Merit and Justice: an experimental test

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Abstract

Merit and justice have a crucial role in ethical theory, and political philosophy. Some theories view as justice as allocation according to merit. Others view justice as holding criteria of its own and viewed as two opposite, independent values. We study experimentally their nature, and their relationship. In our experiment subjects play two games against the computer: a game of skill and a game of luck; after each game they observe the earnings of all subjects in the session. Each subject could reduce the winnings of one other person at a cost to himself.

The majority of subjects used the option to subtract. The decision to subtract and the amount subtracted depend both on whether the game was skill or luck, and the distance between the earnings of the subject and those of others. For fixed distance, subjects subtract more in luck than in skill. In skill games the subtraction becomes more likely, and the amount larger, as the distance increases. The results show that individuals consider favorable outcomes in luck as undeserved, hence they feel more justified to subtract. They instead consider positive outcomes (their own and others') in skill as signal of skill and effort, hence deserving merit; hence they feel more motivated to subtract.

We conclude that merit is attributed if and only if effort or skill affect outcome, and inequality of outcomes is viewed differently depending on whether merit originates the difference or not. Thus, merit and justice are strongly linked in the perception of individuals, and they should be in the our concept of a good society.

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1 Introduction

Homo faber suae quisque fortunae
Appius Cladius Caecus

The relationship between merit and justice has been a permanent theme in the philosophical debate. But no consensus has been reached. At one of two extremes we have theories that identify justice and desert, going back to Aristotele, and later developed by John Locke and John Stuart Mill. The common ground for these theories is that a system is just if it allocates rewards according to merit.

At the other extreme, we have conceptual structures like Rawls', which proceeds from the idea of justice as fair allocations, and separates the foundation of justice from merit. A corollary of this general position is that income and wealth, and the goods things in life, should not be distributed according to moral desert ([19], [20], II, 20). The proof of this corollary is clear: The principle of rewarding according to merit would not have been chosen in the original position. Moral desert as moral worth of character and actions is what is questioned: Rawls recognizes that previous rules and agreements have to be respected. These agreements produce legitimate claims and earned entitlements, and the expectations produced by these agreements are legitimate. But they are a replacement ([20], page 73) for moral desert.

This paper was stimulated by the analysis that Sen made of the conceptual link between the merit and justice (in ([22]), which provides a very clear and forceful criticism of the adoption of reward criteria based on merit. Sen’s argument proceeds from the consideration of two possible justifications for systems that reward merit. The first (action propriety) grounds this justification not on the outcomes of the action, but on the propriety of the action itself. In Adam Smith’s view, an action is considered proper if we introspectively consider it appropriate for the situation, when we reproduce in us the affective response that the situation induces. Introspective evaluation requires viewing the situation from the point of view of the other. When we apply this general criterion of propriety to merit, we conclude that an action deserves merit if in contemplating it we feel prompted to reward.

The second (incentive) sees rewarding merit as a tool to motivate individuals to choose one action rather than another. The purpose of this tool, and a

\[1\] “Everyone agrees that justice [...] must be in accordance with some kind of merit”. [2]

\[2\] In presenting this argument, Rawls explicitly reminds us of the dependence of merit on the idea of good, and observes that lack of agreement on this deprives moral desert of legitimacy: “Having conflicting conceptions of the good, citizens cannot agree on a comprehensive doctrine to specify an idea of moral desert for political purposes.” ([20])

\[3\] “To us, therefore, that action must appear to deserve reward, which appears to be the proper and approved object of that sentiment, which most immediately and directly prompts us to reward, or to do good to another.” ([23], II, I, 1.
measure of its success, is the outcome that this action produces. In this view, actions have no intrinsic positive quality, but only one derived from the outcomes they produce. It is an instrumental view of merit. Sen notes that the incentive view is currently the dominant one among the two proposed, particularly in the economics literature, and on that view he focuses his attention. In modern microeconomic theory, a formal statement of the justification of the incentive view is in the class of Principal Agent models that characterize optimal contracts as a payment depending on outcome. We note in passing that even in those models the connection between incentives and merit is problematic. In the optimal contract between a risk-averse agent and a risk-neutral principal who can only imperfectly observe the action of the agent, the principal’s payment depends on factors that are beyond the control of the agent. At equilibrium typically the action of the agent, although unobserved, is common knowledge to the two parties: still, payment depends on outcome. Thus its variable part is entirely and explicitly dependent on random events, rather than the merit of the agent: modern economic theory clearly shows how hard it is to implement an allocation method completely based on rewarding merit.

Sen offers the key insight that if the justification of merit is instrumental and based on its ability to facilitate certain outcomes, then the desirability of those outcomes must enter into the evaluation of merit. Here a tension arises between merit and justice. If aversion to economic inequality is one of the criteria that society shares, then the evaluation of a system that rewards merit cannot ignore that such system is by its very nature likely to create inequality. Once the values of society are considered, the very concept that is proposed to justify a system based on reward becomes a reason to reject it.

We propose here to analyze these claims and to test them experimentally. Several hypotheses seem natural, and we review them before we present the experimental design.

The first hypothesis concerns the relationship between justice and merit. A key element in the method proposed in [22] is the assumption that social values are well defined and widely accepted, independently of the attitude to merit; first among such values is the aversion to inequality. These values are the measuring rod of the desirability of social tools, like the incentives provided by rewards for merit. However, if these social values are not defined independently of merit, then such measurement is difficult, and may be inconsistent. For example, suppose that the attitude to inequality in outcomes, its strength and intensity, depends in a crucial way on the perceived merit of these outcomes. Then this two steps process (first establish widely accepted values, then use

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4 “The theory of merit, thus, needs to draw on other normative theories.” ([22], page 14).
5 “The contingent nature of merit also indicates that its relationship with economic inequality would depend very much on whether an aversion to economic inequality is included in the objective function of the society. If it is included, then merit for reward would have to be judged in an inequality-sensitive way.” ([22], page 15)
them to evaluate the desirability of merit criteria) is hard because these criteria
are already used in the first step. The question we propose to test experimentally
is whether the perception of merit affects the attitude to inequality.

A second hypothesis focuses on the nature and motivation behind inequality
aversion. Recent studies ([5], [6], [7]) have suggested that emotions may have
a functional role. Emotions like regret facilitate learning, forcing an individual
to consider counterfactual outcomes (“What I would have received had I made
a different choice”) in the evaluation of his past choices. Recent literature in
economics has further developed this theme ([18]). An emotion like envy may
have a similar functional explanation, forcing us to learn from the fortunes of
others (“What I would have received had I done like he did” ([3]) to do a better
use of our own abilities. Such interpretation of social comparison processes was
first proposed in social psychology by Festinger ([11], [12]); in this view, envy is
the social correspondent of regret. But this functional role is meaningful only
when the outcomes of others have merit. Clearly, there is much more to learn
from the success of others when skill and effort are responsible for the outcome,
instead of luck. We cannot learn to be lucky, but we can learn to better use our
skills if we see others performing better than we do.

A third hypothesis concerns the nature of merit, and its recognition. Just
as regret and envy are emotions underlying a social preference that manifests
itself as aversion to inequality, a different emotion may underlie a desire for our
own merit to be recognized by others. Recognition of merit is a basic social
value, just as aversion to inequality; and as such should then be considered a
criterion we apply when we measure success or failure of a society. Adam Smith
analyzes this extensively in the chapter “Of the love of praise, and of that of
Praiseworthiness.” [23]. People love praise: but “the love of praise seems, at
least in a great measure, to be derived from that of praiseworthiness”. The
two complement each other: “The love of praise is he desire of obtaining the
favorable sentiments of our brethren. The love of praiseworthiness is the desire
of rendering ourselves the proper objects of those sentiments.” [TMS, III, 2].
Love of praise is not vanity, precisely because it is aroused under the condition
that it has to be considered deserved by he who enjoys it. It is the social
recognition of a deserved merit.

We propose to test these basic conceptual assumption experimentally. More
specifically, the hypothesis we test is that individual recognize merit, and reveal
this in the attitudes they display towards differences in outcome for which there
is ground for merit (either because of the skill required or the effort employed in
it). To test this hypothesis, we need a behavioral measurement of this response,
and two treatments that clearly separate the role of skill and effort on one hand
from the one of luck.

The behavior we measure is the willingness of subjects to reduce inequality
in outcomes, which they can do by subtracting money earned by others. The
separation between merit (here equal, in a Michael Young ([30]) manner, to
the sum of IQ ad effort) and luck is achieved by using two tasks in which the outcome is clearly dependent by skill and effort in one case and on simply luck in the other.

2 Experimental Design

In the experiment the subjects played two different games against the computer: a game of skill ($S$) and a game of luck ($L$). The games were described to subjects as “Hare and Hounds” and “Guessing game”. The game of skill was a board game with two players: the subject and the computer. To win against the computer the subject needed to use some logical and analytical skills. In the game of luck each subject had to guess a number between 0 and 100, and won if the number was no more than ten units away from a second number randomly generated by a computer. Thus the score won by the subject was entirely determined by chance. Both games were played consecutively for 10 times. After each of the two games the subjects had a possibility to subtract money from one other participant in the experiment. They could also choose to do nothing. If they choose to subtract money from somebody, that person would then be paid less money at the end of the experiment. The subjects did not know from whom they are subtracting money.

The experiment had two order treatments: $SL$ and $LS$. In the $SL$ treatment subjects played the game of skill first, then had a chance to subtract money. After this, they played the game of luck and then again had a chance to subtract money. In the $LS$ treatment the order was reversed: first the game of luck was played and then the game of skill (with subtractions after each game).

All sessions were conducted at the University of Minnesota. A total of 75 subjects participated in the $SL$ treatment in 5 groups of 13 to 16 people. In $LS$ treatment there were 7 groups of 8 to 16 people with 93 subjects in total. All subjects were undergraduate students taking classes at the University. Each session lasted approximately 45 minutes. Most of the subjects had never participated in economics experiments before.

2.1 Game of Skill

The game of skill is the classic Hare and Hounds. Subjects played in the role of hounds and the computer played as hare. The hounds have to trap the hare, and the hare is trying to escape. The hare is trapped if no move is feasible when its turn comes. The two players (subject and computer) alternate in moving. The subject can choose one and only one hound to move, and he can only move to the right or vertically (up or down) by one cell. The hare can move by one cell in any direction. The hare is declared a winner when it passes to the left

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6The game is available on line at www.mazeworks.com
of all three hounds, so that capture is impossible. Neither player can choose to move a piece to an occupied position. To move a hound subject has to drag and drop it to the cell where she wants to move it. Illegal moves are not allowed by the program. A detailed description of the rules of the game as they were presented to subjects is reported in the Appendix 5.

Subjects had 20 minutes to play 10 games. They earned $1 for a game won, and nothing for a game lost. Subjects played at different pace: those who completed 10 games earlier than others were allowed to continue playing without earning any more money. The original program has three levels of difficulty. In the experiment the level was set to intermediate. The computer selected the move following an artificial intelligence program, also described in www.mazeworks.com.

2.2 Game of Luck

Subjects were asked to guess a number between 0 and 100 that was then randomly chosen by the computer. If subject’s guess was within a distance of 10 units from the number chosen by the computer on either side, then the subject earned $1. If it was further than that, the subject earns nothing (see Appendix 5.2 for the exact instructions). The game was played 10 times.

2.3 Subtraction

After playing each game 10 times, subjects were told the amount of money they had won in that game. Then they were proposed a choice to subtract money from another subject, or choose not to do it (see [28] for the possibility given to subjects to subtract money from others in an experimental environment).

Three possibilities were available. A subjects could subtract an amount from one of other subjects and pay for this. Else, he could choose to subtract $1 with probability 0.25 from one other subject and pay nothing. Finally, he could choose to do nothing. In the first case, if subject decided to subtract, say, an amount of $x dollars from somebody, he had to pay $0.1x dollars for it. Both amounts of money would be lost, and not transferred to anybody. A limit on subtractions was imposed so that no subject could lose more than he earned. Also, the subjects who decided to subtract money and pay for it could spend more money in payments than they have. The detailed instructions are reported in the Appendix 5.3. It was clear to the subjects that no part of the amount subtracted was paid to him or to anyone else. Subtraction was completely anonymous. The subject’s screen reported a list of amounts earned by all other subjects in that session. If two subjects won the same amount two entries with that amount would be presented. The option of no subtraction was indicated by the item “nobody”, which appeared in random position in the list. Each subject lost the total amount subtracted in real dollars from him, and the
payment for the subtraction when he chose the costly option.

2.4 Treatments

The experiment had two order treatments: \( SL \) and \( LS \). In the first treatment the order was: skill game, subtraction phase, display of current earnings, luck game, subtraction phase, and finally display of total earnings for each subject in the experiment. Thus, in \( SL \) treatment the first time subjects learned about the subtraction phase was after they play skill game 10 times. The first time they learned about the luck game was after the first subtraction phase. When luck game instructions were given, subjects were not told anything about what would happen afterwards, so their behavior was not influenced by the future subtraction phase. In the second treatment, the order was reversed: first the luck game was played, then the subtraction phase took place, then the current winnings were displayed, then the skill game, then second subtraction, then the display of total earnings.

After the first subtraction phase in both treatments the subjects were shown the amount of money that they won in the first game. This amount was equal to the sum of the money earned playing the game minus the amount of money that was subtracted from them minus the payments for subtraction. Therefore, the subjects could compute how much money they lost after the first game. At the end of the experiment subjects received a participation payment of $10 plus their winnings after both games net of subtractions and payments for subtractions.

3 Results

3.1 How much skill does the skill game require?

An essential component of the experiment is the different nature of the two games. The game in which subjects have to guess a number is clearly a game of luck, and the instructions clearly stated that the computer was going to pick the number randomly. The game of Hare and Hounds instead has some complexity, at least for unexperienced players like the subjects in the experiment.

To illustrate the complexity, consider the optimal strategy presented in [4], Chapter 21. In all trials of the experiment the initial position \(^7\) was such that the hounds player (in our experiment, the subject) wins if he uses the optimal strategy. This strategy however is complex. A way to describe is to first assign a number between 0 and 3 to every cell, and then classify the position of the four animals on the board according to the sum of these values. The winning strategy consists in keeping this sum equal to 3 at every move. It is highly unlikely that subjects understood this strategy and the underlying classification. No evidence

\(^7\)The hounds were placed in three leftmost cells and the hare in the rightmost cell of the display in www.mazeworks.com
of this is given in the debriefing notes at the end of the experiment. Instead, subjects displayed in their decisions and their statements some understanding of how to avoid the most obvious mistakes, and the ability to look ahead in the next two or three moves of the hare.

We may conclude that the Hare and Hounds game was likely perceived by the subjects as a game of skill for the entire set of ten rounds. There was also a sufficient dispersion in the outcome: the mean of the distribution of the amount won is 4.875 with standard error 0.153. The game was, within the limits of the time and possible learning, neither too hard nor too easy.

### 3.2 Decision to Subtract

Subjects choose to subtract frequently: on average, 67.8% of the times. The frequency is similar in the skill games (66.6%) and in the luck games (69.1%), and in a non-parametric test the difference between the two is not significant (Two-sample Wilcoxon-Mann-Whitney rank-sum test, $z = 0.467$, $p = 0.64$). But if we consider the effect of the social distance, measured by the difference between amount earned by the subjects and others, the picture changes completely.

Table 1 reports the effect of the logit estimate of the probability that a subject subtracts money from someone else. The dependent variable is equal to 1 if the subject decides to subtract money from others, either with the costly option or with the zero-cost option. The independent variables are a measure of the distance between the amount earned by the subject and that earned by others, the type of game (Skill or Luck) and the interaction between these two variables. The distance between amounts earned is measured by the variable Gap, which will be described in two steps. First, we define for each subject the difference between the maximum score obtained by any subject, in that game and session, and the score of the subject in the observation. Then we take the maximum difference in the session of the variable just defined. The variable Gap is the ratio of these two variables; so it is the normalization between 0 and 1 of the difference between the maximum score and the score of the subject. The variable Skill is equal to 1 if the game is a game of skill, and 0 if the game is a game of Luck. Standard errors are adjusted for clusters in the identity of the subject, since we have two observations for each subject (one for the Skill and one for the Luck game).

**Place Table 1 here**

Consider Model 3 in Table 1. The Gap variable has no direct significant effect, but has significant effect when interacted with Skill. Everything else being equal, subjects subtract less in a skill game: the coefficient of the variable Skill is negative and significant (coefficient = -1.26, $z = -3$, $p = 0.003$). However, the response to the Gap variable is stronger in the Skill game than in the Luck game: the coefficient of the interaction between the two is positive and significant,
(coefficient = 2.31, $z = 3$, $p = 0.003$). The results are virtually unchanged if we restrict the same analysis to observations where subjects are playing the first game (for example, when subjects play the skill game in the SL treatment), and have no previous experience with the subtraction decision of others. The logit regression restricted to these observations has coefficient = -1.88 ($z = -2.633$, $p = 0.009$) for the Skill variable and coefficient = 3.52 ($z = 2.95$, $p = 0.003$) for the interaction term. \(^8\)

The size of the interaction between the two variables Gap and Skill on the probability of the subject subtracting money from some other subjects is estimated in Table 2. \(^9\)

**Place Table 2 here**

The interaction effect is large: the Gap variable adds an average of 48% (or 71% when we only consider the first game) to the probability of subtracting in skill over the range of its value, while in luck games the effect is statistically zero. In other words, the probability of subtracting is approximately constant with respect to Gap in the luck games. Instead, in skill games the probability increases from values lower than in the luck games when the gap is small, to values that are higher when the gap is large. The two curves cross since the average probability is, as we have just seen, the same in the two games. The crossing is illustrated in the left panel of Figure 1.

**Place Figure 1 here**

The size of the interaction effect is different in the skill and luck games: this is reported in the right panel of Figure 1. Note that on the horizontal axis we report the probability of subtraction. The figure clearly displays two branches: a steep increasing one for the luck games, a flatter, decreasing one for skill. The reason for this pattern is clear. As we have seen, the probability of subtraction in luck games is almost constant around its mean rate, so the corresponding branch in the estimate of interaction effects is almost vertical.

Finally, an estimate of the logit regression of the gap variable, separately for the Skill and Luck games, has a direct interpretation. In the Luck regression, the marginal effect of Gap is statistically zero (marginal effect = $-0.11$, $z = -0.99$, p-value = 0.322 ). In the Skill games the marginal effect is significant, positive and large (marginal effect = 0.393, $z = 3.17$, p-value = 0.002).

So far we have considered the decision to subtract or not. The analysis of how the amount subtracted depends on the Gap and Skill variables are similar.

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\(^8\)See Model 4 in the Table 1  
\(^9\)Since the model in non-linear (with a logit specification) we use the estimation of effect size and significance with the method described in [1], [17]. The interaction, in a non-linear model, varies with the values of the two variables.
Table 3 reports the regression of the amount subtracted by subjects who are willing to subtract at a cost.

**Place Table 3 here**

Subjects also had the option of subtracting 1 dollar with probability 25%, at no cost. To include this second decision in the analysis we add to the amount subtracted at a cost a 25 cents equal to the expected amount subtracted with the no-cost option. The results of the analysis for this second amount are reported in Table 4.

**Place Table 4 here**

The model estimated on observations where subjects play the first game has good significance ($F(3, 67) = 7.48$, p-value $< 0.0005$ for the amount, and $F(3, 67) = 7.37$, p-value $< 0.0005$ for the expected amount). Subjects subtract approximately 2.4 dollars per dollar-unit of gap ($t = 2.49$, p-value $= 0.014$) and 2.5 dollars per dollar-unit of gap for the expected amount ($t = 2.38$, p-value $= 0.019$). The variable Skill has a negative coefficient, as it had in the decision to subtract, but not significant.

The total amount subtracted does not take into account the amount earned by the subject from whom the money earned is subtracted. We will refer to this latter subjects as the “target” subject. We want now to examine whether the fraction is also affected by the nature of the game. Table 5 reports the regression of the fraction of the amount subtracted over the amount earned, over the gap, Skill, and Gap-Skill interaction variables.

**Place Table 5 here**

The same analysis when the amount subtracted is the expected amount (including the 25 cents expected value subtracted at no cost) is reported in Table 6. Model 4 reports, in both Table 5 and Table 6, the analysis restricted to the observations where subjects play for the first time.

**Place Table 6 here**

In both cases the interaction of Gap and Skill is significant and positive: when they decide the amount to subtract, subjects are more sensitive to the distance of their outcome from the one of others when the game is a game of skill, so when outcome is a signal of some hidden, important, quality. In the first game they play the coefficient is ($t = 2.74$, p value $= 0.007$ for the amount, and $t = 2.49$, p value $= 0.003$ for the expected amount)
Subjects could choose any of the others participants in the session as targets of the subtraction. The only information they had to differentiate among the others was given by the amount earned. Who among the other participants was the favorite target? Approximately half of the times, subjects who subtract, do so subtracting money from the top earner in the game. This is true in both games (49 over 112 in the skill game, and 50 over 116 in the luck game.) To estimate more precisely what was affecting the choice of the target, we analyze the fraction of the amount subtracted by the subject over the total amount earned by the target, called Fraction Subtracted/Earned in tables 7 and 8. These tables report an estimate of the effect of the amount earned by the target and by the subject on the fraction of the amount subtracted by the subject over the total amount earned by the target.

Place Table 7 here

When we consider the first game, the amount earned by the target has a positive and significant effect ($t = 3.44$, $p$-value < 0.005).

Place Table 8 here

This effect of the amount earned by the target is even stronger on the fraction of expected amount ($t = 3.59$, $p$-value < 0.0005). The amount earned by the subject has a negative and significant ($t = -2.02$, $p$-value = 0.045) effect, as one should expect because it reduces the distance between subject and target. In conclusion, the distance between the target and the subjects increases the fraction subtracted from the target.

4 Conclusions

The experimental test we run yielded several main results, which throw light on how individuals perceive the nature of justice, moral desert, and their connection. First: when they evaluate the differences in outcome, individuals take into account the origin of the inequality, what caused it or affected it, and adjust their evaluation accordingly. A difference in earnings entirely due to luck is regarded in a completely different way from one due to a combination of skill and effort. Individuals attach merit to an outcome when it is due to skill, and do not when they are due to luck. Thus, the concept of moral desert and justice are deeply connected, and one needs the other for a proper definition.

Second: when they evaluate policies providing remedy to inequality, individuals have a mixed attitude. We may see two principles in action that explain their behavior. These two principles can be clearly seen in the way in which subtraction behavior depends on the Gap in Figure 1. The first is the merit principle: personal responsibility for an outcome is the basis for merit. In the
classical conceptualization of Kleinig ([15]), moral desert is a triadic property, linking a deserving subject, a deserved object, and a basis, in virtue of which the object is deserved by the subject. A necessary condition for a basis of desert is usually taken to be personal responsibility of the subject: A subject deserves an object in virtue of some fact or event only if the subject is responsible for that fact ([8], [10], [16]). Individuals do not deserve what comes to them without responsibility, for example, if it is entirely due to chance. In the latter case it is acceptable to subtract earnings from them (for example, in the form of taxes, or, in our experiment, through direct subtraction). This principle however comes into conflict with the signaling principle: a superior performance in a skill that involves skill and effort is signal of a superior ability, while it is not when the task is only based on chance ([25], [26], [27], [14], [24]). Hence a better performance in a skill task by someone else has a stronger, and negative affective impact on the individual that observes that superior performance.

The interaction of these two principles explains the observed pattern of behavior at the moment of subtraction. If an outcome is due to chance and luck, then reduction of inequality is justified: in fact, everything else being equal, individuals subtract more in skill than in luck games. If the outcome is due to skill (or effort) the negative impact of a the gap between the performance of others and of the individual who observes is proportional to the size of the gap, which is what we observe.

A final result provides support to the hypothesis that emotions responding to comparisons of outcome among peers have a functional reason. Our results show that the individuals are more sensitive to differences due to skill than to luck, as they should because the first is a useful signal, and the second is not. This suggests a final conclusive comment. Reducing inequality makes an important social signal, filtered by emotions, less reliable. From this point of view, the notion of Homo Faber cited at the beginning acquires an important psychological significance. The notion was originally developed signified a recognition of the fact that human skill and effort, or merit, was the principal source of human accomplishments, instead of Luck. 10 Claiming the merit of human accomplishments away from the hands of Fortuna was also a way to claim that human actions should be guided on the basis of moral desert. Homo Faber is an ethical principle, not a descriptive statement.

10Sallust, in the Speech to Caesar that reports Appius’ original sentence, makes this shift clear:

It was accounted true formerly that Fortune gave as gifts kingdoms and empires, as well as the other possessions which are eagerly coveted among mortal men; for they were often found in the hands of the undeserving, as if given capriciously, and they did not remain unspoiled in anyone’s hands. But experience has shown that to be true which Appius says in his verses, that every man is the architect of his own fortune.
Table 1: Decision to subtract. The dependent variable Subtraction is equal to 1 if the subject subtracts score from someone. All Models are logit. Model 1, 2 and 3 are run estimated over all observations. Model 4 only on those in which subject played the first game of the session.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
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<td>b/se</td>
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<td></td>
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<td>(0.384)</td>
<td>(0.525)</td>
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<td>-1.885***</td>
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<td>(0.421)</td>
<td>(0.717)</td>
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<td>3.522***</td>
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</table>

Table 2: Interaction effect: Cross partial derivative of Gap and Skill on the probability of subtracting (see [17]), in the logit Model 3 (first three rows) and Model 4 (last three rows) of Table 1.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>minimum</th>
<th>maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>interaction effect</td>
<td>0.484</td>
<td>0.061</td>
<td>0.369</td>
<td>0.551</td>
</tr>
<tr>
<td>standard error</td>
<td>0.155</td>
<td>0.015</td>
<td>0.131</td>
<td>0.177</td>
</tr>
<tr>
<td>z value</td>
<td>3.098</td>
<td>0.178</td>
<td>2.808</td>
<td>3.478</td>
</tr>
<tr>
<td>interaction effect</td>
<td>0.710</td>
<td>0.103</td>
<td>0.508</td>
<td>0.823</td>
</tr>
<tr>
<td>standard error</td>
<td>0.227</td>
<td>0.036</td>
<td>0.170</td>
<td>0.278</td>
</tr>
<tr>
<td>z value</td>
<td>3.162</td>
<td>0.506</td>
<td>2.632</td>
<td>4.390</td>
</tr>
</tbody>
</table>
Figure 1: *Left Panel:* Estimated probability of Subtraction. On the horizontal axis: Gap. On the vertical axis: probability of subtracting. *Right Panel:* Estimate of the interaction effect. The interaction effect is between Gap and Skill; the underlying model is a logit. On the horizontal axis: probability of subtracting; on the vertical axis: delta method estimate of the interaction effect. In Luck games the probability is close to a constant function of the game variable, around the mean value (of 69.1 %). In skill games, the probability of subtracting varies with the Gap variable, and covers a large range.
Table 3: Amount Subtracted: this is the amount subtracted by subjects who are willing to pay for the subtraction. See Table 1 for the description of independent variables.

<table>
<thead>
<tr>
<th></th>
<th>ASModel1</th>
<th>ASModel2</th>
<th>ASModel3</th>
<th>ASModel4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>b/se</td>
<td>b/se</td>
<td>b/se</td>
<td>b/se</td>
</tr>
<tr>
<td>Gap</td>
<td>0.384</td>
<td>0.389</td>
<td>-0.152</td>
<td>-0.036</td>
</tr>
<tr>
<td></td>
<td>(0.349)</td>
<td>(0.342)</td>
<td>(0.257)</td>
<td>(0.287)</td>
</tr>
<tr>
<td>Skill</td>
<td>0.428***</td>
<td>-0.167</td>
<td>-0.059</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.153)</td>
<td>(0.343)</td>
<td>(0.583)</td>
<td></td>
</tr>
<tr>
<td>Gap × Skill</td>
<td>1.149*</td>
<td>2.435**</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.658)</td>
<td>(1.025)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>constant</td>
<td>0.690***</td>
<td>0.473**</td>
<td>0.755***</td>
<td>0.413**</td>
</tr>
<tr>
<td></td>
<td>(0.205)</td>
<td>(0.195)</td>
<td>(0.157)</td>
<td>(0.169)</td>
</tr>
<tr>
<td>N</td>
<td>336</td>
<td>336</td>
<td>336</td>
<td>168</td>
</tr>
</tbody>
</table>

Table 4: Expected Amount Subtracted: this includes the amount subtracted by subjects who are willing to pay for the subtraction and those who subtract, with 25% probability, 1 dollar at no cost. See Table 1 for the description of independent variables.

<table>
<thead>
<tr>
<th></th>
<th>eASModel1</th>
<th>eASModel2</th>
<th>eASModel3</th>
<th>eASModel4</th>
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</thead>
<tbody>
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<td></td>
<td>b/se</td>
<td>b/se</td>
<td>b/se</td>
<td>b/se</td>
</tr>
<tr>
<td>Gap</td>
<td>0.418</td>
<td>0.423</td>
<td>-0.148</td>
<td>-0.068</td>
</tr>
<tr>
<td></td>
<td>(0.340)</td>
<td>(0.334)</td>
<td>(0.245)</td>
<td>(0.275)</td>
</tr>
<tr>
<td>Skill</td>
<td>0.428***</td>
<td>-0.200</td>
<td>-0.162</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.150)</td>
<td>(0.338)</td>
<td>(0.577)</td>
<td></td>
</tr>
<tr>
<td>Gap × Skill</td>
<td>1.213*</td>
<td>2.517**</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.643)</td>
<td>(1.009)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>constant</td>
<td>0.767***</td>
<td>0.551***</td>
<td>0.848***</td>
<td>0.543***</td>
</tr>
<tr>
<td></td>
<td>(0.200)</td>
<td>(0.189)</td>
<td>(0.149)</td>
<td>(0.160)</td>
</tr>
<tr>
<td>N</td>
<td>336</td>
<td>336</td>
<td>336</td>
<td>168</td>
</tr>
</tbody>
</table>
Table 5: Fraction of amount subtracted over amount earned by the target. See Table 1 for the description of independent variables.

<table>
<thead>
<tr>
<th></th>
<th>fASModel1</th>
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<th>fASModel2</th>
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<th>fASModel3</th>
<th></th>
<th>fASModel4</th>
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<td>b/se</td>
<td>b/se</td>
<td>b/se</td>
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<td></td>
<td></td>
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<tr>
<td>Gap</td>
<td>0.014</td>
<td>0.014</td>
<td>-0.115</td>
<td>-0.073</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>(0.063)</td>
<td>(0.063)</td>
<td>(0.079)</td>
<td>(0.084)</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Skill</td>
<td>-0.037</td>
<td>-0.179***</td>
<td>-0.096</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.028)</td>
<td>(0.064)</td>
<td>(0.102)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gap × Skill</td>
<td></td>
<td></td>
<td>0.274**</td>
<td>0.458***</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.115)</td>
<td>(0.167)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>constant</td>
<td>0.192***</td>
<td>0.210***</td>
<td>0.278***</td>
<td>0.180***</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.040)</td>
<td>(0.045)</td>
<td>(0.055)</td>
<td>(0.063)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>336</td>
<td>336</td>
<td>336</td>
<td>168</td>
<td></td>
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</tbody>
</table>

Table 6: Fraction of expected amount subtracted over amount earned by the target. See Table 1 for the description of independent variables.

<table>
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<tr>
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<th>feASModel2</th>
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<th>feASModel3</th>
<th></th>
<th>feASModel4</th>
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</tr>
</thead>
<tbody>
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<td></td>
<td>b/se</td>
<td>b/se</td>
<td>b/se</td>
<td>b/se</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gap</td>
<td>0.022</td>
<td>0.022</td>
<td>-0.110</td>
<td>-0.092</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>(0.060)</td>
<td>(0.060)</td>
<td>(0.075)</td>
<td>(0.082)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skill</td>
<td>-0.056**</td>
<td>-0.201***</td>
<td>-0.148</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.027)</td>
<td>(0.062)</td>
<td>(0.100)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gap × Skill</td>
<td></td>
<td></td>
<td>0.279**</td>
<td>0.489***</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.112)</td>
<td>(0.164)</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>constant</td>
<td>0.217***</td>
<td>0.245***</td>
<td>0.313***</td>
<td>0.237***</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.039)</td>
<td>(0.043)</td>
<td>(0.052)</td>
<td>(0.060)</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>336</td>
<td>336</td>
<td>336</td>
<td>168</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 7: Fraction of Amount Subtracted over the total amount earned by the target subject (Fraction Subtracted/Earned). The variable Rank target is the ratio of the amount earned by the target over the range of the amounts earned by all subjects. Amount target and Amount subject are the amounts earned by the target subject and by the subject, respectively.

<table>
<thead>
<tr>
<th></th>
<th>FFModel1</th>
<th>FFModel2</th>
<th>FFModel3</th>
<th>FFModel4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>b/se</td>
<td>b/se</td>
<td>b/se</td>
<td>b/se</td>
</tr>
<tr>
<td>Rank target</td>
<td>0.262*** (0.047)</td>
<td>0.233** (0.096)</td>
<td>0.199* (0.104)</td>
<td>–0.159 (0.137)</td>
</tr>
<tr>
<td>Amount target</td>
<td>0.004 (0.011)</td>
<td>0.009 (0.012)</td>
<td>0.065*** (0.019)</td>
<td></td>
</tr>
<tr>
<td>Amount subject</td>
<td>–0.009 (0.008)</td>
<td>–0.014 (0.009)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>constant</td>
<td>0.074*** (0.022)</td>
<td>0.076*** (0.024)</td>
<td>0.112** (0.044)</td>
<td>0.162*** (0.050)</td>
</tr>
</tbody>
</table>

N 336 336 336 168

Table 8: Fraction of Amount Subtracted over the total amount earned by the target subject (Fraction Subtracted/Earned). See Table 8 for independent variables.

<table>
<thead>
<tr>
<th></th>
<th>eFFModel1</th>
<th>eFFModel2</th>
<th>eFFModel3</th>
<th>eFFModel4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>b/se</td>
<td>b/se</td>
<td>b/se</td>
<td>b/se</td>
</tr>
<tr>
<td>Rank target</td>
<td>0.269*** (0.046)</td>
<td>0.233** (0.092)</td>
<td>0.182* (0.099)</td>
<td>–0.149 (0.130)</td>
</tr>
<tr>
<td>Amount target</td>
<td>0.005 (0.010)</td>
<td>0.012 (0.011)</td>
<td>0.064*** (0.018)</td>
<td></td>
</tr>
<tr>
<td>Amount subject</td>
<td>–0.014* (0.007)</td>
<td>–0.018** (0.009)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>constant</td>
<td>0.100*** (0.023)</td>
<td>0.102*** (0.025)</td>
<td>0.155*** (0.043)</td>
<td>0.202*** (0.048)</td>
</tr>
</tbody>
</table>

N 336 336 336 168
5 Appendix

5.1 Subjects

There were five sessions run in SL treatment (three with 16 subjects, one with 14, one with 13). There were 7 sessions run in the LS treatment (two with 16 subjects, two with 15, one with 13, one with 10 and 8).

Before subjects played the game they were given a verbal presentation of the rules. The subjects could ask any questions about the rules of the game at the time of the presentation. The game started once no further questions were asked. The same experimenter presented the rules at all times. Subjects were also instructed to maintain silence and not talk to each other during the play. The experiment was conducted using z-tree [13], LabView 6 and Java based software. The game of skill was realized as a Java applet. This was a modified version of the original applet provided at www.mazeworks.com. The game of luck was realized as part of the z-tree program.

5.2 Rules of the Game

This is the description of the rules taken from www.mazeworks.com:

“On each turn, a single hound moves to a directly connected empty square or octagon, followed by the hare’s similar move. The hounds may only move vertically or forward (to the right), not backward. The hare may move in any direction. To move a piece, drag and drop it with the mouse. There are no captures. The hounds win by trapping the hare so that he is unable to move. The hare can win two ways. He can escape, which he does by moving past (to the left of) all three hounds. Also, if the hounds move 10 times in a row without advancing (i.e. they only move up and down) then the hounds are stalling and the hare wins.”

These are the instructions given to subjects on the screens while they were choosing: “In each period, a random number X between 0 and 100 is generated. Please choose a number Z between 0 and 100. Your profit in this period is $1 if the distance between Z and X is less than 10 and $0 otherwise.”

5.3 Instructions for subtraction

The following instructions were presented to subjects on their screens:

“Here you see the earnings of all subjects but yourself. You have a possibility to subtract money from somebody else. You can do one of the three things: 1) Choose a subject from the list and enter positive amount to subtract; 2) Choose a subject from the list and enter zero amount to subtract; 3) Choose “nobody” from the list and enter zero amount to subtract. In case 1, you have to pay for subtracting money: if you choose to subtract Y dollars, you lose 0.1 Y dollars. In case 2, $1 will be subtracted from the chosen subject with probability 25%
and you don’t pay anything. In case 3 nothing happens. Your earnings are now is $4. Therefore in case 1 you can choose to subtract up to $40 dollars.”
References


