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Abstract

The axioms of expected utility and discounted utility theory have been tested extensively. In contrast, the axioms of social welfare functions have only been tested in a few questionnaire studies involving choices between hypothetical income distributions. In this note, we conduct a controlled experiment with 100 subjects in the role of social planners that tests five fundamental properties of social welfare functions to provide a basic test of cardinal social choice theory. We find that four properties of the standard social welfare functions tested are systematically violated, producing an Allais paradox, a common ratio effect, a framing effect, and a skewness effect in social choice. We also develop a model of salience based social choice which predicts these systematic deviations and highlights the close relationship between these anomalies and the classical paradoxes for risk and time.

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1 Introduction

The neo-classical models of decision making for risk and time – the expected utility and discounted utility theories, have been carefully tested for over half a century. The neo-classical models of social choice have received much less systematic empirical study. While there is a voluminous literature on social preference experiments that focus on tradeoffs between self-interest and other-regarding behavior (e.g., Roth (1995), Cooper and Kagel (2014) and the references therein), and a sizeable literature exists on tradeoffs between equality and efficiency (e.g., Engelmann and Strobel, 2004), to our knowledge, there has not been an incentivized experimental study that tests the basic axioms of cardinal social choice theory upon which the concept of a social welfare function is founded[1].

In this note, we directly test five properties that are satisfied by prominent social welfare functions. Three of these properties apply generally to the standard model (Moulin, 2004) which consists of the class of all additive social welfare functions. The fourth property applies to the special case of power social welfare functions and the fifth property to the special case of the utilitarian social welfare function.

To generate our test questions, we construct a simple and psychologically grounded model of a salience-based social planner. This model extends Leland and Schneider's (2018) model of Salience Weighted Utility over Presentations (SWUP) which provides a unified explanation for anomalies occurring in choices under risk and over time as arising from the same properties of salience perception.

We then place experimental subjects in the roles of social planners whose choices will be implemented with some probability to test the axiomatic foundations of traditional social choice models and the predictions of the newly developed salience model. Specifically, our study tests four basic axioms implicit in traditional social choice theories and an additional property implied by the utilitarian model to reveal other factors affecting social choices such as framing and skewness preference. In our experiment, we observe strong and systematic violations of traditional social choice theory for four of the five properties we test. Each of the modal responses is predicted by the new parameter-free salience model. Our results reveal anomalies for social choice theory that are analogous to the classical anomalies for choices under risk and over time.

[1] Questionnaire studies using scenarios with hypothetical income distributions had the structure of the Allais paradox (Bernasconi (2002), Bosmans and Schokkaert (2004), and Michaelson (2015)). All these studies found support for an Allais paradox in social choice.

2 Principles of Cardinal Welfare Theory

We consider choices made by a social planner over allocations of resources. Let there be a finite set, $\mathcal{U}$, of outcomes and a finite set of individuals, I. An *allocation*, $A : I \to \mathcal{U}$, assigns an outcome to each individual where $n(x)$ is the number of individuals allocated outcome $x \in \mathcal{U}$. Choices under risk and over time have been shown to be subject to systematic framing effects (Tversky and Kahneman, 1981; Magen et al., 2008) in which informationally equivalent representations of the same choice alternatives produce large preference reversals. To test for the possibility of framing effects in social choice, we provide a formalization of the principle of frame invariance. To do so, let $\mathbf{A} := (\mathbf{x},\mathbf{n})$ consist of a vector of outcomes, $\mathbf{x}$, and a vector of individuals, $\mathbf{n}$, over which outcomes are distributed, such that $\mathbf{n_i}$ individuals are allocated outcome $\mathbf{x_i}$. Define $\mathbf{B} := (\mathbf{y}, \mathbf{m})$ analogously. If $\mathbf{A}$ generates the same distribution as allocation A, we say that $\mathbf{A}$ is a *representation* of A. Note that there can be many representations of the same allocation by rearranging the order of the elements of $\mathbf{A}$ or by splitting or combining numbers of individuals who are allocated the same outcome. Using italicized font to denote allocations and bold font for representations of allocations, denote the set of allocations by $\mathcal{F}$. Denote the set of representations of allocations by $\mathbf{F}$. Strictly speaking, in classical social choice theory, the elements of $\mathcal{U}$ are utilities. We label them neutrally as outcomes. In our experiment, the outcomes will be small amounts of money to be distributed among participants which we implicitly use instead of unobservable utilities and which can plausibly be considered to have a common value for the subjects in our experiment.

The standard model in social choice theory assumes that society (or a 'social planner') decides how to allocate resources by choosing among utility profiles to maximize a social welfare function. For a set, I, of individuals, indexed by $i \in \{1, 2, ..., k\}$, and a corresponding utility profile, $u := (u_1, ..., u_k)$, the standard cardinal social welfare functioon, W, can be represented as (1):

$$W(u) = \sum_{i \in I} w(u_i), \tag{1}$$

where u_i is the utility that individual i receives from utility profile u, and w is a social welfare function. Moulin (2004) provides a textbook treatment of cardinal welfare theory and discusses the standard power social welfare function, $w(u_i) = u_i^{\alpha}$

for $\alpha > 0$, which has several noteworthy special cases: When $\alpha = 1$, it reduces to the utilitarian social welfare function that maximizes the sum of utilities. In the limit as α appraoches 0, this specification converges to $w(u_i) = \ln(u_i)$ which is equivalent to the Nash social welfare function that maximizes the product of utilities. For $\alpha < 1$, the social welfare function incorporates a form of inequality aversion.

Formula (1) can be derived from assuming a social planner has complete and transitive preferences that satisfy continuity, symmetry, monotonicity, and an independence axiom (Moulin, 2004). The independence axiom can be stated analogously to the independence axiom of expected utility theory which implies the properties of common consequence independence and common ratio independence. The standard model also implicitly satisfies a basic property of frame invariance. The most commonly used class of social welfare functions additionally satisfies a scale invariance axiom (Moulin, 2004). These properties, stated below, are tested in our experiment.

Let $(u, n; u', n')$ denote an allocation (utility profile) in which n individuals receive utility u and n' individuals receive utility u'. Define allocation $(u, n; u', n'; u'', n'')$ analogously. Let $\succsim$ represent the preference ordering of a social planner over allocations. Let $\hat{\succsim}$ be a preference relation defined over representations of allocations. If $\succsim$ can be represented by any additive social welfare function as in (1), then $\succsim$ satisfies properties 1, 2, and 3, below. If, in addition, $\succsim$ can be represented by a power social welfare function, then $\succsim$ also satisfies property 4. If, in addition, $\succsim$ can be represented by the utilitarian social welfare function, then $\succsim$ also satisfies property 5:

1. **Common Consequence Independence:** For all $u, u', v, v', x, y \in \mathcal{U}$, $(u, n; u', n'; x, k) \succsim (v, n; v', n'; x, k) \Rightarrow (u, n; u', n'; y, k) \succsim (v, n; v', n'; y, k)$.

2. **Common Ratio Independence:** For all $u, u', v, v' \in \mathcal{U}$, any $\lambda \in [0, 1]$, and any $m, m' > 0$ such that $m + m' = n$: $(u, n) \succsim (v, m; v', m') \Rightarrow (u, \lambda n; u', (1 - \lambda)n) \succsim (v, \lambda m; v', \lambda m'; u', (1 - \lambda)(n))$.

3. **Frame Invariance:** For representations $\mathbf{A}$ of A, $\mathbf{B}$ of B, $A \succsim B \Rightarrow \mathbf{A} \hat{\succsim} \mathbf{B}$.

4. **Scale Invariance:** For all $u, u', v, v' \in \mathcal{U}$, any $\lambda > 0$, $(u, n; u', n') \succsim (v, m; v', m') \Rightarrow (\lambda u, n; \lambda u', n') \succsim (\lambda v, m; \lambda v', m')$.

5. **Skewness Invariance:** Let $n > n'$. Then for all $u, u', v, v', w, w' \in \mathcal{U}$, such that $w' > u > w > u'$, and $un + u'n' = wn + w'n'$: $(u, n, u', n') \succsim (v, m; v', m') \Rightarrow (w, n; w', n') \succsim (v, m; v', m')$.

Property 1 states that exchanging a common outcome in which k individuals receive utility x with a common outcome in which k individuals receive utility y should not affect the social planner's preferences. Property 2 implies that mixing two allocations with the same common allocation should not affect the social planner's preferences. Property 3 implies that the social planner's preferences between two allocations should not be affected by informationally equivalent representations of the allocations. Property 4 implies that scaling all outcomes by a constant factor should not affect the social planner's preferences. Property 5 implies that replacing a negatively skewed allocation with a positively skewed allocation that distributes the same total surplus should not affect the social planner's preferences.

A test of principles 1 – 5 above enables us to investigate the formal properties of utilitarian preferences (and more generally, any additive social welfare function) to determine the empirical validity of the standard social choice theory. Of course, while our study takes an empirical approach to social choice theory, it cannot contradict the normative or philosophical views that social welfare functions should have one particular form or another. However, the empirical approach is particularly suited to address the questions regarding how people actually prefer to allocate resources among individuals which cannot be answered from a normative or philosophical perspective.

3 A Salience-based Model of Social Choice

Several recent papers have explored the possibility that choice behavior is influenced by the perceived salience of the attributes of alternatives in a choice set. Bordalo et al. (2012), for example, propose a model to explain anomalies in risky choice in which attention is focused on salient payoffs. Bordalo et al. (2013) consider a model of salience-based consumer choice. Koszegi and Szeidl (2013) present a model of focusing in intertemporal choice in which people over-weight salient attributes of choice alternatives. Leland and Schneider's (2018) salience weighted utility over presentations (SWUP) model provides an explanation for violations of both expected utility and discounted utility theory as arising from the same mathematical structure and the same psychological intuition.

This note extends the modelling approach of SWUP to predict how salience affects the behavior of a social planner who chooses between different social welfare allocations over individuals. This salience model is not a general alternative to the standard social choice models but rather a complementary device for generating predictions regarding how salience perception affects social choice. We use it to generate the set of choices employed in our experiment. We highlight the fact that the salience model was developed prior to the experiment rather than the more common approach in which a theory is developed ex post to fit the experimental data.

To proceed, we adapt the definition of a frame that Leland, Schneider, and Wilcox (2018) employed for choices involving risk and time:

Definition 1 (Frame): A presentation or frame $[\![\mathbf{A},\mathbf{B}]\!]$ of allocations, A and B, is a matrix containing a representation $\mathbf{A}$ of A and a representation $\mathbf{B}$ of B.

A generic frame is presented in Figure 1. Neoclassical economics implicitly assumes that preferences are invariant to equivalent representations of alternatives. However, the choices of an agent whose decisions are influenced by salience considerations may depend on the frame to the extent it determines what attribute values are compared and which are found to be salient.

Figure 1. Presentation or "Frame" for a Choice between Allocations A and B

	(x_1,y_1)	(n_1,m_1)	(x_2,y_2)	(n_2,m_2)		(x_j,y_j)	(n_j,m_j)		(x_J,y_J)	(n_J,m_J)
A	x_1	n_1	x_2	n_2	…	x_j	n_j	…	x_J	n_J
B	y_1	m_1	y_2	m_2	…	y_j	m_j	…	y_J	m_J

Consider a society where each individual, $i \in I$ values resources according to the utility function $u(x_i) = x_j$, for all j where $j \in \{1, ..., \text{J}\}$ indexes the location of the j^{th} outcome in the frame in Figure 1. The assumption of linear utility is perhaps most natural for comparing income distributions, and it serves as a useful approximation that enables one to measure social surplus from observable information (income distributions) rather than from unobservable heterogeneous utility functions. Given a choice between allocations A and B (From Figure 1), a utilitarian social planner satisfies (2):

$$A \succsim B \Longleftrightarrow \sum_{j=1}^{J} n_j x_j \geq \sum_{j=1}^{J} m_j y_j. \tag{2}$$

Next, consider the relation $\hat{\succsim}$ over representations. We refer to $\hat{\succsim}$ as a 'perceptual relation' where $\mathbf{A}\hat{\succsim}\mathbf{B}$ is interpreted as A looks 'at least as good as' B given representation $\mathbf{A}$ of A and $\mathbf{B}$ of B.

Utilitarian preferences can also be represented by the perceptual relation in (3):

$$\mathbf{A}\hat{\succsim}\mathbf{B} \Longleftrightarrow \sum_{j=1}^{J} \mathbf{n_j x_j} \geq \sum_{j=1}^{J} \mathbf{m_j y_j}. \quad (3)$$

Note that (3) can be written equivalently as a comparative model such that $\mathbf{A}\hat{\succsim}\mathbf{B}$ if and only if:

$$\sum_{j=1}^{J} [(\mathbf{n_j} - \mathbf{m_j})(\mathbf{x_j} + \mathbf{y_j})/2 + (\mathbf{x_j} - \mathbf{y_j})(\mathbf{n_j} + \mathbf{m_j})/2] \geq 0. \quad (4)$$

Formula (4) weights attribute differences by their average utility and weights utility differences by their average attribute value. We formalize systematic deviations from (4) by letting tradeoffs between alternatives receive 'salience weights' to reflect the attention allocated to each comparison in the frame. Drawing on the intuition that larger differences attract disproportionate attention and are thereby over-weighted, we incorporate salience weights $\phi(\mathbf{n_j},\mathbf{m_j})$ on differences in the numbers of individuals, and $\mu(\mathbf{x_j},\mathbf{y_j})$ on utility differences such that $\mathbf{A}\hat{\succsim}\mathbf{B}$ if and only if (5) holds:

$$\sum_{j=1}^{J} [\phi(\mathbf{n_j},\mathbf{m_j})(\mathbf{n_j} - \mathbf{m_j})(\mathbf{x_j} + \mathbf{y_j})/2 + \mu(\mathbf{x_j},\mathbf{y_j})(\mathbf{x_j} - \mathbf{y_j})(\mathbf{n_j} + \mathbf{m_j})/2] \geq 0. \quad (5)$$

We refer to this model as salience weighted utility over presentations (SWUP). Analogous SWUP models to (5) that derive SWUP for risk from generalizing expected utility theory and that derive SWUP for choice over time from generalizing discounted utility theory are provided in Leland and Schneider (2018). We refer to an agent who chooses according to (5) as a focal thinker since such an agent focuses on salient differences in attribute values. Since SWUP is frame-dependent, its predictions are tested in a conditional sense, given the frame. The application of SWUP to our experiment implicitly assumes that subjects frame the allocation decisions as they are presented to them. While this observation and the fact that (5) is only specified for binary choice limit the generality of the model, we reiterate that our focus is on testing standard social choice theory and comparing the implications of the standard model with the implications of salience for social choice. To this end, (5) provides a simple way to generate testable predictions for how salience affects social choices. We also note that SWUP is quite general in a different sense – it generates testable predictions across the domains of risk, time, and social choice.

3.1 Properties of Salience Perception

The salience functions μ and ϕ determine the only ways in which a focal thinker differs from a rational agent. We assume a salience function exhibits two properties:

Definition 2 (Salience Function (Bordalo et al., 2013)): A salience function $\sigma(\mathbf{a},\mathbf{b})$ is any (non-negative), symmetric, and continuous function that satisfies the following two properties:

1. **Ordering:** If $[\mathbf{a}',\mathbf{b}'] \subset [\mathbf{a},\mathbf{b}]$ then $\sigma(\mathbf{a}',\mathbf{b}') < \sigma(\mathbf{a},\mathbf{b})$.

2. **Diminishing Sensitivity:** For any $\mathbf{a}, \mathbf{b}, \epsilon > 0, \sigma(\mathbf{a}+\epsilon,\mathbf{b}+\epsilon) < \sigma(\mathbf{a},\mathbf{b})$.

Ordering implies that the difference between values spanning a smaller interval (such as $30 vs. $40) is less salient than a difference spanning a larger interval which contains the smaller interval (such as $10 vs. $50). Diminishing sensitivity (DS), known since the work of Weber and Fechner in the 19th century, implies that for a fixed difference in values, the perceptual system is more sensitive to larger ratios. For instance, DS implies that the comparison between $1 and $100 is more salient than $101 versus $200. To illustrate a simple and tractable special case of SWUP, we use a parameter-free specification of (5) in which $\mu(\mathbf{x},\mathbf{y})$ and $\phi(\mathbf{n},\mathbf{m})$ are given by salience function (6) proposed by Bordalo et al., (2013) that satisfies ordering and diminishing sensitivity. We impose (6) when it is not the case that $\mathbf{a} = \mathbf{b} = 0$, and we otherwise set $\sigma(\mathbf{0},\mathbf{0}) = 0$.

$$\sigma(\mathbf{a},\mathbf{b}) = \frac{|\mathbf{a}-\mathbf{b}|}{|\mathbf{a}|+|\mathbf{b}|}. \tag{6}$$

Formula (6) is perhaps the simplest function satisfying ordering and DS. It is also a special case of a formula for visual contrast that is used in computational neuroscience[2] (Mante et al., 2005; Carandini and Heeger, 2012). Hence, the same

[2] For instance, Carandini and Heeger (2012) define local contrast as $C = (L - L_m)/L_m$ where L is local light intensity and L_m is the mean light intensity. When there are only two light intensities, x and y, with $x > y > 0$, note that $C = [x - (0.5x + 0.5y)]/(0.5x + 0.5y) = (x - y)/(x + y)$. Mante et al. (2005) use a related formula for the local contrast between pixels in an image that includes (6) as a special case.

function used to measure visual contrast between two pixels in an image is used under SWUP to measure 'tradeoff contrast' between two attributes in a frame. The parameter-free specification of SWUP thus has a strong psychological foundation.

Throughout, we illustrate the SWUP model for social choice using formula (5) with salience function (6). For any given frame, this specification of SWUP has no free parameters. We refer to (5, 6) as our parameter-free specification of SWUP.

4 Experimental Design

To test whether the fundamental properties of social choice theories are violated in practice, our experimental design involved allocation decisions using a procedure similar to Engelmann and Strobel (2004) in which there are multiple recipients and the decision maker is a social planner whose payoff is constant across allocations. The framework of this experiment differs from that of Engelman and Strobel (2004) in that they did not test the basic axioms of social choice theory but rather focused on the tradeoff between minimizing equality and maximizing efficiency.

One hundred undergraduate students at a private California university were randomly recruited to participate in the experiment. Each student participated in one session, with twenty students per session. Sessions were held in the experimental laboratory at the Economic Science Institute at Chapman University. The laboratory contains four rows of computer terminals with each computer in a separate cubicle. Five students were seated in each row, with one student per cubicle. Students read the instructions and proceeded through the experiment at their own pace. The experimental materials are provided as screen shots in the supplementary material (SM). Students were not able to see the identities or choices of other students. Students each had a post-it note with a number between 1 and 20 at their computers.

Each student made ten choices between monetary allocations to be allocated among ten students in the room. The ten choice sets were designed to test the potential for anomalous decisions within the social choice framework. Students were informed that one choice from one student in the third or fourth rows would be randomly selected to determine the allocation for the students in the first and second rows and that one choice from one student in the first and second rows would be randomly selected to determine the allocation for the students in the third and fourth rows. Students could not be recipients of their own allocation decisions so as not to confound a student's own risk preferences with her social preferences. The identities of all students including those whose choices determined the actual allocation were kept anonymous.

The experiment was programmed in Qualtrics. The order of the ten allocation decisions and the allocation presented in the top or bottom row of each decision were both randomized within subjects. Students earned \$10 for participation (\$7 as a 'show-up' payment and \$3 for responding to all questions) in addition to their payment from the selected allocation. Potential payments ranged between \$0 and \$50. Following the ten allocation choices, the experiment concluded with the seven-question cognitive reflection test (CRT) due to Toplak et al. (2014) which extends the original CRT from Frederick (2005). The CRT was used to determine if students' cognitive reflection skills are related to the consistency of their allocation decisions with social choice theory.

Once all students completed their responses, one choice was randomly selected to be implemented for the students in the front two rows using a ten-sided die and another choice was randomly selected to be implemented for students in the back two rows. Two more rolls of the ten-sided die selected one student from the back two rows (one from the front two rows) whose choice in the selected decision would determine the allocation to be implemented for the students in the front two rows (back two rows).

Two opaque bags were each filled with ten slips of paper prior to the experiment. One bag had slips numbered 1 through 10, the other had slips numbered 11 through 20. After the allocations were determined for both groups of students, slips were randomly drawn from each bag to implement the selected allocation with prizes from that allocation assigned in monotonically decreasing order to the student with the number on the post-it note that corresponded to the slip drawn. A typical session lasted less than half an hour.

4.1 Allocation Choices used in the Experiment

The ten allocation decisions made by subjects collectively test the five properties in Section 2. By testing these properties, we can test the extent to which subjects conform to the following nested social choice models (with properties they satisfy in parentheses):

1. The class of additive social welfare functions (Properties (1-3)
2. The class of additive power social welfare functions (Properties (1-4)
3. The utilitarian social welfare function (Properties (1-5)

The salience model in (5) with salience function (6) predicts that preferences will systematically deviate from properties (1-3) and property (5) but will conform to property (6). Under the more general salience function in Bordalo et al. (2012) given by $\sigma(\mathbf{a},\mathbf{b}) = |\mathbf{a} - \mathbf{b}/(|\mathbf{a}| + |\mathbf{b}| + \theta)$, the salience model predicts systematic deviations from all five properties. In particular formula (5), with either the parameter-free salience function (6) or the more general salience function (for example, with $\theta = 1$), predicts:

1. deviations from common consequence independence that are analogous to the Allais paradox in risky choice.

2. deviations from common ratio independence that mirror the certainty effect in risky choice.

3. systematic framing effects in which preferences shift toward the more egalitarian allocation or the more utilitarian allocation, depending on which tradeoffs are salient that mirror alignment framing effects in risky choice.

4. skewness preference in which preferences are attracted to positively skewed allocations and averse to negatively skewed allocations that is consistent with the tendency toward skewness preference in risky choice.

The SWUP model in (5) generates different predictions for the parameter-free and the more general salience functions (for example, with $\theta = 1$) when testing the property of scale invariance. While the parameter-free salience function predicts scale invariance to hold, the more general salience function generates a magnitude effect in which preferences shift from inequality-seeking to inequality-averse as payoffs are scaled up. Testing the property of scale invariance thereby enables us to distinguish between the two primary salience functions in the literature.

Our simple experiment thus enables us to test the standard model of social choice theory while also permitting us to test the implications of salience perception for social choice. The ten allocation decisions from the experiment are presented in the following subsections with the predicted choices highlighted in bold. All choices (presented as shown to subjects in the SM) were displayed in words rather than in the matrix form in Figure 1.

4.2 Test of an Allais Paradox for Social Choice

The Allais paradoxes in choice under risk reveal a disproportionate preference for certainty. The common consequence choice pairs, shown below, have a directly analogous structure to the Allais common consequence paradox for choice under risk.

Common Consequence Pair 1

A) 5 people receive $3, 4 people receive $3, and 1 other person receives $3

B) 5 people receive $5, 4 people receive $3, and 1 other person receives $0

Common Consequence Pair 2

A) 6 people receive $3 and the other 4 people receive $0

B) 5 people receive $5 and the other 5 people receive $0

The common consequence pairs involve a choice between assigning $3 each to ten people or assigning $5 to five people, $3 to four people, and $0 to one person (pair 1) and a choice between assigning $3 to six people or $5 to five people (pair 2). The allocations in each pair share a common consequence (four people each receiving $3 in pair 1 and four people receiving $0 in pair 2). A utilitarian planner who maximizes efficiency would prefer B in both choices. A sufficiently inequity-averse planner (i.e., with a sufficiently concave social welfare function) would prefer A in both choices. More broadly, any additive social welfare function that strictly prefers A over B in pair 1 will also strictly prefer A over B in pair 2. The SWUP model in (5, 6) predicts a choice of A in pair 1 due to the salience of one person receiving $0 instead of $3 under allocation B, and a choice of B in pair 2, since the comparison of $3 versus $5 is more salient than allocating money to 5 versus 6 people.

4.3 Test of a Common Ratio Effect for Social Choice

The common ratio effect is another violation of independence. In our experiment, choices to elicit a common ratio effect are translated to a social choice environment.

Common Ratio Pair 1

A) 5 people receive $2 and the other 5 people receive $2
B) 5 people receive $5 and the other 5 people receive $0

Common Ratio Pair 2

A) 2 people receive $2 and the other 8 people receive $0
B) 1 person receives $5 and the other 9 people receive $0

The common ratio choice pairs above, involve a choice between assigning $2 to each of ten people or $5 to each of five people (pair 1) and a choice between assigning $2 to each of two people or $5 to one person (pair 2). Thus, the number of people receiving a payoff in the pair 2 allocations is one-fifth (a common ratio) of the number of people in the pair 1 allocations. A utilitarian decision maker who maximizes efficiency would prefer B in both choices. An inequity-averse planner with a sufficiently concave social welfare function would prefer A in both choices. More broadly, any additive social welfare function that strictly prefers A over B in pair 1 will also strictly prefer A over B in pair 2. The SWUP model in (5, 6) predicts a choice of A in pair 1 and a choice of B in pair 2. The SWUP model thus predicts an equality effect in which social planners deviate from standard theory by exhibiting a disproportionate preference for eliminating inequality. This behavior is analogous the Allais certainty effect in which a decision maker deviates from expected utility theory by exhibiting a disproportionate preference for eliminating risk.

4.4 Test of a Framing Effect for Social Choice

We next provide a test of the property of frame invariance for social choice. A novel prediction of SWUP is that a decision maker's policy preferences (e.g., between a more efficient or a more equitable allocation) will be subject to systematic framing effects. Consider for example the two allocation decisions below. These alignment framing effect pairs each involve a choice between assigning $12 to 2 people, $5 to 4 people and $0 to 4 people versus assigning $13 to 2 people, $5 to 4 people and $0 to 4 people. A preference for efficiency predicts the choice of B and inequity aversion predicts the choice of A. Note that both choice pairs represent exactly the same decision, so that differences in behavior cannot be explained by any standard model of social preferences. In contrast, SWUP predicts a systematic framing effect in which A is chosen over B in Pair 1 since \$12 versus \$0 is the salient comparison in that pair, and B is predicted to be chosen over A in Pair 2 since \$13 versus \$12 is the salient comparison in that pair. This behavior is analogous to 'hidden zero' framing effects that have been observed for risk (Bordalo et al., 2012; Leland, Schneider, and Wilcox, 2018) and time (Magen et al., 2008).

Alignment Framing Effect Pair 1

A) 2 people receive \$5, 2 others receive \$5, 4 others receive \$0, and 2 others receive \$12

B) 2 people receive \$0, 2 others receive \$13, 4 others receive \$5, and 2 others receive \$0

Alignment Framing Effect Pair 2

A) 2 people receive \$0, 2 others receive \$0, 4 others receive \$5, and 2 others receive \$12

B) 2 people receive \$0, 2 others receive \$0, 4 others receive \$5, and 2 others receive \$13

The framing effect predicted by SWUP especially applies to agents who do not have strong preferences for one policy over another. The 'median voter' in a close political election may have particularly weak preferences between candidates or policies. An implication of the framing effect predicted by SWUP is then that the election outcome may hinge on the frame adopted by the median voter. If one views the two framing effect pairs as analogous to two advertisements, SWUP implies that informationally equivalent ads can bias voters toward a more efficient or a more equitable policy by focusing the voters' attention on comparisons that favor one policy over the other.

4.5 Test of Scale Invariance for Social Choice

A general property of a power social welfare function is scale invariance. Scale invariance is also implied by SWUP from (5) with the parameter-free salience function in (6). In contrast, under the BGS salience function, for instance with $\vartheta=1$, SWUP predicts a shift toward more egalitarian allocations as payoffs are scaled up by a common factor. Consider the 'magnitude effect' pairs shown below. Pair 1 involves a choice between assigning $5 each to ten people or assigning $50 to one person and $0 to nine others. Pair 2 is a choice between assigning $0.25 each to ten people or assigning $2.50 to one person and $0 to the others. A utilitarian planner would be indifferent in both choices. An inequity-averse planner with a power social welfare function would prefer A in both choices.

Magnitude Effect Pair 1

A) 1 person receives $5 and the other 9 people receive $5
B) 1 person receives $50 and the other 9 people receive $0

Magnitude Effect Pair 2

A) 1 person receives $0.25 and the other 9 people receive $0.25
B) 1 person receives $2.50 and the other 9 people receive $0

The parameter-free SWUP model in (5, 6) also predicts A in both choices and hence, no magnitude effect. However, under the more general salience function, SWUP predicts a magnitude effect for sufficiently large $\theta > 0$. For instance, if $\theta = 1$, SWUP predicts a choice of A in pair 1 and B in pair 2. The distinction between $\theta = 0$ and $\theta > 0$ is more than a difference in parameter values: It enables us to test the following property of a salience function in the domain of social choice:

Increasing Proportional Sensitivity: For any $\mathbf{ab} > 0, \alpha > 1, \sigma(\alpha\mathbf{a},\alpha\mathbf{b}) > \sigma(\mathbf{a},\mathbf{b})$.

There is an intuitive relationship between increasing proportional sensitivity (IPS) and the diminishing sensitivity property. Diminishing sensitivity implies that for a fixed absolute difference, the perceptual system is more sensitive to larger ratios. The IPS property implies that for a fixed ratio, perception is more sensitive to larger absolute differences. When $\theta = 0$, σ satisfies diminishing sensitivity but not IPS. When $\theta > 0$, σ satisfies both properties.

4.6 Test of a Skewness Effect for Social Choice

The final property we test is skewness invariance. This enables us to test whether social preferences depend on the skewness of the distribution of payoffs in an allocation. Consider, for instance, the skewness effect pairs shown below. Pair 1 involves a choice between assigning 7 people \$12 and 3 people \$11 or assigning 7 people \$16 and 3 people \$6. Pair 2 involves a choice between assigning 7 people \$12 and 3 people \$11 or assigning 7 people \$10 and 3 people \$20. Option B in pair 1 and option B in pair 2 share several features in common: They both have the same total value of \$130, they both have the same degree of equality (as measured for instance by the Gini coefficient, the mean absolute deviation, the standard deviation, and the range of these allocations), and they are compared to the same alternative allocation A. They also have the same absolute magnitude of skewness. In addition, option A has the larger minimum payoff in both pairs. Thus, pure utilitarian preferences or pure Rawlsian preferences (that maximize the payoff of the least fortunate individual as suggested by Rawls (1971)) cannot generate a preference for A in one pair and a preference for B in the other. However, since B is negatively skewed in pair 1 and positively skewed in pair 2, SWUP predicts a preference for A in pair 1 (where the comparison between \$6 and \$11 is salient) and a preference for B in pair 2 (where the comparison between \$20 and \$11 is salient). That is, SWUP predicts an aversion to negatively skewed efficient allocations and a preference for positively skewed efficient allocations, relative to a more equitable allocation. This implication also holds for a concave power social welfare function, although it does not hold for standard inequality measures or for utilitarian or Rawlsian preferences.

Skewness Effect Pair 1

A) 7 people receive \$12 and the other 3 people receive \$11
B) 7 people receive \$16 and the other 3 people receive \$6

Skewness Effect Pair 2

A) 7 people receive \$12 and the other 3 people receive \$11
B) 7 people receive \$10 and the other 3 people receive \$20

The skewness effect predicted by SWUP also provides a social choice-based explanation for the widely observed positively skewed wealth distributions across countries and across time (Behabib and Bisin, 2017). In contrast, utilitarian preferences place no restrictions on the skewness of a society's wealth distribution, while Rawlsian preferences lead to a symmetric wealth distribution.

5 Results

We summarize our main results in Table 1 which displays the distribution of individual choice patterns for each pair of choices. For each pair, the "Equality" column contains the proportion of all 100 subjects who consistently chose the more equitable allocation in that pair. For each choice pair, the "Efficiency" column displays the proportion of all 100 subjects who consistently chose the more utilitarian efficient allocation in that pair. The "SWUP pattern" column displays the proportion of all subjects who exhibited the choice pattern predicted by the SWUP model in (5), using the BGS salience function which predicts systematic deviations from all five properties in Section 2. The parameter-free specification of SWUP predicts the same SWUP patterns as the BGS salience function except that it predicts consistent egalitarian choices in the magnitude effect pair. The "Unexplained" column displays the proportion of all subjects who displayed the opposite form of inconsistency from the predicted SWUP patterns.

Table 1. Proportion of all Subjects exhibiting each Preference Pattern (N = 100)

Tested Effect	Equality (A, A)	Efficiency (B, B)	SWUP Pattern (A, B)	Unexplained (B, A)	Conlisk Z	P-Value
Common Consequence	0.27	0.21	0.47	0.05	7.129	p < 0.001
Common Ratio Effect	0.37	0.16	0.39	0.08	5.044	p < 0.001
Framing Effect	0.05	0.33	0.56	0.06	8.179	p < 0.001
Magnitude Effect	0.55	*	0.14	0.21	-1.186	Not Significant
Skewness Effect	0.22	0.19	0.5	0.09	6.281	p < 0.001

In the table, (X, Y) denotes a choice of X (from set {A,B}) in Pair 1 and a choice of Y (from set {A,B}) in Pair 2

*Allocations within magnitude effect chocies had the same efficiency. 10% chose the less equitable allocation in both choices.

Table 1 also reports Conlisk's (1989) Z-statistic that is designed to test for the presence of systematic bias in pairs of choice problems and which approximates a standard normal distribution. Bounds on the corresponding p-values are also shown. From Table 1 we see that the social choice SWUP model is remarkably successful. The predictions from the model were generated before collecting the data. Despite these restrictions, SWUP accurately predicted the majority choice in nine of the ten allocation decisions under the BGS salience function with ϑ=1. In addition, the simpler parameter-free specification in (5, 6) correctly predicted the majority choice in all ten allocation decisions. Moreover, of the five principles tested, four were significantly violated. Two observations to note from Table 1 are that (i) these four effects are highly systematic, with each pattern predicted by the salience model occurring for between 39 and 56 subjects and the reverse bias occurring for between 5 and 9 subjects, and (ii) for each of these four effects, the predicted pattern is the modal response, occurring more often than consistent preferences for either utilitarian efficiency or equality. Only the magnitude effect implied by the IPS property of salience perception was not observed. Instead, 55 of the 100 subjects chose the more equitable allocation in both magnitude effect choices, consistent with a concave social welfare function or with the parameter-free specification of SWUP.

5.1 Patterns of Behavior within Subjects

A more stringent test of the predictions of social choice theory and SWUP in our experiment is to consider each subject's overall preference pattern to check which model they are best characterized by. To investigate this, we consider individual preference patterns across eight choices[3] – the choice pairs for the framing effect, the skewness effect, the common consequence effect, and the common ratio effect. We fit the social welfare function $w(u_i) = u_i^{\alpha_i}$, where the inequality aversion parameter α_i was fit separately for each subject i and the monetary amounts in each allocation were used in place of the unknown (and unobservable) utility values for the recipients of the allocation. We let $\alpha_i \in (0, 1]$ for all i so that each subject's social preferences included the utilitarian social welfare function ($\alpha_i = 1$) as a special case. We searched through this parameter space for α_i for each subject, i, by computing that subject's social welfare function for 100 values of α_i from 0.01 to 1 at 0.01 increments to find the maximum number of these eight choices which could be best fit for each subject by some $\alpha_i \in \{0.01, 0.02, \ldots, 1.00\}$. We compared these predictions for each subject to the parameter-free predictions of the salience model. This is a strong test of the salience model: Across our subject population we fit 100 free parameters for the social choice theory specification (one for each subject) and we compared that to the parameter-free specification of SWUP (from formulas (5) and (6)) which fits zero parameters. These results are summarized in Table 2 which displays the number of subjects (N) best fit by each model. Remarkably, of the 100 subjects in the experiment, the

[3] The magnitude effect pair was not used for two reasons: (1) The magnitude effect is not a robust prediction of SWUP as noted in Section 4.5 in that it does not hold for the parameter-free salience function, and (2) Both choice alternatives had the same level of efficiency and so utilitarianism does not make a clear prediction for these pairs.

parameter-free salience model predicts the choices of 42% of subjects strictly better than the social choice model. The social choice model predicts the choices of 25% of subjects strictly better than the salience model, and the two models are tied for the remaining 33% of subjects. Hence, the salience model has substantially greater predictive accuracy with substantially fewer parameters. For the social choice model, there was a set of parameter values that achieved the same best fit for each subject. Of the 100 subjects, 54 had sets of best-fitting parameter values that included the utilitarian case ($\alpha_i = 1$). Of these 54 subjects, 14 fit better than salience theory, and an additional 12 were tied with salience theory. Hence, we cannot reject the possibility that up to 26% of our subjects are utilitarian. At the aggregate level, social choice theory with subject-specific inequality-aversion parameters best fits 64.75% of the 800 choices, whereas the parameter-free salience model best fits 70.5% of these choices. This difference is also significant ($p = 0.032$, two-tailed Wilcoxon signed-rank test). A parameter-free social choice specification in which all subjects are utilitarian best fits 49.75% of these choices, not better than random chance.

Table 2. Number of Subjects best fit by each model

	Social Choice Theory ($w(u_i) = u_i^{\alpha_i}$)	Salience Theory (5, 6)	Ties
N	25	42	33

5.2 Social Welfare Preferences and Cognitive Reflection

The cognitive reflection test uncovered substantial heterogeneity in the types of social preferences our subjects exhibited. Since each of the choices in our experiment involved a more egalitarian allocation and a less egalitarian allocation, we computed an 'inequity-aversion' index for each subject defined as the total number of egalitarian choices a subject made out of all 10 decisions. Since eight choices involved a more efficient allocation and a less efficient allocation we also computed an efficiency index for each subject defined as the total number of efficiency-maximizing choices a subject made in these eight decisions. We observed a significant positive correlation between CRT score and efficiency choices ($\rho = 0.362$, $p < 0.001$, two-tailed Pearson correlation test), and a significant negative correlation between CRT score and inequity-averse choices ($\rho = -0.314$, $p < 0.002$, two-tailed Pearson correlation test).

6 Consistency with other Experimental Findings

The preceding section demonstrates that the salience model performs well in our experiment (even though the model's predictions were generated prior to data collection). We now turn briefly to other experimental results on social choice to probe whether the salience model provides a robust explanation of observed social welfare preferences.

6.1 Inequality Aversion and Efficiency Preference

In the following examples of choices made by a social planner between monetary allocations or between medical treatments, the parameter-free SWUP model in (5, 6) predicts the observed preferences for equality and efficiency, as well as observed behavior that contradicts both of these preferences.

Figure 2. Preference for minimizing Inequality and maximizing Efficiency

Preference for Lower Inequality

	$	N	$	N
A	**5**	**1**	**5**	**1**
B	10	1	0	1

Preference for Higher Efficiency

	$	N	$	N	$	N
A	10	1	8	1	1	1
B	**16**	**1**	**8**	**1**	**5**	**1**

Figure 2 displays two decisions. On the left, SWUP predicts an aversion to inequality when allocating a fixed sum of money ($10) between two recipients. In the choice on the right, SWUP predicts a preference for efficiency (allocating $16, $8, and $5 to three individuals instead of $10, $8, and $1 to those individuals). In this latter example from Engelmann and Strobel (2004), subjects were in the position of the recipient who received $8 from either allocation, similar to a situation in which an impartial social planner allocates resources. Engelmann and Strobel observed that over 70% of respondents chose allocation B. In contrast, the Fehr-Schmidt (1999) model of inequity aversion predicts A to be chosen.

6.2 Medical Treatment Allocation

In a recent experiment (Voorhoeve et al., 2017), participants chose between two treatments, only one of which could be implemented. In the experiment, subjects were told that 48 people were initially at a health utility index of 0.95 and 27 were at a health index of 0.91. Treatment 1 would restore 48 people to perfect health (from an initial health utility index of 0.95) while Treatment 2 would restore 27 people to perfect health (from an initial health utility index of 0.91). This choice is shown in Figure 3 with payoffs (health utilities) ranked in monotonically decreasing order.

Figure 3. Observed deviation from Inequity Aversion, Rawls and Utilitarianism

	Health	N	Health	N
Treatment 1	**1**	**48**	**0.91**	**27**
Treatment 2	1	27	0.95	48

In Figure 3, Treatment 2 maximizes efficiency, provides a higher payoff to the worst-off group (as advocated by Rawls, 1971) and results in more equitable health levels (using inequality measures such as mean absolute deviation). Treatment 2 is thus predicted to be selected by the three major paradigms for optimizing social welfare. In contrast, the parameter-free specification of SWUP predicts a preference for Treatment 1 because the difference between restoring 48 versus 27 individuals to perfect health is more salient than the 0.91 versus 0.95 health utility indices. In this respect, SWUP formalizes the effects of salience perception on social welfare. Voorhoeve et al. (2017) observed that the majority of participants preferred Treatment 1.

7 Conclusion

Our experiment identifies four anomalies for social choice that parallel classical anomalies for risk and time. These are summarized in Table 3 and include:

1. violations of common consequence independence (the Allais paradox for risk (Allais, 1953), the cancellation effect for time (Rao and Li, 2011), and the common consequence effect we observe for social choice).

2. boundary effects which reveal a disproportionate preference for eliminating risk (e.g., as revealed by the common ratio effect of Kahneman and Tversky (1979), a disproportionate preference for eliminating time delays prior to a reward (as revealed by present bias (Prelec and Loewenstein, 1991), and a disproportionate

preference for eliminating inequality (as observed from the common ratio and common consequence violations in our experiment).

3. a preference for positively skewed distributions over negatively skewed distributions (which manifests as the fourfold pattern for risk (Tversky and Kahneman, 1992), as the bias toward concentration for time (Koszegi and Szeidl, 2013), and as the preference for positively skewed allocations over negatively skewed allocations that we observe for social choice)

4. violations of frame invariance (the hidden zero framing effect for risk (Bordalo et al., 2012; Leland, Schneider, and Wilcox, 2018), the hidden zero effect for time (Magen et al., 2008; Read et al., 2017), and the alignment framing effect we observe for social choice). Schneider, Leland, and Wilcox (2018) observe a similar framing effect for choice under ambiguity.

Table 3. Observed Parallels between Risk, Time, and Social Choice

Behavior	Choice under Risk	Choice over Time	Choice over Allocations
Independence Violation	Allais Paradox	Cancellation Effect	Common Consequence Effect
Boundary Effect	Certainty Effect	Present Bias	Equality Effect
Skewness Preference	Fourfold Pattern	Concentration Bias	Equity-Efficiency Reversal
Alignment Framing Effect	Framing Effect	Hidden Zero Effect	Framing Effect

Table 3 thereby provides a compact and yet surprisingly comprehensive summary of the most robust systematic deviations from the classical models of rational choice. The behavioral anomalies for risk, time, and social choice in Table 3 are predicted, respectively, by the SWUP models for risk and time in Leland and Schneider (2018) and by the analogous SWUP model for social choice developed here. The salience effects for social choice may be even more consequential than for risk and time, since the type of decision maker most susceptible to salience effects (one who is nearly indifferent between two alternatives) is also most likely to determine political elections and policies on the margin (such as the median voter). Our results may thus suggest broader implications for the effects of salience on social choice.

References

1. Allais, M. (1953). Le comportement de l'homme rationnel devant le risque: critiques des postulats et axioms de l'ecole Americaine. *Econometrica*, 21, 503-546.

2. Benhabib, J., A. Bisin. (2017). "Skewed wealth distributions: Theory and empirics." Washington Center for Equitable Growth. Manuscript.

3. Bernasconi, M. (2002). How should income be divided? Questionnaire evidence from the theory of 'impartial preferences'. In: P. Moyes, C. Seidl & A. Shorrocks (Eds), Inequalities: Theory, Experiments and Applications, *Journal of Economics* (Suppl. 9, 164-195).

4. Bordalo, P., N. Gennaioli, A. Shleifer. (2012). Salience theory of choice under risk. *Quarterly Journal of Economics*, 127, 1243-1285.

5. Bordalo, P., N. Gennaioli, A. Shleifer. (2013). Salience and Consumer Choice. *Journal of Political Economy*, 121, 803-843.

6. Bosmans, K., E. Schokkaert. (2004). Social welfare, the veil of ignorance and purely individual risk: An empirical examination. In: F.A. Cowell (ed). *Research on Economic Inequality*, Volume 11. Amsterdam: Elsevier, 85-114.

7. Carandini, M., D.J. Heeger. (2012). Normalization as a canonical neural computation. *Nature Reviews: Neuroscience*, 13, 51-62.

8. Conlisk, J. (1989). Three variants on the Allais example. *American Economic Review,* 79, 392-407.

9. Cooper, D.J., J.H. Kagel. (2014). Other-regarding preferences: A selective survey of experimental results. Manuscript.

10. Engelmann, D. M. Strobel. (2004). Inequality aversion, efficiency, and maximin preferences in simple distribution experiments. *American Economic Review*, 94, 857-869.

11. Fehr, E., K. Schmidt. (1999). A theory of fairness, competition, and cooperation. *Quarterly Journal of Economics*, 114, 817-868.

12. Frederick, S. (2005). Cognitive reflection and decision making. *Journal of Economic Perspectives*, 19, 25-42.

13. Kahneman, D., A. Tversky. (1979). Prospect theory: An analysis of decision under risk. *Econometrica*, 47, 263-291.

14. Koszegi, B., A. Szeidl. (2013). A model of focusing in economic choice. *Quarterly Journal of Economics*. 128, 53-104.

15. Leland, J., M. Schneider. (2018). Risk preference, time preference, and salience perception. Manuscript.

16. Leland, J., M. Schneider, N. Wilcox. (2018). Minimal and Transparent frames for Risk, Time, and Uncertainty. Manuscript. Forthcoming, *Management Science*.

17. Magen, E., C. Dweck, J. Gross. (2008). The hidden-zero effect. *Psychological Science*, 19, 648–649.

18. Mante, V., R.A. Frazor, V. Bonin, W.S. Geisler, M. Carandini. (2005). Independence of luminance and contrast in natural scenes and in the early visual system. *Nature Neuroscience*, 8, 1690-1697.

19. Michaelson, Z. (2015). Biases in choices about fairness: Psychology and economic inequality. *Judgment and Decision Making,* 10, 198-203.

20. Moulin, H. (2004). *Fair Division and Collective Welfare.* MIT Press. Cambridge, MA.

21. Prelec, D., G. Loewenstein. (1991). Decision making over time and under uncertainty: A Common approach. *Management Science*, 37, 770-786.

22. Rao, L., S. Li. (2011). New paradoxes in intertemporal choice. *Judgment and Decision Making*, 6, 122-129.

23. Read, D., C.Y. Olivola, D.J. Hardisty. (2017). The value of nothing: Asymmetric attention To opportunity costs drives intertemporal decision making. Forthcoming, *Management Science*.

24. Roth, Alvin, E. (1995). Bargaining experiments. In: *The Handbook of Experimental Economics*, John H. Kagel and Alvin E. Roth (eds). Princeton University Press.

25. Schneider, M., J.W. Leland, N. Wilcox. (2018). Ambiguity Framed. Forthcoming, *Journal of Risk and Uncertainty.*

26. Toplak, M.E., R.F. West, K.E. Stanovich. (2014). Assessing miserly information processing: An expansion of the Cognitive Reflection Test. *Thinking and Reasoning*, 20, 147-168.

27. Tversky, A., D. Kahneman. (1981). The framing of decisions and the psychology of choice. *Science*, 211, 453-458.

28. Tversky, A., D. Kahneman. (1992). Advances in prospect theory: Cumulative representation of uncertainty. *Journal of Risk and Uncertainty*, 5, 297-323.

29. Voorhoeve, A., A. Stefansson, B. Wallace. (2017). Similarity and moral choice. Manuscript.

Appendix for Manuscript:

"Salience and Social Choice"

Screen Shots from Experiment

Experimental subjects responded to the choices as presented below. Only one choice was displayed on a screen at any time. The order of choices and the option that appeared on the top or bottom row in each choice were both randomized within subjects. The labels in bold font above each screen shot were not shown to subjects. They are included below to facilitate comparison to the main text.

Instructions

In this experiment, you will be asked several questions. In each question, you will be given a choice between 2 different allocations of funds to be given to ten experiment participants in this room. Your choice may determine the payment of ten participants in this room but it will not determine your payment. Once all participants have completed the questions, one choice from a participant in the first or second row (the front two rows in this room) and one choice from a participant in the third or fourth row (the back two rows in this room) will be randomly selected. The choice from the person in the first or second row will determine the payment of the ten participants in the third and fourth rows. The choice from the person in the third or fourth row will determine the payment of the ten participants in the first and second rows.

All choices will be *anonymous*. No one will know the identity of the participants whose choices are randomly selected to determine payments.

The following is an example of the types of options you will consider:

- 1 person receives $3 and the other 9 people receive $7
- 1 person receives $4 and the other 9 people receive $6

It is important to emphasize there are no "right" answers to these questions. Please choose according to your own preferences. In addition to the payoff you receive from the selected allocation, you will also receive $3 for completing the survey.

→

Common Consequence Pair 1

Please select the allocation of money below that you most prefer to be randomly distributed to ten people in this room (*not* including yourself)

- 5 people receive $5, 4 people receive $3, and 1 other person receives $0
- 5 people receive $3, 4 people receive $3, and 1 other person receives $3

Common Consequence Pair 2

Please select the allocation of money below that you most prefer to be randomly distributed to ten people in this room (*not* including yourself)

- 6 people receive $3 and the other 4 people receive $0
- 5 people receive $5 and the other 5 people receive $0

Common Ratio Pair 1

Please select the allocation of money below that you most prefer to be randomly distributed to ten people in this room (*not* including yourself)

- 5 people receive $2 and the other 5 people receive $2
- 5 people receive $5 and the other 5 people receive $0

Common Ratio Pair 2

Please select the allocation of money below that you most prefer to be randomly distributed to ten people in this room (*not* including yourself)

- 2 people receive $2 and the other 8 people receive $0
- 1 person receives $5 and the other 9 people receive $0

Magnitude Effect Pair 1

Please select the allocation of money below that you most prefer to be randomly distributed to ten people in this room (*not* including yourself)

- 1 person receives $0.25 and the other 9 people receive $0.25
- 1 person receives $2.50 and the other 9 people receive $0

Magnitude Effect Pair 2

Please select the allocation of money below that you most prefer to be randomly distributed to ten people in this room (*not* including yourself)

- 1 person receives $50 and the other 9 people receive $0
- 1 person receives $5 and the other 9 people receive $5

Skewness Effect Pair 1

Please select the allocation of money below that you most prefer to be randomly distributed to ten people in this room (*not* including yourself)

- 7 people receive $12 and the other 3 people receive $11
- 7 people receive $10 and the other 3 people receive $20

Skewness Effect Pair 2

Please select the allocation of money below that you most prefer to be randomly distributed to ten people in this room (*not* including yourself)

- 7 people receive $12 and the other 3 people receive $11
- 7 people receive $16 and the other 3 people receive $6

Alignment Framing Effect Pair 1

Please select the allocation of money below that you most prefer to be randomly distributed to ten people in this room (*not* including yourself)

- 2 people receive $5, 2 others receive $5, 4 others receive $0, 2 others receive $12
- 2 people receive $0, 2 others receive $13, 4 others receive $5, 2 others receive $0

Alignment Framing Effect Pair 2

Please select the allocation of money below that you most prefer to be randomly distributed to ten people in this room (*not* including yourself)

- 2 people receive $0, 2 others receive $0, 4 others receive $5, and 2 others receive $13
- 2 people receive $0, 2 others receive $0, 4 others receive $5, and 2 others receive $12

Cognitive Reflection Test (Seven-question version from Toplak et al., 2014)

Please answer the following questions

A bat and a ball cost $1.10 in total. The bat costs $1.00 more than the ball. How much does the ball cost?

If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets?

In a lake there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake?

If John can drink one barrel of water in 6 days, and Mary can drink one barrel of water in 12 days, how long would it take them to drink one barrel of water together?

Jerry received both the 15th highest and the 15th lowest mark in the class. How many students are in the class?

A man buys a pig for $60, sells it for $70, buys it back for $80, and sells it finally for $90. How much has he made?

Simon decided to invest $8,000 in the stock market one day early in 2008. Six months after he invested, on July 17, the stocks he had purchased were down 50%. Fortunately for Simon, from July 17 to October 17, the stocks he had purchased went up 75%. At this point, Simon has:

broken even ○ gained money ○ lost money ○