Classification: Social Sciences/Economic Sciences

Tracking fairness considerations and choice procedures

Amos Arieli
Department of Neurobiology, the Weizmann Institute of Science

Yaniv Ben-Ami
School of Economics, Tel Aviv University

Ariel Rubinstein
University of Tel Aviv Cafés,
School of Economics, Tel Aviv University and
Department of Economics, New York University

Corresponding Author: Ariel Rubinstein, School of Economics, Tel Aviv University, Israel 69978. Tel: +972-3-640-9908. e-mail: rariel@post.tau.ac.il

Abstract:
Economists are becoming increasingly interested in the decision process involved in making a choice and not only in the actual choice made. The paper contributes to the understanding of the deliberation process in contexts of choice that involve fairness and uncertainty considerations. Eye movement patterns in choice problems where the deliberation process is easily discernable are used to understand the deliberation process in problems where it is less so. The first type of problem involves choosing from among two alternative distributions of income between the participant and another individual. Accumulated experimental results show that although many agents behave selfishly by maximizing their own payoff, many others make choices that are inconsistent with selfishness and can be only explained by fairness considerations. Based on eye movement patterns, we argue that even when participants make the selfish choice they have also taken into account fairness considerations. Furthermore, we classify participants according to their behavior in one problem in which one of the choices could only emerge from fairness considerations. We find that those who made the clearly fair choice have in general a stronger tendency to take into consideration the size of the payment to the other person. The second type of problem involves choice under uncertainty. In contrast to classical economic theory, the eye movement patterns we observed indicate that many participants made their decision by comparing prizes and probabilities separately rather than making an expected utility calculation.

Key-words: Neuroeconomics, Eye tracking, Decision Making, Similarity.

We wish to thank Ayala Arad, Paul Glimcher, Maya Bar-Hillel, Ori Heffetz, Rosemarie Nagel, Doron Ravid and Dan Zeltzer for their valuable comments. We acknowledge support from the Israeli Science Foundation (grant 259/08).

1. Introduction

Economists have traditionally been interested in behaviour rather than in the choice procedures. Recent developments in economics have changed this culture and led to the rise of a new field called Neuroeconomics. Its premise is that information created non-intentionally by decision makers can be utilized to study the decision-making process. The goal of Neuroeconomics is to provide evidence that will allow economists to base their models on more realistic assumptions about how choices are made. It attempts to determine, among other things, whether an individual's choice is an indicator of his true preference for the chosen alternative or is a mechanical outcome of the procedure of choice itself.

Neuroeconomics makes use of several sources of information: neural activity in the brain, eye movements and response time. Here, we focus exclusively on eye movements, as measured by eye tracking. The idea to use eye movements in order to study decision making first appeared in the 70s[1,2] and was revisited recently[3,4]. Eye tracking complements MouseLab[5], another attractive method of gathering procedural information. (See Supplementary Note 1.)

Our first research question involves distributive justice. Participants chose between two payment schemes, each of which specified two amounts of money - one to be paid to the participant and the other to an anonymous individual. Do people who make "selfish" choices have purely selfish motives or do they consider the effect of their choice on the other individual?

Our second question relates to choice under uncertainty. Participants chose between simple lotteries, each described by an amount of money and the probability of obtaining it. Do decision makers evaluate each of the alternatives and then compare them (a choice strategy consistent with expected utility maximization) or do they compare prizes and probabilities separately?

2. Method

Forty seven participants (see Supplementary Note 2) were asked to respond to a sequence of simple virtual choice problems. In each problem, a participant was asked to choose between two alternatives, Left (*L*) and Right (*R*), by clicking on the mouse. Each decision problem was presented on a separate screen (Figure 1a), in which two parameters, *a* and *b*, describe the *L* alternative and two parameters, *c* and *d*, describe the *R* alternative. For example, in some problems, *L* was a lottery which yields $*a* with probability *b* (and $0 with probability 1-b) and *R* was the lottery yielding $*c* with probability *d* (see Supplementary Note 3 for a list of all types of questions). No time restrictions were imposed on the participants and a typical median response time was eight seconds.

We continuously recorded the point of gaze. Analyzing the huge amount of recorded data was not straightforward and therefore, we transformed it into movies showing the path of eye movement on the screen. However, there were only a few cases in which the choice procedure was easily discernable from the movies (a sample movie can be watched at http://arielrubinstein.tau.ac.il/ABR09/).

The method of analysis is based on participant's eye movements between four different parts of the screen: Top Left, Top Right, Bottom Left and Bottom Right (see Supplementary Methods). Eye movements between two sections of the screen are classified into one of six categories: Left-Vertical, Right-Vertical, Top-Horizontal, Bottom-Horizontal, Descending-Diagonal and Ascending-Diagonal. For each problem and each participant, we calculated the proportion of time spent in each of the six types of eye movements. We also calculated a similar vector for the number of transitions. Averaging over all participants produced two measures on which our analysis is based: α for the time spent and β for the number of transitions in each eye movement. The two measures produced almost identical results.

High α-values for the two vertical eye movements will imply that participants' choices were based on relating to each alternative as a unit and comparing them as such. High α-values for the horizontal eye movements will indicate that participants based their decisions on comparing each of the features of the alternatives separately.

3. Choice involving Distributive Justice

A participant was asked to imagine that he and another hypothetical student had completed a task together, with equal effort invested by each of them, and that he is to choose between two compensation schemes. - $*a* for him and $*b* for the other student or $*c* for him and $*d* for the other student. Typical considerations used in such a choice problem are:

"*Selfishness*": The participant cares only about his own compensation which should lead to mostly Top-Horizontal movements.

"*Fairness*": The participant cares about the distribution of income between him and the other student and prefers a more egalitarian distribution, which should lead to predominantly vertical eye movements.

"Aversion to getting less": The participant is averse to getting less than the other student which should also lead to predominantly vertical eye movements.

"*Utilitarianism*": The participant wishes to maximize the combined income of the two students. This procedure can involve either vertical eye movements (in order to compute the sums) or horizontal movements (in order to determine whether his gain is greater than the other student's loss). A particular case of Utilitarianism is "Domination", in which the participant prefers a scheme that provides more income for both participants. Domination is expected to yield horizontal eye movements.

We are interested in interpreting the choices made in problems J1 and J2 (see Figure 1b and 1c). The results show that among the 42 participants 88% chose *L* in problem J1 and 78% chose *L* in J2. The results however cannot be interpreted unambiguously. Thus, the choice of *L* in J1 could be the result of a preference for either Fairness, Selfishness or Aversion to Getting Less. In J2, the fair choice is *R*, while the choice of *L* could be the result of Selfishness, Aversion to Getting Less or Utilitarianism. Eye movements can provide a hint as to the participant's motivation. Figures 1d and 1e present the α's (the averaged percentage of time spent in each of the six transitions) for the participants who chose *L* in J1 and J2, respectively:

In order to interpret the findings in J1 and J2, we can compare them with the eye movements in J3 (Figure 2a) where the only plausible motivation for the choice of *L* is egalitarianism. Out of the 42 of the participants in J3, 48% chose L (see Supplementary Note 4). Figure 2b presents the eye movements for eight participants in J3 for whom eye movements could be clearly interpreted.

However, cases in which eye movements are clearly vertical or clearly horizontal were few in number. Figure 2c presents the α-values (and in parentheses, the β-values) for the participants who chose *L* and for those who chose *R*. Their values are dramatically different ($P < 0.01$ in a Wilcoxon test): those who chose *L* spent 72% of their time in vertical eye movements while those who chose *R* spent 54% of their time in horizontal eye movements (mostly Top-Horizontal), which is consistent with their choice of the selfish alternative.

We found that the group who chose *L* in J3 differs significantly distinct from the group that chose *R* (see Supplementary Results for J3). In particular, in all other problems of this type, the time devoted to vertical eye movements by participants who chose *L* in J3 was consistently longer (by from 10% to 25%) than for those who chose *R* in J3.

With the results of J3 in hand, we can now interpret the choice of *L* in J1 and J2. These would be the choices of a purely selfish decision maker. However, they might be made also by participants who are not purely selfish and take into account the payments for the other student. Indeed, we find a striking similarity between the eye movement patterns of those who chose *L* in J1 and J2 and those who chose *L* in J3: those who chose *L* in each of the three problems show a high proportion of vertical movements (above 60%). Since the choice of *L* in J3 can arise only from fairness considerations, we infer that the considerations of those who chose *L* in J1 and J2 were not purely selfish and probably involved comparing the gain from being selfish to the loss from being fair.

4. Choice under Uncertainty

In another part of the experiment, participants were asked to choose between two simple lotteries (see Figure 3a and 3b). Experiments using this type of decision problem constitute the basis for much of the literature on decision making under uncertainty.

There are two choice procedures that are likely to be used in this type of problem:

a) Computing the expected payoff (or expected utility of the payoff) for each of the lotteries with the aim of choosing the one with the highest expected payoff. Some[6] Neuroeconomic studies, using fMRI data, claim to have found in the brain activity evidence of expected utility like representations. Using such a choice procedure involves vertical eye movements.

b) Comparing prizes and probabilities separately. In the case of a conflict between the probability and prize dimensions, the choice is made according to which difference is perceived as more significant by the decision maker[7]. Using such a choice procedure involves horizontal eye movements.

What procedure is more common? A high proportion of vertical eye movements would indicate that an expected payoff was calculated while a high proportion of horizontal eye movements would indicate that prizes and probabilities were compared separately.

Some evidence for the use of the similarity-based procedure in the choice between lotteries can be found in the results for a group of problems in which the locations of the probability and the dollar amount on the right side of the screen were switched (Figure 3c). In all the problems apart those in this group, the α-values of the diagonal movements were negligible. In contrast, diagonal movements were used intensively in this set of problems (Figure 3d). This indicates that participants are involved in comparing prizes and probabilities separately.

In order to further interpret the choices in U1 and U2 and assess the significance of the proportion of horizontal movements (i.e., 45%), the results were compared to two other cases in which the deliberation process is transparent:

Case a: In D1 and D2 (Figure 4a) participants were asked to indicate which alternative had the larger difference (a-b vs. c-d). In D1 the most straightforward procedure involves computing the differences using vertical eye movements. Indeed, vertical eye movements accounted for 80% of the time spent on this problem. In D2, the easiest way of making the choice is to calculate horizontal differences and indeed the share of vertical eye movements declined to 39% while that of the horizontal eye movements increased to 55%. Figure 4b presents the results for two typical participants: both used vertical eye movements almost exclusively in D1 while in D2 horizontal eye movements dominated.

Case b: In T1,T2 and T3 (Figure 4c), participants were asked to choose between receiving a sum of money on one date and a different sum of money on another date. In this case, it is hard to imagine that any of the participants made a "present-value-like" computation which would have involved vertical eye movements. (The present value of receiving \$x in t years is $x(1+r)^{-t}$ where r is the annual subjective interest rate.) Indeed, we found that 2/3 of eye movements were horizontal, so that participants clearly based their decisions on comparing sums of money and delivery dates separately.

Figures 4d and 4e present the α-values for three typical problems: choice under uncertainty (U1), comparison of differences (D1) and time preferences (T3).

We find that eye movements in U1 and U2 differed from those of the other two problems and in fact fell somewhere in between. The proportion of vertical eye movements in the problems involving choice under uncertainty were well below the proportion in a problem like D1 and well above the proportion in problems involving time preferences, such at T3, in which it is clear that participants used a similarity-based procedure. We conclude that in lottery problems participants use a procedure that is largely, but not solely similarity-based.

Another conclusion comes from the comparison between problems which differ in the difficulty of calculating the expectation. In U3-U4 (difficult) the percent of horizontal movements is 59-70% whereas it is only 45-48% in U1-U2 (easy). We infer that when the expectation calculation is relatively difficult participants tend to use a procedure which relies even more heavily on a similarity-based comparison.

5. Conclusion

The aim of this study was to shed light on the procedures used by decision makers in certain contexts through the use of eye tracking. In choice problems involving distributive justice, we conclude that individuals do care about fairness considerations, even when their choice was consistent with selfishness. In the context of choice under uncertainty, we conclude that participants based their choice heavily, though not exclusively, on comparing prizes and probabilities separately.

References

1. Russo, E.J. & Rosen, L.D. An Eye Fixation Analysis of Multialternative Choice. *Memory & Cognition*. **3**, 267-276 (1975).
2. Russo, E.J. & Dosher B.A. Strategies for Multiattribute Binary Choice. *Journal of Experimental Psychology: Learning, Memory, and Cognition*. **9**, 676-696 (1983).
3. Wang, J.T., Spezio M & Camerer C.F. Pinocchio's Pupil: Using Eyetracking and Pupil Dilation to Understand Truth-telling and Deception in Games. *http://www.hss.caltech.edu/~camerer/pinocchio2.pdf*. (2006).
4. Reutskaja, E., Pulst-Korenberg J., Nagel R., Camerer C.F. & Rangel A. Economic Decision Making Under Conditions Of Extreme Time Pressure And Option Overload: An Eye-Tracking Study. *Unpublished*. (2008).
5. Payne J.W., Bettman, J.R. & Johnson E.J. The Adaptive Decision Maker. *New York: Cambridge University Press*. (1993).
6. Glimcher, P.W., Dorris M.C. & Bayer H.M.. Physiological Utility Theory and the Neuroeconomics of Choice. *Games and Economic Behavior*. **52**, 213-256 (2005).
7. Rubinstein, A. Similarity and Decision-Making Under Risk. *Journal of Economic Theory*. **46,** 145-153 (1988).

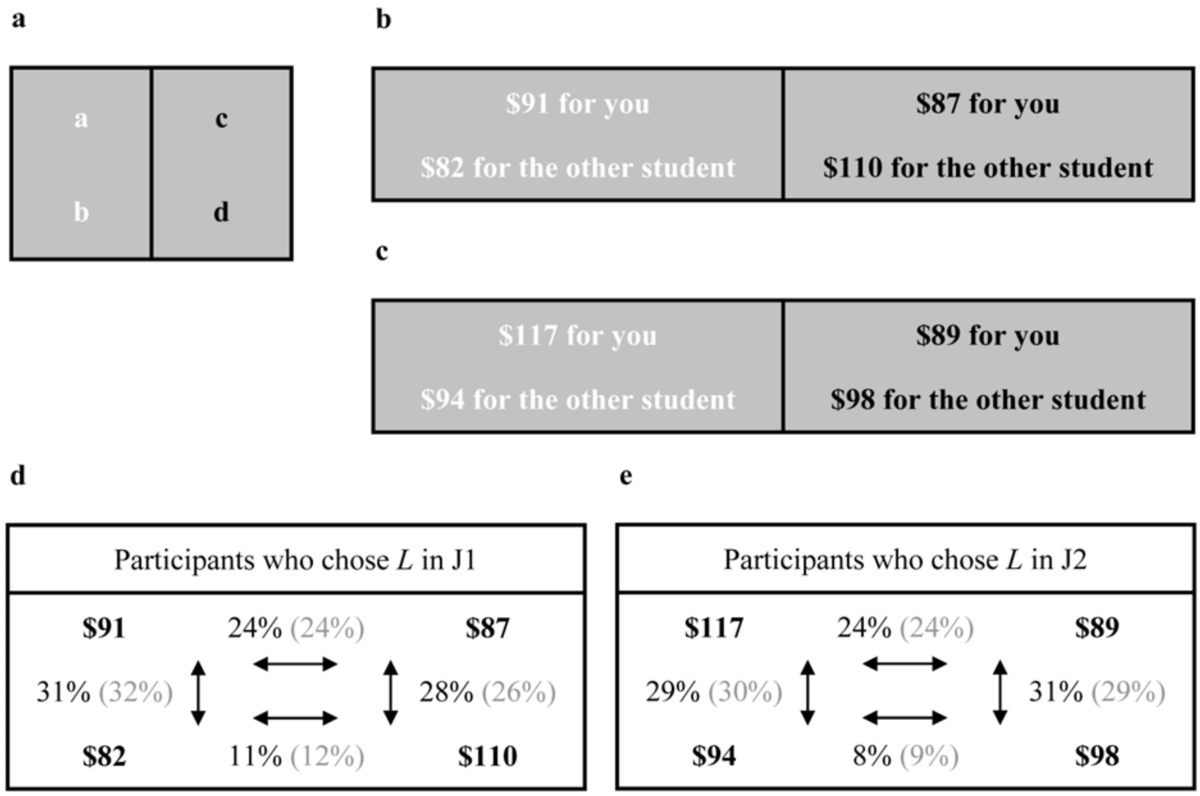


Figure 1| In problems involving Distributive Justice about 60% of the movements are vertical. a, Schematic representation of the screen shown to the participants. **b**, J1. **c**, J2. **d**, α's (β's in parentheses) for those who chose L in J1. **e**, α's (β's in parentheses) for those who chose L in J2.

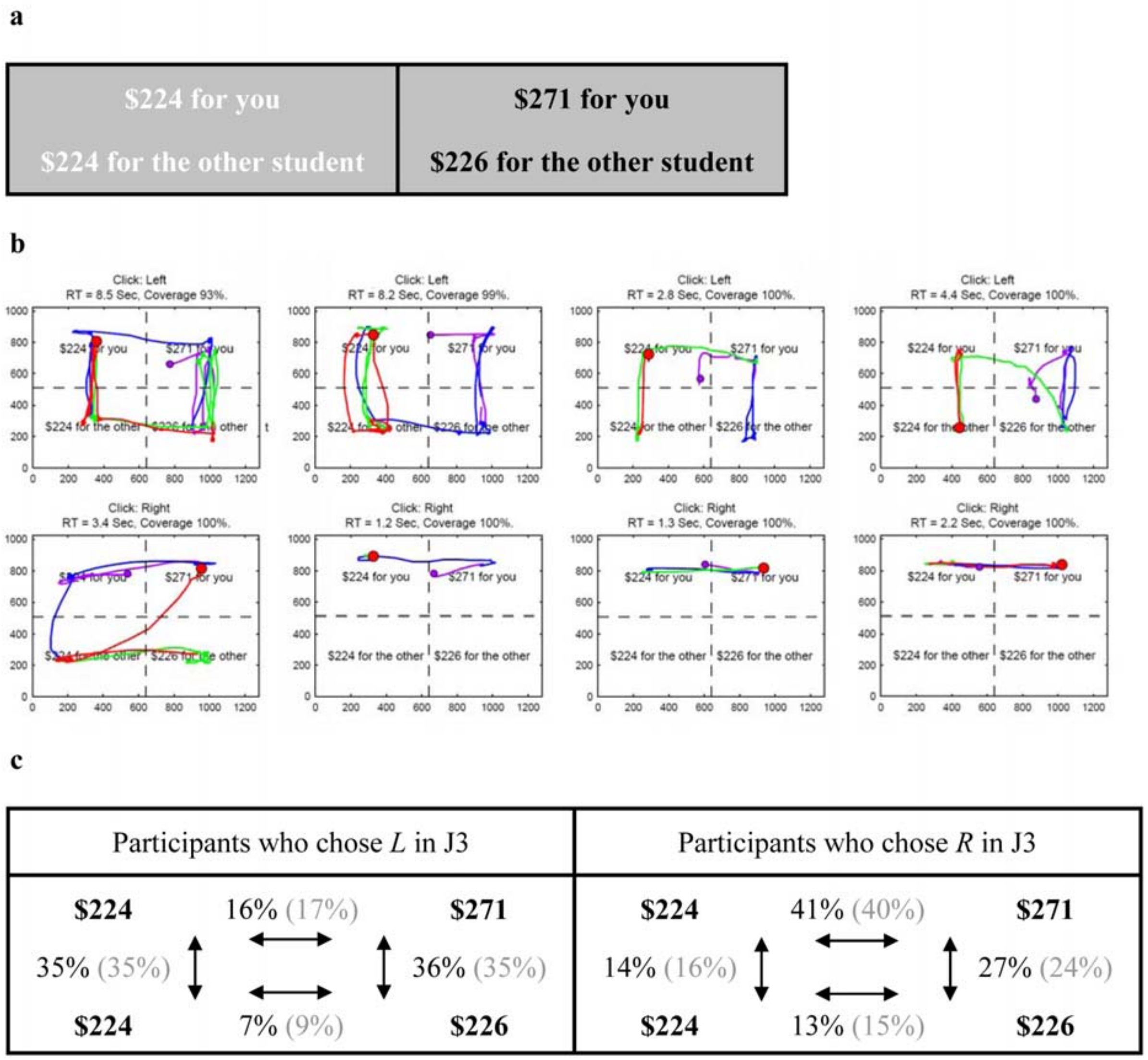


Figure 2| The choice of *L* in problem J3 indicates non-selfish considerations and is characterized by a high proportion of vertical movements. **a**, J3. **b**, Eye movements for eight participants while responding to problem J3: Top row: four participants who chose the "fair" option (L). Bottom row: four participants who chose the "selfish" option (R). The time sequence is divided into four equal segments and the order indicated by color: purple → blue → green → red. The purple and red dots indicate eye position at the beginning and end of the process, respectively. **c**, α's (and β's) for participants who chose L and R in J3.

a

$\$x_1$ With probability p_1	$\$x_2$ With probability p_2

b

	The lotteries		% of choices		α-values					
	$L = (x_1, p_1)$	$R = (x_2, p_2)$	%L	%R						
U1	($3000, 0.15)	($4000, 0.11)	61%	39%	**24%**	**23%**	18%	27%	4%	4%
U2	($1700,0.4)	($1300,0.5)	54%	46%	**21%**	**24%**	24%	24%	5%	3%
U3	($637,0.649)	($549,0.732)	42%	58%	17%	18%	**28%**	**31%**	3%	4%
U4	($5283,0.27)	($5279,0.269)	93%	7%	14%	12%	**38%**	**32%**	3%	2%

c

$\$x_1$ With probability p_1	With probability p_2 $\$x_2$

d

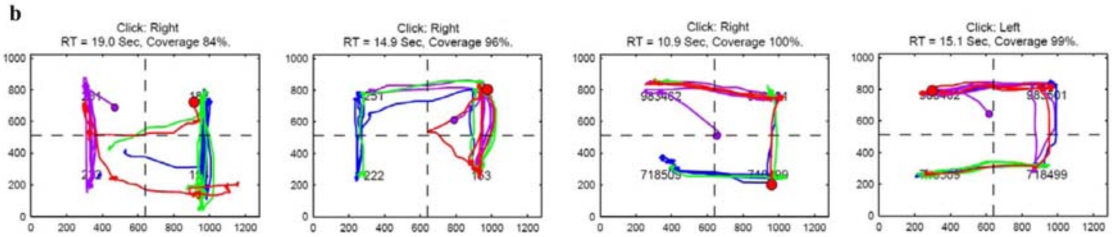
	The lotteries		% of choices		α-values					
	$L = (x_1, p_1)$	$R = (p_2, x_2)$	%L	%R						
U5	$5000 0.16	0.11 $7000	54%	46%	22%	23%	15%	10%	9%	22%
U6	$2468 0.26	0.53 $1234	5%	95%	19%	21%	16%	8%	15%	21%
U7	$4947 0.640	0.638 $4952	63%	37%	17%	16%	12%	7%	22%	26%
U8	$621 0.87	0.82 $652	67%	33%	17%	18%	13%	9%	19%	22%

Figure 3| Two layouts of choice under uncertainty problems. **a**, scheme for choice under uncertainty problems. **b**, α values in lottery choice problems (purple and green emphasize the difference in α-values between problems in which an expected payoff calculation is easy and difficult). **c**, choice under uncertainty problem: diagonal layout. **d**, α values in lottery choice problems with diagonal layout.

a

	The differences		% of choices		α - values					
	L* = *a* – *b	***R* = *c* – *d***	%*L*	%*R*						
D1	251 222	187 153	21%	79%	37%	43%	12%	5%	2%	1%
D2	983462 718509	983501 718499	21%	79%	18%	22%	35%	20%	3%	3%

b



c

	The alternatives		% of choices		α- values					
	***L* = (x_1,t_1)**	***R* = (x_2,t_2)**	%*L*	%*R*						
T1	$351.02 On 20-Jun-2009	$348.23 On 12-Jul-2009	93%	8%	15%	15%	24%	38%	3%	4%
T2	$467.39 On 17-Dec-2009	$467.00 On 16-Dec-2009	55%	45%	13%	13%	36%	31%	5%	2%
T3	$500.00 On 13-Jan-2009	$508.00 On 13-Apr-2009	73%	27%	13%	14%	25%	42%	3%	3%

d

Participants who chose *L* in U1			Participants who chose *R* in U1		
$3000	19% (24%)	**$4000**	**$3000**	17% (21%)	**$4000**
28% (28%)		18% (16%)	18% (18%)		31% (29%)
P 0.15	25% (22%)	**P 0.11**	**P 0.15**	30% (27%)	**P 0.11**

e

All participants in D1			All participants in T3		
251	12% (13%)	**187**	**$500.00**	25% (31%)	**$508.00**
37% (37%)		43% (42%)	12% (14%)		14% (15%)
222	5% (5%)	**153**	**On 13-Jan**	42% (33%)	**On 13-Apr**

Figure 4 | The proportion of vertical eye movements in problems involving choice under uncertainty is between problems like D1 and T3. a, α's for problems in which differences were compared. **b**, Eye movements for two participants while responding to D1 (left two) and D2 (right two). **c,** α's for time preference problems. Experiments took place during June-September 2008. **d,** α's (and β's) for participants who chose L and R in U1. **e**, α's (and β's) for all participants in D1 and T3.

Supplementary Information: Tracking fairness considerations and choice procedures

Supplementary Notes:

Note 1: Using early eye tracking techniques, Russo and Rosen[1] studied multi-alternative choice while and Russo and Dosher[2] investigated multi-attribute binary choice. They concluded that feature-by-feature comparisons make up much of the decision procedure. More recently, Wang et al.[3] investigated behavior in a sender-receiver game and Reutskaja et al.[4] studied choice of snack foods under time pressure and option overload.

MouseLab is another method that allows the gathering of data on a large number of participants. In MouseLab, the participant accesses the information information hidden behind boxes on the computer screen by moving the cursor over the boxes. The site http://www.mouselabweb.org demonstrates the method and allows one to try it out. One advantage of eye tracking over this method is that it records natural unintentional movements while the need to move the mouse in MouseLab requires an unnatural information acquisition strategy[5].

Note 2: The participants (24 males and 23 females; average age of 27) all had normal or corrected-to-normal vision and were students (in fields other than economics) in Rehovot, Israel. All of them signed an informed consent form in accordance with the Declaration of Helsinki.

The participants were paid only a show-up fee of $12. We did not pay subjects for choices made and there is ample evidence that the lack of monetary incentives does not change subjects' choices significantly[6]. In any case, note that we are interested only in the choice process that led participants to make their particular choices and not in the choice distributions, which are reported only for the sake of completeness.

Note 3: Following are the questions used in the study:

(1) Sums: The parameters are integers. "Which is the larger sum: $a+b$ or $c+d$?"

(2) Differences: The parameters are integers. "Which difference is larger: $a–b$ or $c–d$?"

(3) Risk preferences: "Which lottery would you choose: \$*a* with probability *b* or \$*c* with probability *d*?"

(4) Time preferences: The parameters *a* and *c* are dollar amounts and *b* and *d* are dates. "Which would you prefer: to receive \$*a* at time *b* or \$*c* at time *d*?"

(5) Social preferences: The participant was asked to imagine that he and another hypothetical student had completed a task together, with equal effort invested by each of them, and that he is to choose between two compensation schemes. The parameters are dollar amounts. "Which scheme would you choose: \$*a* for you and \$*b* for the other student or \$*c* for you and \$*d* for the other student?"

We did not alternate the sides on which the alternatives are presented. In order to check whether presenting alternatives on the left side (white letters) or the right side (black letters) makes any difference, we calculated the distribution of response time over all the problems for participants who chose *L* (N=902) and participants who chose *R* (N=805). We found that the average response times of the two groups were practically identical (5.81 sec and 5.75 sec; T-test p-value of 42.5%).

Note 4: The participants in this study were students in the Sciences. We suspect that the results for distributive justice questions would have been different for Economics students. In an on-line survey among 355 Economics students at the University of Basel, only 17% of the students chose *L*. For more on the difference between economics and non-economics students with regard to social preferences, see Fehr, Naef and Schmidt[7].

Supplementary Methods:

We used a high-speed eye-tracking system (iView) made by SensoMotoric Instruments (SMI) which is based on an infrared light camera. It captures (at a sampling frequency of 240Hz or one sample every 4.2 milliseconds) a high-resolution image of the pupil and corneal reflection. The few observations in which the absolute gaze position was not identified by the eye tracker for more than 40% of the participant's deliberation time were omitted.

Figure 1 provides examples of the eye movement paths for four participants who were comparing differences (251–222 vs. 187–153).

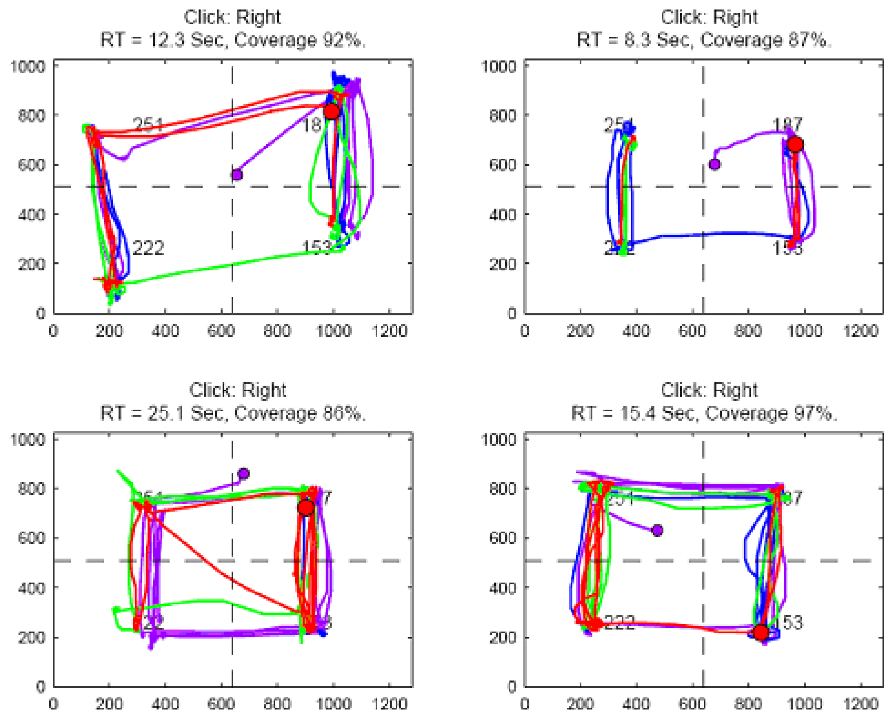


Figure 1: Eye movements of four participants while solving problem D1, in which they compared differences (251–222 vs. 187–153). The time sequence is divided into four equal segments and the order indicated by color: purple → blue → green → red. The purple and red dots indicate eye position at the beginning and end of the process, respectively.

We calculated the proportion of time spent by a participant in each of the six eye movements while responding to a certain problem as follows:

(i) Let 0 be the point in time at which the problem is first presented and T be the point in time at which the participant clicked on the mouse.

(ii) Denote the transition times between sections of the screen by: $t_1, t_2, \ldots, t_k, \ldots, t_n$.

(iii) The segment of time $[0,T]$ is divided into n intervals:

$[0, (t_1 + t_2)/2], [(t_1 + t_2)/2, (t_2 + t_3)/2], \ldots\ldots, [(t_{n-1} + t_n)/2, T]$. The duration of the k'th interval ($k=1,..,n$) is credited to the total for the eye movement that occurred at time t_k.

(iv) By dividing the time credited to each category of eye movement by the total of all the eye movements, we obtain the MTP (Movement-Time-Proportion) vector consisting of six numbers representing the proportion of time spent in each movement.

(v) We averaged the MTPs over all participants for each problem and denoted this vector of averages as α.

The measure α is sensitive to variation in the level of difficulty in understanding the question's parameters (e.g., if one of the parameters takes a long time to read, this will lengthen the duration of the movement into and out of that section of the screen). Therefore, we also produced a similar vector for the number of transitions. In this case, each transition contributes a value of 1 to the corresponding eye movement total. Dividing by the total number of transitions, we obtain the MTC (Movement-Count-Proportion) vector and averaging over all participants we obtained a statistic we denote as β. The two measures yielded almost identical results.

Note that we omitted any period for which the eye tracker did not identify the eye position, which was usually the result of blinking. In order to identify diagonal movements, which always pass briefly through another section of the screen, we also omitted any period in which the participant's gaze did not stay in a particular section for at least 100 msec.

Our method differs from those used in some previous studies. Russo and Rosen[1] and Russo and Dosher[2] based their analysis on counting movements from one section of the screen, X, to another, Y, and back to X. In contrast, we base our analysis on counting movements from X to Y even if there is no return to X. In problems where the response time is relatively long, the two approaches yield the same qualitative results. In problems where the response time is relatively short, their method does not yield sufficient data to make significant inferences.

Supplementary results for J3

Table 1 shows that in all the problems involving distributive justice the time devoted to vertical movements by participants who chose *L* in J3 (denoted by J3-L) was consistently longer - by 10%-25% - than for those who chose *R* (denoted by J3-R).

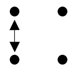
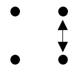
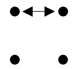
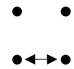
Types of Eye-Movements:										
#	*L*	*R*	J3-L	J3-R	J3-L	J3-R	J3-L	J3-R	J3-L	J3-R
J1	\$91 \$82	\$87 \$110	33%	28%	30%	26%	21%	28%	10%	11%
J2	\$117 \$94	\$89 \$98	32%	27%	36%	29%	18%	28%	8%	9%
J3	\$224 \$224	\$271 \$226	35%	15%	37%	28%	16%	41%	7%	13%
J4	\$231 \$231	\$234 \$278	34%	18%	40%	33%	14%	31%	6%	11%
J5	\$85 \$170	\$93 \$141	20%	11%	35%	22%	25%	45%	13%	18%
J6	\$155 \$60	\$136 \$78	21%	13%	30%	19%	31%	46%	11%	15%

Table 1: α's in all distributive justice problems (J1-J6) for participants who chose *L* or *R* in J3.

In Figure 2, each data point represents a participant and its color indicates his choice in J3 (blue for *L* and red for *R*). The position on the diagram indicates the proportion of time spent by the participant in horizontal and vertical movements. It is evident that members of the group J3-L display patterns of deliberation that systematically differ from those of the J3-R group (i.e. the blue points tend to be above the red points).

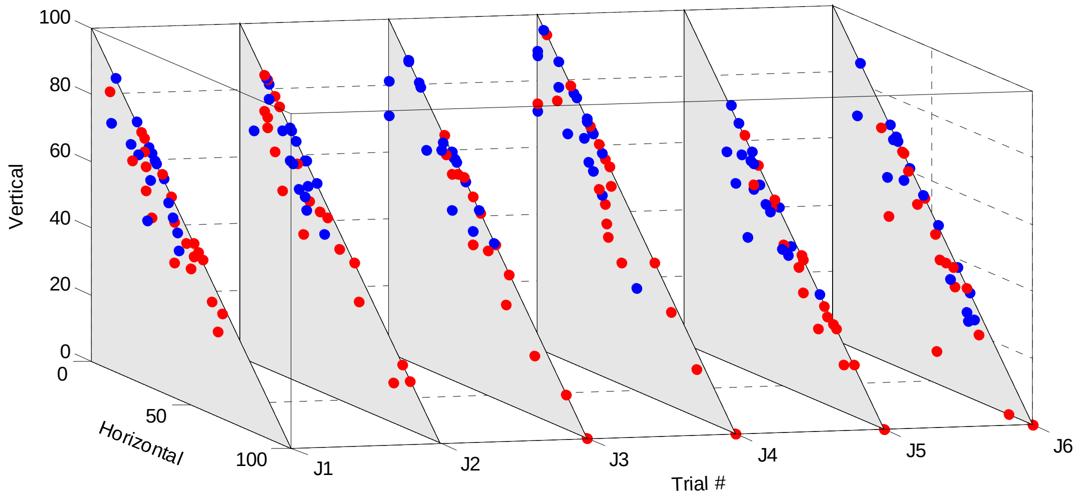


Figure 2: Proportions of horizontal and vertical movements in problems J1-J6

The two populations also differ in terms of behavior. A choice of *R* in J2 appears to indicate that greater weight is being given to fairness. This alternative was chosen by 44% of the J3-L group but by only 5% of the J3-R group. The choice of *L* in J4 is also associated with fairness and was chosen by all of the J3-L group but by only 38% of the J3-R group. Similarly, in J6 the entire J3-L group chose *R* vs. only 40% of the J3-R group.

References

1. Russo E.J. & Rosen L.D. An Eye Fixation Analysis of Multialternative Choice. *Memory & Cognition*. **3**, 267-276 (1975).
2. Russo E.J. & Dosher B.A. Strategies for Multiattribute Binary Choice. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, **9**, 676-696 (1983).
3. Wang, J.T., Spezio M. & Camerer C.F. Pinocchio's Pupil: Using Eyetracking and Pupil Dilation to Understand Truth-telling and Deception in Games. *http://www.hss.caltech.edu/~camerer/pinocchio2.pdf*. (2006).
4. Reutskaja, E., Pulst-Korenberg J., Nagel R., Camerer C.F. & Rangel A. Economic Decision Making Under Conditions Of Extreme Time Pressure And Option Overload: An Eye-Tracking Study. *Unpublished.* (2008).
5. Lohse, G.L. & Johnson E.J. A Comparison of Two Process Tracing Methods for Choice Tasks. *Organizational Behavior and Human Decision Processes*. **68**, 28-43 (1996).

6. Camerer, C.F. & Hogarth R. The Effects of Financial Incentives in Economics Experiments: A Review and Capital-Labor-Production Framework. *Journal of Risk and Uncertainty*. **7,** 42 (1999).

7. Fehr, E., Naef M. & Schmidt K.M. Inequality Aversion, Efficiency, and Maximin Preferences in Simple Distribution Experiments: Comment. *American Economic Review*. 96(**5**), 1912-1917 (2006).