Do Professional Traders Exhibit Myopic Loss Aversion? An Experimental Analysis

by

Michael S. Haigh and John A. List

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Authors: Michael S. Haigh and John A. List, University of Maryland*

Abstract: Two behavioral concepts, loss aversion and mental accounting, have recently been combined to provide a theoretical explanation of the equity premium puzzle. Recent experimental evidence suggests that undergraduate students' behavior is consistent with this "myopic loss aversion" conjecture. Our suspicion is that, much like certain anomalies in the realm of riskless decisions, these behavioral tendencies will be severely attenuated when real market players are put to the task. Making use of a unique subject pool—professional futures and options pit traders recruited from the Chicago Board of Trade—we do find behavioral differences between professionals and students. Yet, rather than discovering that the anomaly disappears, the data suggest that professional traders exhibit myopic loss aversion *to a greater extent* than undergraduate students.

Key Words: Equity premium puzzle, Futures Traders, Experiments

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Michael S. Haigh
Assistant Professor
Dept. of Ag & Resource Economics
University of Maryland
College Park, MD 20742
(301) 405 – 7205 (Tel)
(301) 314 – 9091 (Fax)
mhaigh@arec.umd.edu

John A. List
Professor
Dept. of Ag & Resource Economics
University of Maryland
College Park, MD 20742
(301) 405 – 1288 (Tel)
(301) 314 – 9091 (Fax)
jlist@arec.umd.edu

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One mainstay among economists is their fascination with anomalies and unsolved puzzles. Arguably one of the most provocative enigmas in recent years is the equity premium puzzle: given the return of stocks and bonds over the last century, an unreasonably large level of risk aversion would be necessary to explain why investors are willing to hold bonds at all (Rajnish Mehra and Edward Prescott, 1985). Recently, Shlomo Benartzi and Richard Thaler (1995) combine two behavioral concepts—loss aversion (Daniel Kahneman and Amos Tversky, 1979) and mental accounting (Richard Thaler, 1985)—to provide a theoretical explanation for the observed equity premium puzzle. While only a few experimental studies have tested Benartzi and Thaler's (1995) "myopic loss aversion (MLA)" theory, the results thus far have been quite strong: both Richard Thaler et al. (1997) and Uri Gneezy and Jan Potters (1997) have verified the existence of MLA among undergraduate students.[1]

Yet, at least since the seminal work of Gary Becker (1962), economists have recognized that it is behavior at the margin, not at the mean, that drives market outcomes. Combining Becker's intuition, with the fact that some recent studies (List, 2002; 2003) suggest that market anomalies in the realm of riskless decisionmaking are not evident (or are attenuated severely) among real economic players, the current lot of experimental studies and their verification of MLA should be viewed with caution.[2] Our suspicion is that, much like certain anomalies

[1] Extending this work, Gneezy et al. (2002) also tested for MLA among undergraduate students, but allowed for market interaction (unlike the previous studies that were only concerned with individual decision-making). They too found that their subjects exhibited MLA even though their experiment allowed for a competitive environment.

[2] This point is strengthened given that there are many reasons to suspect that professionals' behavior may differ from non-professionals' due to training, regulation, etc. (Peggy Burns, 1985; Charles Holt and A.P. Villamel, 1986). Peter Locke and Steven Mann (2000) take the argument further by suggesting that any research that ignores the use of professional traders is likely to be received passively because "ordinary" individuals, as opposed to professional traders, are unlikely to have any substantial impact on price because they are too far removed from the price discovery process.

associated with riskless decisions, MLA will be severely attenuated when real market players are put to the task.

To examine this premise, we crafted an experimental design that allowed our major treatment variable—individual experience—to be determined endogenously. This approach provides us with an opportunity to observe behavior of agents who have endogenously selected certain markets in which to earn a living, while simultaneously making use of controls afforded by an experiment. To this end, we strived to find a subject pool that would be on the opposite end of the "experience spectrum" from undergraduate students in terms of evaluating gains and losses and dealing with temporal aspects of investing. Our search concluded when the Chicago Board of Trade (CBOT) agreed to provide i) access to professional futures and options pit traders and ii) space on the exchange to carry out our experiments.

Making use of undergraduate students as our experimental control group, we find that the fifty-four professional futures and options pit traders did indeed behave differently than undergraduate students. Yet, instead of displaying a lack of MLA as we expected, the professional traders exhibited a *greater degree* of MLA than our student subjects. This finding, which provides initial evidence on the existence of MLA within key market makers in the financial economy, suggests traders prefer assets they can evaluate in a more aggregate manner. This result has considerable normative and positive implications. For example, it is directly at odds with expected utility theory, which postulates that traders prefer flexible assets (Christian Gollier et al., 1997). Furthermore, it highlights that equilibrium asset prices are inextricably linked to information feedback and portfolio flexibility.

The remainder of our study proceeds as follows. In the next Section, we describe our experimental design, our subject pool, and the details of the experimental parameters and procedures. In Section II we report our results. Section III summarizes and concludes the paper.

I. Experimental Design and Procedures

The importance of professional traders in the price discovery process is unarguable, as an essential feature of markets is that marginal traders determine prices. Thus, while certainly individual violations of economic theory are important in their own right, these violations do not necessarily suggest that market outcomes will violate economic theory. To study whether MLA is prevalent among individuals who have naturally selected into positions of marginal traders in a real marketplace, we used a straightforward 2X2 experimental design (see Table I). Because one important purpose of our project was to explore whether agents who are professional traders exhibited MLA, we used undergraduate students as our experimental control group. Using a between-person experimental design, we included both undergraduate students and professional traders in two distinct treatments: Treatment F (denoting frequent feedback) and Treatment I (denoting infrequent feedback). And, to ensure comparability with the extant literature, we closely followed an important published paper when crafting our experimental protocol and parameters.[3]

In the first part of Treatment F, subjects were confronted with a sequence of nine rounds in which they were endowed with 100 units per round (see below for exchange rate details). In each of the nine rounds, the subject decided what portion of this endowment (0 to 100 units) she desired to bet in a lottery which returned two and a half times the bet with 1/3 probability and nothing with 2/3 probability. As illustrated in the experimental instructions contained in

[3] Appendix A contains our experimental instructions for student Treatment F, which closely follow Gneezy and Potters (1997). Instructions for Treatment I are similar to Treatment F with the necessary adjustments (see below).

Appendix A, subjects were made aware of the probabilities, payoffs, and the fact that the lottery is played directly after all subjects had made their choices for that round; thus, subjects play the rounds one by one. In addition, subjects were informed that monies earned were to be summed and paid in private at the end of the experiment.

In the second part of Treatment F, similar to part 1, subjects again played a sequence of lotteries, but in this case there were two important procedural differences from part 1: i) subjects bet with monies earned in part 1 and ii) they only bet in three rounds. To determine the range of possible bets in each round of the second part of Treatment F, we summed the agents earnings from the nine rounds in part 1 and divided this figure by three.

Contrasting with this "frequent feedback" environment is Treatment I, which is identical to Treatment F except in Treatment I agents placed their bets in blocks of three. Rather than placing their round bet and realizing the round outcome before proceeding to the next round, in Treatment I agents decided in round t how much of their 100 unit endowment they wished to bet in the lotteries for each of three rounds: t, t+1, and t+2. Following Gneezy and Potters (1997), we restricted the bets to be homogeneous across the three rounds and to be between 0 and 100 units. Most importantly, after subjects placed their bets, they were informed about the combined realization of the three rounds. This contrasts with our assignment of gains and losses after each round in Treatment F, and provided heterogeneity in the evaluation period. Again, in the second part of the experiment, subjects played with their earned funds from part 1. Thus, in part 2 of Treatment I, subjects made one decision: how much of their earnings to bet in the three periods.

Previous efforts have shown that this simple framing change can have remarkable effects on betting behavior. To cite just one of the examples described earlier, using Dutch undergraduate students, Gneezy and Potters (1997) found that the average percent of endowment bet is significantly greater in the low feedback treatment compared to the high feedback treatment: 67.4 percent versus 50.5 percent. While subjective expected utility does not predict MLA, Benartzi and Thaler's (1995) theory provides an explanation for this finding. The explanation relies on loss aversion and mental accounting, which when combined can lead to the framing effects observed. To illustrate, assume that an agent is loss averse and weighs losses relative to gains at a rate of $\delta > 1$. The expected utility of the gamble in Treatment F is therefore $1/3(2.5) + 2\delta/3(-1)$, which takes on a positive value if $\delta < 1.25$. An agent in Treatment I, on the other hand, may view her expected utility per decision task as follows: $1/27(7.5) + 6/27(4) + 12/27(0.5) + 8\delta/27(-3)$, $2\delta/3(-1)$, which is positive if $\delta < 1.56$, making the lottery sequence in Treatment I more attractive than the lottery sequence in Treatment F.

As summarized in Table I, we recruited 64 subjects for our student treatments from the undergraduate student body at the University of Maryland. Each treatment was run in a large classroom on the campus of the University of Maryland. To ensure that decisions remained anonymous, the subjects were seated far apart from each other. The trader subject pool included 54 traders from the CBOT.[4] Each of the trader treatments was run in a large room on-site at the CBOT. As in the case of the students, communication between the subjects was prohibited and the traders were seated such that no subject could observe another individual's decision.

Prior to moving to a discussion of the experimental results, a few noteworthy aspects of our experimental design merit further consideration. First, all treatments were run with pen and

[4] We refer to all subjects recruited from the CBOT as "traders". In practice, however the 54 traders recruited consisted of locals, brokers, clerks and exchange employees (e.g., floor managers or market reporters) who worked in the open outcry environment. Given that we found no statistical difference between floor participant types, we pool participants and collectively call them "traders". Note that this finding is intuitive since the average non-local/broker had accumulated approximately 9 years of floor experience and many reported to have had several years of experience as either a local or broker. Finally, the average trader (including non-locals/brokers) was involved with about 537 traded contracts daily. These factors combined suggested that we could pool the data and collectively name the participants as traders.

paper. After subjects made their decisions and the lottery results were realized, experimenters circulated to ensure that payoffs were calculated correctly. Then the agents made their decisions for the next decision period. Second, in the student treatments the exchange rate was 1:1 (1 cent for each unit), and in the trader treatments the exchange rate was 4:1 (4 cents for each unit). The different exchange rates served the purpose to control for stake effects across subject pools. Our decision to quadruple the stakes for traders was based on a detailed discussion with CBOT officials about trader wage rates.[5] Third, data for the student (trader) treatments were gathered in four (four) distinct sessions and no subject participated in more than on treatment.

II. Results

Our key comparative static result is an examination of behavioral differences across frequent and infrequent treatments between subject types. Since MLA suggests that the average bet in Treatment F should be less than the average bet in Treatment I, we begin by directly comparing betting levels from part 1 of the experiment. Figure I and the upper left quadrant of Table II summarize our major experimental results. The data clearly indicate the presence of a treatment effect. For instance, Figure I and Table II reveal that while traders bet, on average, nearly 75 units in treatment I, they bet only 45 units in Treatment F. Column 5 in Table II shows that this difference in betting rates is statistically significant at the $p < .01$ level ($z = -5.58$) using a non-parametric Mann-Whitney test, which has a null hypothesis of no treatment effect, or that

[5] CBOT officials suggested that designing a 30-minute game with an expected average payout of approximately $30 was more than a reasonable approximation to an average trader's earnings for an equivalent amount of time on the floor (in our experiment the median trader's earnings for approximately 25 minutes of their time turned out to be about $40.00, see Table II). Among the traders, approximately 48% reported to trade commodities, 41% traded financial instruments and 11% traded both. However, because different assets trade at different hours in the open outcry setting (e.g., most commodities 9:20am – 1:15pm CT, and most financials 7:20am – 2:00pm CT), the average floor trader would be working in the open outcry environment for approximately 5 hrs 5 minutes suggesting that at this rate a trader would earn approximately $128,100 per year (based on 250 trading days in the open outcry environment). This is considerably greater than the average amount that the median trader reported to earn to us (between $40,000 - $49,000 per year). Therefore, it seems that the payoffs in our experiment warranted the traders' attention. Indeed, post-experimental discussions with the traders indicated that these stakes were salient.

the two samples are derived from identical populations.[6] As results in rows 1-3 in Table 2 suggest, this finding holds for every block of three rounds in part 1.

Our student data, which are consonant with results presented in Gneezy and Potters (1997), exhibit a similar pattern (albeit not as striking): in Treatment I subjects bet on average 62.50 units versus 50.89 units in Treatment F. While this difference is significant at the $p < .01$ level using a Mann-Whitney test ($z = -2.94$), differences in the round blocks are not always significant at conventional levels. Nevertheless, these results, combined with Gneezy and Potters (1997), suggest that the extent of MLA across student subject pools is quite stable.

More importantly for our purposes, Figure I highlights an unexpected data pattern across subject pools: in stark contrast to our expectations, in Treatment F traders bet *less* than students, whereas in Treatment I they bet *more* than students. Comparing student and trader data in Treatment I (column 8 in Table II), we find that traders bet significantly more than students at the $p < .01$ level ($z = 3.05$). This difference in betting behavior is also observed at the round level, although the difference is not statistically significant for rounds 1-3 at conventional levels. Turning to Treatment F, while traders consistently bet less than students, the differences are never statistically significant at conventional levels. Yet, combining the results across part 1 of Treatments F and I provides a surprising insight: *traders fall prey to MLA to a greater degree than students*.[7] While several key experimental parameters have changed, one potential

[6] The fact that subjects are confronted with an upper (100) and lower (0) bound, the distribution must be non-normal. Moreover, results from the Kolmogorov-Smirnov test confirm the non-normality of the data. All Mann-Whitney results are corrected for the presence of ties.

[7] Although analysis of the raw data provides sharp evidence, there has been no attempt to control for the panel nature of our data. To provide a robustness test, we estimate the following panel data regression model: $bet = f(\beta`Z) + \omega_{it}$; where Z includes a set of treatment (I or F) and subject characteristics (student or trader), and $\omega_{it} = u_t + \alpha_i + e_{it}$; $E[\alpha_i] = 0$, $E[u_t] = 0$, $E[\alpha_i^2] = \sigma_\alpha^2$, $E[u_t^2] = \sigma_u^2$, $E[\alpha_i\alpha_j] = 0$ for $i \neq j$, $E[u_t\alpha_z] = 0$ for $t \neq z$, and u_t, α_i, e_{it}, are orthogonal for all i and t. α_i and u_t are random effects which control for unobservable subject and time effects; e_{it} is the well-behaved error term. Even after controlling for time and subject specific effects, our results strongly support the conclusions from the raw data: *traders fall prey to MLA to a greater extent than students*.

explanation for why this particular behavioral anomaly is immutable and anomalies associated with riskless decisionmaking are labile (List, 2002; 2003), is that behavior over risky decisions may represent a much different cognitive process than riskless decisionmaking draws upon.

In part 2 of the experiment, subjects bet their own funds and therefore the level of endowment was equal to 1/3 of the subject's earnings (E) from part one. Therefore, for both subject pools the level of the bet (Y) and the percent of the bet (W) are of interest, where Y $= \sum_{10}^{12} X_t (\leq E)$ (and $X_{10} = X_{11} = X_{12}$) for Treatment I. The percent of the bet (W) is simply equal to 100Y/E. Summary statistics of both of these variables are presented in the lower portion of Table II.

The pattern of results for personal funds is consistent with betting patterns observed in part 1. In both relative and absolute terms, traders exposed to less information (Treatment I) bet larger quantities at the $p < .01$ level ($z = -2.07$ and $z = -2.33$). These differences are also economically significant: whereas traders bet approximately 60 percent of their funds in Treatment I, they bet less than 40 percent in Treatment F. We find it incredible that the mere fact of a simple framing of information feedback would induce professional traders to increase their betting levels by 50 percent. While the empirical results in part 2 are not as strong for student subjects, using a one-sided alternative the level and percent bet are significantly different across Treatments F and I at the $p < .049$ and $p < .155$ levels (see column 6 in Table II). Combining student and trader results suggests, again, that professional traders exhibited a greater degree of MLA than students.[8]

[8] But here the differences are only marginally significant: using a one-sided alternative Treatment I differences are significant at the $p < .12$ level (see column 8 in Table II).

III. Concluding Remarks

Two behavioral concepts, loss aversion and mental accounting, have been cleverly combined to provide a theoretical explanation of the equity premium puzzle (Benartzi and Thaler, 1995). Although only a few empirical tests have been carried out to explore the predictive powers of the theory (e.g., Thaler et al., 1997; Gneezy and Potters, 1997; Gneezy et al., 2002), the experimental tests to date have provided strong results in favor of the theory. Yet, these experiments, like many economics experiments, are open to criticism because they are based on observing the behavior of undergraduate students. This can be problematic because students' behavior may not be representative of behavior in naturally occurring environments, where selection effects may have created distinct populations of economic decision-makers. Combining this insight with the fact that recent studies indicate that market experience eliminates, or severely attenuates, market anomalies in riskless settings (List, 2002; 2003) implies that the current evidence in favor of MLA should be viewed with caution.

To provide some initial insights into the role that experience plays in potentially attenuating MLA, we recruited fifty-four experienced futures and options floor traders from the CBOT. Making use of undergraduate students as our control group, we find an unexpected result: while both traders and students fall prey to MLA, traders fall prey to MLA to a *greater* extent than students. At a fundamental level, this result is important since our marginal traders, which are vital components in the price discovery process exhibit more evidence of MLA than <u>any</u> other subject pool that has been evaluated to date. More broadly, our findings suggest that expected utility theory may not model professional traders' behavior well, and this finding lends credence to behavioral economics and finance models, which are beginning to relax the rationality assumptions used in standard financial economics.

Table I. Experimental Design

Subject Type	Treatment F	Treatment I
Students	32	32
Traders	27	27

Note: Numbers represent sample sizes. Treatment F had subjects placing bets in two parts. Part 1 included nine rounds and part 2 included three rounds. After each round the subject was informed of the outcome. Treatment I was identical except subjects placed bets for three rounds at a time rather than for each round. Thus, subjects in Treatment F received frequent feedback, whereas subjects in Treatment I received infrequent feedback.

Figure I. Summary of Part 1 Betting Patterns

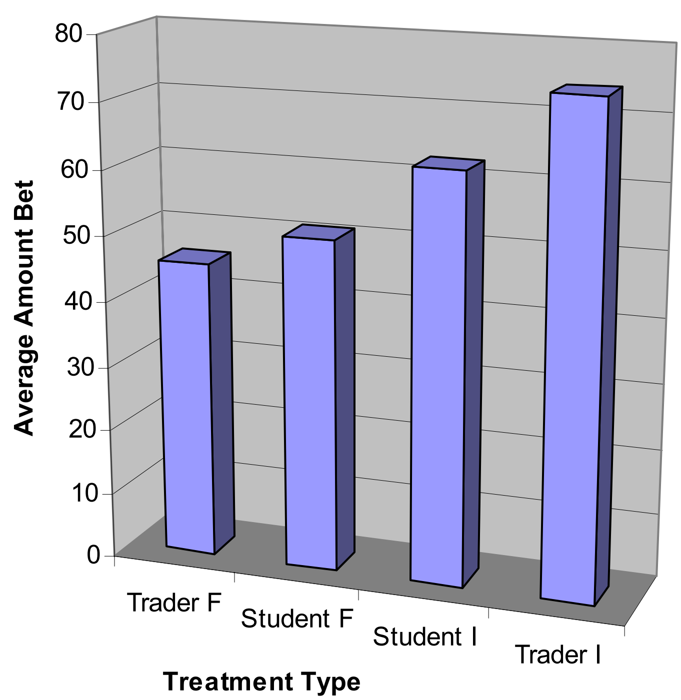

Table II. Evaluating and Comparing the Betting Patterns for Traders[a] and Students[b].

	Mean and (Standard deviation) bets in Frequent (F) and Infrequent (I) Treatments				Mann Whitney z statistics and [p-values]			
	Trader F	*Trader I*	*Student F*	*Student I*	*Trader F v Trader I* [c]	*Student F v Student I* [c]	*Trader F v Student F* [d]	*Trader I v Student I* [d]
					Round 1			
Rounds 1- 3	48.85 (30.88)	66.22 (27.50)	42.77 (31.16)	56.50 (25.75)	-2.19 [0.014]	-2.35 [0.009]	0.82 [0.411]	1.40 [0.162]
Rounds 4 – 6	39.10 (33.11)	75.56 (24.58)	51.77 (30.64)	62.72 (26.69)	-3.90 [0.000]	-1.48 [0.069]	-1.64 [0.101]	2.02 [0.044]
Rounds 7 – 9	48.83 (34.24)	81.41 (22.74)	58.13 (28.52)	68.28 (26.88)	-3.55 [0.000]	-1.45 [0.073]	-1.10 [0.272]	1.98 [0.048]
Rounds 1 – 9	45.59 (32.69)	74.29 (25.49)	50.89 (30.48)	62.50 (26.56)	-5.58 [0.000]	-2.94 [0.002]	-1.165 [0.244]	3.05 [0.002]
					Round 2			
Level of bet (Y)	362.04 (321.10)	538.00 (345.17)	377.22 (391.31)	502.88 (381.78)	-2.07 [0.019]	-1.66 [0.049]	-0.18 [0.855]	0.45 [0.653]
Percent Bet (W)	39.39 (34.89)	59.73 (32.05)	40.88 (31.08)	49.34 (33.86)	-2.33 [0.010]	-1.02 [0.155]	-0.51 [0.610]	1.18 [0.239]
Total Earnings for Rounds 1 and 2 (Z)	977.00 (601.63)	1017.54 (768.44)	956.05 (868.93)	1281.79 (910.13)	-0.11 [0.455]	-1.61 [0.053]	0.92 [0.357]	-0.47 [0.637]

a. N = 54 equally divided between the High and Low frequencies.
b. N = 64, equally divided between the High and Low frequencies.
c. [p –values] associated with the Mann-Whitney z score is based on one-tailed significance.
d. [p –values] associated with the Mann-Whitney z score is based on two-tailed significance.

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Appendix A. Experimental Instructions for Student Treatment F

Instructions for part 1

Part 1 of the experiment consists of 9 successive rounds. In each round you will start with an amount of 100 units (1 unit = 1 cent). You must decide which part of this amount (between 0 units and 100 units) you wish to bet in the following lottery:

> You have a chance of 2/3 (67%) to lose the amount you bet and a chance of 1/3 (33%) to win two and a half times the amount you bet.

You are requested to record your choice on your Registration Form. Suppose you decide to bet an amount of X units (100 ≥ X ≥ 0) in the lottery. Then you must fill in the amount X in the column headed *Amount in lottery*, in the row with the number of the present round.

Whether you win or lose in the lottery depends on your personal *win color*. This color is indicated on top of your individual sheet. Your win color can be Red, Blue or White, and is the same for all 9 rounds. In any round you win in the lottery if your win color matches the *round color* that will be drawn by the assistant, and you lose if your win color does not match the round color.

The round color is determined as follows. After you have recorded your bet in the lottery for the round, the assistant will, in a random manner, pick one color from a cup containing three colors: Red, Blue, and White. The color drawn is the round color for that round. If the round color matches your win color you win in the lottery; otherwise you lose. Since there are three colors, one of which matches your win color, the chance of winning in the lottery is 1/3 (33%) and the chance of losing is 2/3 (67%).

Hence, your earnings in the lottery are determined as follows. If you have decided to put an amount of X units in the lottery, then your earnings in the lottery for the round are equal to -X if the round color does not match your win color (you lose the amount bet) and equal to +2.5X if the round color matches your win color (you win two and a half times the amount bet).

The round color will be shown to you by the assistant. You are requested to record this color in the column *Round colors*, under *win* or *lose*, depending on whether the round color does or does not match your win color. Also you are requested to record your earnings in the lottery in the column *Earnings in lottery*. Your total earnings for the round are equal to 100 units (your starting amount) plus your earnings in the lottery. These earnings are recorded in the column *Total earnings*, in the row of the corresponding round. Each time we will come by to check your Registration Form for errors in calculation.

After that you are requested to record your choice for the next round. Again you start with an amount of 100 units, a part of which you can bet in the lottery. The same procedure as described above determines your earnings for this round. It is noted that your private win color remains the same, but that for each round a new round color is drawn by the assistant. All subsequent rounds will also proceed in the same manner. After the last round has been completed, your earnings in all rounds will be summed. This amount determines your total earnings for part 1 of the experiment. Then the instructions for part 2 of the experiment will be announced.

Instructions for part 2

Part 2 of the experiment is almost identical to part 1, but differs in two respects. First, part 2 consists of 3 rounds (instead of 9 rounds). Second, in part 2 you do not get any additional starting amount from us. You play with the money that you have earned in part 1. To that purpose, we first divide your earnings in part 1 by three. The resulting amount is your *starting amount S* for each of the three rounds. Again you are asked which part of this amount (between 0 and S) you wish to bet in the lottery.

> You have a chance of 2/3 (67%) to lose the amount you bet and a chance of 1/3 (33%) to win two and a half times the amount you bet.

You are asked to record your choice on the Registration Form. Suppose you decide to bet an amount of X units ($S \geq X \geq 0$), then you must fill in the amount X under *Amount in lottery*.

Your private *win color* is the same as in part 1 and can be found on top of your Registration From. After you have recorded your bet for the present round, the assistant will again, in a random manner, pick one color from a cup containing three colors: Red, Blue, and White. The color drawn is the *round color*. If this round color matches your win color you win in the lottery, otherwise you lose.

If you have decided to bet an amount X in the lottery, then your earnings in the lottery are equal to -X if the round color does not match your win color (you lose the amount bet for the round) and equal to +2.5X if the round color does match your win color (you win two and a half times the amount bet for the round).

You are again requested to record the round color and your earnings in the lottery on the Registration Form. Your total earnings for the round are equal to your starting amount S plus your earnings in the lottery. You are asked to record these on your Registration Form. We will come by to check your form for errors.

After that you are requested to make your choice for the next round. Again you can choose to bet part of your starting amount in the lottery. The same procedure as described above determines your earnings. Round 3 will proceed in the same manner. After that, your earnings in the three rounds will be added. This amount determines your total earnings in part 1 and 2 of the experiment.