental sessions, and "inexperienced" as those who had participated no more than 5 times. We recruited approximately equal numbers of participants from these two subpopulations. Those who had participanted 6 to 9 times were not recruited, to give a more clear distinction between the groups.

Hypothesis 4 *Participants with greater experience in experiments will have higher maximization rates in prepayment treatments.*

Within a standard battery of demographics questions asked at the end of the session, after all choices were made, we included a question asking participants, "Do you consider yourself good at mathematics?"[6] Such self-reports of mathematical skill have been used as a behavioral indicator in economics and psychology (Ashcraft and Kirk, 2001; Ashcraft and Ridley, 2005; Marsh et al., 2012), and it has been argued that mathematical anxiety could shape individuals' behaviors when facing challenging circumstances (Bandura, 1977).

Hypothesis 5 *Participants who report confidence in their ability to carry out mathematical calculations will have higher maximization rates in prepayment treatments.*

The experiments were conducted in the laboratory of the Centre for Behavioural and Experimental Social Science (CBESS) at the University of East Anglia. Participants were recruited from the lab's standard subject pool, which is managed using the hRoot system (Bock et al., 2012). The choice task was computerised using zTree (Fischbacher, 2007). Sessions took place between November 2014 and October 2015. Sessions were brief, lasting around 20 minutes for the postpayment treatments **Base** and $\boldsymbol{\Sigma}$ and 30 minutes for the prepayment treatments $\boldsymbol{\Sigma\pounds}$ and $\boldsymbol{\Sigma\pounds}\mathcal{I}$, including instructions and final payment.

3 Results

We report on 206 participants who participated in the task. The results in HAA focus on the rate of maximization by participants in the two "low-spades" trials, in which a spade card is present but is not the earnings-maximizing choice. We report this measure for each treatment in Table 2, where we also present breakouts of the low-spade maximization rate overall for each demographic characteristic, as well as the proportions reported by HAA for comparison.

As the breakouts by demographic are averaged over all treatments, the maximization rates presented are only indicative. The breakdown of males (44.2%) and females[7] is comparable to our participant pool and the University's student body as a whole. Among the 94 highly-experienced participants, 44 (46.8%) are male, while among the 112 less-experienced participants, 47 (43.8%) are male; the difference in composition is not statistically significant (Fisher's exact test $p = 0.667$) and again mirrors the participant pool. A total of 106 (51.5%) considered themselves good at mathematics, with 86 (41.7%) saying they were not; 14 preferred not to say. Self-reported mathematics confidence is independent of whether the participant was among the highly-experienced cohort;

[6] This was implemented as a radio box, with options for Yes, No, or "Prefer not to say" as the possible responses.
[7] One participant declined to disclose their gender.

Subsample	Value	N	Low-spade maximization rate
HAA results	**Base**	61	95.1%
HAA results	**Σ£**	50	66.0%
Our sample, all participants		206	70.6%
Treatment	**Base**	49	79.6%
Treatment	**Σ**	49	73.5%
Treatment	**Σ£**	54	60.2%
Treatment	**Σ£**$\mathcal{I}$	54	70.4%
Math-confident	No	86	59.3%
Math-confident	Yes	106	78.8%
Math-confident	Decline to say	14	78.6%
Experience	Fewer than 6 sessions	112	70.1%
Experience	More than 9 sessions	94	71.3%
Gender	Female	114	66.2%
Gender	Male	91	76.4%
Native English speaker	No	73	66.4%
Native English speaker	Yes	130	74.2%
Degree course	Not economics	181	68.0%
Degree course	Economcs	25	90.0%

Table 2: Low-spade maximization rates, disaggregated by treatments and demographic characteristics. The first two rows report the comparable results from HAA. Not all demographics breakouts of our data add up to $N = 206$ due to blank responses.

Fisher's exact test does not reject the null hypothesis that the responses to the math confidence question have the same distribution in both groups (p-value 0.904). However, there is a relationship between gender and reported math confidence: 61.5% of males (56 in total) answered in the affirmative as opposed to 43.9% of females (50 in total).[8]

Aggregate maximization rates do not directly inform us further about the distribution of choices. It could be the case, for example, that the result is driven by some participants failing to maximize on either low-spades trial. A more detailed view of the data is offered in Table 3. For each participant, we tabulate the number of maximizing choices in high-spades and low-spades trials, respectively. From this analysis, we see that the number of participants maximizing exactly one on low-spades trials falls between the number maximizing both times and neither time; that is, the distribution of low-spades maximization is not bimodal.[9]

[8]Fisher's exact test rejects the null hypothesis of independence between gender and reported math level (p-value 0.008).

[9]We also provide, as Appendix C, a more detailed summary of distributions of choices broken down by each of the

# Maximizing choices on high spades	0			1			2			
# Maximizing choices on low spades	0	1	2	0	1	2	0	1	2	Total
Base	0	0	0	2	2	3	3	8	31	49
Base (HAA)	0	0	0	0	1	0	0	5	55	61
Σ	1	1	1	3	4	6	1	11	21	49
Σ£	0	0	1	2	2	2	10	17	20	54
Σ£ (HAA)	0	0	0	0	0	0	10	14	26	50
Σ£$\mathcal{I}$	0	1	2	3	2	4	7	9	26	54

Table 3: Distribution of maximizing choices on high spades and low spades trials. Each observation is one participant.

Result 1 *We replicate HAA's result that the maximization rate on low-spades trials is lower in* **Σ£** *than in* ***Base****, although we find a substantially lower magnitude for the effect.*

Support. HAA support their result by considering low-spades trials, and reporting the percentage of choices in those trials in which the participant chose the earnings-maximizing card. We find a maximization rate of 79.6% in **Base**, which decreases to 60.2% in **Σ£**. We reject the null hypothesis that these rates are the same (using the Mann-Whitney test with the individual participant as the unit of observation; $p = 0.007$). Using the full distribution of maximizing choices by participant from Table 3, we can also reject the null hypothesis of equal distributions (using Fisher's exact test, $p = 0.072$).

The overall maximization rates on low-spades trials in **Σ£** are similar in our data (60.2%) and HAA's (66.0%). Our results differ substantially, however, in **Base**, where HAA report a 95.1% maximization rate as opposed to our 79.6%. Table 3 also demonstrates that our high-spades maximization rates, while high, are still lower than HAA's; in fact, only one participant in HAA failed to maximize in both high-spades trials. These suggest that the very high maximization rates reported for high-spades trials, and for low-spades trials in **Base** may not travel to broader subject pools, and as a result the magnitude of the treatment effect of **Σ£** relative to **Base** may be overstated in HAA's data. □

To test the remaining hypotheses, we report an ordered probit regression. For each participant, the dependent variable is the number of low-spades trials on which the participant chose the earnings-maximizing card. We include dummies for each of the three treatment characteristics **£**, $\mathcal{I}$, and **Σ**. We also include dummy variables for each of the five demographics: the response to

seven sets.

Variable	(1)	(2)	(3)	(4)
£	-0.394	-0.455**	-0.458**	-0.504**
	(0.228)	(0.231)	(0.232)	(0.237)
$\mathcal{I}$	0.317	0.588**	0.590**	0.739***
	(0.223)	(0.238)	(0.238)	(0.248)
$\boldsymbol{\Sigma}$	-0.239	-0.267	-0.264	-0.231
	(0.246)	(0.250)	(0.250)	(0.254)
Math-confident		0.729***	0.728***	0.615***
		(0.181)	(0.181)	(0.187)
Experienced			0.035	0.046
			(0.169)	(0.174)
Male				0.293*
				(0.179)
Native speaker				0.277
				(0.179)
Economics student				0.777*
				(0.338)
Constant cut 1	-1.346	-0.969	-0.951	-1.374
Constant cut 2	-0.482	-0.057	-0.039	-0.380
Observations	206	206	206	206

Table 4: Ordered probit regression for determinants of maximization behavior on low-spades trials. The unit of observation is the individual participant; the dependent variable is the number of low-spades trials on which that participant chose the earnings-maximizing card. Standard errors reported in parentheses. * denotes significantly different from zero at 10%; ** at 5%; *** at 1%.

the mathematics self-confidence question (Math-confident $= 1$), whether they were in the subsample recruited from highly-experienced participants (Experienced $= 1$), whether the participant is male (Male $= 1$), whether the participant is a native speaker of English (Native speaker $= 1$), and whether the participants is a student in the School of Economics (Economics $= 1$).[10] The parameter estimates are reported in Table 4. To aid in interpreting the results of the regression, in Table 5 we report the predicted proportion of earnings-maximizing choices in low-spades trials, for each treatment, depending on the values of Male and Math-confident.

Result 2 *The mere mention of the total value of spades does not significantly affect behavior in postpayment conditions.*

Support. In all specifications, the estimated coefficient on the dummy variable $\boldsymbol{\Sigma}$ is not statistically different from zero. This is consistent with the comparison between the overall low-spade

[10]We coded missing values for demographics as a separate level; we omit the parameter estimates here.

	Math-confident = 1		Math-confident = 0	
	Male	Female	Male	Female
Base	89.4%	82.5%	71.4%	62.2%
$\mathbf{\Sigma}$	85.2%	76.8%	64.6%	54.5%
$\mathbf{\Sigma}$**£**	72.9%	61.7%	48.2%	37.4%
$\mathbf{\Sigma}$**£**$\mathcal{I}$	89.5%	82.6%	71.5%	62.3%

Table 5: Predicted low-spade maximization rate, by gender and reported mathematics self-confidence.

maximization rate of 73.5% in treatment $\mathbf{\Sigma}$ and the 79.6% observed under **Base**. □

Result 3 *The effect of alternate instructions is significant. The alternate instructions emphasizing the link between each set and payment lead to higher maximization rates.*

Support. The low-spade maximization rate in $\mathbf{\Sigma}$**£**$\mathcal{I}$ is 70.4%, as compared to 60.2% in $\mathbf{\Sigma}$**£**. In the regression, the coefficient on the instructions dummy variable $\mathcal{I}$ is positive, and significant in all specifications using demographic controls. □

Result 4 *Participants with extensive prior experience in experiments do not choose earnings-maximizing cards at a different rate than those with less experience.*

Support. The coefficient on Experienced in Table 4, while positive, is small in magnitude and not statistically significant. This is consistent with the aggregate maximization rates in Table 2, showing very experienced participants having a maximization rate of 71.3% as compared to 70.1% for less experienced ones. □

Result 5 *Reported mathematics confidence is a strong predictor of the likelihood to choose earnings-maximizing cards in low-spades trials.*

Support. The coefficient on Math-confident in Table 4 is positive and significant at the 1% level. The magnitude is large; as can be seen from the predictions in Table 5, participants who indicated confidence in their mathematics ability choose earnings-maximizing cards between roughly 10% to 20% more often, mirroring the aggregate advantage observed by math-comfortable participants as reported in Table 2. The response to this question alone can account for about 50% of the non-earnings-maximizing card choices in low-spades trials. □

We close by remarking briefly on the other demographics. We did not have hypotheses in mind regarding these, so these observations are post-hoc. Males do choose earnings-maximizing cards more often than females, even when controlling for mathematics self-confidence.[11] Being a native English speaker does not have a statistically significant effect.[12] Finally, we observe (with some admitted pride!) that students in economics maximize earnings significantly more often.

4 Conclusion

HAA reported a striking result: in this simple choice task with no objective risk, participants sometimes failed to choose earnings-maximizing cards when, and only when, they received a prepayment based on a non-earnings-maximizing choice. In our experiment, with a different participant pool and somewhat higher incentives, but using the original instructions, we have reproduced their treatment effect, albeit with a smaller magnitude.

Using subsequent experimental treatments, HAA argued that an explicit linkage between payment amounts and given choices is required to activate this effect. Based on this, we considered an alternative wording of the instructions, in which that linkage was made even more salient than in the original. We find that the more explicit wording reduced the treatment effect; in fact, the maximization rate on low-spades trials is comparable between postpayment and prepayment treatments when the alternate instructions are used.

We also find evidence that the maximization rates vary significantly by the characteristics of the participant. The design of this task does not easily permit the picking apart of different behavioral "types," and as such it is not possible to ask whether the lower maximization rates observed in their prepayment experiment are attributable to an across-the-board change in performance for all people, or whether the effect is due to large behavioral changes in a subset of the population. We find that reported mathematics self-confidence is a strong predictor of maximization rates. The arithmetic required for this experimental task is used in everyday economic life, and is well within the capabilities of any undergraduate student, so one would anticipate it should pose no barrier to earnings maximization. Nevertheless, we find the answer to this question to be a strong predictor of maximization rates. Our results suggest in favor of the type-based explanation, with participants who identify as being "not a math person" showing lower maximization rates.

We find that our participants who have been in many experiments previously do not behave differently than those who have been in relatively few. At least for this task, we do not find evidence that experience helps participants understand the task more clearly, or that participants who come to many experiments are systematically different with respect to this choice task. We expect that this result is specific to the fact this is an individual choice task.

[11] We note that all sessions were led by the same female experimenter.

[12] The non-native speakers in our sample come primarily from countries where the principal language is in the Indo-European family.

The combination of the strong treatment effect of alternative instructions and the strong effect of demographic characteristics suggest that the maximization rate in this task is highly variable across different conditions. It is sensitive to the manipulation of experimental protocols, which includes - but is not limited to - prepayment. When combined with the significance of mathematical self-confidence, although indeed there is no objective uncertainty in these choices and therefore they are strictly speaking riskless, our results indicate that ambiguity as perceived by participants may explain some, or possibly all, of the treatment effects observed in this task. A simpler account of the result is that participants must exert cognitive effort to evaluate whether the default is earnings-maximizing. When the cost of this effort is higher, due either - more objectively - to parsing out the task instructions, or - more subjectively - to the mental cost of doing an uncomfortable activity, participants are less likely to move away from the default.

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A Comparison of instructions

In this appendix, we provide the full text of the instructions for each of the four treatments. In addition, we provide the instructions as used by Hochman et al. (2014) for comparison.

A.1 Treatment Base

A.1.1 This paper

This is an experiment in the economics of decision making. If you follow the instructions and make appropriate decisions, you can earn an appreciable amount of money. You will receive your earnings for today's session in cash before you leave the laboratory.

It is important that you remain silent and do not look at other people's work. If you have any questions, or need assistance of any kind, please raise your hand and an experimenter will come to you. If you talk, laugh, exclaim out loud, etc., you will be asked to leave and you will not be paid. We expect and appreciate your cooperation.

We will now describe the session in more detail. Please follow along with these instructions as they are read aloud.

On your computer monitor, you will be given sets of four playing cards, face-up, several times. Each time, you will select and keep one card.

After all of these sets are completed, you will be paid based on the cards you have selected. Each card is worth its point value times 10p, so a three is worth three times 10p, a nine is worth nine times 10p, et cetera. Aces are worth 10p, jacks are worth eleven times 10p, queens are worth twelve times 10p, and kings are worth thirteen times 10p.

However, those values apply only to cards that are NOT spades. Spades (♠) are worth their point value times 25p, not 10p. The ace of spades is worth 25p, the two of spades is worth two times 25p, and so on.

At the end of the game, we will pay you for the cards you have selected.

A.1.2 HAA

Thank you for your participation. Feel free to ask questions at any time if anything is unclear. There are no tricks or catches to this game, we simply ask that you pay attention to the instructions and think carefully about your decisions. You will be paid some amount of money at the end of the game; how much you are paid will be determined by the decisions you make.

You will be given sets of four playing cards, face-up, several times. Each time, you will select and keep one card.

After all of these sets are completed, you will be paid based on the cards you have selected.

Each card is worth its point value in dimes, so a three is worth three dimes, a nine is worth nine dimes, et cetera. Aces are worth one dime, jacks are worth eleven dimes, queens are worth twelve, and kings are worth thirteen.

However, those values apply only to cards that are NOT spades. Spades are worth their point value in quarters, not dimes. The ace of spades is worth one quarter, the two of spades is worth two quarters, and so on. We have placed the cards ace through five of spades in the deck randomly.

At the end of the game, we will pay you for the cards you have selected.

A.2 Treatment Σ

This is an experiment in the economics of decision making. If you follow the instructions and make appropriate decisions, you can earn an appreciable amount of money. You will receive your earnings for today's session in cash before you leave the laboratory.

It is important that you remain silent and do not look at other people's work. If you have any questions, or need assistance of any kind, please raise your hand and an experimenter will come to you. If you talk, laugh, exclaim out loud, etc., you will be asked to leave and you will not be paid. We expect and appreciate your cooperation.

We will now describe the session in more detail. Please follow along with these instructions as they are read aloud.

On your computer monitor, you will be given sets of four playing cards, face-up, several times. Each time, you will select and keep one card.

After all of these sets are completed, you will be paid based on the cards you have selected.

Each card is worth its point value times 10p, so a three is worth three times 10p, a nine is worth nine times 10p, et cetera. Aces are worth 10p, jacks are worth eleven times 10p, queens are worth twelve times 10p, and kings are worth thirteen times 10p.

However, those values apply only to cards that are NOT spades. Spades (♠) are worth their point value times 25p, not 10p. The ace of spades is worth 25p, the two of spades is worth two times 25p, and so on. We have placed the cards ace through five of spades in the deck randomly. The value of the five spades, ace through five, equals a total of three pounds and seventy-five pence: one plus two plus three plus four plus five is fifteen times 25p i.e. three pounds and seventy-five pence.

At the end of the game, we will pay you for the cards you have selected.

A.3 Treatment Σ£

A.3.1 This paper

This is an experiment in the economics of decision making. If you follow the instructions and make appropriate decisions, you can earn an appreciable amount of money. You will receive your earnings for today's session in cash before you leave the laboratory.

It is important that you remain silent and do not look at other people's work. If you have any questions, or need assistance of any kind, please raise your hand and an experimenter will come to you. If you talk, laugh, exclaim out loud, etc., you will be asked to leave and you will not be paid. We expect and appreciate your cooperation.

We will now describe the session in more detail. Please follow along with these instructions as they are read aloud.

On your computer monitor, you will be given sets of four playing cards, face-up, several times. Each time, you will select and keep one card.

After all of these sets are completed, you will be paid based on the cards you have selected. Each card is worth its point value times 10p, so a three is worth three times 10p, a nine is worth nine times 10p, et cetera. Aces are worth 10p, jacks are worth eleven times 10p, queens are worth twelve times 10p, and kings are worth thirteen times 10p.

However, those values apply only to cards that are NOT spades. Spades (♠) are worth their point value times 25p, not 10p. The ace of spades is worth 25p, the two of spades is worth two times 25p, and so on. We have placed the cards ace through five of spades in the deck randomly.

The value of the five spades (ace through five) equals a total of three pounds and seventy-five pence: one plus two plus three plus four plus five is fifteen times 25p i.e. three pounds and seventy-five pence. We will give you this amount up front.

However, if you do not choose all of the five spade cards, you will need to give us back some of this money at the end of the game. The amount you return will be the value of the spade card(s) that you did NOT choose.

For example, if you do not pick up the three of spades, you will return three times 25p to us from your three pounds and seventy-five pence.

At the end of the game, if you have not selected all spades, we will pay you for the cards you have selected, and you will refund us money for the spades you have not selected.

A.3.2 HAA

Thank you for your participation. Feel free to ask questions at any time if anything is unclear. There are no tricks or catches to this game, we simply ask that you pay attention to the instructions and think carefully about your decisions. You will be paid some amount of money at the end of the game; how much you are paid will be determined by the decisions you make.

You will be given sets of four playing cards, face-up, several times. Each time, you will select and keep one card.

After all of these sets are completed, you will be paid based on the cards you have selected. Each card is worth its point value in dimes, so a three is worth three dimes, a nine is worth nine dimes, et cetera. Aces are worth one dime, jacks are worth eleven dimes, queens are worth twelve, and kings are worth thirteen.

However, those values apply only to cards that are NOT spades. Spades are worth their point value in quarters, not dimes. The ace of spades is worth one quarter, the two of spades is worth two quarters, and so on. We have placed the cards ace through five of spades in the deck randomly.

The value of the five spades (ace through five) equals a total of three dollars and seventy-five cents: one plus two plus three plus four plus five is fifteen quarters i.e. three dollars and seventy five cents. We will give you these fifteen quarters up front.

However, if you do not choose all of the five spade cards, you will need to give us back some of this money at the end of the game. The amount you return will be the value of the spade card(s) that you did NOT choose.

For example, if you do not pick up the three of spades, you will return three quarters to us from your three dollars and seventy-five cents.

At the end of the game, if you have not select all spades, we will pay you for the cards you have selected, and you will refund us money for the spades you have not selected.

A.4 Treatment $\Sigma£\mathcal{I}$

This is an experiment in the economics of decision-making. If you follow the instructions and make appropriate decisions, you can earn an appreciable amount of money. You will receive your earnings for today's session in cash before you leave the laboratory.

It is important that you remain silent and do not look at other people's work. If you have any questions, or need assistance of any kind, please raise your hand and an experimenter will come to you. If you talk, laugh, exclaim out loud, etc., you will be asked to leave and you will not be paid. We expect and appreciate your cooperation.

We will now describe the session in more detail. Please follow along with these instructions as they are read aloud.

On your computer monitor, you will be given sets of four playing cards, face-up, several times. No card will appear more than one time during the experiment. Each time, you will select and keep one card. After all of these sets are completed, you will be paid based on the cards you have selected.

The value of a card to you depends on the card's suit and point value. Spades (♠) are worth their point value times 25p. The ace of spades is worth 25p, the two of spades is worth two times 25p, and so on.

We have placed the cards ace through five of spades in the deck randomly. The values of these five spades (ace through five) equal a total of three pounds and seventy-five pence, because one plus two plus three plus four plus five is fifteen times 25p is three pounds and seventy-five pence. We will give you this amount up front.

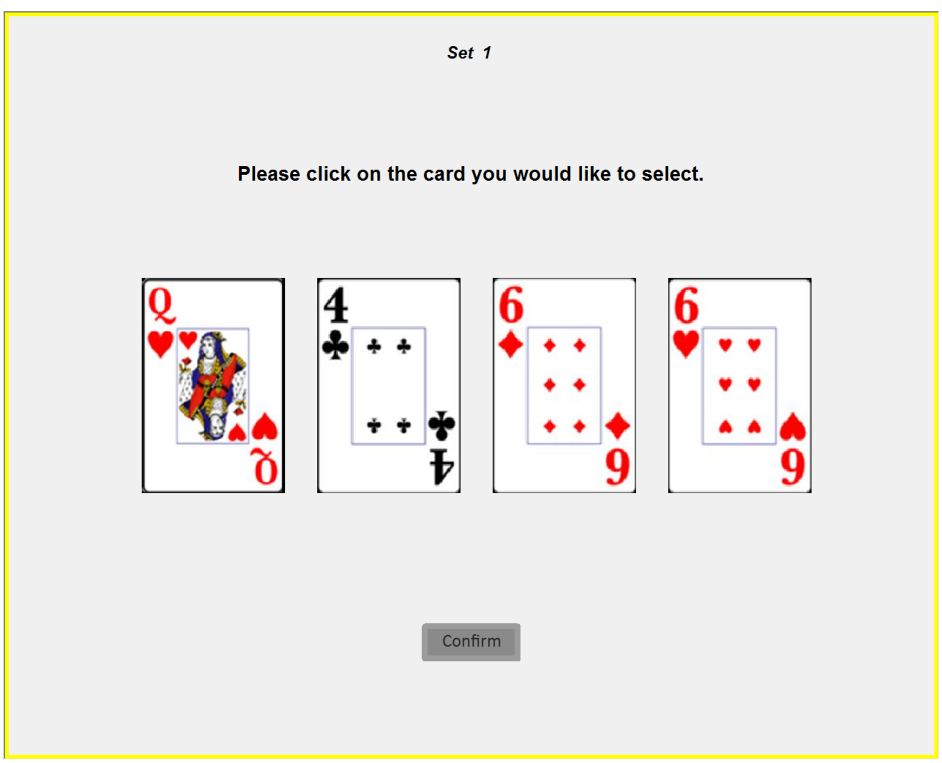
Cards of the other suits, hearts (♡), diamonds (♢), and clubs (♣), are worth their point value times 10p. So, a three is worth three times 10p, a nine is worth nine times 10p, et cetera. In these suits, aces are worth 10p, jacks are worth eleven times 10p, queens are worth twelve times 10p, and kings are worth thirteen times 10p.

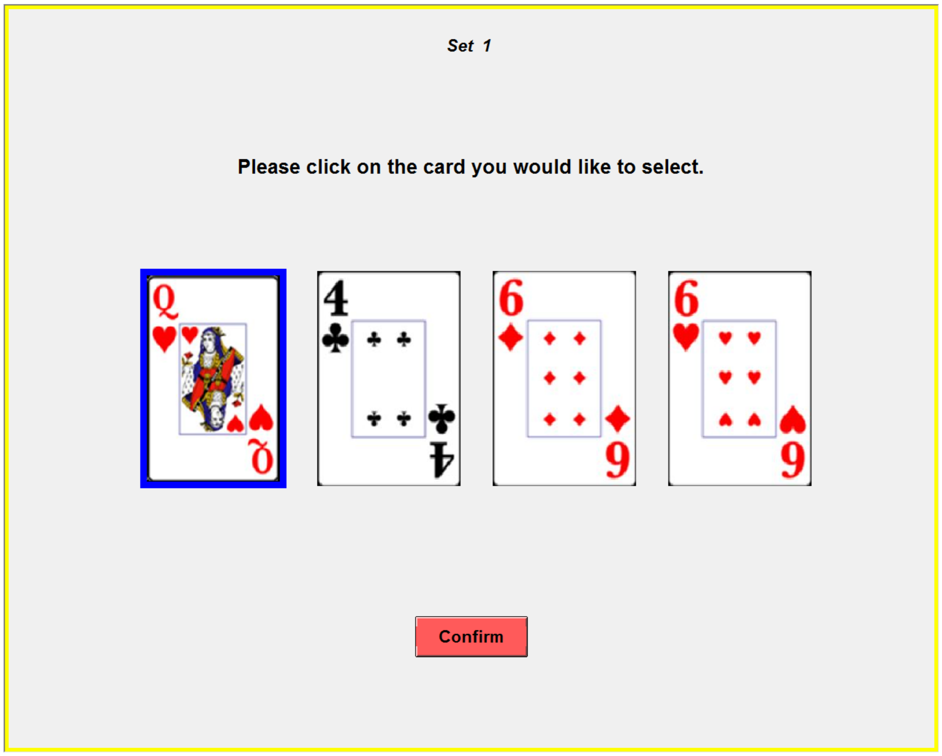
At the end of the experiment, you will leave the lab with a total payment equal to the sum of the values of the cards you select. For each set of four playing cards, there are three possible scenarios:

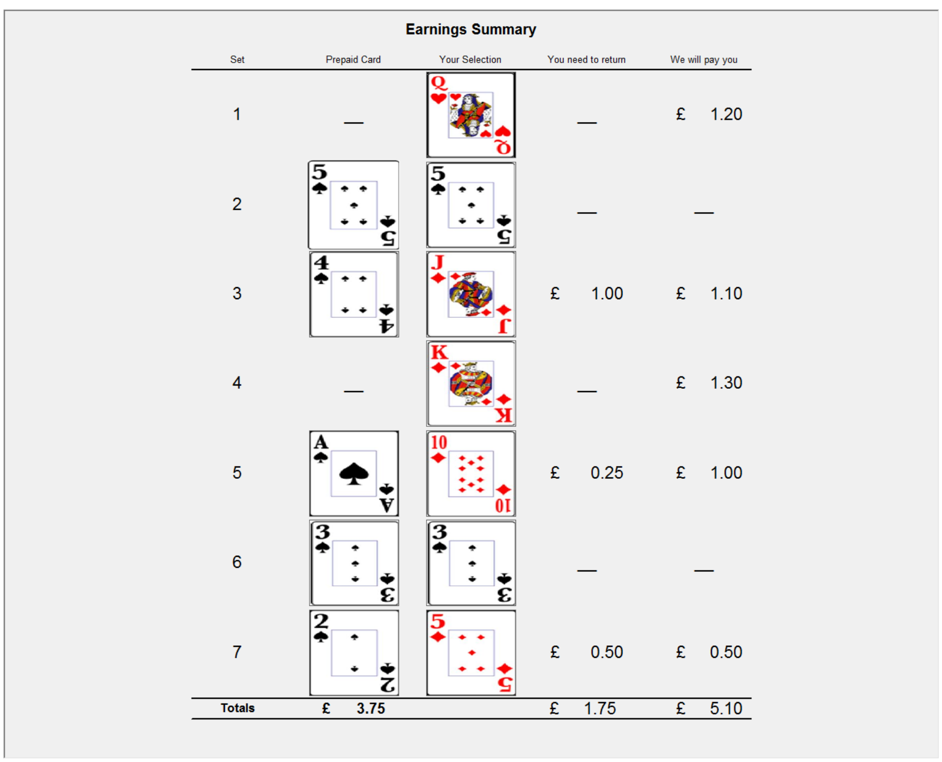
- There is not a spade among the four cards. Then, at the end of the session, you will receive a payment for that set equal to the value of the card you select.
- There is a spade among the four cards, but you select a different card. Then, at the end of the session, you will pay us back from your up front payment an amount equal to the value of the spade, and you will receive a payment from us equal to the value of the card you did select. For example, if you did not select three of spades but instead select four of diamonds; we will pay you 40p corresponding to the four of diamonds and you need to refund us 3 times 25p corresponding to the three of spades.

- There is a spade among the four cards, and you select the spade. Then, because you have already received payment for that spade card in your up front payment, you will not pay us back anything for that set, nor will you receive any additional payment for that set.

B Screenshots of participant interface







Earnings Summary

Set	Prepaid Card	Your Selection	You need to return	We will pay you
1	—	Q♥	—	£ 1.20
2	5♠	5♠	—	—
3	4♠	J♦	£ 1.00	£ 1.10
4	—	K♦	—	£ 1.30
5	A♠	10♦	£ 0.25	£ 1.00
6	3♠	3♠	—	—
7	2♠	5♦	£ 0.50	£ 0.50
Totals	£ 3.75		£ 1.75	£ 5.10

C Choice distributions at the set level

In this appendix we provide a more detailed view on the seven sets of cards faced by the participants. In each table, the first row shows the four cards that were used in the set. The next row contains the values of the cards; the data for the card(s) which maximize earnings are displayed in bold. The total number of choices and corresponding frequencies for each card are presented for each treatment, **Base**, Σ, **Σ£**, and **Σ£**$\mathcal{I}$, in separate rows, recalling that **Base** and **Σ£** are replications of HAA's.

Set 1	Q♡		4♣		6♢		6♡	
Value	**£1.20**		£0.40		£0.60		£0.60	
Base	**94%**	**46**	4%	2	2%	1	0%	0
Σ	**88%**	**43**	8%	4	2%	1	2%	1
Σ£	**96%**	**52**	4%	2	2%	1	0%	0
Σ£$\mathcal{I}$	**96%**	**50**	2%	1	2%	1	0%	0

Set 2	2♡		3♢		5♠		3♡	
Value	£0.20		£0.30		**£1.25**		£0.30	
Base	0%	0	0%	0	**100%**	**49**	0%	0
Σ	0%	0	6%	3	**94%**	**46**	0%	0
Σ£	0%	0	2%	1	**98%**	**53**	0%	0
Σ£$\mathcal{I}$	0%	0	6%	3	**94%**	**49**	0%	0

Set 3	J♢		4♠		7♡		9♡	
Value	**£1.10**		£1.00		£0.70		£0.90	
Base	**73%**	**36**	27%	13	0%	0	0%	0
Σ	**71%**	**35**	29%	14	0%	0	0%	0
Σ£	**54%**	**29**	46%	25	0%	0	0%	0
Σ£$\mathcal{I}$	**69%**	**35**	31%	16	0%	0	2%	1

Set 4	J♣		K♢		7♢		6♣	
Value	£1.10		**£1.30**		£0.70		£0.60	
Base	2%	1	**98%**	**48**	0%	0	0%	0
Σ	6%	3	**92%**	**45**	0%	0	0%	0
Σ£	2%	1	**96%**	**52**	0%	0	2%	1
Σ£$\mathcal{I}$	0%	0	**98%**	**51**	2%	1	0%	0

Set 5	4♡		10♢		A♠		8♡	
Value	£0.40		**£1.00**		£0.25		£0.80	
Base	0%	0	**86%**	**42**	14%	7	0%	0
Σ	0%	0	**76%**	**37**	22%	11	2%	1
Σ£	0%	0	**67%**	**36**	31%	1	2%	1
Σ£$\mathcal{I}$	0%	0	**81%**	**42**	15%	8	4%	2

Set 6	3♠		2♣		A♢		4♢	
Value	**£0.75**		£0.20		£0.10		£0.40	
Base	**86%**	**42**	0%	0	4%	2	10%	5
Σ	**67%**	**33**	0%	0	12%	6	20%	10
Σ£	**87%**	**47**	2%	1	0%	0	11%	6
Σ£$\mathcal{I}$	**83%**	**43**	0%	0	4%	2	13%	7

Set 7	5♢		2♢		3♣		2♠	
Value	**£0.50**		£0.20		£0.30		**£0.50**	
Base	**53%**	**26**	0%	0	2%	1	**45%**	**22**
Σ	**41%**	**20**	0%	0	0%	0	**59%**	**29**
Σ£	**7%**	**4**	0%	0	0%	0	**93%**	**50**
Σ£$\mathcal{I}$	**10%**	**5**	0%	0	0%	0	**90%**	**47**