Range effect and preference reversals across domains

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Similar anomalies have been documented in risky choice and intertemporal choice. I explain the similarity with the range effect, which says that people care more about attributes that differ more in their choice set. I use a model to show that the range effect gives a unique explanation to the common ratio effect, the common difference effect, and magnitude effects. The model also provides a characterisation of procedural preference reversals between choice and valuation. Finally, I apply the model to social distances and predict new anomalies, one of which I confirm in a laboratory experiment.

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1 Introduction

We usually keep risk and time separate and handle them with separate models. For example, we capture the attitude toward risk with the expected utility model

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and the attitude toward time with the discounted utility model.

A substantial literature, however, shows that risk and time are connected: anomalies observed in one domain have their counterpart in the other domain; and adding, say, risk to a decision problem brings forth the same phenomena as would adding time.[1] To explain this connection most have assumed that one domain comes before the other, for example that delaying a reward makes it more risky (Baucells and Heukamp, 2010; Epper et al., 2011; Halevy, 2008).

I suggest instead that the connection between the domains results from a single effect independent of the domains: the *range effect*. The range effect says that people put more weight on attributes that differ more in their choice set. On this effect I build a model that shows that the anomalies observed in the different domains all emerge from the range effect. The model makes new predictions in the domain of social distances, one of which I verify in a laboratory experiment.

The model, in order to bind the domains together, uses the concept of psychological distance. In general, psychological distances measure the distance between us and things that we cannot directly experience: things that are unlikely, remote in time, or experienced by others. Construal level theory (Liberman et al., 2007; Trope and Liberman, 2010) has shown how these distances—risk, temporal distance, social distance—are manifestations of a unique psychological distance.[2] It has also shown that people use the same mental processes to 'traverse psychological distance', whatever the specific type.[3] As a consequence, whether people deal with

[1]Rotter (1954) was the first to suggest a link between risk and time. For early research in economics, Prescott and Lucas (1972), Brown and Lewis (1981), and especially Quiggin and Horowitz (1995), showed how decisions involving risk and decisions involving time are formally equivalent. For early empirical research in the wake of Rotter (1954), see Mischel and Grusec (1967). In psychology see the experiments by Benzion et al. (1989); Chapman and Weber (2006); Keren and Roelofsma (1995); Weber and Chapman (2005a). Closer to economics see Anderhub et al. (2001); Baucells and Heukamp (2010); Dean and Ortoleva (2015). Finally, see Prelec and Loewenstein (1991) for a comparison of the anomalies of expected utility and exponential discounting.

[2]The first way to establish this claim has been to show that one distance affects the perception of others, for example that temporal distance affects social distance (Bartels and Rips, 2010; Pronin et al., 2008; Pronin and Ross, 2006; Stephan et al., 2011; Yi et al., 2011), or that risk affects other distances (Wakslak, 2012). The second way has been to directly study the interplay between the distances and and the mechanisms behind their perception (Bar-Anan et al., 2007; Fiedler et al., 2012; Maglio et al., 2013).

[3]In time see temporal construal theory (Liberman and Trope, 1998; Trope and Liberman, 2000, 2003), the original name of construal level theory. In risk see Todorov et al. (2007); Wakslak and Trope (2009); Wakslak et al. (2006). More generally see Liberman and Trope (2008, 2014)

risk, with time, or with social distances, they will use the same mental processes.

The mental process I focus on is the range effect, best illustrated by this experiment from Goldstein (1990). Goldstein asked subjects to rate 6 apartments characterised by monthly rent and time to walk to campus. Some subjects faced a wide spread of rents, from \$250 to \$500. Others faced a narrow spread, from \$300 to \$400. Goldstein found that subjects cared more about rent when rent was widely spread. Similar evidence comes from the weight-change literature (Fischer, 1995; Mellers and Cooke, 1994; von Nitzsch and Weber, 1993; Wedell, 1998; Wedell and Pettibone, 1996) and the similarity literature (Mellers and Biagini, 1994; Mellers et al., 1992a,b). The range effect recently surfaced in economics with Kőszegi and Szeidl's (2013) focusing model and I rely on their approach to capture the range effect.

To see how the range effect explains anomalies, take the following example. Imagine choosing between a sure 30€ and a gamble offering an 80% chance of winning 40€. Then, divide all probabilities by 4, so that you now choose between a 25% chance of winning 30€ and a 20% chance of winning 40€. Expected utility theory tells you that if you picked the 30€ in the first choice you should pick the 25% chance of winning 30€ in the second choice. Many people, however, pick the 30€ in the first choice but then switch to the 20% chance of winning 40€: this is the common ratio effect, one of the most robust anomalies of risky choice.[4] The common ratio effect is usually explained by the fanning-out of indifference curves or by decision weights (Starmer, 2000). The range effect explains things differently: In the first choice the range of probabilities is $100\% - 80\% = 20\%$, but in the second choice it shrinks to $25\% - 20\% = 5\%$. The change triggers a range effect and makes the amount of money loom bigger, tilting people into choosing the more risky gamble. The range effect similarly explains the common difference effect observed in intertemporal choice, as well as magnitude effects observed in both domains. It also provides an intuitive characterisation of procedural preference reversals between choice and monetary valuation.

The advantage of this approach is that the model can be easily applied to other, less-common psychological distances. I do so by applying the model to social distances. The model assumes that people have a social discount function, meaning

for reviews.

[4]See the main text for references on the effects mentioned in the introduction.

that people discount money received by others as a function of the social distance. This assumption can be traced back to Smith and Edgeworth and matches a large number of observations from economics and psychology. The model then transposes well-known anomalies from the risk and time domain to the social distance domain. It also predicts preference reversals between choice and valuation of allocations characterised by social distances. I test this prediction in a laboratory experiment where I study and measure real social distances: social distance between individuals with students from different Faculties at the University of Nottingham, and social distance between individuals and groups with charities. The experiment demonstrates how social distances can be studied in the laboratory and confirms the prediction of the model.

Researchers have proposed other explanations to the link between risk and time. As already mentioned some have argued that risk comes before time, for delaying a reward makes it more risky (Baucells and Heukamp, 2010; Epper et al., 2011; Halevy, 2008). Others have argued instead that time comes before risk: if a random process repeats every period, a low-probability event will on average happen later than a high-probability one (Rachlin et al., 2000, 1987, 1986, 1991; Rachlin and Siegel, 1994). Here I do not assume that one domain precedes the other but I treat risk and time as manifestations of a single psychological distance and apply the same range effect to both domains. This approach is most closely related to Prelec and Loewenstein (1991). They set up a model with two functions—one to capture attitude toward probabilities or delays, the other the attitude toward amounts of money—and explain the anomalies by imposing restrictions on their shape. I complement their work by showing that the range effect explains *why* the functions change their shape in the first place. None of these papers, however, consider procedural preference reversals between choice and valuation, and none look at social distances. Finally the present paper is part of a larger literature investigating the effects of range and attention on decision making (Andersson et al., 2016; Bordalo et al., 2012, 2013; Cunningham, 2013; Dertwinkel-Kalt et al., 2017; Kőszegi and Szeidl, 2013).

2 A model of range effect and psychological distances

I start by setting up the model and looking at its main properties.

2.1 Setup

An agent faces options $\omega = (x, d) \in \mathcal{C} \subseteq X \times D$. x is an amount of money, $x \in X = [0, +\infty[$, while d measures the psychological distance between the agent and an option. $d = 0$ denotes options that are readily available and $d > 0$ distant options, so $d \in D = [0, +\infty[$. If a larger d makes the option better, we say that d has a positive polarity, denoted by $\underset{(+)}{d}$; otherwise, we say that d has a negative polarity, denoted by $\underset{(-)}{d}$ (Prelec and Loewenstein, 1991).

Under the standard axioms (Fishburn and Rubinstein, 1982; Prelec and Loewenstein, 1991, see Appendix A.1 for more details), there exist functions u and f_d capturing attitudes toward money and psychological distance such that the agent's *undistorted utility* is

$$U(x, d) = f_d(d)u(x)$$

with u increasing with $u(0) = 0$, $f_d(\underset{(+)}{d})$ increasing and $f_d(\underset{(-)}{d})$ decreasing with $f_d(0) > f_d(d) > 0\ \forall d$, such that $\forall (x, d), (x', d') \in X \times D, (x, d) \succsim (x', d')$ if and only if $U(x, d) \geq U(x', d')$. The function U thus stands for the rational model.

When we interpret d as a date t, the options become simple delayed payments $\omega = (x, t)$, indicating an amount of money x received at a date t. $t = 0$, the present, corresponds to the smallest psychological distance $d = 0$. Because we prefer to receive money sooner than later, t has a negative polarity $\underset{(-)}{t}$, implying a decreasing $f_t(t)$. In intertemporal choice the standard model is the discounted utility model $DU(x, t) = \delta^t u(x)$, with δ the temporal discount factor. Since U stands for the rational model and the discounted utility model is the simplest model to match the assumptions, I take $f_t(t) = \delta^t$ and $U(x, t) = DU(x, t)$.

When we interpret d as a probability p, the options become simple binary gambles $\omega = (x, p)$ indicating an amount of money x received with probability p. $p = 1$, certainty, corresponds to $d = 0$. Because we prefer sure money to risky money,

p has a positive polarity $\underset{(+)}{p}$, implying an increasing $f_p(p)$. In risky choice the standard model is expected utility $EU(x, p) = pu(x)$; therefore, $f_p(p) = p$ and $U(x, p) = EU(x, p)$.

2.2 Distorted utility

Yet, instead of maximising U, the agent actually maximises the *distorted utility*

$$\tilde{U}(x, d; \mathcal{C}) = f_d(d)^{g(\Delta_d)} u(x)^{g(\Delta_x)}$$

in which $g(\Delta_d)$ is the weight on psychological distance d and $g(\Delta_x)$ the weight on money x. The weights depend on the attribute ranges Δ_d and Δ_x:

Assumption 1 (Attribute ranges)**.**

$$\Delta_d = \max_{d \in \mathcal{C}_d} f_d(d) - \min_{d \in \mathcal{C}_d} f_d(d) \qquad \text{and} \qquad \Delta_x = \max_{x \in \mathcal{C}_x} u(x) - \min_{x \in \mathcal{C}_x} u(x).$$

If the function g is increasing the model generates a positive range effect, whereby increasing the range of an attribute makes people weight this attribute more. On the other hand if g is decreasing then the model generates a negative range effect. As reviewed in the introduction evidence disproportionally points toward the positive range effect:

Assumption 2 (Positive range effect)**.** The weights $g(\Delta_d)$ and $g(\Delta_x)$ are increasing in their arguments.

U correctly represents preferences but $\tilde{U}$ incorporates biases, so U can be seen as consumption utility and $\tilde{U}$ as decision utility. Further, we call the set $\mathcal{C}$ the consideration set (Kőszegi and Szeidl, 2013): the agent only considers options in $\mathcal{C}$ and only these affect the ranges and so the weights.

It is understood that the functions f_d and u have similar ranges so that Δ_d and Δ_x are comparable; otherwise we can rescale them with the function g. Keeping that in mind, assume for simplicity that g is linear, which makes ranges and weights interchangeable:

Assumption 3 (Linearity of g)**.** $g(\Delta_d) = \Delta_d$ and $g(\Delta_x) = \Delta_x$.

To simplify further I will also ignore the subscript on f_d, unless needed.

With these assumptions, when applied to time and risk distorted utility becomes

$$\tilde{U}(x,t;\mathcal{C}) = \left(\delta^t\right)^{\Delta_t} u(x)^{\Delta_x} \qquad \text{and} \qquad \tilde{U}(x,p;\mathcal{C}) = p^{\Delta_p} u(x)^{\Delta_x}.$$

2.3 Properties of the distorted utility

$\tilde{U}$ correctly represents $\succsim$ when the attribute ranges are equal. In this case, following the terminology of Kőszegi and Szeidl (2013), we say that the attributes are balanced in $\mathcal{C}$:

Property 1. *If the attributes are balanced in $\mathcal{C}$, $\Delta_d = \Delta_x$, then $\tilde{U}(x_1,d_1;\mathcal{C}) \geq \tilde{U}(x_2,d_2;\mathcal{C}) \Leftrightarrow U(x_1,d_1) \geq U(x_2,d_2)$.*

Proof. $\Delta_d = \Delta_x = \Delta$ and $\tilde{U}(x_1,d_1;\mathcal{C}) \geq \tilde{U}(x_2,d_2;\mathcal{C}) \Leftrightarrow f(d_1)^{\Delta}u(x_1)^{\Delta} \geq f(d_2)^{\Delta}u(x_2)^{\Delta}$ $\Leftrightarrow f(d_1)u(x_1) \geq f(d_2)u(x_2) \Leftrightarrow U(x_1,d_1) \geq U(x_2,d_2)$. □

$\tilde{U}$ also correctly represents $\succsim$ when there is dominance:

Property 2. *If $u(x_1) > u(x_2)$ and $f(d_1) > f(d_2)$ then $\tilde{U}(x_1,d_1;\mathcal{C}) \geq \tilde{U}(x_2,d_2;\mathcal{C}) \Leftrightarrow U(x_1,d_1) \geq U(x_2,d_2)$.*

Proof. If $u(x_1) > u(x_2)$ and $f(d_1) > f(d_2)$, $f(d_1)u(x_1) > f(d_2)u(x_2) \Leftrightarrow U(\omega_1) > U(\omega_2)$. Since $\Delta_x, \Delta_d > 0$, $f(d_1)^{\Delta_d} > f(d_2)^{\Delta_d}$ and $u(x_1)^{\Delta_x} > u(x_2)^{\Delta_x}$ so $f(d_1)^{\Delta_d}u(x_1)^{\Delta_x} > f(d_2)^{\Delta_d}u(x_2)^{\Delta}_x \Leftrightarrow \tilde{U}(\omega_1) > \tilde{U}(\omega_2)$. □

Therefore, to concentrate on cases in which U and $\tilde{U}$ make different predictions, assume that one option is psychologically closer and that the other offers more money:

Assumption 4. $\omega_1 = (x_1,d_1)$ and $\omega_2 = (x_2,d_2)$ are such that $f(d_1) > f(d_2)$ and $u(x_2) > u(x_1)$. As a consequence,

$$\Delta_d = f(d_1) - f(d_2) \qquad \text{and} \qquad \Delta_x = u(x_2) - u(x_1).$$

To give insight into the main mechanism of the model, imagine we introduce a third option $\omega_3 = (x_3,d_3)$ and look at its impact on the choice between ω_1 and ω_2.

Property 3. *Let $\mathcal{C} = \{\omega_1,\omega_2\}$, $\mathcal{C}' = \{\omega_1,\omega_2,\omega_3\}$ and $\tilde{U}(\omega_1;\mathcal{C}) = \tilde{U}(\omega_2;\mathcal{C})$.*

(1) If $u(x_3) \in \left[u(x_1), u(x_2)\right]$ *and* $f(d_3) \in \left[f(d_2), f(d_1)\right]$*, then* $\tilde{U}(\omega_1; \mathcal{C}') = \tilde{U}(\omega_2; \mathcal{C}')$*.*

(2.a) If only $f(d_3) \in \left[f(d_2), f(d_1)\right]$ *then* $\exists u(x_3) \notin \left[u(x_1), u(x_2)\right]$ *such that* $\tilde{U}(\omega_2; \mathcal{C}') > \tilde{U}(\omega_1; \mathcal{C}')$*;*

(2.b) If only $u(x_3) \in \left[u(x_1), u(x_2)\right]$ *then* $\exists f(d_3) \notin \left[f(d_2), f(d_1)\right]$ *such that* $\tilde{U}(\omega_1; \mathcal{C}') > \tilde{U}(\omega_2; \mathcal{C}')$*.*

Proof. (1) Denote by (Δ'_x, Δ'_d) the ranges in $\mathcal{C}'$. Since $u(x_3) \in \left[u(x_1), u(x_2)\right]$ and $f(d_3) \in \left[f(d_2), f(d_1)\right]$, $\Delta'_x = \Delta_x$ and $\Delta'_d = \Delta'_d$, and $\tilde{U}(\omega_1; \mathcal{C}) = \tilde{U}(\omega_2; \mathcal{C}) \Leftrightarrow \tilde{U}(\omega_1; \mathcal{C}') = \tilde{U}(\omega_2; \mathcal{C}')$ follows.
(2.a) Since $f(d_3) \in \left[f(d_2), f(d_1)\right]$, $\Delta_d = \Delta'_d$. Imagine that $u(x_3) > u(x_2) \Leftrightarrow \Delta'_x = u(x_3) - u(x_1) > \Delta_x = u(x_2) - u(x_1)$. Then, $\left(\frac{u(x_2)}{u(x_1)}\right)^{\Delta'_x} > \left(\frac{u(x_2)}{u(x_1)}\right)^{\Delta_x} = \left(\frac{f(d_1)}{f(d_2)}\right)^{\Delta_d} \Leftrightarrow \tilde{U}(\omega_2; \mathcal{C}') > \tilde{U}(\omega_1; \mathcal{C}')$.
(2.b) Similar. □

If introducing ω_3 changes a range, $\tilde{U}$ predicts that choice will change. This is a pure range effect, similar to the effect documented by the weight-change literature mentioned in the introduction. I have also observed this effect in another paper (Castillo, 2018).

In what follows, however, we will not add a third alternative. Instead we will vary the attributes of ω_1 and ω_2 and look at the prediction of $\tilde{U}$.

3 Simple preference reversals in choice

In a simple pairwise choice between ω_1 and ω_2, only ratios of attribute matter for U and the standard models:

Remark 1. $(x_1, d_1) \sim (x_2, d_2) \Leftrightarrow U(x_1, d_1) = U(x_2, d_2) \Leftrightarrow \frac{f(d_1)}{f(d_2)} = \frac{u(x_2)}{u(x_1)}$.

Therefore, choice has no reason to change as long as the attribute ratios stay constant. For $\tilde{U}$, however, attribute differences also matter:

Proposition 1 (Simple reversals)**.** *Assume that* $\tilde{U}(\omega_1; \mathcal{C}) = \tilde{U}(\omega_2; \mathcal{C})$*.*

(1) If d_1 *and* d_2 *change such that* $f(d_1)/f(d_2) = f(d'_1)/f(d'_2)$*, then* $\tilde{U}(\omega_1; \mathcal{C}) > \tilde{U}(\omega_2; \mathcal{C})$ *if and only if* $\Delta'_d = f(d'_1) - f(d'_2) > \Delta_d = f(d_1) - f(d_2)$*.*

(2) If x_1 and x_2 change such that $u(x_2)/u(x_1) = u(x_2')/u(x_1')$, then $\tilde{U}(\omega_2; \mathcal{C}) > \tilde{U}(\omega_1; \mathcal{C})$ if and only if $\Delta_x' = u(x_2') - u(x_1') > \Delta_x = u(x_2) - u(x_1)$.

Proof. (1) $\tilde{U}(\omega_1; \mathcal{C}) = \tilde{U}(\omega_2; \mathcal{C}) \Leftrightarrow (f(d_1)/f(d_2))^{\Delta_d} = (u(x_2)/u(x_1))^{\Delta_x}$. Now change d_1', d_2' such that $f(d_1')/f(d_2') = f(d_1)/f(d_2)$. $\tilde{U}(\omega_1; \mathcal{C}) > \tilde{U}(\omega_2; \mathcal{C}) \Leftrightarrow (f(d_1')/f(d_2'))^{\Delta_d'} > (u(x_2)/u(x_1))^{\Delta_x}$ occur if and only if $\Delta_d' > \Delta_d$.
(2) Similar. □

Hence, *increasing* the range of an attribute tilts choice toward the option better in *this* attribute. An interpretation is that increasing the range increases the attention of the agent toward this attribute.

Note the contrapositive of Proposition 1; for example, $\tilde{U}(\omega_2; \mathcal{C}) > \tilde{U}(\omega_1; \mathcal{C})$ if and only if $\Delta_d' < \Delta_d$. In other words, *decreasing* the range of an attribute tilts choice toward the option better in the *other* attribute. The positive range effect is thus the mirror of the similarity effect (Mellers and Biagini, 1994), by which attributes receive less weight when their range decreases.

3.1 Application to time

If we interpret d as a date t, Proposition 1 coincides with two well-known anomalies of intertemporal choice:

Common difference. Let $t_1 = t$ and $t_2 = t + \tau$ with $\tau > 0$. We have $\omega_1 \sim \omega_2 \Leftrightarrow u(x_1)/u(x_2) = \delta^\tau$. Hence, if τ stays constant, U predicts the same choice in pairs (ω_1, ω_2) for any t. In the discounted utility model this property comes from the stationarity axiom.

However, the range $\Delta_t = \delta^t - \delta^{t+\tau} = \delta^t(1 - \delta^\tau)$ is decreasing in t. So, if t increases, Proposition 1 predicts that the agent chooses ω_2. Similarly, if t decreases, the agent chooses ω_1. This pattern is the common difference effect (Benzion et al., 1989; Thaler, 1981).[5] Typically interpreted as hyperbolic discounting, it is here the result of the range effect.

Magnitude effect with time. Instead, let $u(x_1) = u(x)$ and $u(x_2) = \beta u(x)$ with $\beta > 1$. We have $\omega_1 \sim \omega_2 \Leftrightarrow \delta^{t_1 - t_2} = \beta$. Similarly to the common difference example, if β stays constant then U predicts the same choice in pairs (ω_1, ω_2) for

[5] See Frederick et al. (2002) for many additional references.

any $u(x)$. This is a consequence of the separation between attitude toward time and attitude toward money in the discounted utility model.

However, $\Delta_x = u(x)(\beta - 1)$ is increasing in $u(x)$, so if $u(x)$ increases Proposition 1 predicts that the agent chooses ω_2. In other words, as $u(x)$ increases the agent becomes more patient. This is the magnitude effect (Kirby, 1997; Thaler, 1981),[6] here also a result of the range effect.

3.2 Application to risk

If instead we interpret d as a probability p, Proposition 1 coincides with two anomalies of risky choice:

Common ratio. Let $p_1 = p$ and $p_2 = \alpha p$ with $\alpha \in]0, 1[$. We have $\omega_1 \sim \omega_2 \Leftrightarrow u(x_1)/u(x_2) = \alpha$. Hence, if α stays constant, U predicts the same choice in pairs (ω_1, ω_2) for any p. In expected utility theory this property comes from the independence axiom.

But $\Delta_p = p - \alpha \cdot p = p(1 - \alpha)$ is increasing in p, so if p increases Proposition 1 predicts that the agent chooses ω_1; and, if p decreases, the Proposition predicts that the agent chooses ω_2. This is the common ratio effect (Allais, 1953; Kahneman and Tversky, 1979).[7] Researchers have explained it with the fanning-out of indifference curves or with decision weights (Starmer, 2000); for us it results, again, from the range effect.

Magnitude effect with risk. Finally, the magnitude effect in the risk domain operates as in the time domain: U predicts the same choice in pairs (ω_1, ω_2) for any $u(x)$; increasing $u(x)$, however, increases Δ_x and Proposition 1 predicts that the agent chooses ω_2. In other words, as $u(x)$ increases the agent becomes more risk *tolerant*.

At first glance this prediction contradicts the peanuts effect, which says that increasing x makes people more risk *averse* (Markowitz, 1952; Weber and Chapman, 2005b). However, the prediction and the peanuts effect are slightly different: in the prediction above the *utilities* increase, but in the peanut effect the *amounts*

[6] See again Frederick et al. (2002) for additional references.

[7] See also Battalio et al. (1990); Carlin (1992); Starmer and Sugden (1989), and finally Starmer (2000) for more references.

of money increase.[8] Note further that the 'reverse peanuts effect', closer to the prediction above, is also sometimes observed (Chapman and Weber, 2006; Jones and Oaksford, 2011; Weber and Chapman, 2005b).

Here we have looked at only one distance at a time. Appendix A.2 shows how the model can handle two distances at the same time to predict additional effects, such as the common ratio using delay effect and the common difference using probability effect (Baucells and Heukamp, 2010, 2012).

4 Procedural preference reversals between choice and valuation

Simple pairwise choice is one way to get at people's preferences. There is a second one: asking people to report a valuation for each option, typically a monetary equivalent, and comparing the valuations. The two elicitation procedures should reveal the same preferences; instead, researchers have found that different procedures reveal different preferences (see Seidl, 2002, for a review of this litterature). I will now show how the model provides an intuitive explanation of these procedural preference reversals.

Imagine an experiment where subjects face ω_1 and ω_2 and complete two tasks. In the first task, 'Choice', they make a pairwise choice between ω_1 and ω_2. As we have already seen the consideration set is $\mathcal{C}^{\text{c}} = \{\omega_1, \omega_2\}$ and the ranges are $\Delta_x = u(x_2) - u(x_1)$ and $\Delta_d = f(d_1) - f(d_2)$.

In the second task, 'Monetary Valuation', subjects report an amount of money x_i^{MV} that makes them indifferent between the option ω_i and $(x_i^{\text{MV}}, 0)$. $(x_i^{\text{MV}}, 0)$ is the monetary valuation ω_i. I model the process of forming a monetary valuation as a sequence of choices between ω_i and the implicit options $\left\{(x_i^{\text{MV}}, 0),\ x_i^{\text{MV}} \in [0, x_i]\right\}$. The smallest valuation considered by a subject is 0; the largest is the amount of money offered by the option. The consideration set resulting from these many

[8]The prediction and the peanuts effect contradict each other only if u is homogeneous of degree 1, in which case increasing the payoffs while keeping their ratio constant also increases the utilities while keeping their ratio constant.

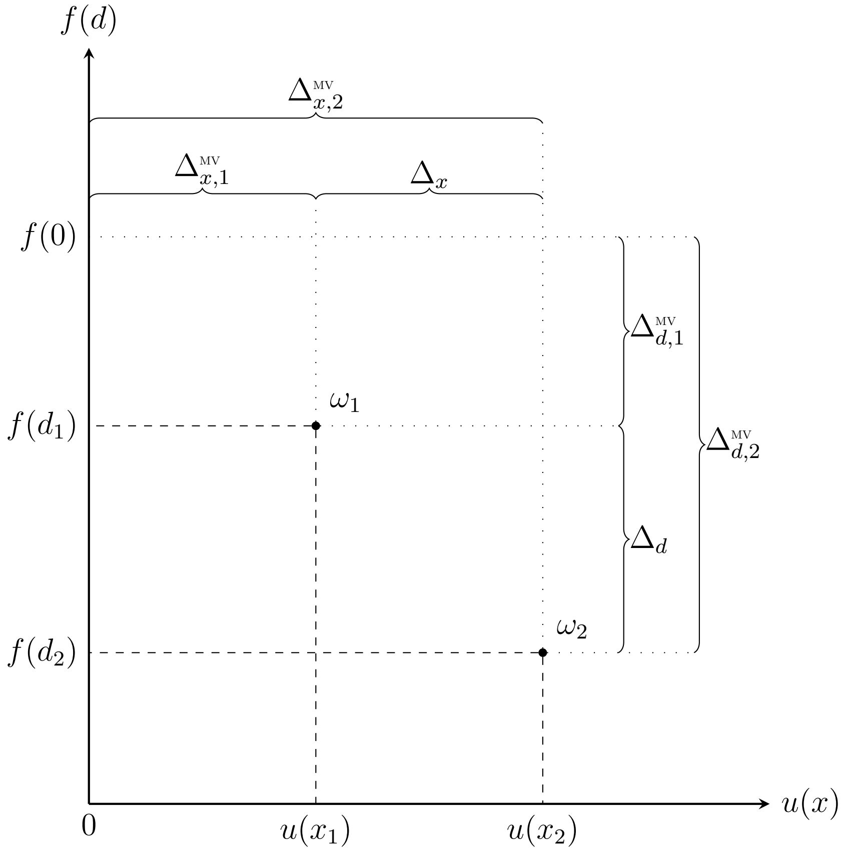


Figure 1: Parameters and ranges in Choice and Monetary Valuation.

implicit options is $\mathcal{C}_i^{\text{MV}} = \left\{\omega_i, \left\{(x_i^{\text{MV}}, 0)\right\}_0^{x_i}\right\}$, which generates the ranges

$$\Delta^{\text{MV}}_{x,i} = u(x_i),$$
$$\Delta^{\text{MV}}_{d,i} = f(0) - f(d_i).$$

The monetary valuations are such that $\tilde{U}(\omega_1; \mathcal{C}_1^{\text{MV}}) = \tilde{U}(x_1^{\text{MV}}, 0; \mathcal{C}_1^{\text{MV}})$ and $\tilde{U}(\omega_2; \mathcal{C}_2^{\text{MV}}) = \tilde{U}(x_2^{\text{MV}}, 0; \mathcal{C}_2^{\text{MV}})$. If $x_1^{\text{MV}} > x_2^{\text{MV}}$, ω_1 is said to be *indirectly* revealed preferred to ω_2. Figure 1 summarises the parameters and the ranges.

Comparing Choice and Monetary Valuation, we say that

Definition 1. A subject has a consistent preference for ω_1 if ω_1 is chosen and ω_1 receives a higher monetary valuation ($x_1^{\text{MV}} > x_2^{\text{MV}}$); and a consistent preference for ω_2 if ω_2 is chosen and ω_2 receives a higher monetary valuation ($x_2^{\text{MV}} > x_1^{\text{MV}}$).

A subject exhibits a *standard preference reversal* if ω_1 is chosen and ω_2 receives a higher monetary valuation; and a *counter preference reversal* if ω_2 is chosen and ω_1 receives a higher monetary valuation.

The terms 'standard' and 'counter' come from the preference reversal literature, which found that people tend to choose close and small-stake options but report higher valuations for distant and large-stake options.

With all the elements in place, I can now characterise preference reversals between choice and valuation.

Proposition 2 (Procedural reversals)**.** *The agent exhibits a standard preference reversal if*

$$\left(\frac{f(d_1)}{f(d_2)}\right)^{\frac{\Delta_d}{\Delta_x}} > \frac{u(x_2)}{u(x_1)} > \frac{\left(f(d_1)/f(0)\right)^{\Delta^{\text{MV}}_{d,1}/\Delta^{\text{MV}}_{x,1}}}{\left(f(d_2)/f(0)\right)^{\Delta^{\text{MV}}_{d,2}/\Delta^{\text{MV}}_{x,2}}},$$

and a counter preference reversal if the inequalities are reversed.

Proof. If the agent chooses ω_1 in Choice, $\tilde{U}(\omega_1; \mathcal{C}^{\text{C}}) > \tilde{U}(\omega_2; \mathcal{C}^{\text{C}}) \Leftrightarrow f(d_1)^{\Delta_d} u(x_1)^{\Delta_x} > f(d_2)^{\Delta_d} u(x_2)^{\Delta_x} \Leftrightarrow (f(d_1)/f(d_2))^{\Delta_d/\Delta_x} > u(x_2)/u(x_1)$, which gives the first inequality.

Then, from the Monetary Valuation of ω_1, we have

$$\begin{aligned}\tilde{U}(\omega_1; \mathcal{C}^{\text{MV}}_1) = \tilde{U}(x^{\text{MV}}_1, 0; \mathcal{C}^{\text{MV}}_1) &\Leftrightarrow f(d_1)^{\Delta^{\text{MV}}_{d,1}} u(x_1)^{\Delta^{\text{MV}}_{x,1}} = f(0)^{\Delta^{\text{MV}}_{d,1}} u(x^{\text{MV}}_1)^{\Delta^{\text{MV}}_{x,1}} \\ &\Leftrightarrow u(x^{\text{MV}}_1) = u(x_1) \left(\frac{f(d_1)}{f(0)}\right)^{\Delta^{\text{MV}}_{d,1}/\Delta^{\text{MV}}_{x,1}},\end{aligned}$$

and similarly from the Monetary Valuation of ω_2,

$$\tilde{U}(\omega_2; \mathcal{C}^{\text{MV}}_2) = \tilde{U}(x^{\text{MV}}_2, 0; \mathcal{C}^{\text{MV}}_2) \Leftrightarrow u(x^{\text{MV}}_2) = u(x_2) \left(\frac{f(d_2)}{f(0)}\right)^{\Delta^{\text{MV}}_{d,2}/\Delta^{\text{MV}}_{x,2}}.$$

Then, preference for ω_2 is indirectly revealed in Monetary Valuation if

$$\begin{aligned} x_2^{\text{MV}} > x_1^{\text{MV}} \Leftrightarrow u(x_2) \left(\frac{f(d_2)}{f(0)}\right)^{\Delta^{\text{MV}}_{d,2}/\Delta^{\text{MV}}_{x,2}} &> u(x_1) \left(\frac{f(d_1)}{f(0)}\right)^{\Delta^{\text{MV}}_{d,1}/\Delta^{\text{MV}}_{x,1}} \\ \Leftrightarrow \frac{u(x_2)}{u(x_1)} &> \frac{\Big(f(d_1)/f(0)\Big)^{\Delta^{\text{MV}}_{d,1}/\Delta^{\text{MV}}_{x,1}}}{\Big(f(d_2)/f(0)\Big)^{\Delta^{\text{MV}}_{d,2}/\Delta^{\text{MV}}_{x,2}}}, \end{aligned}$$

which gives the second inequality. □

The first inequality in Proposition 2 means that the agent chooses ω_1. The second inequality ensures that the agent gives a higher monetary valuation to ω_2. In the model preference reversals arise because the attributes, money and psychological distance, are subject to different attribute ranges in Choice and Monetary Valuation and so are weighted differently, giving rise to different revealed preference.

Since standard preference reversals come primarily from the overvaluation of ω_2 (Cubitt et al., 2004; Tversky et al., 1990), let us focus on the second inequality and do simple comparative statics.

Corollary 2.1. *The larger the spread between $f(d_1)$ and $f(d_2)$, the less pronounced the overpricing of ω_2.*

Proof. Fix $f(d_2)$ and take $f(d_1) = f(d_2)+\Delta_d$. The right-hand term of the inequality in Proposition 2 becomes

$$\frac{\Big(\big(f(d_2)+\Delta_d\big)/f(0)\Big)^{(f(0)-f(d_2)-\Delta_d)/\Delta^{\text{MV}}_{x,1}}}{\Big(f(d_2)/f(0)\Big)^{\Delta^{\text{MV}}_{d,2}/\Delta^{\text{MV}}_{x,2}}}.$$

The top-part of this fraction increases as Δ_d increases, bringing it closer to the middle term of the inequality in Proposition 2. □

This Corollary to Proposition 2 predicts that the more dissimilar ω_1 and ω_2 are in terms of psychological distance, the less ω_2 is going to be overpriced in Monetary Valuation and so the less should we observe preference reversals.

4.1 Application to time

When applied to the time domain, Proposition 2 predicts that, for some pairs of delayed payments (ω_1, ω_2), we should observe people choosing ω_1 in pairwise Choice but indirectly revealing a preference for ω_2 in Monetary Valuation. This prediction is confirmed by Tversky et al. (1990).

To give an example, assume that u is linear and that the daily discount rate is $\delta = 0.8$, and take $\omega_1 = (£5, 1 \text{ day})$ and $\omega_2 = (£7, 10 \text{ days})$. In Choice, $(\delta^{t_1}/\delta^{t_2})^{\Delta_t/\Delta_x} = (0.8^1/0.8^{10})^{(0.8^1-0.8^{10})/2} = 2$ and $u(x_2)/u(x_1) = 7/5 = 1.4$ so the subject chooses ω_1. In Monetary Valuation,

$$\frac{\delta^{t_1 \Delta^{\text{MV}}_{t,1}/\Delta^{\text{MV}}_{x,1}}}{\delta^{t_2 \Delta^{\text{MV}}_{t,2}/\Delta^{\text{MV}}_{x,2}}} = \frac{\left(0.8^1\right)^{(1-0.8^1)/5}}{\left(0.8^{10}\right)^{(1-0.8^{10})/7}} = 1.32,$$

which is smaller than $u(x_2)/u(x_1)$ so ω_2 receives a higher monetary valuation and is indirectly revealed preferred to ω_1. This pattern is the standard preference reversal.

4.2 Application to risk

Proposition 2 similarly predicts procedural preference reversals in the risk domain, which are maybe the most documented anomaly of expected utility theory (Cubitt et al., 2004; Lichtenstein and Slovic, 1971, 1973; Lindman, 1971; Plott and Grether, 1979; Seidl, 2002).

For example, assuming again that u is linear, the model predicts a preference reversal with $\omega_1 = (0.8, £5)$ and $\omega_2 = (0.2, £7)$. In Choice, we have $(p_1/p_2)^{\Delta_d/\Delta_x} = (0.8/0.2)^{0.6/2} = 1.52$ and $u(x_2)/u(x_1) = 7/5 = 1.4$, so the agent chooses ω_1. In Monetary Valuation,

$$\frac{p_1{}^{\Delta^{\text{MV}}_{p,1}/\Delta^{\text{MV}}_{x,1}}}{p_2{}^{\Delta^{\text{MV}}_{p,2}/\Delta^{\text{MV}}_{x,2}}} = \frac{0.8^{0.2/5}}{0.2^{0.8/7}} = 1.19,$$

which is smaller than $u(x_2)/u(x_1)$ so ω_2 receives a higher monetary valuation and is indirectly revealed preferred.

5 Social distance as a psychological distance

We have looked at time and risk, the psychological distances most familiar to economists, but nothing prevents us from looking at other psychological distances. For instance, let us look at social distances.

Social distances are ‘an attempt to reduce to something like measurable terms the grades and degrees of understanding and intimacy which characterize personal and social relations generally’ (Park, 1924). More precisely, Rummel (1976) notes that we have to distinguish between objective and subjective social distance: Two people can live in the same city, be of the same age, have the same education and share the same social status; yet hate each other because of perceived differences in motivation, temperaments, abilities, moods, states, wants, means, and goals, and because of different degrees of sympathy, liking or affection. Karakayali (2009) goes further in his review of the sociological literature and distinguishes four dimensions of social distance. There is first an *affective distance*, according to which we are closer to people we *feel* closer to. There is also a *normative distance*, grounded on criteria that place people in different groups, creating thus objective distance. For example, people in the same social class tend to be socially closer to each other. Then there is an *interactive distance*, since we also tend to be closer to people we interact a lot with. Finally there is the *habitual and cultural distance*, which diminishes when people share rites and customs.

Abstracting from these distinctions, consider social distances s that measure the social separation between individuals or groups caused by one or several of the elements just outlined. The options ω become allocations (x, s) that provide an amount of money x to a person or a group socially separated from the agent by a social distance s. The undistorted utility is then $U(x, s) = f_s(s)u(x)$, with $f_s(s)$ the *social discount function.* In other words, people discount payments received by others as a function of the social distance.

This idea has a long tradition in economics. We can find it in Smith (1759) and even more explicitly in Edgeworth (1881, Appendix IV):[9]

> . . . between the frozen pole of egoism and the tropical expanse of utilitarianism, there has been granted to imperfectly-evolved mortals an

[9]For a discussion of sympathy in the works of Adam Smith, see Sally (2001). For altruism and social distances in Edgeworth, see Collard (1975).

> intermediate temperate region; the position of one for whom in a calm moment his neighbour's happiness as compared with his own neither counts for nothing, nor yet 'counts for one,' but counts for a fraction. We must modify the utilitarian integral [...] by multiplying each pleasure, except the pleasures of the agent himself, by a fraction—a factor doubtless diminishing with what may be called the social distance between the individual agent and those of whose pleasures he takes account.

Since then, several studies have verified that people care about social distances and that decreasing social distance increases generosity.[10]

In order to go further, assume that social discounting is constant, so that $U(x, s) = \sigma^s u(x)$, where σ is the *social discount factor*. This functional form is supported by research that reveals the similarities between time and social distances (Bartels and Rips, 2010; Pronin et al., 2008; Pronin and Ross, 2006; Stephan et al., 2011; Yi et al., 2011), leading researchers to use functionally equivalent models to describe decision-making in the presence of one or the other (Goeree et al., 2010; Jones and Rachlin, 2006; Rachlin and Jones, 2008; Vekaria et al., 2017). We can also see this parallel in Albert's (1977) derivation of temporal-comparison theory from Festinger's (1954) social comparison theory.

With these assumptions, the distorted utility is

$$\tilde{U}(x, s; \mathcal{C}) = \left(\sigma^s\right)^{\Delta_s} u(x)^{\Delta_x},$$

and we can apply Proposition 1 to this new domain of social distance.

Common social distance. Let $s_1 = s$ and $s_2 = s + \tau$ with $\tau > 0$. We have $\omega_1 \sim \omega_2 \Leftrightarrow \frac{u(x_1)}{u(x_2)} = \sigma^\tau$, which does not depend on s. Hence, if τ stays constant, U predicts the same choice in pairs (ω_1, ω_2) for any s. In other words, only the degree

[10] For example, in dictator games, dictators are less generous under double-blind procedures that increase the subjective social distance between dictators and receivers (Hoffman et al., 1994, 1996), and more generous when identification increases, thus decreasing the social distance (Bohnet and Frey, 1999a,b; Charness and Gneezy, 2008; Frey and Bohnet, 1997). Minimal groups (Chen and Li, 2009; Tajfel et al., 1971) and natural groups (Klor and Shayo, 2010; Ruffle and Sosis, 2006) also generate subjective and objective social distance and affect generosity. Similarly, distance on a network decreases generosity (Brañas-Garza et al., 2010; Goeree et al., 2010; Leider et al., 2009).

of separation τ between the recipients of the allocations should matter, not the distance s between the agent and the closest recipient.

However, $\Delta_s = \sigma^s - \sigma^{s+\tau} = \sigma^s(1 - \sigma^\tau)$ is decreasing in s. Proposition 1 thus predicts that, for small social distances, the agent favours the closest recipient and chooses ω_1; but that, for large social distances, the agent favours the more distant recipient and chooses ω_2. Social discounting is then hyperbolic, similarly to what happens in the time domain.

Hyperbolic social discounting has been observed in psychology but only with hypothetical social distances (Bradstreet et al., 2012; Jones and Rachlin, 2006, 2009; Rachlin and Jones, 2008; Sharp et al., 2012). In economics, Goeree et al. (2010) observed an hyperbolic social discount function after measuring social distances on a network. Instead of assuming hyperbolicity of the social discount function, hyperbolicity here comes from the range effect.

Magnitude effect with social distances. As we already did for previous magnitude effects, assume now $u(x_1) = u(x)$ and $u(x_2) = \beta u(x)$ with $\beta > 1$. We have $\omega_1 \sim \omega_2 \Leftrightarrow u(x_2)/u(x_1) = \beta$: U predicts the same choice as long as β stays constant.

However, Δ_x is increasing in $u(x)$, creating a magnitude effect. We should thus observe people favouring their close friends over distant strangers for small amounts of money but then favouring the strangers for sufficiently large amounts.

We already know that common social distance effects exist. Magnitude effects in the social domain also sound plausible but might require large amounts of money. Proposition 2 offers a more easily testable prediction:

Preference reversals between choice and valuation with social distances. For some ω_1 and ω_2 people choose the allocation ω_1 but report a higher Monetary Valuation for ω_2.

The model predicts that we should observe procedural preference reversals with options involving social distances. Corollary 2.1, on page 14, further predicts that more spread out social distances should generate more preference reversals. These novel predictions provide the ideal testing ground for the model.

6 An experiment on procedural preference reversals involving social distances

As we have already seen, the basic elements of a preference reversal experiment are as follows: In Choice, subjects choose between ω_1 and ω_2; in Monetary Valuation, they report for each option an amount of money that makes them indifferent between this amount and that option. If the preference reversal phenomena carries over to the social distance domain, standard preference reversals should be more common than counter preference reversals. We first need to translate this basic setup to the social domain.

6.1 Experimental design

6.1.1 Social distances in the laboratory

In principle the model accommodates two types of social distance: social distance between individuals, and social distance between individuals and social groups. The experiment studies both types with two separate settings. In the first one, the 'Faculty Setting', I invited subjects from a given faculty at the University of Nottingham, and the allocations benefited students from other faculties. In the second setting, the 'Charity Setting', the allocations benefited charities.

To construct ω_1 and ω_2 we need to be able to tell what are small and large social distances, therefore we need to measure them. For the distance between individuals I use the Inclusion of Other in the Self scale (Aron et al., 1992). This measure has proven popular in psychology (see for example Aron and Mashek, 2004; Aron et al., 2004; Cialdini et al., 1997) and has recently entered the toolbox of economists (Gächter et al., 2015, 2017). Its counterpart to measure the social distance between individuals and groups is the Inclusion of Ingroup in the Self scale (Schubert and Otten, 2002; Tropp and Wright, 2001; Wright et al., 2004).

I conducted online surveys using these measures to find small and large social distances. For the Faculty Setting I invited students from all faculties at the University of Nottingham and administered the Inclusion of Other in the Self scale with targets being students from other Faculties. Members of the Faculty of Arts reported the greatest difference between members of the Faculty of Social Sciences and the Faculty of Engineering. Therefore, I decided to invite members of the Faculty of Arts in the Faculty Setting, with members of the Faculty of Social Sciences serving as recipients in ω_1 and members of the Faculty of Engineering serving as recipients in ω_2. For the Charity Setting I administered the Inclusion of Ingroup in the Self scale with one of several charities as the target. Participants reported that Cancer Research UK was their closest charity, and The Salvation Army, their most distant; these charities were thus selected as recipients in ω_1 and ω_2.

To isolate the effect of the social distances, the experiment controlled for selfish motives by having allocations that never benefited the subjects themselves. For example, in the Faculty Setting subjects chose between a member of the Faculty of Arts receiving a small amount or a Member of the Faculty of Engineering receiving a large amount, but the subjects themselves received the same show-up fee regardless. The experiment also controlled for reputation concerns and second-order beliefs by making the recipients of the allocations unaware of the experiment. For them receiving money was a surprise and appeared to come from the experimenters. Finally I controlled for social image concerns by running the experiment double-blind. The assistants checking the register were the only ones to know the names of the subjects, they stayed outside the laboratory and they were blind to the treatment. Effectively, subjects knew that we could never find who made which choice.

6.1.2 Tasks and procedures

In the two settings, the payment in ω_1 was fixed at £5 and the payment in ω_2 varied between £6 and £10, resulting in five pairs of allocations: (£5, £6), (£5, £7), (£5, £8), (£5, £9) and (£5, £10). For each pair subjects made a pairwise Choice and reported their Monetary Valuation for each allocation.

In addition, subjects completed the Inclusion of Other in the Self (in the Faculty Setting) or the Inclusion of Ingroup in the Self (in the Charity Setting) scales. This way, we can check for each subject whether what we call small and large social distances matches their perception of the social distances. Subjects in the Charity Setting also indicated how familiar they were with Cancer Research UK and The Salvation Army. Appendix B.1 gives a sample of each task.

The ordinal payoff scheme (Cubitt et al., 2004; Tversky et al., 1990) made Choice and Monetary Valuation strategically equivalent: At the end of the experiment a random mechanism chose a pair of allocations. Then, for this pair of allocations another random mechanism chose Choice or Monetary Valuation. If Choice was selected then we implemented the allocation that the subject chose; if Monetary Valuation was selected then we implemented the allocation that received the higher valuation. The instructions (see Appendix B.2) explained the ordinal payoff scheme in details and featured control questions.

I implemented the allocations as follows. If, in the Faculty Setting, the allocation to implement was, for example, £7 to a member of the Faculty of Engineering, a member of the Faculty of Engineering was invited to participate in the Charity Setting and was paid £7 at the end of this experiment. Participants in the Faculty Setting were provided the date, time and location of the experiments featuring the participants of the Charity Setting and they were actively encouraged to come monitor the payments. In the Charity setting, Cancer Research UK and The Salvation Army were also paid as a result of the ordinal payoff scheme and the choices of the participants. I sent to all participants in the Charity Setting receipts of the donations.

6.2 Results

The experiment was conducted in the CeDEx laboratory at the University of Nottingham. Subjects were recruited with ORSEE (Greiner, 2015). 108 subjects participated in the experiment (56 in the Faculty setting and 52 in the Charity setting) over 6 sessions between mid-December 2014 and mid-January 2015. The average payment was £10.9 (SD = £3.5) and the average session lasted 1 hour 15 minutes.

6.2.1 Preference reversals

Table 1 shows the frequencies of the different patterns. The patterns are defined as in Cubitt et al. (2004): A subject is *Consistent for* ω_1 if she chooses ω_1 and reports a weakly higher Monetary Valuation for ω_1; and *Consistent for* ω_2 if she chooses ω_2 and reports a weakly higher Monetary Valuation for ω_2. A subjects commits a *Standard Reversal* if she chooses ω_1 but reports a strictly higher Monetary

Table 1: Frequencies of the different patterns by Setting.

	Faculty			Charity			
	All	$s_1 \geq s_2$	$s_1 > s_2$	All	Known	Known $+ s_1 \geq s_2$	Known $+ s_1 > s_2$
Consistent for ω_1	28	25	13	78	38	37	31
Consistent for ω_2	130	97	34	133	121	80	41
Standard reversal	98	90	48	32	15	12	7
Counter reversal	19	13	5	17	6	6	6

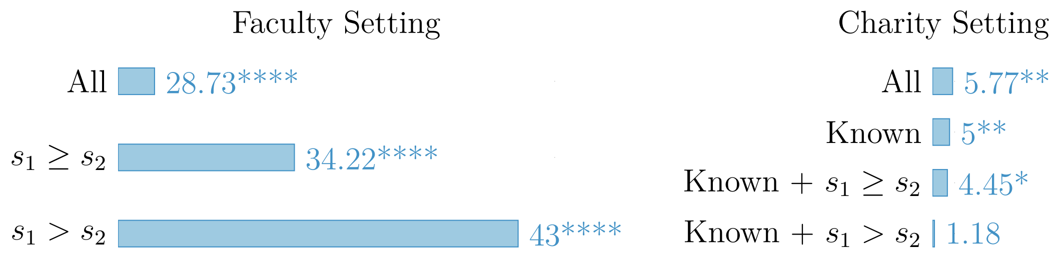
Notes. $s_1 \geq s_2$: recipient of ω_1 received a weakly higher Inclusion of Other in the Self (in the Faculty Setting) or Inclusion of Ingroup in the Self (in the Charity Setting) score than recipient of ω_2; $s_1 > s_2$: strictly higher. Known: subject indicated for both charities 'I know the name but I have only a vague idea of what it does' or 'I know the name and I have a good idea of what it does'.

Valuation for ω_2; and a *Counter Reversal* if she chooses ω_2 but reports a strictly higher Monetary Valuation for ω_1.

For the time being focus on the columns 'All' that look at the raw data without any added requirement, so we have 56 subjects in the Faculty Setting and 52 subjects in the Charity Setting. First of all, note that some subjects are consistent for ω_1. If no subjects were consistent for ω_1 it would mean that subjects did not care about social distances and simply maximised the amount of money of the allocation. Instead subjects care about social distances and trade them off with the amount of money, a result that goes in the same direction as the literature on social distance reviewed previously.

We then look at preference reversals. Following Cubitt et al. (2004) we say that there is a preference reversal phenomenon if the proportion of Standard Reversals is greater than the proportion of Counter Reversals; or, equivalently, if the net proportion of reversals (proportion of Standard Reversals minus proportion of Counter Reversals) is significantly greater than 0. I rely on one-sided McNemar's χ^2 tests to test this hypothesis. Figure 2 displays such net proportion of preference reversals as well as the significance levels. We see that there is a preference reversal phenomenon in the Faculty Setting and in the Charity Setting, but that it is more pronounced in the Faculty Setting.

However, in the Charity Setting, some subjects might have been unfamiliar with Cancer Research UK or The Salvation Army; their answers would not be reliable. To control for this, 'Known'—in Table 1 and Figure 2—only looks at subjects



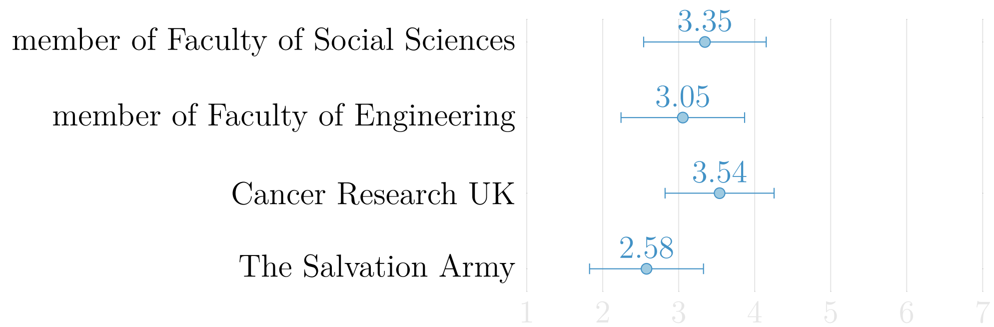
Notes. McNemar tests. One, two, three and four symbols indicate significance at $\alpha = 0.1$, 0.05, 0.01 and 0.001. $s_1 \geq s_2$: recipient of ω_1 received a weakly higher Inclusion of Other in the Self (in the Faculty Setting) or Inclusion of Ingroup in the Self (in the Charity Setting) score than recipient of ω_2; $s_1 > s_2$: strictly higher.
Known: subject indicated for both charities 'I know the name but I have only a vague idea of what it does' or 'I know the name and I have a good idea of what it does'.

Figure 2: Net proportion of preference reversals by Setting.

who indicated for both charities 'I know the name but I have only a vague idea of what it does' or 'I know the name and I have a good idea of what it does'. This requirement decreases the number of subjects available for analysis in the Charity Setting to 36. Still, we see in Figure 2 that preference reversals stay significant in both Settings.

We can also control for the perception of social distances using the Inclusion of Other in the Self (in the Faculty Setting) and the Inclusion of Ingroup in the Self (in the Charity Setting) scores reported by the subjects during the experiment. The allocations are correctly constructed when the recipient in ω_1 is socially closer than the recipient in ω_2, otherwise subjects face no trade-off between amounts of money and social distance.

The scores range from 1 to 7 with a larger score meaning for us a smaller social distance. Imposing the requirement that $s_1 \geq s_2$—that the recipient in ω_2 received a weakly higher score than the recipient of ω_2— decreases the number of subjects to 45 in the Faculty Setting and to 27 in the Charity Setting. With a strict inequality, $s_1 > s_2$, the number of subjects drops to 20 and 17. Despite the small sample size, Figure 2 shows that the net proportion of preference reversals remains significant in the Faculty Setting. In the Charity Setting, however, the net proportion decreases and ultimately vanishes.



Notes. The scores obtained with the Inclusion of Other in the Self scale and the Inclusion of Ingroup in the Self scale range between 1 and 7, 7 corresponding to the smallest social distance.
Error bars represent one standard deviation.

Figure 3: Average of the reported Inclusion of Other in the Self (Faculty Setting) and Inclusion of Ingroup in the Self (Charity Setting) scores.

6.2.2 Social distances

Why are preference reversals less frequent in the Charity Setting? Corollary 2.1 gives us a clue: social distances might have been more spread out in the Charity Setting than in the Faculty Setting, thus creating less overpricing of ω_2 in Monetary Valuation. Intuition tells a similar story. Students of the Faculty of Social Sciences and of the Faculty of Engineering have a lot in common—they study in the same city, in the same university and even sometimes in the same buildings, and they also share extra-curricular activities—whereas Cancer Research UK and The Salvation Army are nothing alike—they use different means to reach different goals and they attract different kinds of people.

Figure 3 reveals the averages of the Inclusion of Other in the Self (Faculty Setting) and the Inclusion of Ingroup in the Self (Charity Setting) scores. As anticipated, in the Faculty Setting subjects perceived similarly a member of the Faculty of Social Sciences and a member of the Faculty of Engineering: the difference is not significant (two-sided Wilcoxon signed rank test, exact $p = 0.1428$)[11] and 25 out of 55 subjects (45%) reported the same score for both. On the other hand in the Charity Setting subjects thought Cancer Research UK and The Salvation Army were different: the difference is significant (two-sided Wilcoxon signed rank test, exact $p < 0.001$) and only 11 out of 52 subjects (25%) reported the same scores.

[11]By using the Wilcoxon signed rank test I assume that the Inclusion of Other in the Self and the Inclusion of Ingroup in the Self are at least ordinal measures and that the differences between scores is also ordinal.

Therefore, more spread out social distances do indeed engineer less preference reversals. This result further confirms the predictions of the model.

7 Conclusion

To explain the similarities between risky choice and intertemporal choice, I have proposed a model based on a simple psychological mechanism: people put more weight on attributes that differ more. The model explains the common ratio effect, the common difference effect, and magnitude effects as a result of the range effect. It also gives a simple characterisation of procedural preference reversals between choice and valuation. Since the model does not depend on a particular domain, I apply it to choice across social distances. One of the new predictions of the model is that we should observe procedural preference reversals using social distances. I confirm this prediction in a laboratory experiment, which further gives support to the model.

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Appendices

Appendix A Additional results

A.1 Axiomatisation of U

The options are $\omega = (x, d) \in X \times D$. If a larger d makes the option better, we say that d has a positive polarity, denoted by $\underset{(+)}{d}$; otherwise, we say that d has a negative polarity, denoted by $\underset{(-)}{d}$ (Prelec and Loewenstein, 1991).

The next Axiom specifies the outcome-distance structure:

Axiom A.1 (Structure)**.** X is a real interval and D is either a set of non-negative integers or an interval of non-negative real numbers.

We then introduce the following axioms, adapted from Fishburn and Rubinstein (1982) and Prelec and Loewenstein (1991):

Axiom A.2 (Rationality)**.** $\succsim$ is complete and transitive.

Axiom A.3 (Continuity)**.** $\forall (x, d) \in X \times D$, the sets $\Big\{(x', d') \mid (x', d') \succsim (x, d)\Big\}$ and $\Big\{(x', d') \mid (x, d) \succsim (x', d')\Big\}$ are closed.

Axiom A.4 (Monotonicity)**.** If $x' \geq x$ then $(x', d) \succsim (x, d)$.

Axiom A.5 (Zero outcome)**.** If $x = 0$ then $(x, d') \sim (x, d)$.

Axiom A.6 (Polarity of d)**.** If $\underset{(+)}{d'} \geq \underset{(+)}{d}$ then $(x, d') \succsim (x, d)$. If $\underset{(-)}{d'} \geq \underset{(-)}{d}$ then $(x, d') \precsim (x, d)$.

Axiom A.7 (Double-cancellation)**.** $\forall\, x, y, z \in X$ and $d, e, f \in D$, if $(x, d) \sim (y, e)$ and $(y, f) \sim (z, d)$ then $(x, f) \sim (z, e)$.

Axiom A.8 (Zero distance)**.** If $d = 0$ then $(x, d) \succ (x, d')\ \forall d'$.

A.1-A.7 imply that there is a real-valued function $U(x, d) = f(d)u(x)$ with u increasing with $u(0) = 0$, $f_d(\underset{(+)}{d})$ increasing and $f_d(\underset{(-)}{d})$ decreasing with $f_d(d) > 0\ \forall d$, such that $\forall (x, d), (x', d') \in X \times D, (x, d) \succsim (x', d')$ if and only if $U(x, d) \geq U(x', d')$ The proof, with minor adjustments, is given by Fishburn and Rubinstein (1982, Theorem 3). A.8 adds $f_d(0) > f_d(d)\ \forall d$.

A.2 More than one psychological distance

In the main text we have looked at one psychological distance at a time. Many situations, however, feature more than one distance: options can be risky *and* delayed, or delayed *and* experienced by other people. Therefore, we look now at options that feature two psychological distances: $\omega = (x, d_1, d_2)$. The undistorted utility becomes $U(x, d_1, d_2) = f_d(d_1, d_2)u(x)$.

To deal with multiples distances the standard models use multiplicative separability. For example, when dealing with delayed, simple binary gambles $\omega = (x, p, t)$, the standard model is the discounted expected utility model $DEU(x, p, t) = p\delta^t u(x)$. Thus, to keep the comparison with the standard models assume that

Assumption 5 (Multiplicative separability)**.** $f_d(d_1, d_2) = f_1(d_1)f_2(d_2)$.

The rest of the model proceeds as before: the agent does not maximise U; instead, the agent maximises the distorted utility

$$\tilde{U}(x, d_1, d_2; \mathcal{C}) = \Big(f_1(d_1)f_2(d_2)\Big)^{\Delta_d} u(x)^{\Delta_x}$$

with

$$\Delta_d = \max_{(d_1,d_2)\in\mathcal{C}_d} f_1(d_1)f_2(d_2) - \min_{(d_1,d_2)\in\mathcal{C}_d} f_1(d_1)f_2(d_2),$$

while Δ_x remains the same.

We consider the choice between two options $\omega_1 = (x_1, d_{1,1}, d_{2,1})$ and $\omega_2 = (x_2, d_{1,2}, d_{2,2})$. The first option is overall closer, $f_1(d_{1,1})f_2(d_{2,1}) > f_1(d_{1,2})f_2(d_{2,2})$; the second option yields a larger amount of money, $u(x_2) > u(x_1)$. In this context, Proposition 1, with some minor adjustments, delivers the same predictions as before.

Let me focus on the situation where the options share a psychological distance, say distance 2: $d_{2,1} = d_{2,2} = \bar{d}_2$. For U and the standard models $\bar{d}_2$ simply disappears from the analysis. Things are different for $\tilde{U}$:

Corollary 1.1. *Assume that* $\tilde{U}(\omega_1; \mathcal{C}) = \tilde{U}(\omega_2; \mathcal{C})$ *and* $d_{2,1} = d_{2,2} = \bar{d}_2$*. If* $f_2(\bar{d}_2)$ *increases then* $\tilde{U}(\omega_1; \mathcal{C}) > \tilde{U}(\omega_2; \mathcal{C})$*.*

Proof. We have $\Delta_d = f_1(d_{1,1})f_2(\bar{d}_2) - f_1(d_{1,2})f_2(\bar{d}_2) = f_2(\bar{d}_2)\Big(f_1(d_{1,1}) - f_1(d_{1,2})\Big)$, so increasing $f_2(\bar{d}_2)$ triggers part *(1)* of Proposition 1. □

When the common distance $\bar{d}_2$ increases the range of distances increases as well, and $\tilde{U}$ predicts that the agent chooses ω_1.

This new prediction matches two effects already mentioned in the literature:

Common ratio using delay. Assume that the options are delayed, simple binary gambles $\omega_1 = (x_1, p_1, \bar{t})$ and $\omega_2 = (x_2, p_2, \bar{t})$. We have $\omega_1 \sim \omega_2 \Leftrightarrow \delta^{\bar{t}} p_1 u(x_1) = \delta^{\bar{t}} p_2 u(x_2)$, so $\bar{t}$ should not influence choice.

The range of distances, however, is $\Delta_d = \delta^{\bar{t}}(p_1 - p_2)$. As $\bar{t}$ increases, $\delta^{\bar{t}}$ and Δ_d decrease and the agent chooses ω_2. In other words, delaying both options by the same amount makes the agent more risk-tolerant, a phenomenon observed by Baucells and Heukamp (2010).

Common difference using probability. Assume instead that $\omega_1 = (x_1, \bar{p}, t_1)$ and $\omega_2 = (x_2, \bar{p}, t_2)$. We have $\omega_1 \sim \omega_2 \Leftrightarrow \delta^{t_1} \bar{p} u(x_1) = \delta^{t_2} \bar{p} u(x_2)$: similarly to the previous example the common probability $\bar{p}$ should not influence choice.

But $\Delta_d = \delta^{t_1 - t_2}(\bar{p})$ is increasing in $\bar{p}$. So replacing $\bar{p}$ by $\alpha\bar{p}$ with $\alpha \in]0, 1[$ decreases Δ_d, leading the agent to choose ω_2. Multiplying the common probability by the same ratio thus makes the agent more patient. This phenomenon was observed by Keren and Roelofsma (1995).

Baucells and Heukamp (2010, 2012) provide another explanation to both phenomena with their probability and time trade-off model. In their model, probabilities are first transformed into delay-like distances, then traded off with real delays. They obtain the phenomena above by making assumptions on the shape of the functions used in the model.

Instead, the present model uses a precise psychological mechanism, the range effect, to predict both phenomena. The advantage is that the mechanism is simple and, as we have seen before, makes predictions in multiple domains. For example, the model predicts *common ratio using social distance effects* and *common difference using social distance effects*: people become more risk-tolerant and more patient as allocations benefit more socially distant people. It also predicts *common social distance using probability effects* and *common social distance using delay effects*, according to which people become less focused on social distances, and so more inclined to maximise the amount of the allocation, as the allocations become more risky and more delayed.

Appendix B Details of the experiment

B.1 Samples of the task

Figure 4 displays samples of all the tasks present in the decision booklets.

B.2 Instructions

The next pages reproduces the instructions as they were seen by the subjects. They are here reproduced two-pages-on-one to save space.

Option A: We give £5 to *the member of the Faculty of Social Sciences*
Option B: We give £10 to *the member of the Faculty of Engineering*

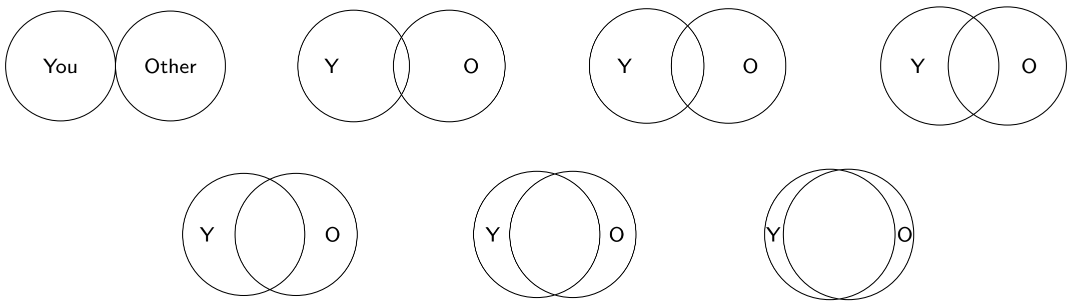
Choose **A** or **B**:

How much money *given to you* would be just as good as us giving £6 to *the Salvation Army*?

Please write the amount here:

We will refer to this amount as your equivalence valuation of giving £6 to the Salvation Army.

Please consider the member of the Faculty of Engineering. Select the pair of circles that best represents how you feel toward *the member of the Faculty of Engineering*:



Indicate your answer by drawing a line around the pair of circles you select.

Indicate how familiar you are with *The Salvation Army* by ticking one of the following options:

- ☐ I have never heard of it
- ☐ I have only heard the name
- ☐ I know the name but I have only a vague idea of what it does
- ☐ I know the name and I have a good idea of what it does

Figure 4: Examples of the tasks.

Instructions

Welcome to the experiment. It is composed of two parts: Part 1 and Part 2. You will receive a fixed payment of £5 at the end of the experiment and you will earn more depending on your choices during Part 2. Please remain silent and do not speak with other participants. If you have a question of any kind, please raise your hand at any time and an experimenter will come to your desk.

You have in your possession two envelopes, respectively labelled ‘Part 1’ and ‘Part 2’. They contain the material you will need for this experiment. Please do not open any of the envelopes until instructed to do so by the experimenters.

Before we proceed, we would like you to verify that you are from the Faculty of Arts. If this is the case, please tick the following checkbox:

☐ I acknowledge I am a member of the Faculty of Arts.

If this is not the case, please raise your hand and wait for an experimenter to come to your desk.

We have a lot of procedures in place throughout the experiment designed to ensure your anonymity. The first one is the use of an identification number. This is the number printed at the top of this page. Each of the experimental packages that you saw outside the room had a different identification number. In effect, one of the identification numbers has been randomly attributed to you as you randomly selected one of the experimental packages. Your decisions are linked to this identification number, not to your identity. We are trying our best not to link your decisions to your identity, so please play your part in not allowing anyone—*including the experimenters*—to see this identification number. For similar reasons, do not write anything on any of the pages that would allow us to identify you.

We will now present Part 1 of the experiment in detail.

Part 1

You will be randomly matched with one participant from the Faculty of Social Sciences and one participant from the Faculty of Engineering. From now on, we will use the expressions ‘the member of the Faculty of Social Sciences’ and ‘the member of the Faculty of Engineering’ to refer to the two participants you will be matched with. This matching will be constant throughout the experiment. You will not be told who these people are either during or after the experiment. The only information disclosed is their Faculty membership. Also, they will not be told who you are. As a matter of fact and as explained below, participants from the Faculty of Social Sciences and the Faculty of Engineering will not even know that this experiment took place.

In this part of the experiment, we will give money to the member of the Faculty of Social Sciences or to the member of the Faculty of Engineering depending on your choices. Hence, *the money donated is not your money* and nothing is taken from you.

There are only members of the Faculty of Arts in this room; hence, none of your choices in Part 1 will affect someone in this room nor will their choices affect you.

The experimental material for Part 1 of the experiment is composed of the present instructions and the envelope labelled ‘Part 1’. Do not open the envelope until instructed to do so.

We will start by describing the tasks.

Tasks

There will be three types of tasks, which we call **allocation tasks**, **equivalence tasks** and **circle tasks**.

Allocation tasks

Allocation tasks ask you to choose between two alternatives. Here is an example:

> **Option A**: We give £y to *the member of the Faculty of Social Sciences*
> **Option B**: We give £z to *the member of the Faculty of Engineering*
>
> Choose **A** or **B**:

You will choose one of the two options by writing 'A' or 'B'. There will be a range of such tasks involving different money amounts.

Equivalence tasks

In equivalence tasks, we propose an allocation of a specific amount to either the member of the Faculty of Social Sciences or the member of the Faculty of Engineering. We then ask you to specify how much money we would have to *give to you* instead so that you would think that amount of money was just as good as the proposed allocation. Here is an example:

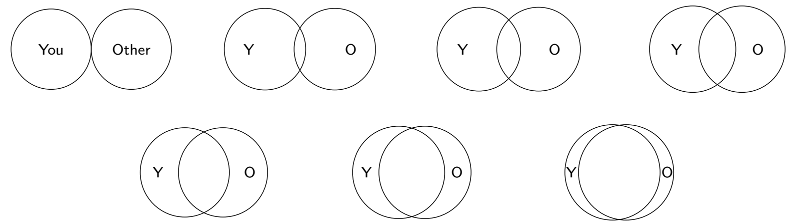
> How much money *given to you* would be just as good as us giving £w to *the member of the Faculty of Social Sciences*?
>
> Please write the amount here:
>
> We will refer to this amount as your equivalence valuation of giving £w to the member of the Faculty of Social Sciences.

The participant (and hence the Faculty) and the amount of the allocation will change from task to task.

We will never actually give money to you as part of those tasks, but as explained later your answers to the equivalence tasks may affect which participant we will give money to, so please give considered and careful answers.

Circle tasks

For these tasks, we will ask you how you feel toward the participants you have been matched with. You will be asked in this way:

> Please consider the member of the Faculty of Engineering. Select the pair of circles that best represents how you feel toward *the member of the Faculty of Engineering*:
>
> 
>
>
> Indicate your answer by drawing a line around the pair of circles you select.

Procedure

In a minute, we will ask you to open the envelope labelled 'Part 1'. In it, you will find a booklet containing several of the aforementioned tasks in a random order. On each page, just as at the top of these instructions, you will notice a number: this is your identification number.

As a consequence of your decisions, one of two people with whom you will be matched with—the member of the Faculty of Social Sciences and the member of the Faculty of Engineering—will get paid. We will now explain who and how much. After the experiment and after everybody has left, we will open the envelopes. We will then randomly select one pair of amounts, say $(£y, £z)$, independently for each participant. You would have encountered each of those two amounts twice:

- both of them at the same time in an allocation task, where you had to choose between giving $£y$ to the member of the Faculty of Social Sciences and giving $£z$ to the member of the Faculty of Engineering;
- each of them separately in equivalence tasks, where you had to tell us the amount of money given to you that you think is just as good as giving to the member of the Faculty of Social Sciences or to the member of the Faculty of Engineering.

We will then flip a coin to select between the allocation task and the equivalence task:

- If the allocation task is selected, we will give the money to the person you chose;
- If the equivalence task is selected, we will give the money to the person for which you indicated a higher equivalence valuation.

Let us illustrate this with an example. Imagine two fictitious Faculties: the Faculty of Xenostudies and the Faculty of Patascience. As explained earlier, assume you have been paired with one member from each of those fictitious Faculties. Imagine that the amounts (£5,£10) are selected. During the experiment, you encountered those amounts in the following allocation task:

> **Option A**: We give £5 to the member of the Faculty of Xenostudies
> **Option B**: We give £10 to the member of the Faculty of Patascience
>
> Choose **A** or **B**: A

Suppose you chose **A**, that is, giving £5 to the member of the Faculty of Xenostudies you have been paired with.

You also faced an equivalence task with the member of the Faculty of Xenostudies:

> How much money given to you would be just as good as us giving £5 to the member of the Faculty of Xenostudies?
>
> Please write the amount here: 4
>
> We will refer to this amount as your equivalence valuation of giving £5 to the member of the Faculty of Xenostudies.

This example supposed that you stated that the member of the Faculty of Xenostudies having £5 and you getting £4 makes you indifferent. You faced a similar question with the member of the Faculty of Patascience:

> How much money given to you would be just as good as us giving £10 to the member of the Faculty of Patascience?
>
> Please write the amount here: 2
>
> We will refer to this amount as your equivalence valuation of giving £10 to the member of the Faculty of Patascience.

Here, imagine that you stated that the member of the Faculty of Patascience having £10 and you getting £2 are just as good.

Finally, we use a coin flip to determine whether it is your response to the allocation task, or your responses to the equivalence tasks that determine the person we will pay on your behalf:

- If the allocation task is selected, we are going to give £5 to the member of the Faculty of Xenostudies because this is what you chose in the allocation task involving the member of the Faculty of Xenostudies and the member of the Faculty of Patascience.
- If the equivalence task is selected, we are going to give £5 to the member of the Faculty of Xenostudies because your equivalence valuation of giving £5 to the member of the Faculty of Xenostudies (£4) is greater than your equivalence valuation of giving £10 to the member of the Faculty of Patascience (£2).

Hence, in this particular example, the money is always given to the member of the Faculty of Xenostudies. This would not have been the case had the answers been different.

At this stage, we will know to whom the money is allocated and we will give the money accordingly. Members of the Faculty of Social Sciences and the Faculty of Engineering will get paid on 13 January 2015 during an experimental session at 10am or at 3pm. You are free to come to the laboratory that day at any of these times to monitor the payment.

We will never tell members of the Faculty of Social Sciences and of the Faculty of Engineering about this experiment. For participants receiving money, the money will appear to come from the experimenter. Participants not receiving money will not know they could have received some money had your choices be different.

Questions on the procedure

We would like to make sure you understand the procedure fully. Please answer the following questions. Once you have finished, raise your hand and an experimenter will come to your desk to verify your answers. There is no identification number on top of those pages so that the experimenters cannot learn your identification number. When s/he comes, please make sure s/he cannot see the other pages. Your answers here have no consequence for the rest of the experiment.

Question 1

Imagine the amounts (£5,£12) are selected after the experiment. The following choices have been made in the relevant allocation tasks and equivalence tasks:

Option A: We give £5 to the member of the Faculty of Social Sciences
Option B: We give £12 to the member of the Faculty of Engineering

Choose **A** or **B**: B

How much money given to you would be just as good as us giving £5 to the member of the Faculty of Social Sciences?

Please write the amount here: 4

We will refer to this amount as your equivalence valuation of giving £5 to the member of the Faculty of Social Sciences.

How much money given to you would be just as good as us giving £12 to the member of the Faculty of Engineering?

Please write the amount here: 14

We will refer to this amount as your equivalence valuation of giving £12 to the member of the Faculty of Engineering.

What happens if the allocation task is selected? Please tick one:

☐ We will give £5 to the member of the Faculty of Social Sciences

☐ We will give £12 to the member of the Faculty of Engineering

What happens if the equivalence task is selected? Please tick one:

☐ We will give £5 to the member of the Faculty of Social Sciences

☐ We will give £12 to the member of the Faculty of Engineering

Question 2

Imagine the amounts (£5,£8) are selected after the experiment. The following choices have been made in the relevant allocation tasks and equivalence tasks:

Option A: We give £8 to the member of the Faculty of Engineering
Option B: We give £5 to the member of the Faculty of Social Sciences

Choose **A** or **B**: B

How much money given to you would be just as good as us giving £5 to the member of the Faculty of Social Sciences?

Please write the amount here: 7

We will refer to this amount as your equivalence valuation of giving £5 to the member of the Faculty of Social Sciences.

How much money given to you would be just as good as us giving £8 to the member of the Faculty of Engineering?

Please write the amount here: 3

We will refer to this amount as your equivalence valuation of giving £8 to the member of the Faculty of Engineering.

What happens if the allocation task is selected? Please tick one:

☐ We will give £5 to the member of the Faculty of Social Sciences

☐ We will give £8 to the member of the Faculty of Engineering

What happens if the equivalence task is selected? Please tick one:

☐ We will give £5 to the member of the Faculty of Social Sciences

☐ We will give £8 to the member of the Faculty of Engineering

Question 3

Which tasks are relevant if the amounts (£5,£10) are selected? Tick all that apply:

☐ How much money given to you would be just as good as us giving £20 to the member of the Faculty of Engineering?

Please write the amount here:

We will refer to this amount as your equivalence valuation of giving £20 to the member of the Faculty of Engineering.

☐ **Option A**: We give £5 to the member of the Faculty of Social Sciences
Option B: We give £8 to the member of the Faculty of Engineering

Choose **A** or **B**:

☐ **Option A**: We give £5 to the member of the Faculty of Social Sciences
Option B: We give £10 to the member of the Faculty of Engineering

Choose **A** or **B**:

☐ How much money given to you would be just as good as us giving £5 to the member of the Faculty of Social Sciences?

Please write the amount here:

We will refer to this amount as your equivalence valuation of giving £5 to the member of the Faculty of Social Sciences.

☐ **Option A**: We give £5 to the member of the Faculty of Social Sciences
Option B: We give £12 to the member of the Faculty of Engineering

Choose **A** or **B**:

☐ How much money given to you would be just as good as us giving £10 to the member of the Faculty of Engineering?

Please write the amount here:

We will refer to this amount as your equivalence valuation of giving £10 to the member of the Faculty of Engineering.

You can now open the envelope labelled ‘Part 1’, take out the booklet and start completing the tasks. *Once you have completed a task, please turn the page and do not consider it again.* Once you have completed all the tasks, replace the booklet in the envelope along with the present instructions and close the envelope. Then, please raise your hand. When everybody has finished, we will collect the envelopes and mix them under the supervision of several randomly selected participants.

Notice that each envelope returned will look exactly the same, and since your identification number is attributed randomly we will not be able to tell who filled which booklet.

If you have any question, please raise your hand and an experimenter will come to your table to answer it.