Ambiguity Attitudes, Framing, and Consistency
Online Appendix

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1.1 Framing

This section presents results on the effect of framing by testing whether the proportions of types depend on the framing of choices. Table A1 summarizes the framing in experiments GI_2, GI_3, LI, LE and GE.

Framing	**Gain**	**Loss**
Implicit (Subjects must infer ambiguous alternative)	GI_2, GI_3	LI
Explicit (Subjects are told which alternative is ambiguous)	GE	LE

Table A1: The framing in experiments GI_2, GI_3, LI, LE and GE

1.1.1 Versions

With pairwise comparisons of the versions, we find a significant difference at the 0.05 level for stp between version LI and LE, and between versions LE and GE. Similarly, we find a significant difference at the 0.10 level for PIR between the same versions. Furthermore, we find a significant difference at the 0.10 level for sas between versions GI_3 and LE. When only using students the results are similar. In the student sample, we find a significantly greater difference for PIR, and instead of sas being significantly different between versions GI_3 and LE, we now find a significant difference between versions LI and LE.

	Version				
	GI_3	LI	LE	GE	Significance
waa	43	44	49	44	
saa	28	27	31	31	
stp	46	51	36	52	**(LI,LE),**(LE,GE)
PIR	32	36	24	38	*(LI,LE),*(LE,GE)
was	20	19	25	21	
sas	7	8	16	12	*(GI_3,LE)

(a) All

	Version				
	GI_3	LI	LE	GE	Significance
waa	43	45	53	45	
saa	30	27	34	33	
stp	46	52	32	56	**(LI,LE), **(LE,GE)
PIR	32	40	21	42	**(LI,LE),**(LE,GE)
was	21	18	24	18	
sas	8	6	16	11	*(LI,LE)

(b) Students

Comment a: *(i&j) and **(i&j) means that the proportions are significantly different between versions i and j. One star indicates significance at the 10% level and two stars indicate significance at the 5% level.
Comment b: P-values from test of independence using equation (A1).

Table A2: Test of independence between versions

	GI_3	LI	LE
LI	0.860		
LE	0.712	0.581	
GE	0.768	0.631	0.935

(a) saa - All

	GI_3	LI	LE
LI	0.787		
LE	0.576	0.418	
GE	0.661	0.486	0.895

(b) saa - Students

	GI_3	LI	LE
LI	0.916		
LE	0.471	0.523	
GE	0.928	0.990	0.525

(c) waa - All

	GI_3	LI	LE
LI	0.778		
LE	0.229	0.349	
GE	0.745	0.959	0.389

(d) waa - Students

	GI_3	LI	LE
LI	0.501		
LE	0.195	0.048	
GE	0.453	0.923	0.043

(e) stp - All

	GI_3	LI	LE
LI	0.407		
LE	0.116	0.020	
GE	0.244	0.716	0.010

(f) stp - Students

	GI_3	LI	LE
LI	0.617		
LE	0.240	0.092	
GE	0.443	0.773	0.055

(g) PIR - All

	GI_3	LI	LE
LI	0.353		
LE	0.139	0.021	
GE	0.234	0.770	0.012

(h) PIR - Students

	GI_3	LI	LE
LI	0.832		
LE	0.084	0.112	
GE	0.325	0.420	0.433

(i) sas - All

	GI_3	LI	LE
LI	0.702		
LE	0.156	0.078	
GE	0.568	0.349	0.405

(j) sas - Students

	GI_3	LI	LE
LI	0.928		
LE	0.430	0.367	
GE	0.915	0.840	0.492

(k) was - All

	GI_3	LI	LE
LI	0.664		
LE	0.632	0.377	
GE	0.736	0.934	0.437

(l) was - Students

Comment: P-values from test of independence using equation (A1).

Table A3: P-values from test of independence between versions

1.1.2 Gain vs. Loss Aggregates

We find no significant difference at the 0.05 level when comparing the Gain and Loss aggregates. However, stp and PIR are significantly different at the 0.10 level with higher proportions in the Gain aggregate (see Table A4). When we only use students, stp becomes significantly different at the 0.05 level.

	GAIN	LOSS	p_T^F
waa	43	46	0.330
saa	30	29	0.838
stp	49	44	0.087*
PIR	35	30	0.070*
was	20	22	0.443
sas	9	12	0.201
N	161	163	

(a) All

	GAIN	LOSS	p_T^F
waa	44	48	0.128
saa	31	30	0.792
stp	50	44	0.030**
PIR	37	31	0.062*
was	19	20	0.689
sas	9	10	0.498
N	136	127	

(b) Students

Comment a: $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.
Comment b: P-values from test of independence using equation (A1).

Table A4: Test of independence between Gain and Loss aggregates

1.1.3 Implicit vs. Explicit Aggregates

When comparing the Implicit and Explicit aggregates we find that the difference is significant at the 0.05 level for sas, with a higher share in the Explicit aggregates (see Table A5). When only using students, the difference for waa and saa also becomes significant at the 0.10 level, with higher shares in the Explicit aggregates.

	Implicit	Explicit	p_T^F
waa	43	46	0.327
saa	28	31	0.227
stp	49	44	0.103
PIR	34	31	0.258
was	20	23	0.161
sas	8	14	0.000**
N	170	154	

(a) All

	Implicit	Explicit	p_T^F
waa	44	49	0.083*
saa	28	33	0.077*
stp	49	44	0.146
PIR	36	32	0.186
was	19	21	0.456
sas	7	13	0.001**
N	145	118	

(b) Students

Comment a: $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.
Comment b: P-values from test of independence using equation (A1).

Table A5: Test of independence between Implicit and Explicit aggregates

1.1.4 Permissibility of Aggregating Versions Excluding Non-Students

	LI	GE	LE
GI_3	0.11	0.12	0.12
LI		0.05	0.16
GE			0.16

	L	I
G	0.06	
E		0.08

Figure A1: Significantly different distributions when we consider students only?

Comment: Using data from student subjects only, for each comparison between versions, we compute three K-S statistics comparing, respectively: (i) the distribution of r_1; (ii) the distribution of r_2; and (iii) the sums of the parallels to the diagonal $r_1 = r_2$, starting in the NW corner. We report the largest of these. None of these are sufficiently large to confidently reject the hypothesis that the distributions are drawn from the same underlying distribution. (The borderline for rejecting the hypothesis that two distributions are drawn from the same distribution at the 10% level varies with population size. For comparisons of individual versions it is roughly 0.21; for the aggregates, it is roughly 0.15.)

1.1.5 Modelling the data excluding Non-Students

Model parameters	**GI₃**	**LI**	**GE**	**LE**	**G**	**L**
$1-a$ (likelihood of diverging from stp in an ambiguity-seeking direction when given the opportunity)	0.10	0.11	0.09	0.11	0.11	0.11
$1-d$ (likelihood of diverging from stp in an ambiguity-averse direction when given the opportunity)	0.23	0.20	0.20	0.24	0.23	0.22
$a-d$ (indicator of the prevalence of ambiguity aversion over seeking)	0.13	0.09	0.11	0.13	0.12	0.11
μ (mean of the distribution along the SW-NE diagonal)	0.31	0.31	0.33	0.32	0.32	0.32
σ (standard deviation)	0.036	0.037	0.050	0.062	0.041	0.042
Fit						
K_I ($r_1 = r_2$ diagonal)	0.05	0.07	0.06	0.09	0.07	0.10
K_{II} (parallels to $r_1 = r_2$ diagonal)	0.07	0.04	0.03	0.07	0.02	0.05

Figure A2: The best-fitting models, students only

Comment: In the top part of the table, the columns give the parameters of the model that best fits the data for the respective versions (or aggregation of versions). The bottom part gives our two K-S statistics for these instantiations of the model (lower numbers indicate a better fit). All best-fitting models pass our K-S tests. For individual versions, the lower limit for the 10% confidence level is roughly 0.13; for combined versions, it is roughly 0.11 (because of a larger population size).

1.2 Inconsistency

This section presents results on whether ambiguity attitudes correlate with inconsistency. For each type of ambiguity attitude, independence tests are used to test whether the observed proportions ($\hat{\rho_{i,T}}$) are significantly different between inconsistency groups using equation (A2). We find that ambiguity neutrality (stp and PIR) decreases monotonically with inconsistency, and that the difference in the prevalence of these types between the Low and High inconsistency groups is significant at the 0.05 level. Ambiguity seeking (sas and was) increases monotonically with inconsistency and the difference between the Low and High inconsistency groups is significant at the 0.05 level. These differences remain significant even if we exclude the area devoted to PIR (we perform this robustness test because there is a small overlap between PIR on the one hand and sas and was on the other, as detailed in Figure 2 of the main paper), and when only considering students. These dynamics are summarized in Figure A3.

	Low	Moderate	High	p_T^M
waa	45	44	43	0.967
saa	33	27	28	0.724
stp	63	45	34	0.001**
PIR	48	33	21	0.002**
was	11	22	33	0.004**
sas	4	10	19	0.007**
waa\PIR	45	39	37	0.548
saa\PIR	26	21	21	0.758
was\PIR	13	18	29	0.031**
sas\PIR	2	6	16	0.006**

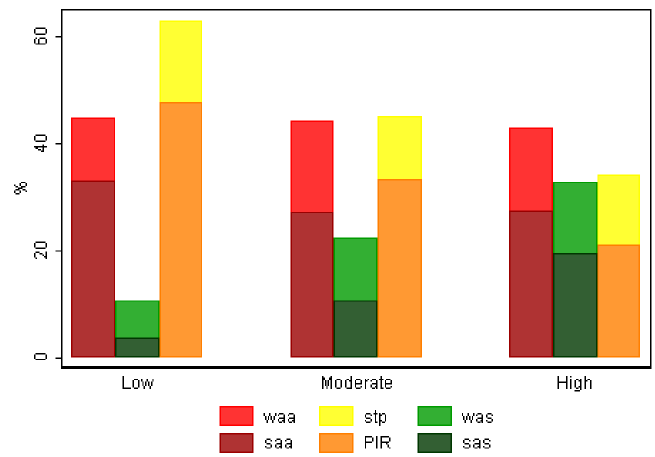
(a) All

	Low	Moderate	High	p_T^M
waa	46	44	45	1
saa	33	27	30	0.773
stp	63	45	33	0.003**
PIR	48	34	22	0.009**
was	10	22	32	0.01**
sas	4	10	19	0.013**

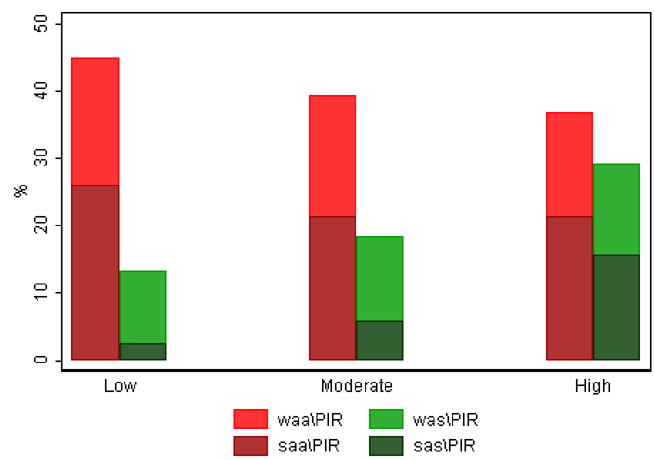
(b) Students

Comment a: $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.
Comment b: P-value from the test of independence using equation (A2).

Table A6: Test of independence between inconsistency groups



(a) Using all squares



(b) Excluding *PIR* squares

Figure A3: Weighted distribution of types by consistency group

2 Are the First and Final Round Different?

As mentioned in the main text, two questions arise about our use of a titration to reveal subjects' ambiguity attitudes. The first is whether it gives some subjects a reason to misrepresent their preferences in the very first choice, because they would thereby get access to alternatives they regard as more favourable. The monetary payoffs associated with each bet were chosen to make such misrepresentation unprofitable for risk-neutral subjects who honour the principle of insufficient reason, but some ambiguity-averse subjects would profit from it. For example, some ambiguity-averse subjects would prefer to incur the expected cost of choosing the ambiguous option against their preference in the first choice in our titration in order to gain access to two subsequent bets with a higher proportion of red cards; an ambiguity-averse subject who chose in this manner would then be classified as ambiguity neutral and/or ambiguity seeking. The phenomenon could also arise for some ambiguity-seeking subjects, who might prefer to incur the expected cost of choosing against their preference in the first choice in order to gain access to two subsequent bets with a greater share of ambiguous cards; an ambiguity-seeking subject who chose in this manner would then be classified as ambiguity neutral and/or ambiguity loving.

We believe it is unlikely that such misrepresentation occurred on a significant scale. Subjects were not informed about the titrations they would face and so lacked the knowledge required to exploit the opportunity for misrepresentation. And a subject who chose in line with their true preferences in round 1 would not learn what would have happened if they had chosen differently. Nonetheless, it is possible that some inquisitive subjects strayed from their preferred choices in rounds 2 and 3 and made correct conjectures about the decision tree which would then inform their behaviour in round 4. Some subjects who displayed their true ambiguity aversion in round 1 would then have made choices consistent with ambiguity neutrality and/or ambiguity seeking in round 4. We therefore investigated whether such a shift occurred. Tables A7 and A8 report the results of two tests for all of the versions of our experiment (GI_2 through LE) that we draw on in the main paper.

Table A7 reports the distribution of ambiguity attitudes in round 1 and round 4; it also reports the results of a McNemar tests on the proportion of subjects who "switched" towards or away from each attitude between these rounds. In four out of five experiments, there is a modest (and not statistically significant) increase in behaviour consistent with ambiguity aversion. In one case (version LI), there is a decrease in behaviour consistent with strong ambiguity aversion (significant at the 5% level), but not with weak ambiguity aversion. We conclude that there is no evidence for an across-the-board shift away from ambiguity averse behaviour.

In all experiments, there is a shift away from ambiguity seeking, but this shift is modest and not statistically significant in four out of five experiments. Only in LE is this shift both large and statistically significant (at the 1% level). We conclude that there is only weak evidence of an across-the-board shift away from ambiguity seeking. Rather than use of the manipulation strategy, we conjecture that this is due to the fact that ambiguity seeking is not stable; as Charness et al. (2013) argue and as we show in Section 4 of the main paper, ambiguity seekers are highly inconsistent.

Table A8 reports the results of three Kolmogorov-Smirnov (K-S) tests on the distribution of answers across our 8×8 grids. The results are in line with the tests reported in Table A7: only in version LE can we say with confidence that subjects' responses in round 1 and round 4 are different. (Note that in this Appendix, we check that our results in the main paper are robust to excluding LE.)

The second question is whether paying subjects for a random selection of their choices allows them to hedge across choices, thereby distorting the representation of their ambiguity attitudes (Bade, 2015; Oechssler and Roomets, 2014). In our experiment, subjects could not hedge between rounds, because they were informed that each round used new decks. However, as noted in Binmore et al. (2012, p. 228), subjects who knew the decision trees they faced could hedge within the two parts of a given round by choosing B_a when offered the choice between R_k and B_a, and choosing $R\&W_a$ when offered the choice between $W\&B_k$ and $R\&W_a$. Since each choice is equally likely to be played for real, this is equivalent to turning down an equiprobable lottery between R_k and $W\&B_k$ in favour of an equiprobable lottery between B_a and $R\&W_a$. The latter has a probability 1/2 of winning. No appeal to the principle of insufficient reason is then necessary to justify playing according to its tenets.

We believe it is unlikely that subjects employed such a hedging strategy. In the first round, subjects lacked the requisite knowledge of the decision trees they faced and, as mentioned, we found no evidence of a systematic decrease in ambiguity aversion in subsequent rounds. Moreover, the strategy is rather complex (it involves thinking several choices ahead and matching one's behaviour in a one-winning-colour choice with one's later behaviour in a corresponding two-winning colour choice). Indeed, in Binmore et al. (2012), we compared a version of our experiments which allowed a simpler form of hedging with one in which this opportunity was eliminated, and our statistical tests were not able to distinguish the two data sets.

		GI_2		p	GI_3		p	LI		p	GE		p	LE		p
		1	4		1	4		1	4		1	4		1	4	
Averse	waa	42	45	0.84	38	50	0.39	50	37	0.04**	42	46	0.70	44	55	0.13
	saa	26	28	1.00	26	31	0.69	31	26	0.38	31	32	1.00	30	33	0.85
Neutral	stp	46	51	0.35	46	51	0.15	41	58	0.00***	49	53	0.73	32	37	0.57
	PIR	36	42	0.48	32	36	0.15	32	42	0.11	37	41	0.68	27	26	1.00
Seeking	was	28	25	0.68	21	15	0.13	23	22	1.00	22	20	0.85	38	15	0.00***
	sas	13	13	0.77	10	5	0.18	12	11	1.00	14	11	0.79	23	10	0.02**

Comment a: $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.
Comment b: P-values from McNemar Test: taking the null hypothesis to be that the prevalence of each attitude is independent of the round of the experiment.
Comment c: The columns GI_2, GI_3, etc. report the percentage share of choices consistent with each ambiguity attitude in each of our experiments? first (1) and final (4) rounds. (We mention only the experiments which we use for our results in the paper, which is why GI_1 is omitted.) The adjacent column reports the results of a McNemar test for each attitude on the distribution of subjects across a 2×2 grid with: (i) the number of subjects that displayed the attitude in both round 1 and 4; (ii) the number of subjects that displayed the attitude in 1 and did not display it in 4; (iii) the number of subjects that did not display it in round1 and did display it in 4; and (iv) the number of subjects that did not display the attitude in both 1 and 4. The p-value displayed is the probability of obtaining the observed difference (or a greater difference) under the null hypothesis that the underlying distributions in the first and final rounds are the same.

Table A7: Ambiguity attitudes' independence in round 1 versus round 4 using McNemar test

	GI_2	GI_3	LI	GE	LE
K-S tests	0.09	0.13	0.13	0.05	0.23**

Comment a: ** : no more than 5% chance of wrongly rejecting the hypothesis that the distributions are drawn from the same underlying distribution.
Comment b: For round 1 and round 4, we compared the distribution of responses across the whole of our 8×8 grid. For each comparison between round 1 and round 4 in a given version, we compute three Kolmogorov-Smirnov (K-S) statistics comparing, respectively: (i) the distribution of r1; the distribution of r2; (iii) the sums of the parallels to the diagonal $r_1 = r_2$. Lower K-S statistics indicate a smaller difference between rounds. We report the largest of these. In all versions but LE, these K-S tests do not permit us to say that the first and final round are different. (The borderline for 10% significance differs with population size in each version, but is roughly 0.19.)

Table A8: Ambiguity attitudes' independence in round 1 versus round 4 using K-S test

3 Robustness to Excluding Version LE

In this section the independence analysis of Table A6 is replicated excluding Version LE. The results are presented in Table A9. Using the 0.05 level as a benchmark, excluding Version LE does not change the conclusions regarding the relationship between inconsistency and ambiguity.

	Low	Medium	High	p_T^M
waa	44	43	43	0.995
saa	32	26	28	0.815
stp	67	46	35	0.001**
PIR	52	34	21	0.002**
was	10	23	32	0.007**
sas	3	11	17	0.022**
waa\PIR	43	38	37	0.739
saa\PIR	23	21	22	0.978
was\PIR	12	18	29	0.035**
sas\PIR	0	6	13	0.006**

Comment a: $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.
Comment b: P-value from the test of independence using equation (A2).

Table A9: Test of independence between inconsistency groups excluding Version LE

4 Permissibility of Aggregating Versions

First, we provide the aggregate results for Version GI_2 (see Figure A4). We do so in order to correct one error in the data reported for this Version in Binmore et al. (2012).

Version GI$_2$ (gains; ambiguity implicit)

percentages, 76 subjects, 4 observations each

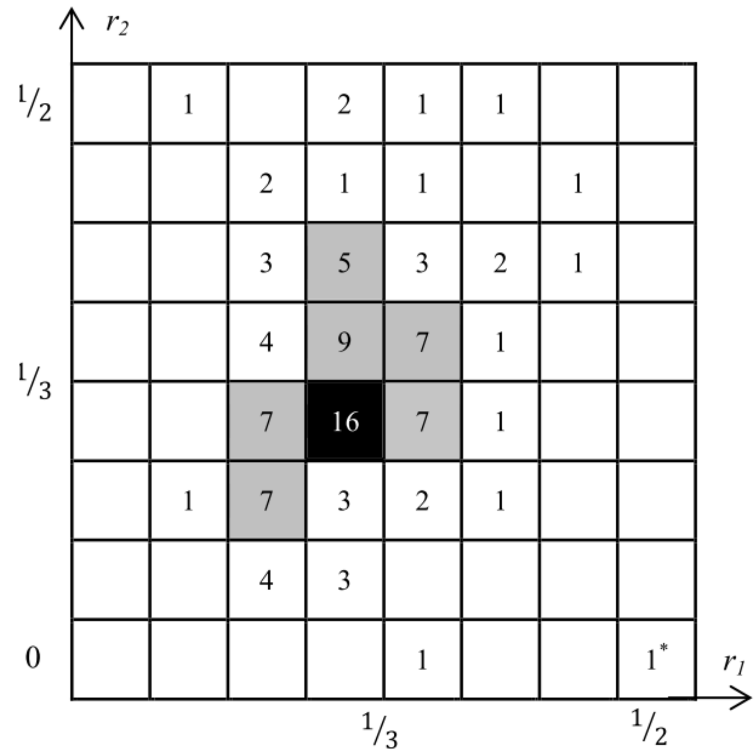


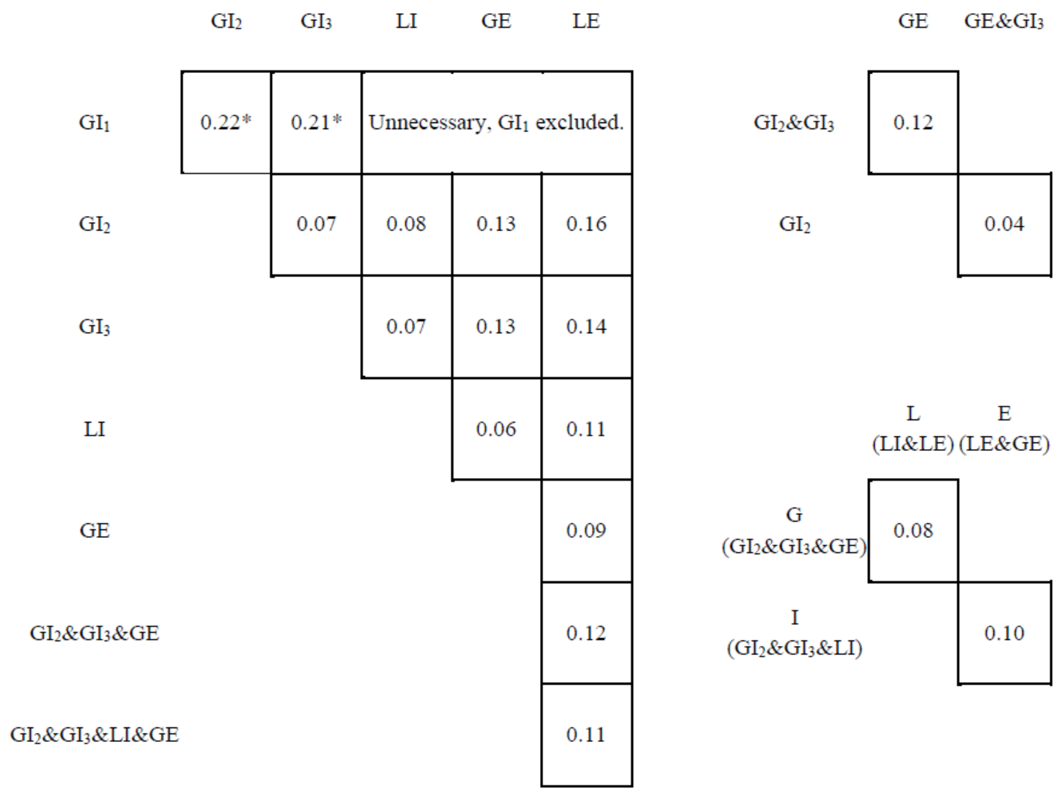
Figure A4: Results for Version GI$_2$

Comment: Shaded squares indicate an especially high concentration of responses.
* This cell entry was erroneously omitted in Binmore et al. (2012, p. 226). (The analysis in that paper was done with the correct data.)

We now ask whether it is permissible to aggregate the data from our experiments for the purposes of studying the relationship between consistency and ambiguity attitudes. We therefore employ the K-S test outlined in Section 3.2 of our main paper for all six versions of our experiment (Versions GI$_1$, GI$_2$, and GI$_3$ reported in Binmore et al. (2012) and Versions LI, LE and GE reported here) as follows:

1. We exclude a version from our aggregated data if the largest of the three K-S statistics indicates that it is different at the 10% significance level from any other version. This excludes only Version GI$_1$.

2. For the remaining versions, we assess whether it is permissible to add various salient combinations of versions to other such combinations. E.g. we compare "all gain versions" (Version GI$_2$, GI$_3$, and GE) to "all loss versions" (LI and LE). No version or combination of versions is excluded by this test (see Figure A5).



	GI_2	GI_3	LI	GE	LE
GI_1	0.22*	0.21*	Unnecessary, GI_1 excluded.		
GI_2		0.07	0.08	0.13	0.16
GI_3			0.07	0.13	0.14
LI				0.06	0.11
GE					0.09
GI_2&GI_3&GE					0.12
GI_2&GI_3&LI&GE					0.11

	GE	GE&GI_3
GI_2&GI_3	0.12	
GI_2		0.04

	L (LI&LE)	E (LE&GE)
G (GI_2&GI_3&GE)	0.08	
I (GI_2&GI_3&LI)		0.10

* = no more than 10% chance of wrongly rejecting the hypothesis that the distributions are drawn from the same underlying distribution.

Figure A5: Significantly different distributions?

Comment: For each comparison between (combinations of) versions, we compute four K-S statistics comparing, respectively: (i) the distribution of r_1; the distribution of r_2; and (iii) the sums of the parallels to the diagonal $r_1 = r_2$, starting in the NW corner. We report the largest of these. We focus on the salient groupings and on the individual version that, besides Version GI_1, was most different from others (Version LE). Version GI_1 fails these tests; all other combinations investigated pass our K-S tests.

5 Demography and Correlations

	All		GI_2	GI_3	LI	LE	GE
Female	55.0%	(220)	52.6%	52.5%	48.9%	57.5%	64.2%
Male	45.0%	(180)	47.4%	47.5%	51.1%	42.5%	35.8%
Students	82.8%	(331)	89.5%	91.3%	80.0%	75.3%	77.8%
Other	17.3%	(69)	10.5%	8.8%	20.0%	24.7%	22.2%
	Female	Male					
Student	55.0%	45.0%					
Other	55.1%	44.9%					

Table A10: Gender and status

The distribution of gender and status (student or not a student) is presented in Table A10. The dataset consists of 400 subjects, of which 55% (220) are female and 45% (180) are male. The percentage of females is lowest in Version LI (48.9%) and highest in Version GE (64.2%). A large majority (83%) are students. The gender distribution between students and non-students is almost identical. The percentage of students is lowest in Version LE (75.3%) and highest in Version GI_3 (91.3%).

	Students	Other	All
< 20	15% (51)	1% (1)	13% (52)
$20-29$	79%(262)	49%(34)	74% (296)
$30-39$	5% (17)	28% (19)	9% (36)
$40-49$	0% (1)	14% (10)	3% (11)
≥ 50	0% (0)	7% (5)	1% (5)

Comment: The youngest subjects are 18 years old (16 subjects), the median age is 22 years, and the oldest is 71 years old.

Table A11: Age distribution

The age distribution is presented in Table A11. The age ranges from 18 to 71 years. The majority of subjects (74%) are 20 to 29 years old, while 13% are younger than 20 years old and 13% are older than 30. Note that the age distribution of students and non-students differs.

	status	gender	age
M n	-0.17****	0.11**	0.01
waa	0.05	-0.05	-0.00
saa	0.06	-0.12**	-0.07
stp	-0.00	-0.02	-0.03
PIR	0.08	-0.15***	-0.12**
was	-0.07	0.09*	0.04
sas	-0.07	0.12**	0.00

Comment a: $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$, $^{****}p < 0.001$.
Comment b: Point-Biserial correlation coefficient for status and gender, and Pearson correlation coefficient for age.

Table A12: Correlation coefficients

Table A12 presents correlation coefficients and their significance. The measure of inconsistency (M_n) is negatively correlated with being a student. Being female is positively correlated with the measure of inconsistency and with ambiguity seeking (sas and was) while it is negatively correlated with PIR. Finally, age is negatively correlated with PIR.

6 Test Statistics

6.1 The Hypothesis

We consider two kinds of categories: different versions and different consistency groups. The aim is to test whether the difference between categories' proportions of ambiguity attitudes is significant. For each category i and type T, let $\hat{\rho}_{i,T}$ be the observed proportion in our dataset. Also, let ρ_i be the proportion in the (true) population and N_i be the total number of subjects in category i in our dataset. Consider two categories, i and j. Our null hypothesis is that $\rho_{i,T} = \rho_{j,T} = \rho_T$.

6.2 Unconditional

Assume that we are considering the data from two versions. Under the null hypothesis, the distribution of $N_i \cdot (\hat{\rho}_{i,T} - \hat{\rho}_{j,T})$, is approximately normal with the following mean and variance:

$$E[N_i \cdot (\hat{\rho}_{i,T} - \hat{\rho}_{j,T})] = 0,$$
$$Var[N_i \cdot (\hat{\rho}_{i,T} - \hat{\rho}_{j,T})] = (N_i^{-1} + N_j^{-1})\rho_{ij,T}(1 - \rho_{ij,T}) = \sigma^2_{ij,T}.$$

The best estimate for ρ_T is the maximum likelihood estimator giving all observations equal weight. That is simply the proportion of types T in version i and j. Let the observed difference be w_T and let $z = \frac{x}{\sigma_{ij,T}}$. Then our p-value is

$$p^F_{ij,T} = \sqrt{2/\pi} \int_{w/\sigma_{ij,T}}^{\infty} e^{-\frac{1}{2}z^2} dz. \tag{A1}$$

6.3 Conditional

Now assume that we are considering the data from our three consistency groups: Low consistency, Middle consistency and High consistency. For each type T, we have $\hat{\rho}_{L,T}$, $\hat{\rho}_{M,T}$ and $\hat{\rho}_{H,T}$. Let $\phi_{1,T} = \max\{\hat{\rho}_{L,T}, \hat{\rho}_{M,T}, \hat{\rho}_{H,T}\}$, $\phi_{2,T} = \text{median}\{\hat{\rho}_{L,T}, \hat{\rho}_{M,T}, \hat{\rho}_{H,T}\}$, and $\phi_{3,T} = \min\{\hat{\rho}_{L,T}, \hat{\rho}_{M,T}, \hat{\rho}_{H,T}\}$. Furthermore, let the corresponding total number of subjects in the groups be $\Phi_{1,T}$, $\Phi_{2,T}$ and $\Phi_{3,T}$.[1]

Now, let $w_T = \phi_{1,T} - \phi_{3,T}$. We want to calculate the probability of observing a difference greater than or equal to w_T. Since we are picking the largest and the smallest proportion we need to condition this on $\phi_{1,T} > \phi_{2,T} > \phi_{3,T}$:[2]

$$p^M_T = P(\phi_{1,T} - \phi_{3,T} \geq w_T \mid \phi_{1,T} > \phi_{2,T} > \phi_{3,T}).$$

Note that

$$\phi_{1,T} - \phi_{3,T} = \phi_{12,T} + \phi_{23,T},$$

[1]For example, $\phi_{1,sas}$ is the proportion of subjects of type *sas* in the low consistency group and $\Phi_{1,sas}$ is the number of subjects of all types in the low consistency group.

[2]Otherwise we would be calculating the probability of the difference between any two randomly chosen proportions to be greater than or equal to w_T.

where $\phi_{12,T} = \phi_{1,T} - \phi_{2,T}$ and $\phi_{23,T} = \phi_{2,T} - \phi_{3,T}$. The density function for $\phi_{ij,T}$ is

$$f_{ij,T}(x) = \begin{cases} \frac{2}{\sqrt{2\pi}\sigma_{ij,T}} e^{-\frac{1}{2}(\frac{x}{\sigma_{ij,T}})^2} & x \geq 0, \\ 0 & x < 0. \end{cases}$$

The following arguments hold under the null hypothesis. Since $\phi_{12,T}$ and $\phi_{23,T}$ are two independent random variables, the density function for ϕ_T is the convolution of $f_{12,T}$ and $f_{23,T}$,

$$f_T(y) = \frac{2}{\pi} \int_{w_T/\sigma_T}^{\infty} e^{-\frac{1}{2}z^2} dz \int_{-z\frac{\sigma_{12,T}}{\sigma_{23,T}}}^{z\frac{\sigma_{23,T}}{\sigma_{12,T}}} e^{-\frac{1}{2}v^2} dv, \tag{A2}$$

where $v = \frac{\sigma_T}{\sigma_{12,T}\sigma_{23,T}}(x - y\frac{\sigma_{12,T}^2}{\sigma_T^2})$, $z = \frac{y}{\sigma}$ and $\sigma_T^2 = \sigma_{12,T}^2 + \sigma_{23,T}^2$.

References

Bade, S. (2015). Randomization devices and the elicitation of ambiguity-averse preferences. *Journal of Economic Theory*, 159:221–235.

Binmore, K., Stewart, L., and Voorhoeve, A. (2012). How much ambiguity aversion? *Journal of risk and uncertainty*, 45(3):215–238.

Charness, G., Karni, E., and Levin, D. (2013). Ambiguity attitudes and social interactions: An experimental investigation. *Journal of Risk and Uncertainty*, 46(1):1–25.

Oechssler, J. and Roomets, A. (2014). Unintended hedging in ambiguity experiments. *Economics Letters*, 122(2):243–246.

Instructions and sample choices.

Version Gain, Implicit 3

Introductory screens

p. 1

Thank you for participating in this experiment. This experiment has several stages:

1. A practice round. This familiarizes you with the basic setup and is **NOT** played for money**.**

2. Twenty-four choices from card decks. At the end of the experiment, two of these choices will be randomly selected to be played for money.

3. Some survey questions.

4. The randomly selected decks will be played for real.

Click here to continue

p. 2

You will be given some information about various decks of coloured cards. Each deck will contain three colours. For example, these may be RED, BLACK or WHITE.

For each deck, you must choose which colour or colours to bet on. Sometimes you will only be able to choose one colour, sometimes you will be able to choose two. You win if (and only if) the card drawn from the deck is a colour you chose.

Click here to continue

p. 3

Each deck of cards contains only cards that are RED, BLACK or WHITE. The number of cards of each colour will vary with each new deck. You will always be told how many cards are in each deck. You will also be told the number of RED cards in each deck, but the precise number of BLACK cards and the precise number of WHITE cards will be kept a secret.

For example, the deck below has 6 RED cards and 15 cards that are BLACK or WHITE, but only we know how many of these 15 cards (which we show as grey with a '?') are BLACK and how many are WHITE.

Click here to continue

p. 4

It could be that all the cards that are **NOT** RED are BLACK
(put your mouse cursor over the '?' cards to view)

(Note: when the subject placed the mouse over the ‘?’ cards, they ‘flipped’ to show that they are all BLACK)

Click here to continue

p. 5

Or it could be that all the cards that are **NOT** RED are WHITE
(put your mouse cursor over the '?' cards to view)

(Note: when the subject placed the mouse over the ‘?’ cards, they ‘flipped’ to show that they are all WHITE)

Click here to continue

p. 6

Or it could be that the cards that are **NOT** RED are one of the many possible mixtures of BLACK and WHITE. For example *(put your mouse cursor over the '?' cards to view)*:

(Note: when the subject placed the mouse over the ‘?’ cards, they ‘flipped’ to show that they are a mix of BLACK cards and WHITE cards)

Click here to continue

p. 7

Practice Choice 1 (Not for money)

Each deck of cards will be placed in a card shuffler. The third card from the top wins. Your task is to choose a winning colour. Here is a practice choice in which you can bet on one colour only: either on RED or on BLACK:

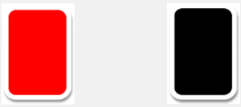
6 Red cards

29% Red

15 Black or White cards

71% Black or White

Please click on your choice of winning card



Red Black

p. 8

Practice Choice 2 (Not for money)

In this practice choice your choices are restricted to RED & BLACK or WHITE & BLACK:

If you choose RED & BLACK, you avoid losing if the third card from the top turns out to be BLACK or RED. If you choose WHITE & BLACK, you win if the top card turns out to be WHITE or BLACK. Otherwise you lose.

---

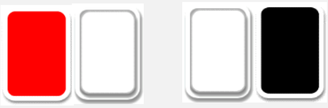
8 Red cards

38% Red

13 White or Black cards

62% White or Black

Please click on your choice of winning cards



Red & White

White & Black

p. 9

Now please get up and <u>come to the front of the room</u>, where the experimenter will show you how the deck of cards is shuffled for the two practice choices. If these had been played for real, would you have won?

When you get back, please

Click here to continue

p. 10

2. Introduction to ROUND 1 of the main experiment (for money)

This round of the main experiment consists of **two** equally important parts. In each part, you will make three choices.

Part 1. You will choose either RED or BLACK for three different decks of cards.

Part 2. You will choose either 'RED & WHITE' or 'WHITE & BLACK' for three different decks of cards. The decks used in this part of the experiment are the same as those used in the first part.

Click here to continue

p. 11

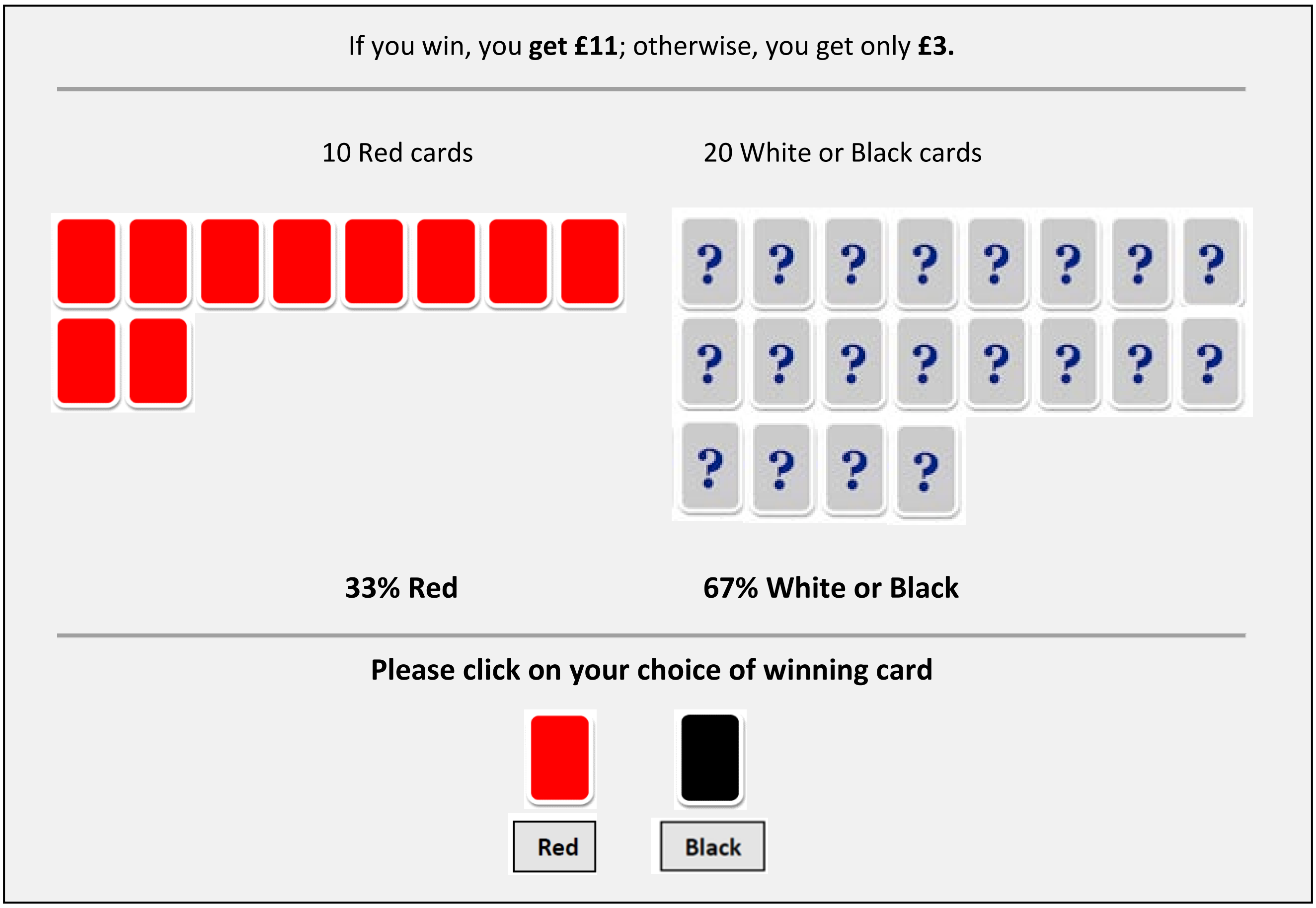
<u>Part 1</u>

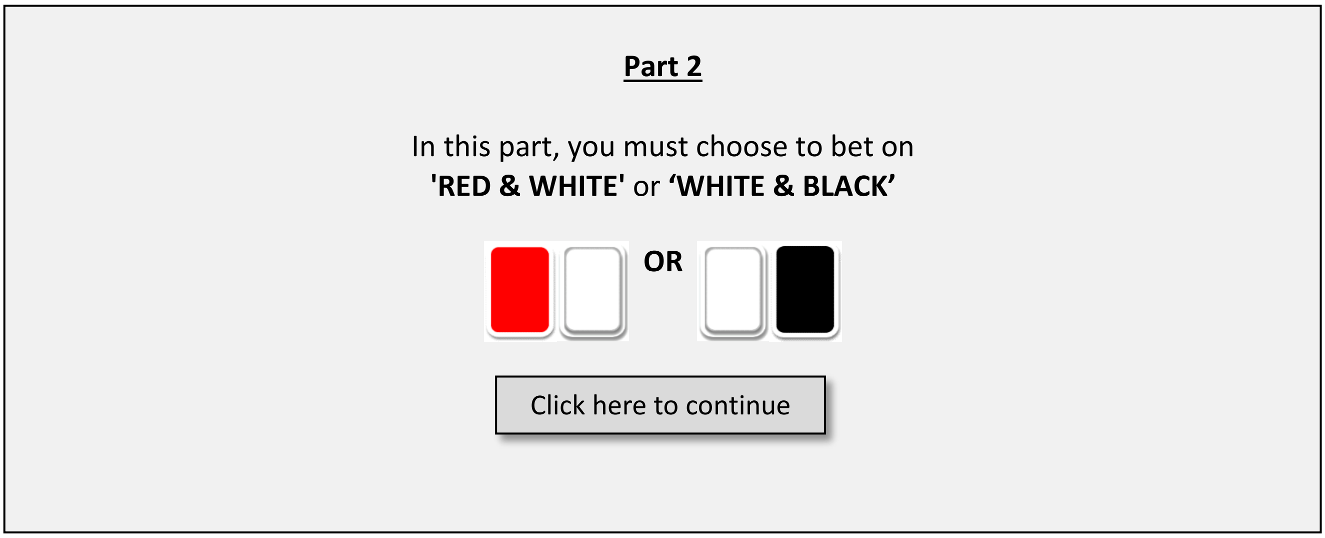
In this part, you must choose to bet on RED or BLACK

 **OR** 

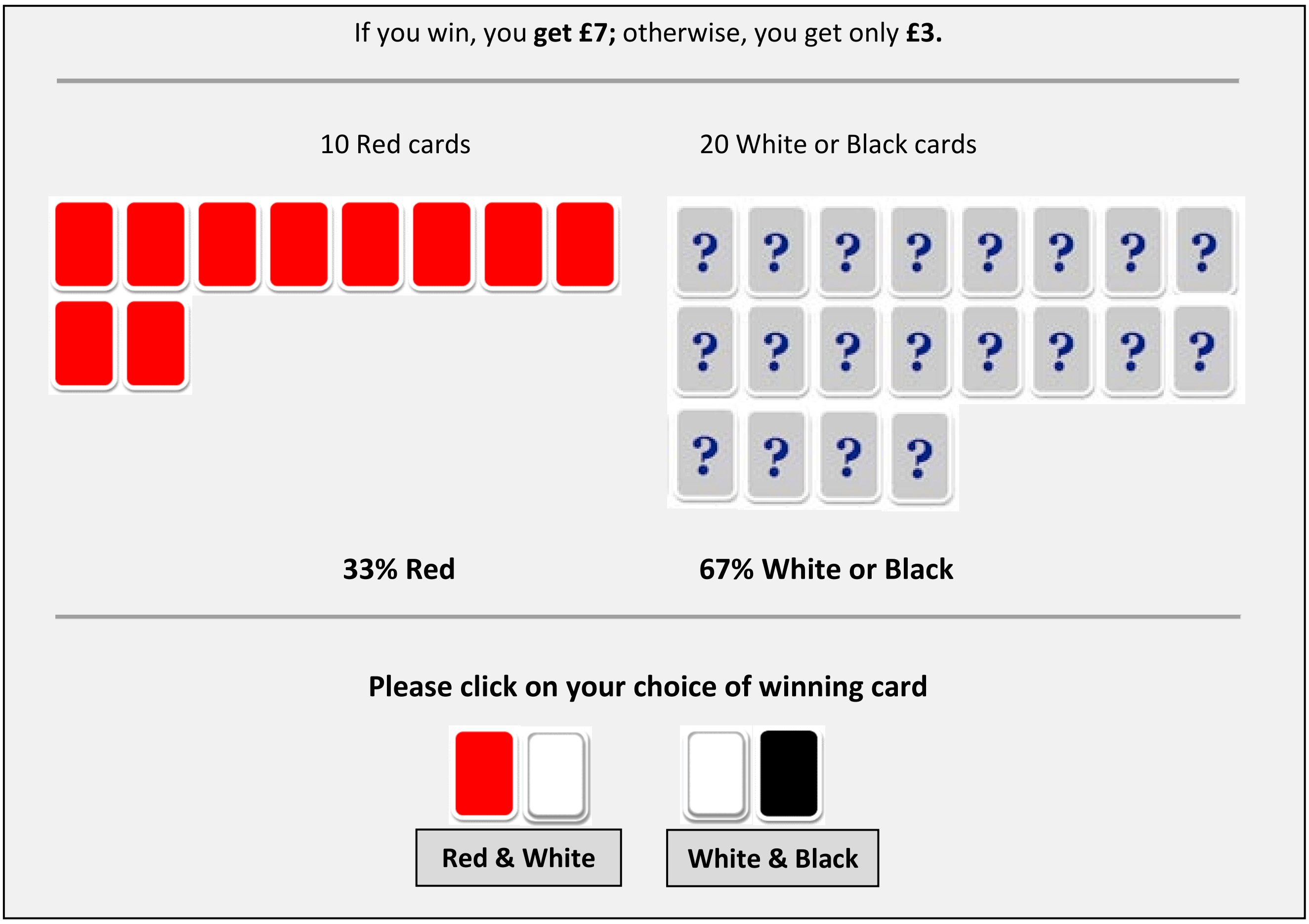
Click here to continue

A sample R_k versus B_a screen





A sample $R\&W_a$ versus $W\&B_k$ screen

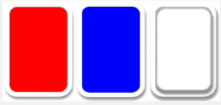


After subjects had completed both parts of round 1, the following screen was displayed:

Introduction to ROUND 2 (for money)

In this round, you will now face another six choices just like the ones you just made, except that we will be using **NEW** card decks.

The rules are the same as in the first round, but with different colours:



Part 1. You will choose either RED or BLUE as the winning card.

Part 2. You will choose either 'RED & WHITE' or 'WHITE & BLUE' as the winning cards.

Click here to continue

The same screen was displayed after subsequent rounds, except that the relevant colours changed.

Version Loss, Implicit

Introductory screens

p. 1

Thank you for participating in our experiment.

You have been given £25 worth of plastic coins. **Your aim is to lose as few as possible.** At the end of the experiment, each coin you have **kept** will be worth £1 in real money.

In the experiment, you will make many choices between gambles (based on card decks) in which these coins are at stake. At the end of the experiment, two of these gambles will be randomly selected to be played **for real**.

If you win both gambles, you will keep all your coins and leave with £25. If you lose one or both gambles, you will lose some of your coins. You can never lose more than £20 worth of coins.

Click here to continue

p. 2

This experiment has several stages:

1. A practice round. This familiarizes you with the basic setup and is **NOT** played for money**.**

2. Twenty-four choices from card decks. At the end of the experiment, two of these choices will be randomly selected to be played for money.

3. Some survey questions.

4. The randomly selected decks will be played for real.

Click here to continue

p. 3

You will be given some information about various decks of coloured cards. Each deck will contain three colours. For example, these may be RED, BLACK or WHITE.

For each deck, you must choose which colour or colours to bet on. Sometimes you will only be able to choose one colour, sometimes you will be able to choose two. You avoid losing if (and only if) the card drawn from the deck is a colour you chose.

Click here to continue

p. 4

Each deck of cards contains only cards that are RED, BLACK or WHITE. The number of cards of each colour will vary with each new deck. You will always be told how many cards are in each deck. You will also be told the number of RED cards in each deck, but the precise number of BLACK cards and the precise number of WHITE cards will be kept a secret.

For example, the deck below has 6 RED cards and 15 cards that are BLACK or WHITE, but only we know how many of these 15 cards (which we show as grey with a '?') are BLACK and how many are WHITE.

Click here to continue

p. 5

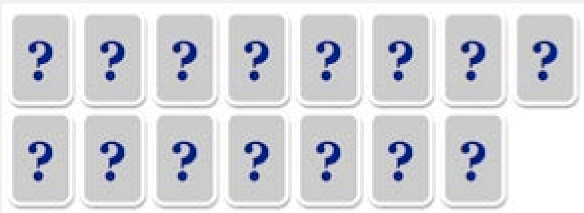
It could be that all the cards that are **NOT** RED are BLACK
(put your mouse cursor over the '?' cards to view)

(Note: when the subject placed the mouse over the '?' cards, they 'flipped' to show that they are all BLACK)

Click here to continue

p. 6

Or it could be that all the cards that are **NOT** RED are WHITE
(put your mouse cursor over the '?' cards to view)



(Note: when the subject placed the mouse over the '?' cards, they 'flipped' to show that they are all WHITE)

Click here to continue

p. 7

Or it could be that the cards that are **NOT** RED are one of the many possible mixtures of BLACK and WHITE. For example *(put your mouse cursor over the '?' cards to view)*:

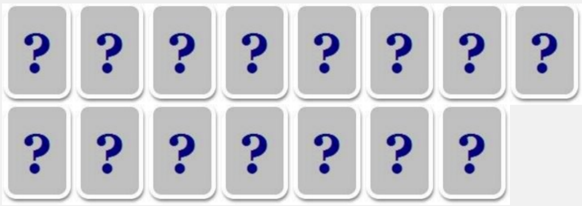
(Note: when the subject placed the mouse over the '?' cards, they 'flipped' to show that they are a mix of BLACK cards and WHITE cards)

Click here to continue

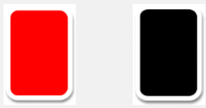
p. 8

Practice Choice 1 (Not for money)

Each deck of cards will be placed in a card shuffler. The third card from the top wins. Your task is to avoid choosing a losing colour. Here is a practice choice in which you can bet on one colour only: either on RED or on BLACK:

6 Red cards	15 White or Black cards
	
29% Red	**71% White or Black**

Please click on your choice of winning card



Red Black

p. 9

Practice Choice 2 (Not for money)

In this practice choice your guesses are restricted to RED & BLACK or WHITE & BLACK:

If you choose RED & BLACK, you avoid losing if the third card from the top turns out to be BLACK or RED. If you choose WHITE & BLACK, you win if the top card turns out to be WHITE or BLACK. Otherwise you lose.

---

8 Red cards

38% Red

13 White or Black cards

62% White or Black

Please click on your choice of winning cards

Red & Black | **White & Black**

p. 10

Now please get up and <u>come to the front of the room</u>, where the experimenter will show you how the deck of cards is shuffled for the two practice choices. If these had been played for real, would you have avoided losing some of your coins?

When you get back, please

Click here to continue

p. 11

2. Introduction to ROUND 1 of the main experiment (for money)

This round of the main experiment consists of **two** equally important parts. In each part, you will make three choices.

Part 1. You will choose either RED or BLACK for three different decks of cards.

Part 2. You will choose either 'RED & WHITE' or 'WHITE & BLACK' for three different decks of cards. The decks used in this part of the experiment are the same as those used in the first part.

Click here to continue

p. 12

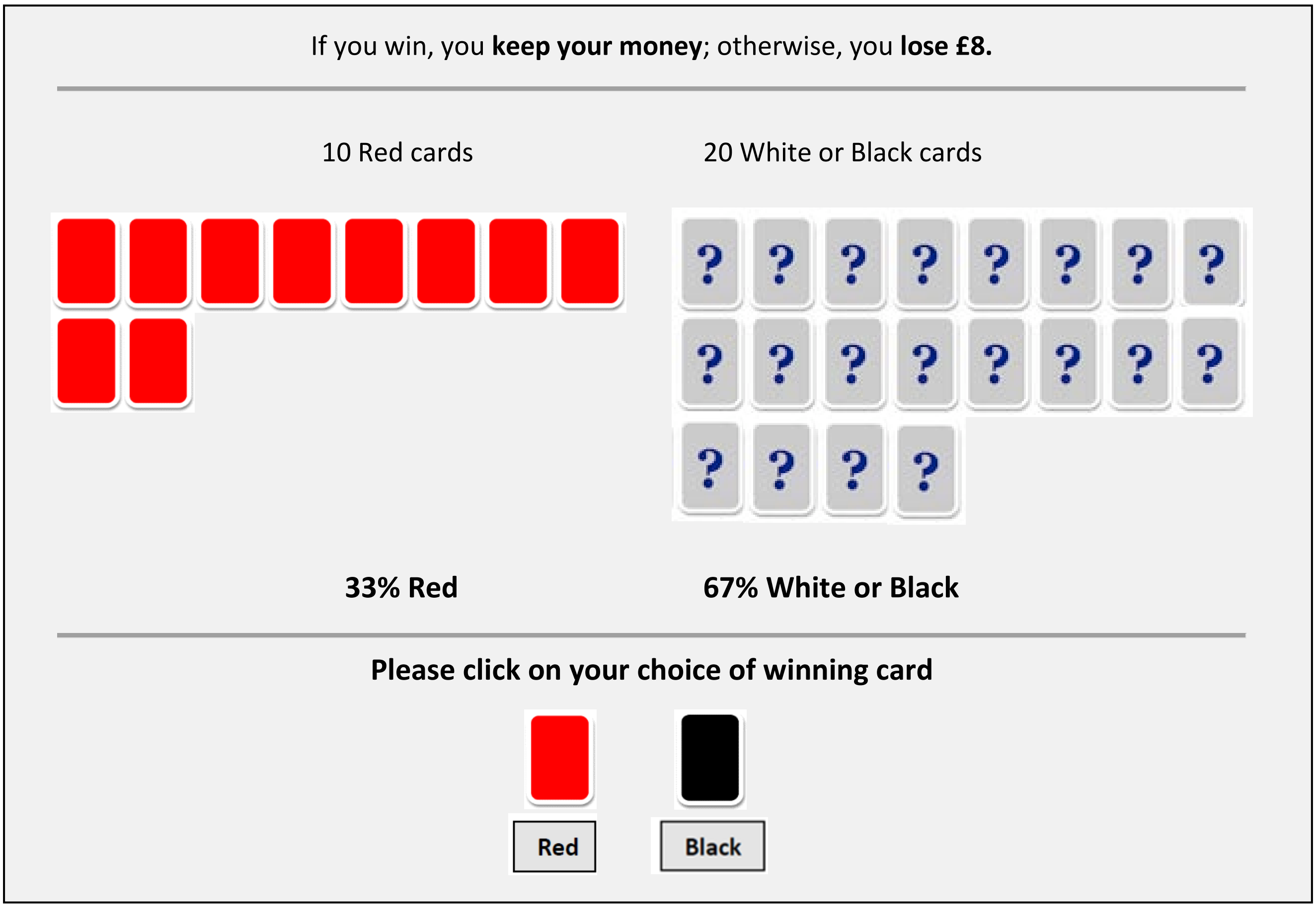
<u>Round 1, Part 1</u>

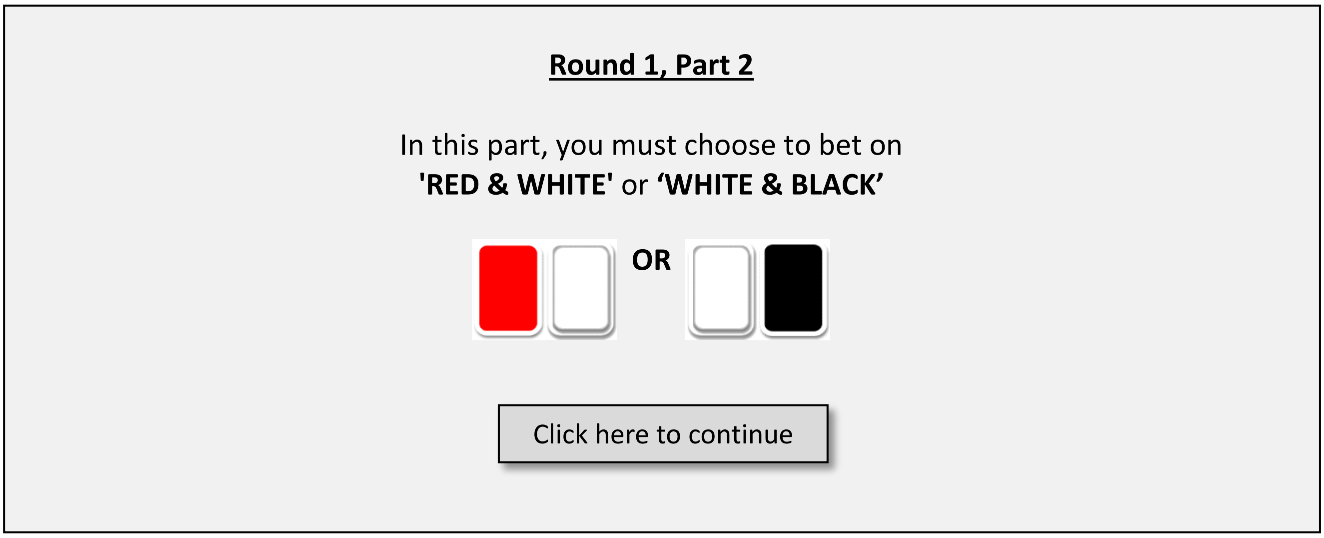
In this part, you must choose to bet on RED or BLACK

OR

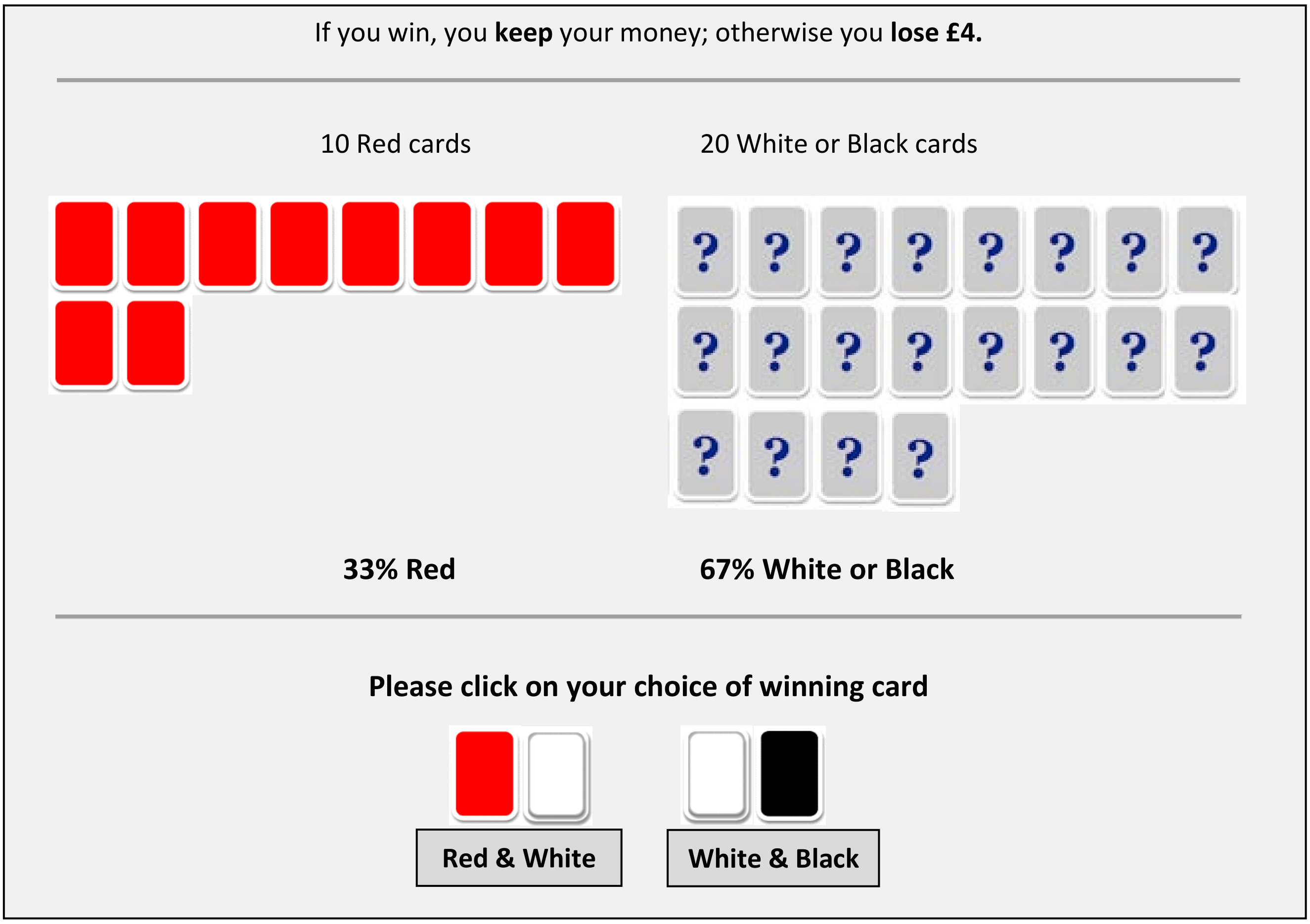
Click here to continue

A sample R_k versus B_a screen





A sample $R\&W_a$ versus $W\&B_k$ screen

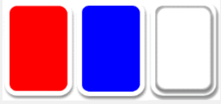


After subjects had completed both parts of round 1, the following screen was displayed:

Introduction to ROUND 2 (for money)

In this round, you will now face another six choices just like the ones you just made, except that we will be using **NEW** card decks.

The rules are the same as in the first round, but with different colours:



Part 1. You will choose either RED or BLUE as the winning card.

Part 2. You will choose either 'RED & WHITE' or 'WHITE & BLUE' as the winning cards.

Click here to continue

The same screen was displayed after subsequent rounds, except that the relevant colours changed.

Version Loss, Explicit

Introductory screens

p. 1

Thank you for participating in our experiment.

You have been given £25 worth of plastic coins. **Your aim is to lose as few as possible.** At the end of the experiment, each coin you have **kept** will be worth £1 in real money.

In the experiment, you will make many choices between gambles (based on card decks) in which these coins are at stake. At the end of the experiment, two of these gambles will be randomly selected to be played **for real**.

If you win both gambles, you will keep all your coins and leave with £25. If you lose one or both gambles, you will lose some of your coins. You can never lose more than £20 worth of coins.

Click here to continue

p. 2

This experiment has several stages:

1. A practice round. This familiarizes you with the basic setup and is **NOT** played for money**.**

2. Twenty-four choices from card decks. At the end of the experiment, two of these choices will be randomly selected to be played for money.

3. Some survey questions.

4. The randomly selected decks will be played for real.

Click here to continue

p. 3

You will be given some information about various decks of coloured cards. Each deck will contain three colours. For example, these may be RED, BLACK or WHITE.

For each deck, you must choose which colour or colours to bet on. Sometimes you will only be able to choose one colour, sometimes you will be able to choose two. You avoid losing if (and only if) the card drawn from the deck is a colour you chose.

Click here to continue

p. 4

Each deck of cards contains only cards that are RED, BLACK or WHITE. The number of cards of each colour will vary with each new deck. You will always be told how many cards are in each deck. You will also be told the number of RED cards in each deck, but the precise number of BLACK cards and the precise number of WHITE cards will be kept a secret.

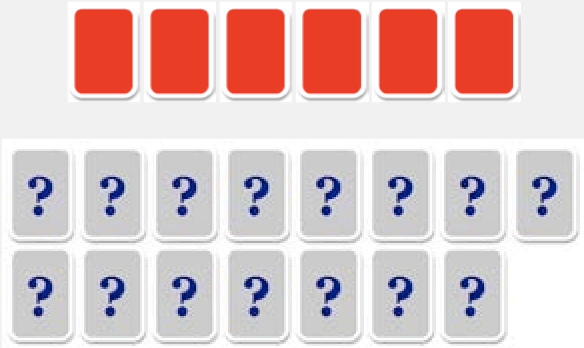
For example, the deck below has 6 RED cards and 15 cards that are BLACK or WHITE, but only we know how many of these 15 cards (which we show as grey with a '?') are BLACK and how many are WHITE.

Click here to continue

p. 5

It could be that all the cards that are **NOT** RED are BLACK

(put your mouse cursor over the '?' cards to view)



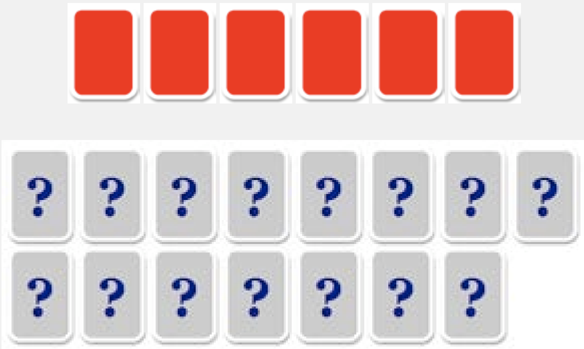
(Note: when the subject placed the mouse over the '?' cards, they 'flipped' to show that they are all BLACK)

Click here to continue

p. 6

Or it could be that all the cards that are **NOT** RED are WHITE

(put your mouse cursor over the '?' cards to view)

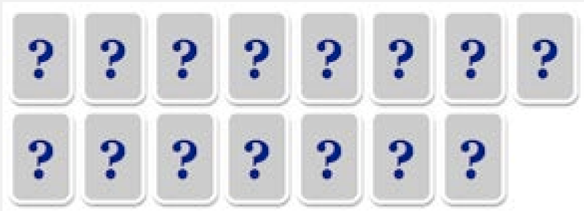


(Note: when the subject placed the mouse over the '?' cards, they 'flipped' to show that they are all WHITE)

Click here to continue

p. 7

Or it could be that the cards that are **NOT** RED are one of the many possible mixtures of BLACK and WHITE. For example *(put your mouse cursor over the '?' cards to view)*:



(Note: when the subject placed the mouse over the ‘?’ cards, they ‘flipped’ to show that they are a mix of BLACK cards and WHITE cards)

Click here to continue

p. 8

Practice Choice 1 (Not for money)

You will make choices between betting on a colour or colours for which you know the chance of winning, and a colour or colours for which you do **NOT** know the chance of winning.

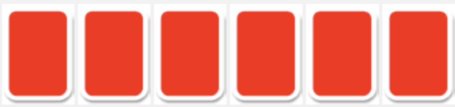
For example, in the following practice choice:

If you bet on RED, your chance of winning is 29% (because the number of RED cards is 6 out of a total of 21 cards in the deck).

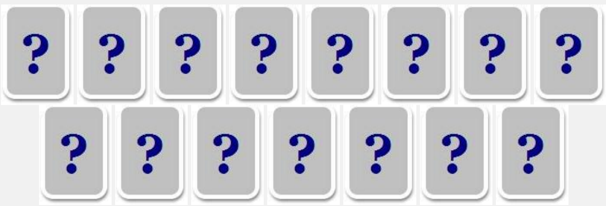
If you bet on WHITE, your chance of winning ranges from 0% to 71% (because the number of WHITE cards can range from 0 to 15 out of a total of 21 cards in the deck).

---

6 Red cards



15 White or Black cards



Please click on your choice of winning card

29% Red **From 0% to 71% White**

Red **White**

p. 9

Practice Choice 2 (Not for money)

In the following practice choice:

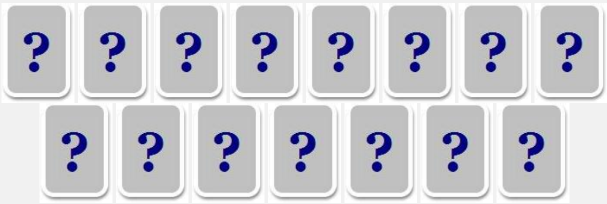
If you choose ‘RED & WHITE’, you win if the third card from the top in the shuffled deck is RED or WHITE. Your chance of winning ranges from 29% to 100% (because the number of cards that are RED or WHITE can range from 6 to 21 out of a total of 21 cards).

If you choose ‘WHITE & BLACK’, you win if the third card from the top in the shuffled deck is WHITE or BLACK. Your chance of winning is 71% (because the number of cards that are WHITE or BLACK is 15 out of a total of 21 cards).

---

6 Red cards

15 White or Black cards



Please click on your choice of winning cards

From 29% to 100% Red or White

Red & White

71% White or Black

White & Black

p. 10

N**ow please get up and <u>come to the front of the room</u>**, where the experimenter will show you how the deck of cards is shuffled for the two practice choices. If these had been played for real, would you have avoided losing some of your coins?

When you get back, please

Click here to continue

p. 11

2. Introduction to ROUND 1 of
the main experiment (for money)

This round of the main experiment consists of **two** equally important parts. In each part, you will make three choices.

Part 1. You will choose either RED or BLACK for three different decks of cards.

Part 2. You will choose either 'RED & WHITE' or 'WHITE & BLACK' for three different decks of cards. The decks used in this part of the experiment are the same as those used in the first part.

Click here to continue

p. 12

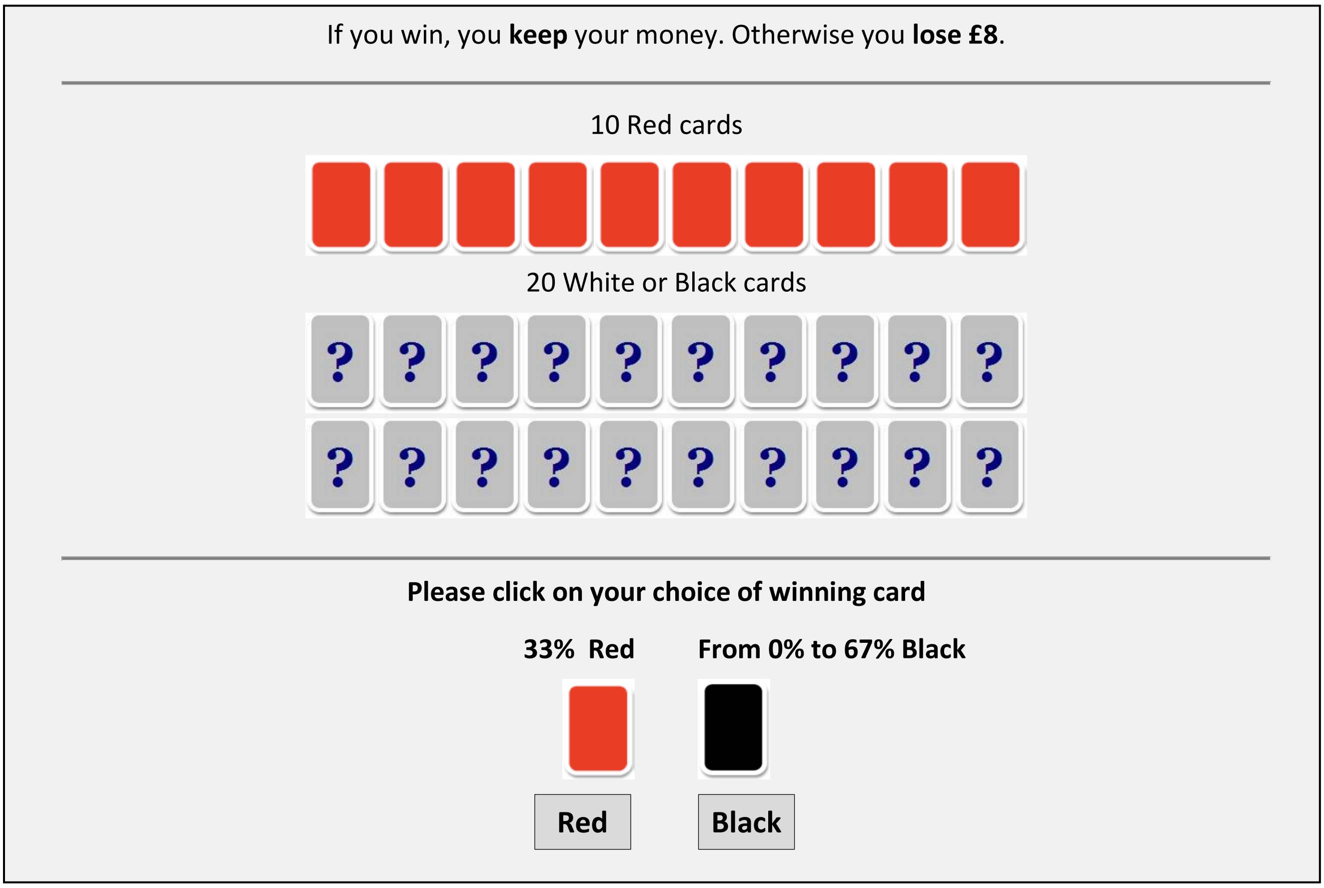
<u>Part 1</u>

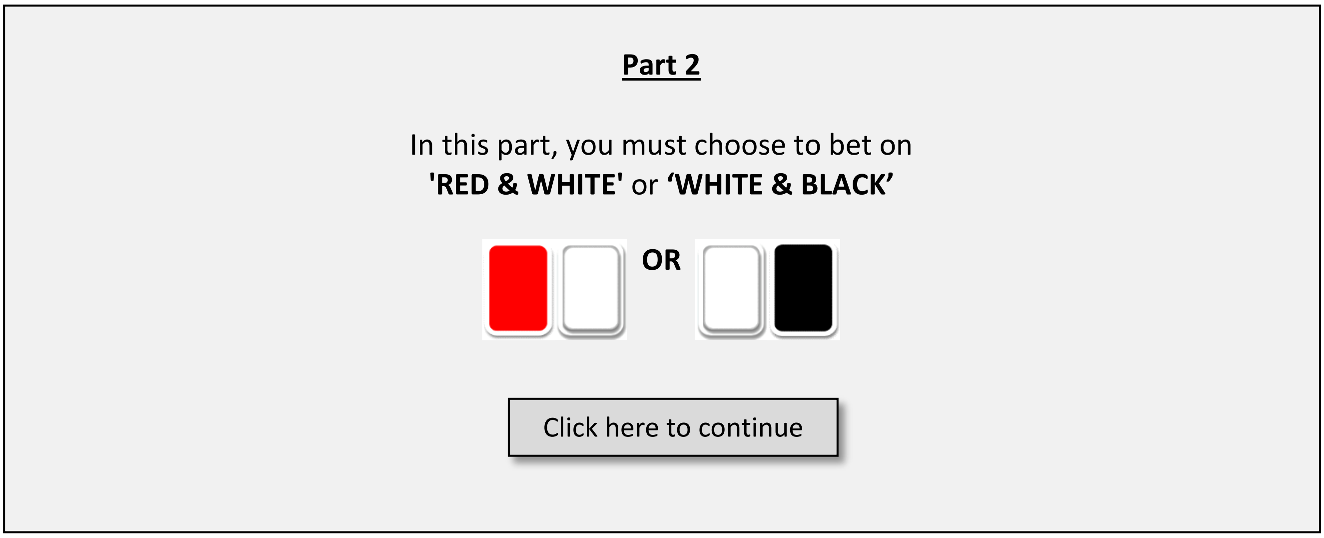
In this part, you must choose to bet on RED or BLACK


OR

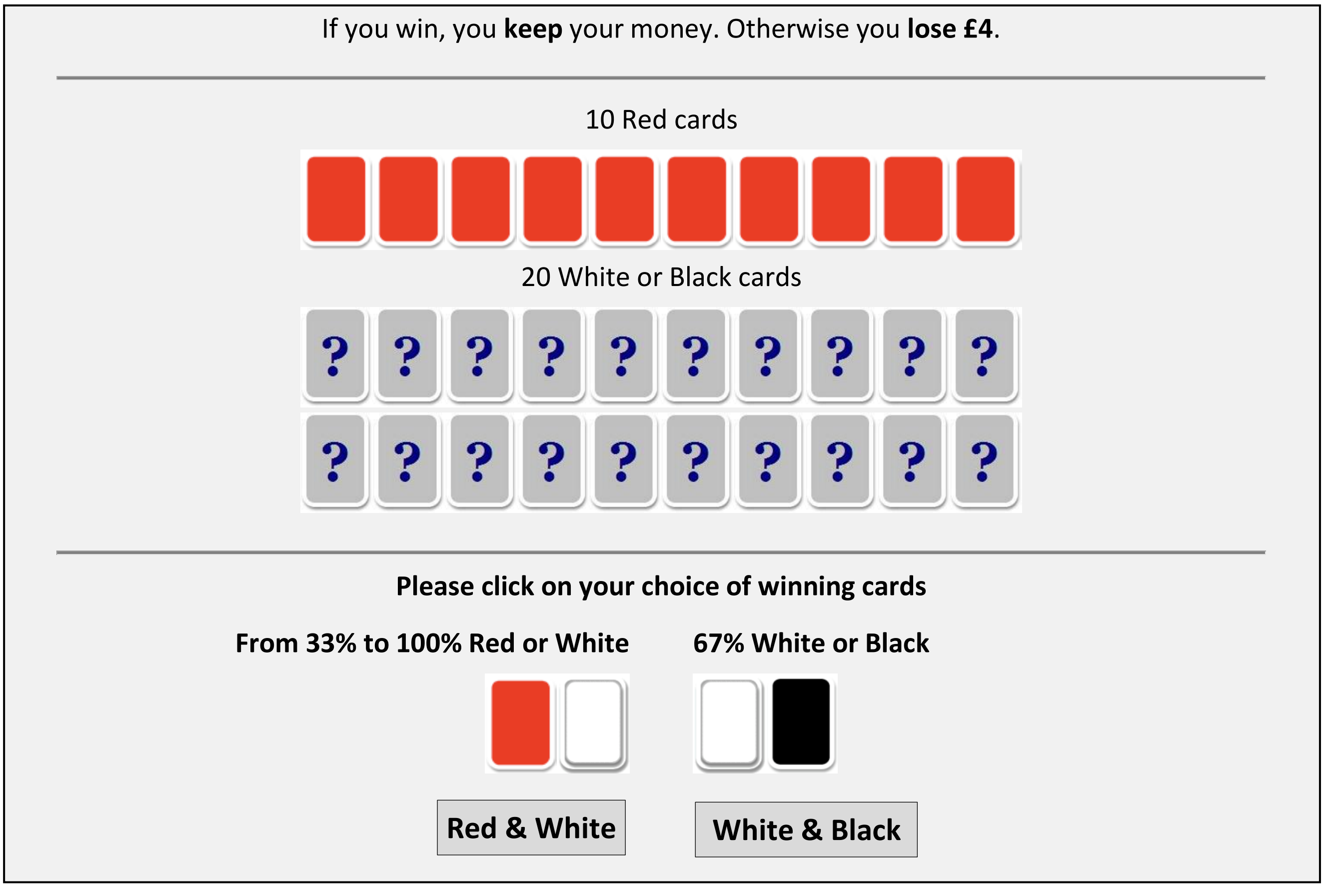

Click here to continue

A sample R_k versus B_a screen





A sample $R\&W_a$ versus $W\&B_k$ screen

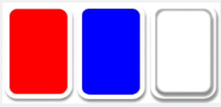


After subjects had completed both parts of round 1, the following screen was displayed:

Introduction to ROUND 2 (for money)

In this round, you will now face another six choices just like the ones you just made, except that we will be using **NEW** card decks.

The rules are the same as in the first round, but with different colours:



Part 1. You will choose either RED or BLUE as the winning card.

Part 2. You will choose either 'RED & WHITE' or 'WHITE & BLUE' as the winning cards.

Click here to continue

The same screen was displayed after subsequent rounds, except that the relevant colours changed.

Version Gain, Explicit

Introductory screens

p. 1

Thank you for participating in this experiment. This experiment has several stages:

1. A practice round. This familiarizes you with the basic setup and is **NOT** played for money**.**

2. Twenty-four choices from card decks. At the end of the experiment, two of these choices will be randomly selected to be played for money.

3. Some survey questions.

4. The randomly selected decks will be played for real.

Click here to continue

p. 2

You will be given some information about various decks of coloured cards. Each deck will contain three colours. For example, these may be RED, BLACK or WHITE.

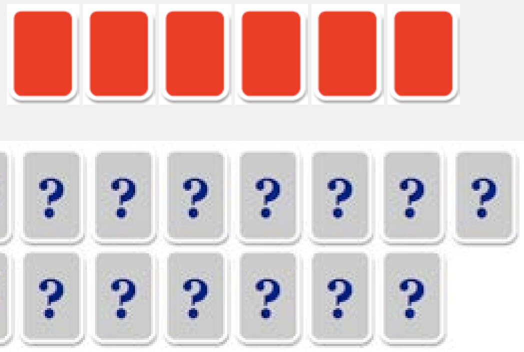
For each deck, you must choose which colour or colours to bet on. Sometimes you will only be able to choose one colour, sometimes you will be able to choose two. You win if (and only if) the card drawn from the deck is a colour you chose.

Click here to continue

p. 3

Each deck of cards contains only cards that are RED, BLACK or WHITE. The number of cards of each colour will vary with each new deck. You will always be told how many cards are in each deck. You will also be told the number of RED cards in each deck, but the precise number of BLACK cards and the precise number of WHITE cards will be kept a secret.

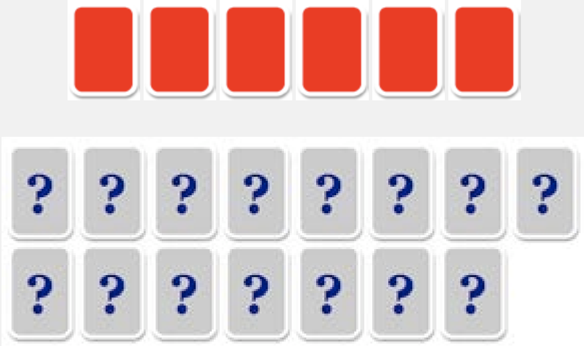
For example, the deck below has 6 RED cards and 15 cards that are BLACK or WHITE, but only we know how many of these 15 cards (which we show as grey with a '?') are BLACK and how many are WHITE.



Click here to continue

p. 4

It could be that all the cards that are **NOT** RED are BLACK
(put your mouse cursor over the '?' cards to view)

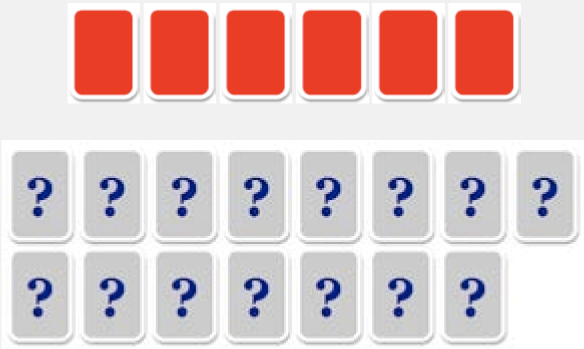


(Note: when the subject placed the mouse over the '?' cards, they 'flipped' to show that they are all BLACK)

Click here to continue

p. 5

Or it could be that all the cards that are **NOT** RED are WHITE
(put your mouse cursor over the '?' cards to view)

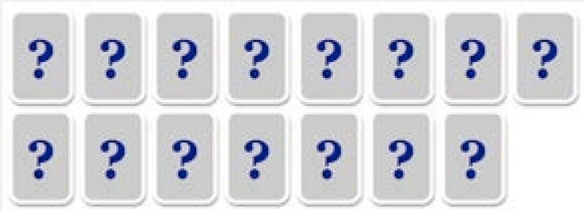


(Note: when the subject placed the mouse over the '?' cards, they 'flipped' to show that they are all WHITE)

Click here to continue

p. 6

Or it could be that the cards that are **NOT** RED are one of the many possible mixtures of BLACK and WHITE. For example *(put your mouse cursor over the '?' cards to view)*:



(Note: when the subject placed the mouse over the '?' cards, they 'flipped' to show that they are a mix of BLACK cards and WHITE cards)

Click here to continue

p. 7

Practice Choice 1 (Not for money)

You will make choices between betting on a colour or colours for which you know the chance of winning, and a colour or colours for which you do **NOT** know the chance of winning.

For example, in the following practice choice:

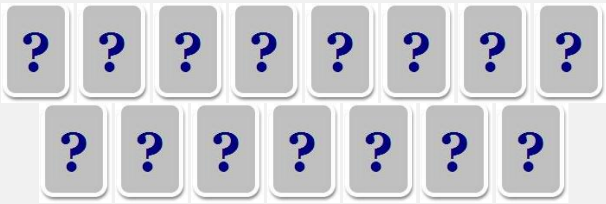
If you bet on RED, your chance of winning is 29% (because the number of RED cards is 6 out of a total of 21 cards in the deck).

If you bet on WHITE, your chance of winning ranges from 0% to 71% (because the number of WHITE cards can range from 0 to 15 out of a total of 21 cards in the deck).

---

6 Red cards

15 White or Black cards



Please click on your choice of winning card

29% Red **From 0% to 71% White**

Red White

p. 8

Practice Choice 2 (Not for money)

In the following practice choice:

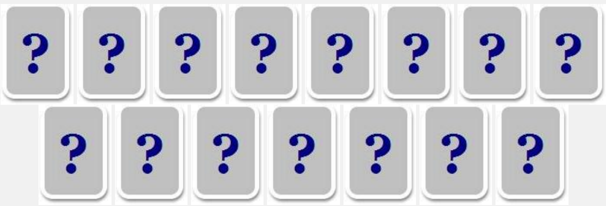
If you choose 'RED and WHITE', you win if the third card from the top in the shuffled deck is RED or WHITE. Your chance of winning ranges from 29% to 100% (because the number of cards that are RED or WHITE can range from 6 to 21 out of a total of 21 cards).

If you choose 'WHITE and BLACK', you win if the third card from the top in the shuffled deck is WHITE or BLACK. Your chance of winning is 71% (because the number of cards that are WHITE or BLACK is 15 out of a total of 21 cards).

---

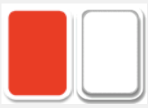
6 Red cards

15 White or Black cards



Please click on your choice of winning cards

From 29% to 100% Red or White



Red & White

71% White or Black

White & Black

p. 9

Now please get up and <u>come to the front of the room</u>, where the experimenter will show you how the deck of cards is shuffled for the two practice choices. If these had been played for real, would you have won?

When you get back, please

Click here to continue

p. 10

2. Introduction to ROUND 1 of
the main experiment (for money)

This round of the main experiment consists of **two** equally important parts. In each part, you will make three choices.

Part 1. You will choose either RED or BLACK for three different decks of cards.

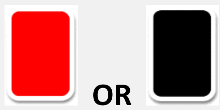
Part 2. You will choose either 'RED & WHITE' or 'WHITE & BLACK' for three different decks of cards. The decks used in this part of the experiment are the same as those used in the first part.

Click here to continue

p. 11

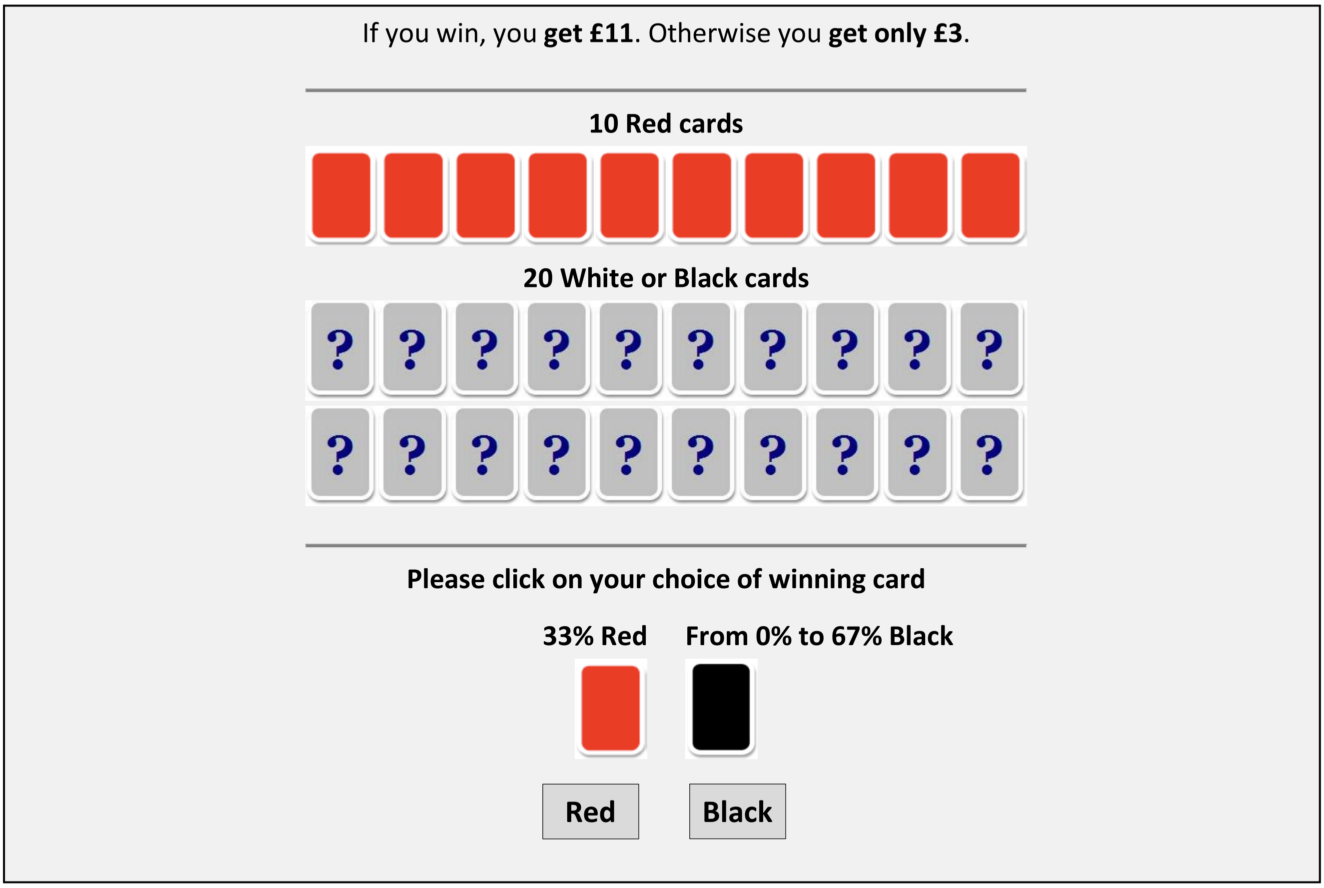
Part 1

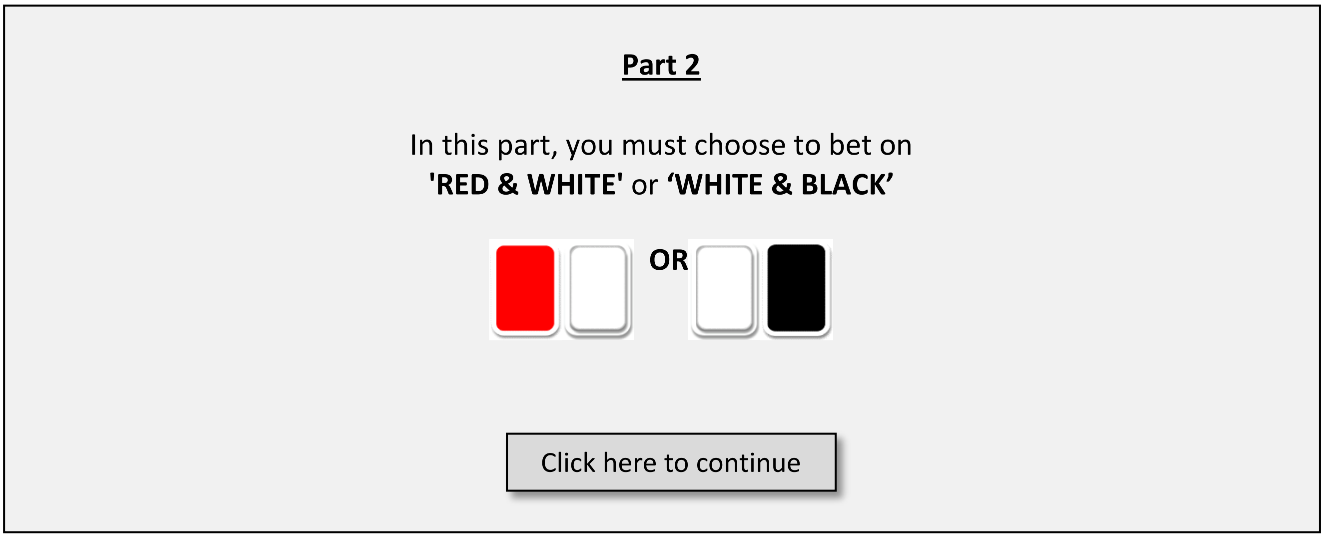
In this part, you must choose to bet on RED or BLACK



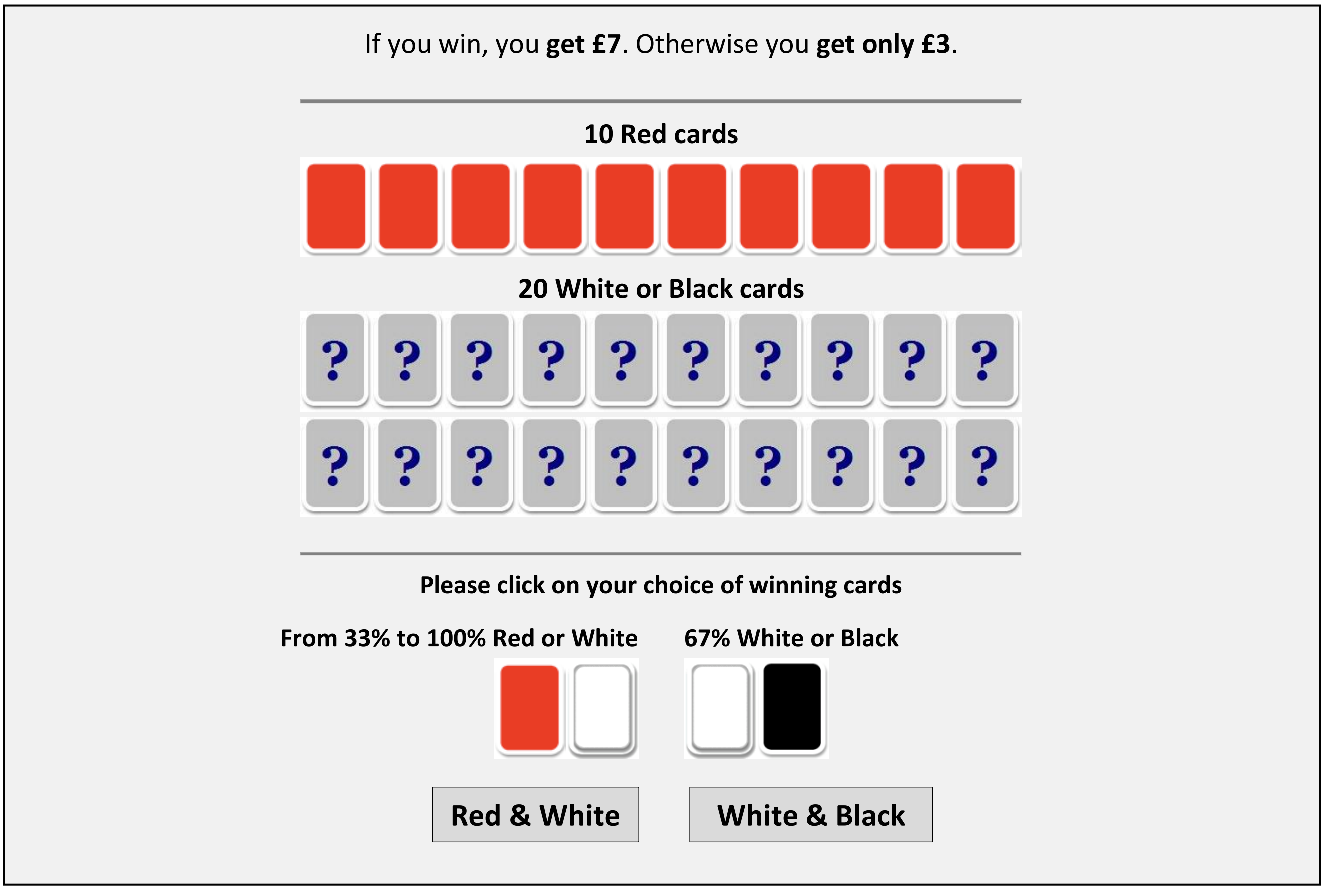
Click here to continue

A sample R_k *versus* B_a *screen*





A sample *R&W$_a$ versus W&B$_k$ screen*

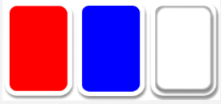


After subjects had completed both parts of round 1, the following screen was displayed:

Introduction to ROUND 2 (for money)

In this round, you will now face another six choices just like the ones you just made, except that we will be using **NEW** card decks.

The rules are the same as in the first round, but with different colours:



Part 1. You will choose either RED or BLUE as the winning card.

Part 2. You will choose either 'RED and WHITE' or 'WHITE and BLUE' as the winning cards.

Click here to continue

The same screen was displayed after subsequent rounds, except that the relevant colours changed.