Experimental studies on the psychology of property rights

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4. Dilution Illusion

4.1. Introduction

Standard economic theory predicts that only the representation in real terms matters. There is, however, evidence that the nominal representation of choices influences decision-making. A prominent example is the distinction between the face value of money and its purchasing power (Fisher 1928). Studies show that people tend to neglect the purchasing power of money in favor of focusing on the nominal representation of money, which is also known as money illusion (Shafir, Diamond and Tversky 1997). This bias is also found in non-monetary and probabilistic contexts (Burson *et al.* 2009; Hsee *et al.* 2003; Kirkpatrick and Epstein 1992). The overarching conclusion of these studies is that the nominal representation of choices biases decision-making.

Extant research on framing effects due to changes in the nominal representations has focused primarily on *individual* decision-making (Hsee and Hastie 2006). It is unclear, however, to what extent the nominal representation of choices can also affect *interpersonal* decision-making. There are situations in which it is possible to disadvantage or advantage another person in real terms but not nominally, and vice versa. For example, it is possible to appropriate value from a shareholder without affecting the number of shares held by this shareholder through issuance of new shares, which dilutes the value of a single share (Johnson *et al.* 2009). The monetary value of a single share can vary because the number of shares can be increased or decreased but this does not affect the value of the shares combined. Theoretically, a shareholder can appropriate value from another shareholder through either (1) theft or (2) dilution with the same outcome in real terms. Thus, a distinction can be made between nominal appropriation (theft) and real appropriation (dilution).

There is convincing evidence that people are averse to stealing, even if the probability of being caught is zero (Engel 2011; Gächter and Riedl 2005; Hoffman *et al.* 1994; Levitt 2006; List 2007; Oxoby & Spraggon 2008). Empirical research on theft aversion has mainly focused on providing evidence for its existence (e.g., List 2007) and how ownership can be established to induce theft aversion (e.g., Oxoby & Spraggon 2008). It is implicitly assumed that theft aversion is an aversion to appropriating from others in real terms. However, extant research on theft aversion confounds theft as nominal appropriation of possessions *and* appropriation in real terms. This chapter disentangles real appropriation from nominal appropriation to study to what extent theft aversion depends on this distinction.

We present an experiment that is based on the dictator game. In the standard implementation of the game two participants are paired, the donor (also known as the dictator) and the recipient, and endowed with a fixed sum of money. The donor can decide how much to divide the endowment between herself and the recipient. In our variation the endowment consists of shares and the monetary value of a single share depends on the total number of shares. In our baseline treatment donors are unable to change the number of shares, which corresponds to the standard implementation (Engel 2011). In the Dilution treatment, however, donors can only expropriate value from the recipient by issuing new shares to themselves. Thus, in the Dilution treatment nominal appropriation is not possible. We find that donors are more selfish in the Dilution treatment than in the baseline treatment, which we dub the dilution illusion. In the Destruction treatment, donors can only expropriate value from the recipient by destroying shares of the recipient. Here we find the opposite effect that donors are less selfish in the Destruction treatment. Combined, our findings provide evidence that theft aversion is moderated by the nominal representation of the distribution of mediums. Our formal analysis shows that this is consistent with an aversion to inequality in nominal distributions. To the best of our knowledge, this study is the first to explore the decision-making biases arising from the nominal representation of value in an incentivized social context.

4.2. Literature review

Standard economic theory assumes that people make choices in such a way that it maximizes perceived value. We adhere to the economic definition of value, which is the maximum amount the decision-maker is willing and able to give up to obtain a good. In the literature money is often used as a measure of value for the sake of simplicity and comparability. As a result, choices in studies are usually framed in terms of a currency and its distribution. However, the value of money is subject to change over time, often in the form of inflation. This results in that over time the value of a given unit decreases. Thus, in nominal terms nothing changed but in real terms money becomes less valuable.

This change poses an arithmetical challenge to decision-makers who need to choose from options that involve both the present and the future. To be able to compare this type of choice sets in real terms it is often necessary to calculate the monetary value of these choices at a single point in time. For example, assuming an inflation rate of 100%, the value of \$100 in one year is equal to the value of \$50 today ($\frac{\$100}{1+100\%}$). To meet the standard economic assumption of value maximization it is predicted that decision-makers always choose the optimal choice in real terms and are able to ignore the nominal denomination of value. However, there is strong evidence that people are prone to take into account the nominal denomination of choices, which also known as *money illusion* (Shafir *et al.* 1997).

Money illusion is the tendency to make choices such that the nominal amount is maximized, even if this leads to suboptimal choices in real terms. Shafir *et al.* (1997) find, for example, that respondents prefer receiving a 5% raise with 4% inflation to receiving a 2% raise without any inflation. A simple calculation shows that the latter is actually optimal in real terms (5% - 4% = +1% < +2%). Shafir *et al.* (1997) argue that money illusion occurs due to the inherent saliency of value denominations, simplicity of comparing nominal choices and the fact that in many cases the nominal terms are highly correlated with real terms. More recent studies show that money illusion is such a robust bias that it can be observed at the aggregate market level, which can explain rigid prices in labor, asset and housing markets (Fehr and Tyran 2001; Fehr and Tyran 2005; He and Zhou 2014; Noussair, Richter, and Tyran 2012).

A phenomenon that is conceptually similar to money illusion is the ratio bias, which also known as the denominator neglect. In a classic study Kirkpatrick and Epstein (1992) find that participants prefer a lottery with a 10 in 100 odds over a lottery with a 1 in 10 odds even though the objective odds of these two lotteries are exactly the same ($\frac{10}{100} = \frac{1}{10}$). Dale *et al.* (2007) show that the ratio bias can also be found if the lottery with the greater nominator is actually the lottery with a lower probability of winning ($\frac{28}{100}$ versus $\frac{3}{10}$). The ratio bias is similar to money illusion because both biases result from weighing the nominator more that standard economic theory would predict. The main difference is the context: ratio bias is applies to probabilities while money illusion applies to inflation rates. Chen *et al.* (2012) argue, however, that the ratio bias and money illusion are of the same nature.

The psychological effect that accounts for money illusion can also occur in situations in which money is not used as a denominator. A broader bias, which also encompasses money illusion, is *medium maximization* (Hsee *et al.* 2003). Medium maximization can be defined as the preference to maximize the amount of a medium instead of only taking into account how much value the medium represents. Hsee *et al.* (2003) argue that anything that is used to obtain value is in essence a medium. They provide the example of a frequent flyer who accumulates miles (medium 1: miles) as part of the airline's loyalty program. These miles can be exchanged for booking a flight with a sizeable discount (medium 2: flight). The flight is booked to a destination to enjoy a holiday (medium 3: holiday), which brings about happiness and, thus, value. In this example medium maximization occurs if, for example, the flyer prefers to collect more miles even though she knows that she's not planning to exchange these for something valuable.

The study of medium maximization, specifically that of money illusion, has been predominately restricted to situations in which choices did not have consequences to others or only hypothetically (Hsee *et al.* 2009; Shafir *et al.* 1997). However, there are many situations in which multiple persons are affected because the underlying value of a medium might be distributed among multiple 'shareholders'. For example, in 2006 the Reserve Bank of Zimbabwe decided to significantly increase the money supply to pay a sovereign debt. As a result, the value of a single Zimbabwean dollar was diluted to share the value with the newly issued supply of money. This led to a sharp increase in the inflation rate (Hanke and Kwok 2009). The population at large was disadvantaged because the purchasing power of the Zimbabwean dollar decreased drastically. An alternative strategy for the government of Zimbabwe would have been to payoff its debt by increasing taxes. This would mean that the population of Zimbabwe would be affected nominally and in real terms. The outcome, however, would have been the same. But due to a difference in framing, the ability to expropriate value by diluting the value of money might lead to more selfish decision-making than if value expropriation could only take place through taking the medium as well.

We argue that decision-makers are more likely to expropriate value from others if the victims are not affected nominally, which we dub the dilution illusion. The dilution illusion is an illusion in the sense that diluting the value of a single unit of a medium appears as if victims are not deprived of anything while, in fact, their possessions are becoming less valuable. In the case of theft, victims are deprived of their possessions and, thus, also the value that those possessions carry. A perfectly self-regarding individual will commit theft if the probability of being caught is zero (Becker 1968). However, studies provide strong evidence in support for the existence of an aversion to stealing (Gächter and Riedl 2005; Hoffman *et al.* 1994; Levitt 2006; List 2007; Oxoby and Spraggon 2008). This implies that even if the probability of being caught is zero, people are prone to self-enforce the norm against stealing. To study to what extent the possibility to dilute leads to more expropriation than the possibility the steal, it is necessary that the ratio of nominal units and the monetary value of a unit is able to vary.

Disentangling this ratio can clarify to what extent the aversion to theft is actually an aversion to *nominal* expropriation. For example, imagine a fund with only two shareholders, Alice and Bob, and each person holds two shares (4 shares = 100% of the fund). To expropriate 25% of the fund's value, Alice can either steal or dilute Bob's shares. Alice stealing one share from Bob ($\frac{2+1}{4} = 75\%$) has the same effect in real terms as issuing four more shares to herself ($\frac{2+4}{4+4} = 75\%$). In the case of theft, Bob is affected nominally because to transfer value from Bob to Alice, Alice has to dispossess Bob from one share. In the case of dilution, however, Alice does not have to dispossess Bob to transfer value to herself; issuing more shares decreases the value of a single share. The dilution illusion entails that Alice with the ability to dilute is predicted to expropriate more value than Alice with the ability to steal. Because the difference between the two situations is a nominal difference, the difference constitutes a difference in framing only.

In the above scenario Alice can only affect the number of shares she possesses. Besides creating new shares, Alice could also destroy her own shares. This would effectively transfer value from Alice to Bob. For example, if Alice destroys a single share of her own, then her stake decreases from $\frac{2}{4}$ to $\frac{2-1}{4-1} = \frac{1}{3}$ while Bob's stake increases from $\frac{2}{4}$ to $\frac{2}{4-1} = \frac{2}{3}$. Interestingly, if Alice is only able to affect the number of shares held by Bob, destroying Bob's shares is the only method for Alice to transfer value to herself. For example, if Alice destroys one of Bob's shares, then the value of her possessions increases from $\frac{2}{4}$ to $\frac{2}{4-1} = \frac{2}{3}$ while the total value of Bob's shares decrease from $\frac{2}{4}$ to $\frac{2-1}{4-1} = \frac{1}{3}$. Thus, the situation in which Alice issues two new shares to herself is in real terms equivalent to Alice destroying one of Bob's shares ($v_A = \frac{2+2}{4+2} = \frac{2}{4-1} = \frac{2}{3}$). Although these two outcomes in real terms are identical, the framings are opposable. Indeed, the scenario in which Alice can only affect the shares of Bob might induce an effect that is the opposite of the dilution illusion, which we call the ruin illusion. Ruin illusion is the tendency to expropriate *less* value due to an aversion to nominal expropriation.

The scenario with Alice and Bob can be mapped unto to the dictator game (DG), which has been studied extensively to explore the nature of social preferences (Forsythe *et al.* 1994). Namely, in the DG two participants are paired, a donor and a recipient, and are endowed with a sum of money. Only the donor is allowed to decide how the endowment is distributed between the two, which is called the offer. A self-regarding donor is expected to always expropriate the complete endowment. However, a large of body of replications and variations of the DG show that donors on average offer a proportion of the endowment that is well above zero (Engel 2011).

There is strong evidence that donors expropriate even less if the framing suggests that recipients are entitled to a part of the endowment (Hoffman *et al.* 1994; List 2007). For example, donors who are informed that the recipient earned the endowment, offer on average more to the recipient than donors who are not provided any information about the distribution of property rights (Oxoby and Spraggon 2008). Donors' tendency to expropriate less if framing attributes property rights to the recipient can be described as a form of theft aversion. Theft aversion can be defined as an aversion to expropriating in real terms. However, extant research on theft aversion does not disentangle the nominal representation of the endowment from the representation in real terms. Thus, it is still unclear to what extent theft aversion depends on the nominal representation of the endowment's distribution between the donor and the recipient. Standard economic theory predicts that theft aversion is independent of the nominal representation and, thus should not affect decision-making.

We hypothesize that the nominal representation does moderate theft aversion. Specifically, we predict that donors will expropriate more if expropriation does not affect the recipient nominally but does make the donor better off (*dilution illusion*). Similarly, we predict that donors will expropriate less if expropriation affects the recipient negatively in nominal terms without the donor being better off nominally (*ruin illusion*). Destroying shares does not increase the number of shares held by Alice while regular theft increases both the value of the shares held by Alice and the *number* of shares held.

The strength of the illusions might be moderated by the decision-maker's ability to see through the veil of mediums. As in the case of inflation, the real effect can be calculated or easily estimated using simple arithmetical operations. Thus, a higher cognitive ability might mitigate the effect of the dilution illusion. Studies show that a higher cognitive ability reduces susceptibility to framing effects (Oechssler, Roider and Schmitz 2009; Stanovich and West 1998). LeBoeuf and Shafir (2003) find evidence that people who think about themselves that they think more deeply about problems are less susceptible to common framing effects. They argue that this can be explained by a general preference for consistent decision-making, which in turn mitigates framing effects because these would lead to inconsistent choices. More relevant, there is evidence for the notion that a higher cognitive ability decreases the susceptibility to the ratio bias (Pacini and Epstein 1999; Stanovich and West 2008). We hypothesize that participants with a higher cognitive ability are less sensitive to changes in the nominal representation.

4.3. Experimental design

The experiment was conducted on Amazon Mechanical Turk (Horton, Rand and Zeckhauser 2011). The experiment consists of a variation of the dictator game (DG), which we dub the Shareholders Game (SG). In the DG and SG two participants, a donor and a recipient, are paired and endowed with a sum of money. Only the donor can decide on how the endowment will be divided. This decision is called an offer. An offer of 0% means that the donor is allocating the full endowment to herself while an offer of 100% means that the donor is allocating everything to the recipient. The standard framing of the DG is that the dividable endowment simply consists of money. Accordingly, in the DG the donor chooses how much money to offer to the recipient. Instead of money, in the SG the pairs are endowed with tokens, which are shares of the endowment and, thus, function as a medium. The monetary value of all tokens combined is fixed and, thus, does not depend on the total number of tokens. As a result the monetary value of a single token varies and is defined as the monetary value of the endowment divided by the total number of tokens. At the end of the experiment, participants receive the monetary value of the tokens.

In the SG the initial number of endowed tokens is 120. The donor and the recipient are initially allocated 60 tokens each. Dependent on the treatment donors can affect the number of tokens of held by both, the recipient only or herself only. Another difference between the DG and the SG is that in the SG there is a distinction between the total endowment and the dividable endowment. Tokens represent the total endowment but the donor can only affect the distribution of the *dividable* endowment. More precisely, donors and recipients always receive at least 1/10 of the total endowment each. This distinction is technically necessary to allow for comparing donors' offers between treatments. For reasons of consistency and clarity, an offer is presented in this study as a percentage of the dividable endowment, which is 10/12 of the total endowment (Table 4.1).

Table 4.1: ***Donors' choice set***

TAKING	Donor Tokens	110	100	90	80	70	60	50	40	30	20	10
	Recipient Tokens	10	20	30	40	50	60	70	80	90	100	110
DILUTION	Donor Tokens	660	300	180	120	84	60	43	30	20	12	5
	Recipient Tokens	60	60	60	60	60	60	60	60	60	60	60
DESTRUCTION	Donor Tokens	60	60	60	60	60	60	60	60	60	60	60
	Recipient Tokens	5	12	20	30	43	60	84	120	180	300	660
	Label	A	B	C	D	E	F	G	H	I	J	K
	Donor Money	$2.20	$2.00	$1.80	$1.60	$1.40	$1.20	$1.00	$0.80	$0.60	$0.40	$0.20
	Recipient Money	$0.20	$0.40	$0.60	$0.80	$1.00	$1.20	$1.40	$1.60	$1.80	$2.00	$2.20
	Offer	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

Notes. Donors can choose from eleven offers and each column represents an offer. The standard framing of an offer is in terms of percentages. For example, an offer of 10% means that 10% of the divisible endowment is offered to the recipient. In the experiment this corresponds to a value transfer of $0.80 from the recipient to the donor. In each treatment an offer corresponds to a nominal change in the number of tokens. In the Taking treatment offers below 50% implies that tokens are transferred from the recipient to the donor and offers above 50% are transfers from the donor to the recipient. Note that the transfer of value with each offer is the same across treatments. Destroying 17 or 55 tokens results in an absolute real change of $0.198 and $1.015 respectively, instead of $0.20 and $1.00. In the experiment these amounts are rounded off to match the payoff that corresponds to that offer in the other treatments.

We manipulate donors' ability to affect the number of tokens. In the Taking treatment the total number of tokens cannot be changed. Donors can only transfer tokens. Thus, the only way for donors to disadvantage the paired recipient is by taking tokens. For example, an offer of 20% corresponds to transferring 30 tokens from the recipient to oneself. Considering that the total number of tokens cannot change in the Taking treatment, the value of a single token is constant. This treatment corresponds to the taking framing of a DG (Dreber *et al.* 2013).

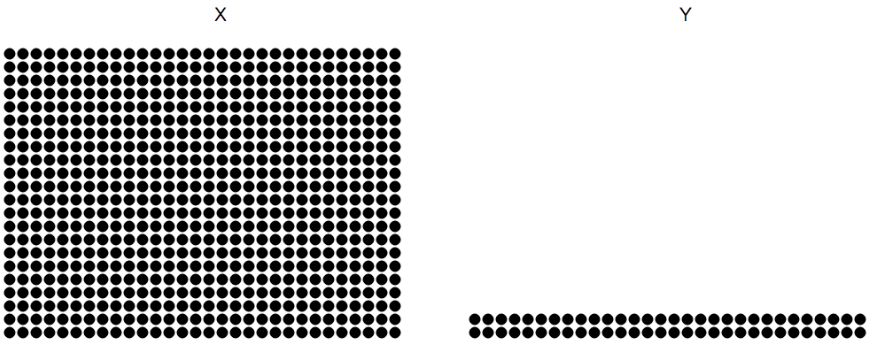
In the Dilution treatment the donor cannot affect the number of tokens held by the recipient. However, the donor can increase or decrease the number of tokens held. Increasing the number of tokens dilutes the value of a single token while decreasing this amount increases the value of a single token. For example, an offer of 20% corresponds to creating 120 tokens, which are allocated to the donor. Considering that in this case the donor will have 120+60

= 180 tokens and the recipient 60 tokens, the donor in essence expropriates to herself $\frac{180}{180+60} = \frac{3}{4}$ of the total endowment (80% of the dividable endowment). Donors can advantage recipients by destroying their own tokens. As a result the value of a single token increases as the total endowment is divided by fewer tokens.

In the Destruction treatment donors cannot change the number of tokens they possess but they can change the number of tokens held by the recipient. In this treatment a donor can only disadvantage the recipient by destroying tokens held by the recipient. This results in fewer tokens, which increases the value of a single token and is monetarily advantageous to the donor. To advantage the recipient, donors can increase the number of tokens held by the recipient, which would dilute the total value of the tokens held by donors.

In Table 4.1 an overview of the donor's choice set for each treatment is provided. Even though the donor's choice set differs considerably in nominal terms across treatments, in real terms the choice sets are identical. Thus, any behavioral difference between treatments can be attributed only to the nominal framing. All participants were required to answer a question that tests their understanding of the experiment. Only participants who answered this question correctly were paired and included in the sample. 66% of all participants provided a correct answer. Participants who provided an incorrect answer did not receive any feedback that they provided the incorrect answer to prevent discovering the correct answer through trial-and-error.

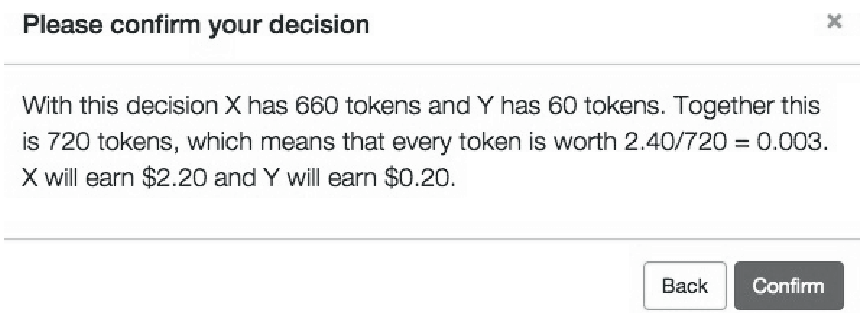
Figure 4.1: ***Visualization token distribution***



Note. Visualization of the distribution of tokens in the Dilution treatment for the offer 0%. In this case the donor has 660 tokens and the recipient has 60 tokens.

In the next screen donors were shown a visualization of the token distribution (Figure 4.1). Donors were free to select any possible offer to view how it would impact the distribution of tokens between the two parties. After selecting an offer, donors could submit their definitive choice. Donors were not made aware beforehand that submission triggers the appearance of a dialog box with more information about their offer and the possibility to reconsider their offer. The dialog box provides information about the distribution of the tokens, the monetary value of a single token and the monetary distribution that results from the submitted offer (Figure 4.2). This procedure allows for measuring the intuitive response of donors, which is the initial offer, and provides insight about to what extent informational feedback about the distribution in real terms affects decision-making. Furthermore, this design avoids any biases that might result from donors' reluctance to calculate the real consequences (Feldman and Ruffle 2015).

Figure 4.2: ***Confirmation dialog box***



Notes. After submitting an offer, donors are asked to confirm their decision in a dialog box. The dialog box provides information about the precise distribution of tokens, the monetary value of a single token and the precise distribution of monetary value.

We also manipulated the order of the scale to take into in case it matters in which order we offer the options. Pairs were either allocated to a treatment in which the first offer starts with 0% or to a treatment in which the first offer starts with 100%. We find that the distribution of donors' offer is not significantly different if the order of the offer scale is descending compared to ascending (Mann-Whitney, U = 17704.0, p = 0.54). At the level of the individual treatments, we find that the scale order does not affect the distribution offers in the Taking and Destruction treatment (p > 0.90) but in the Dilution treatment offers tend to be higher if the scale is descending (p = 0.07). Due to the lack of any significant order effects, the observations of the two order groups have been combined for subsequent analysis.

Recipients received the same instructions as donors and were shown the same screens. The only difference is that the submitted recipient's offer is not implemented but reflects what the recipient beliefs what the paired donor will choose. To elicit recipients' beliefs about what the donor will offer, recipients could earn a bonus of $0.20 if they correctly predicted what their paired donor offered. 34.2% of the recipients predicted the exact offer, and this is 45.2% if you include predicted offers with a deviation of not more than 10 percentage points from the actual offer.

In the next screen recipients are asked to evaluate to what extent they like or dislike the donor's offer. We implement a novel measure that avoids strategic interaction but requires effort to signal a certain response. The scale starts at zero, which is shown prominently in the middle of the screen. Participants can click on the red button to decrement this amount by one or on the green button to increment the amount by one. It is not possible to increase or decrease automatically by holding the button or using the keyboard. Every increase or decrease requires a click, which necessitates little but some physical effort. The minimum amount is -500 and the maximum amount is 500. Even though the chosen value is not communicated to the donor and nor does it affect the monetary outcome of the experiment, the measure allows recipients to emit a costly signal of their subjective evaluation of the donor's offer. Donors were also presented the same measure but were asked to indicate to what extent they think the recipient likes or dislikes the offer.

Before the end of the experiment both recipients and donors were asked to answer three questions to measure cognitive ability. Following Oechssler *et al.* (2009), we implement the Cognitive Reflection Test (CRT) to be able to study the moderating effect of cognitive ability on framing effects. The CRT aims to measure to what degree participants are conscientious, reflective and thoughtful in their thinking (Frederick 2005). There is evidence that CRT is a reliable predictor of susceptibility to framing effects and biases (Toplak, West and Stanovich 2011). The first of the three CRT questions provides the following logical challenge: “A bat and a ball cost $1.10. The bat costs $1.00 more than the ball. How much does the ball cost (in cents)?” Participants who only think superficially about this question are likely to provide 10 cents as the correct answer. The correct answer is actually 5 cents, which requires cognitive effort to determine. Goodman, Cryder and Cheema (2013) show that participants in Amazon Mechanical Turk do not score significantly different on the CRT compared to “community” participants. Of all participants, including those who did not provide a correct answer to the control question, 28% answered correctly to all three CRT items. This percentage is 48% if only the included sample is considered. These are categorized as participants with a high CRT score.

4.4. Theoretical predictions

A standard economic assumption is that individuals maximize their private wealth. Moreover, they are assumed to evaluate their wealth by the real value of their possessions. But these assumptions are not always supported in practice, which is illustrated by experimental evidence. Only some individuals are selfish but many appear to regard the consequences of their own decisions for other individuals’ wealth (Forsythe *et al.* 1994). And as we discuss above, money illusion has been shown to have tangible impact on economic efficiency.

Here we show that pro-social tastes combined with money illusion may lead to dilution illusion in our experiment. For this we will assume that our participants may hold other-regarding preferences over the *nominal* allocation of tokens rather than over the real division of monetary value. That social preferences may be sensitive to an ex-ante distribution of tokens rather than an ex-post distribution of value. Roth and Murnighan (1982) show that people prefer equal divisions of lottery tickets even when the resulting division of winnings is unequal in any event.

In all our treatments an allocation (s,t) of s tokens for the donor and t tokens for the recipient results in the division (x,y) of a fixed prize value v, where $x = sv/(s+t)$ is the donor's share and $y = tv/(s+t)$ is the recipient's share of the prize. A donor sensitive to real value computes her utility from the distribution (x,y) and a donor sensitive to nominal value computes her utility from the distribution (s,t). A selfish donor will assign the highest utility to the distribution that gives her the highest earning x or the highest number of tokens s, respectively. In our experiment this is always achieved by the 0% offer, with exception of the destruction treatment where the nominal amount of own tokens is fixed.

This changes when we consider other-regarding individuals who may be willing to share the prize, and may exhibit dilution illusion when the relative nominal differences between s and t differ from the corresponding relative real differences between x and y. To illustrate how dilution illusion may affect decisions we consider the simple model of inequity aversion proposed by Fehr and Schmidt (1999). A donor with parameters of 'envy' α and 'guilt' β, where α

$\geq \beta \geq 0$, evaluates a distribution (x,y) of value by $u(x,y) = x - \beta(x-y)$ when she earns more than her recipient, $x \geq y$; and by $u(x,y) = x - \alpha(y-x)$ when she earns less. Her utility therefore increases in her own earning and decreases in the difference between the earnings. Fehr and Schmidt (1999) show that behavior in a number of economic games can be reasonably described by this model assuming that 40% of the participants are very inequity averse with $\beta = 0.6$, a further 30% are selfish with $\beta = 0$, and the remaining 30% hold an intermediate guilt parameter $\beta \in (0,0.6)$.

An inequity averse individual in a dictator game prefers the equal division of earnings whenever her $\beta > 0.5$ and otherwise prefers the selfish division. To see this, note first that according to the inequity aversion model a donor will never choose a distribution of tokens or monetary payoffs where she earns less than the recipient. She would always prefer the even division, which gives her more and simultaneously reduces the difference in either tokens or monetary earnings. A rational donor therefore considers only the divisions where she earns at least as much as the recipient. Her utility is then given by $u(x,y) = x - \beta(x-y)$ which in a dictator game with a fixed prize value v we may rewrite $u(x,y) = u(x, v-x) = x - \beta(2x - v) = x(1-2\beta) + \beta v$. This increases in x whenever $\beta < 0.5$ and decreases in x whenever $\beta > 0.5$. A donor with high guilt β will therefore choose the lowest x such that $x > y$, and that leads to the even division. A donor with low guilt will choose the highest possible x, offering 0% to the recipient. If all our participants consider the division in real values then, based on the above distribution of guilt, we should in all our treatments see about a half of them making the selfish offer 0%.

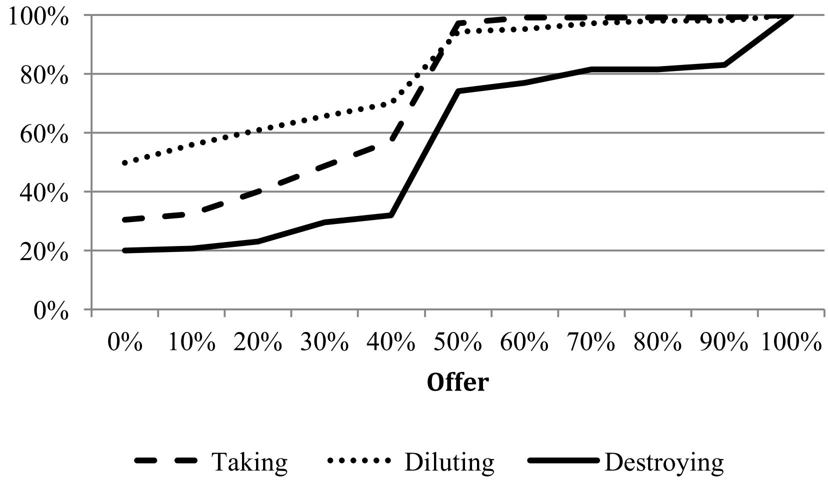
Consider now a nominal value sensitive donor with utility $u(s,t) = s - \beta(s-t)$. Again this donor will never choose a distribution of tokens or monetary payoffs where she earns fewer tokens than the recipient. In the taking treatment the real and nominal distributions coincide in relative terms, and again a donor chooses an even division when $\beta > 0.5$. In contrast, in the Dilution treatment any such donor would add as many tokens as possible to her own account and thus offer 0%, but in the Destruction treatment only a self-regarding donor (with $\beta = 0$) will destroy the tokens in the recipient's account to offer 0%. To see this, note that in the Dilution treatment the utility can be rewritten as $u(s,t) = u(t+c,t) = t + c - \beta c = t + c(1-\beta)$ where t is fixed and the donor chooses the number c of tokens to create for herself. This utility increases in c for all reasonable guilt parameters and all donors prefer to create as many tokens as possible, resulting in a 0% offer to the recipient. In the Destruction treatment the utility can be rewritten as $u(s,t) = u(s, s-d) = s - \beta d$ where s is fixed and the donor chooses the number d of recipient's tokens to destroy. This utility decreases in d for all donors except those with $\beta = 0$, that is, the self-regarding donors who are indifferent between the offers. All other-regarding donors choose $d = 0$ and offer the even division of earnings.

In summary, a donor with a high guilt parameter $\beta = 0.6$ and sensitive to the nominal allocation will evenly divide the tokens and earnings in the Taking treatment, but maximize its own tokens in the Dilution treatment, giving 0% to the recipient. This donor would effectively be subject to the dilution illusion. Similarly, a nominally sensitive donor with a low but positive guilt aversion will give 0% to the recipients in both the Taking and the Dilution treatments but will share evenly in the Destruction treatment.

Recent models of social preferences imply that prosocials participants might be more affected by dilution illusion. For instance, the model in Charness and Rabin (2002), with the corresponding parameter estimates, predicts that a subject sensitive to the nominal allocation of tokens is eight times more likely to offer 0% in the Dilution treatment than in the taking treatment (with the predicted probabilities of selfish offers being 88% and 12% respectively). Again, no difference is predicted for participants whose preferences depend on the real distribution of monetary value.

4.5. Results

Figure 4.3: ***Cumulative distribution of donors' initial offers***



Notes. $N = 383$. Donors' initial offer.

FINDING 1 *Initial offers are lower in the Dilution treatment than in the Taking treatment*

The distribution of initial offers in the Taking treatment differs from the distribution of initial offers in the Dilution treatment (Figure 4.3). The median initial offer in the Taking treatment (40%) is considerably higher than the median initial offer in the Dilution treatment (10%). Further analysis reveals that donors' initial offers are on average 28% lower in the Dilution treatment than in the Taking treatment (Mann-Whitney, $U = 6025.00$, $p = 0.005$). Also the percentage of donors who considered initially the lowest offer is significantly higher in the Dilution treatment than in the Taking treatment ($\chi^2(2) = 28.00$, $p < 0.001$). Furthermore, the percentage of donors who initially offered an equal split in real terms is significantly lower in the Dilution treatment than in Taking treatment ($\chi^2(2) = 11.21$, $p = 0.004$). In sum, the option to dilute the recipient lowers donors' offers. The results are in line with our theoretical predictions assuming that a third of donors consider the nominal rather than the real distribution. These findings strongly support the hypothesis for the existence of the dilution illusion. Furthermore, we find that recipients' expected initial offer is on average lower in the Dilution treatment than in the Taking treatment (Mann-Whitney, $U = 4828.0$, $p < 0.001$).

Table 4.2: ***Descriptives of initial offers***

	Mean offer (SD)	Median offer	Offer 0%	Offer < 50%	Offer 50%	Offer > 50%	N
donor							
Taking	29.8% (0.23)	40%	30.5%	57.1%	40.0%	2.9%	105
Dilution	21.5% (0.26)	10%	49.7%	69.9%	24.5%	5.6%	143
Destruction	47.8% (0.32)	50%	20.0%	31.9%	42.2%	26.9%	135
Recipient							
Taking	36.2% (0.24)	50%	24.8%	42.9%	48.6%	8.6%	105
Dilution	20.7% (0.28)	0%	55.2%	74.8%	18.2%	7.0%	143
Destruction	45.1% (0.31)	50%	17.8%	35.6%	40.7%	23.7%	135

Notes. $N = 383$. The numbers shown for the recipient pertains to their initial *expected* offer.

FINDING 2 *Compared to initial offers, the dilution illusion is less pronounced in the final offers*

After showing donors that their initial offer is not definitive and providing information about the monetary consequences of this offer, donors were offered the possibility to reconsider their offer as many times as they wished. Donors in the Dilution treatment considered more offers than in the Taking treatment ($M_{\text{taking}} = 1.2$ versus $M_{\text{diluting}} = 1.8$, Mann-Whitney, U = 6210.50, $p = 0.001$). Note that 73.6% of the donors did not reconsider their initial offer and, thus, submitted their initial offer as their final offer. This percentage, however, differs significantly between treatments (Taking: 88.6%, Dilution: 72.0%, Destruction: 63.7%, $\chi^2(2) = 19.11$, $p < 0.001$). Relatively more donors submitted their initial offer in the Taking treatment compared to donors in the Taking and Destruction treatments combined (Taking: 88.6%, Dilution and Destruction: 68.0%, $\chi^2(2) = 16.63$, $p < 0.001$). Thus, donors in the Dilution and Destruction treatments were more likely to recalibrate their offer once they were made aware of the consequences in monetary terms. This implies that at least for some donors, the initial offer is based on intuitive decision-making and, thus, donors refrain from manually or mentally calculating the monetary consequences of their choice.

A Wilcoxon Signed-Ranks Paired Difference Test reveals that in general donors' initial offer is significantly higher than the final offer (Z = 3.00, $p = 0.003$). We find, however, that the distribution of the difference between the initial and final offer differs significantly between treatments (Kruskal-Wallis, $\chi^2(2) = 24.81$, $p <$

0.001). In the Dilution treatment donors tend to offer 2.2 percentage points more in the final offer while in the Destruction treatment the final offer is 10.9 percentage points lower than in the initial offer (Table 4.2).

Even after providing the possibility to donors to reconsider their offer, differences in the final offer between treatments remain. Specifically, the distribution of final offers differs significantly between treatments (Kruskal-Wallis, $\chi^2(2) = 14.99$, $p < 0.001$). The proportion of donors who offered nothing also differs significantly between treatments ($\chi^2(2) = 9.68$, $p < 0.01$). Thus, even after providing donors the opportunity to reconsider their offer while revealing information about the monetary distribution of their offer, they were still susceptible to the dilution illusion.

On average, final offers in de Dilution treatment were 16% lower than in the Taking treatment (Mann-Whitney, U = 6678, $p = 0.12$). The proportion of donors who offered nothing is 38% higher in the Dilution treatment than in the Taking treatment ($\chi^2(1) = 3.88$, $p = 0.049$). These findings marginally support the existence of the dilution illusion considering donors were more selfish in the Dilution treatment than in the Taking treatment but not significantly so.

Table 4.3: ***Descriptives of final offers***

	Mean offer (SD)	Mean change from initial to final offer (SD)	Median offer	Offer 0%	Offer < 50%	Offer 50%	Offer > 50%	*N*
donor								
Taking	28.4% (0.22)	−0.01 (0.13)	40%	32.4%	58.1%	41.0%	1.0%	105
Dilution	23.8% (0.25)	+0.02 (0.19)	10%	44.8%	64.3%	32.2%	3.5%	143
Destruction	36.9% (0.29)	−0.11 (0.27)	50%	27.4%	45.2%	42.2%	12.6%	135
Recipient								
Taking	33.8% (0.23)	−0.02 (0.10)	50%	26.7%	46.7%	48.6%	4.8%	105
Dilution	19.1% (0.24)	−0.02 (0.20)	0%	55.2%	73.4%	23.1%	3.5%	143
Destruction	40.0% (0.28)	−0.05 (0.23)	50%	22.2%	36.3%	46.7%	17.0%	135

Notes. $N = 383$. The numbers shown for the recipient pertains to their final *expected* offer.

FINDING 3 *Offers in the Destruction treatment are lower than in the Taking treatment*

Besides predicting the dilution illusion, we also hypothesized the existence of an opposite effect—ruin illusion—if donors can only affect the shares of recipients. We find that the distribution of initial offers in the Taking treatment also seems to differ considerably from the same distribution in the Destruction treatment (Figure 4.3). Indeed, analysis reveals that donors' initial offers are on average 60% higher in the Destruction treatment than in the Taking treatment (Mann-Whitney, U = 4746.50, $p < 0.01$). Remarkably, the percentage of donors who initially offered more than half of the piece in real terms to the donors is significantly higher in the Destruction treatment than in Taking treatment ($\chi^2(2) = 23.59$, $p < 0.01$). Furthermore, donors who offered more to themselves than the recipients were a minority in the Destruction treatment (45.2%), which is significantly lower than in the Taking treatment ($\chi^2(2) = 3.94$, $p = 0.05$). The proportion of donors who gave more to the recipient than to themselves also differs significantly between treatments ($\chi^2(2) = 16.72$, $p < 0.01$). This proportion is much higher in the Destruction treatment than in the other two treatments. These finding strongly support the hypothesis for the existence of the ruin illusion. In the Destruction treatment final offers were 30% higher than in the Taking treatment (Mann-Whitney, U = 7270, $p < 0.01$).

FINDING 4 *Donors with a high CRT score offer less to recipients*

Initial offers of donors with a high CRT score are on average 24% lower than the initial offers made by donors with a low CRT score

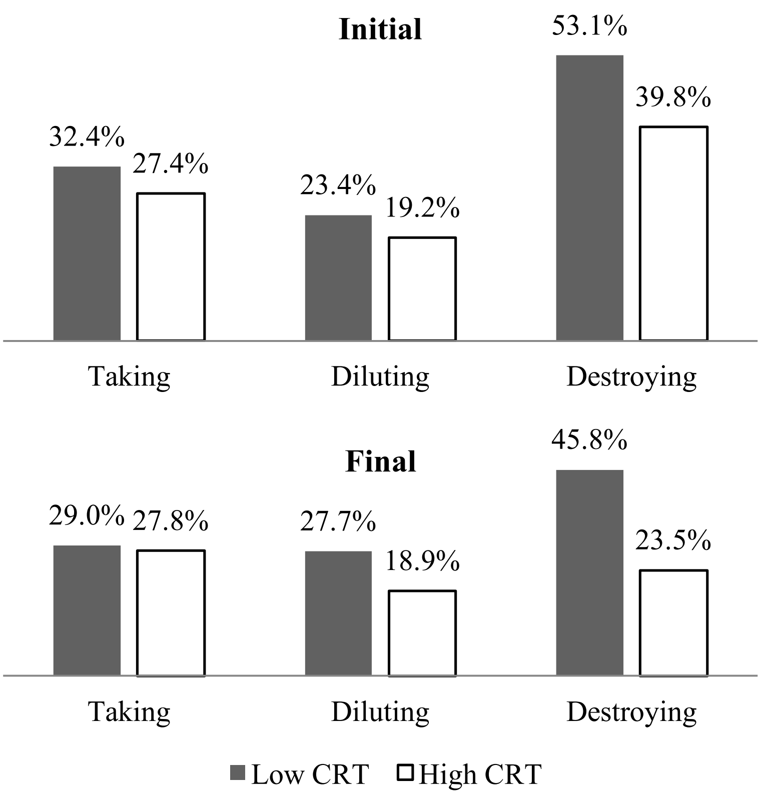
(Mann-Whitney, U = 14942.0, $p < 0.01$). The difference is more pronounced in the final offers. Specifically, final offers of donors with a high CRT score are on average 34% lower than the initial offers made by donors with a low CRT score (Mann-Whitney, U = 13903.5, $p < 0.01$). These findings strongly suggest that increased cognitive ability leads to more selfish decision-making.

Further analysis reveals that in the Taking treatment cognitive ability does not affect average final offers (Mann-Whitney, U = 1356.0, $p = 0.89$). However, in the Dilution treatment donors with a high CRT score offered on average 31.8% less than donors with a low CRT score (Mann-Whitney, U = 2077.5, $p = 0.05$). In the Destruction treatment donors with a high CRT score offered on average 49% less than donors with a low CRT score (Mann-Whitney, U = 1206.5, $p < 0.001$). Thus, the association between cognitive ability and offers is only found in the two treatments in which the nominal representation can be separated from the distribution in real terms.

FINDING 5 *Offers between treatments are more similar among donors with a high CRT score*

The distribution of initial offers differ significantly between treatments among donors with a low and high CRT score (Low: Kruskal-Wallis, $\chi^2(2) = 44.46$, $p < 0.001$; High: Kruskal-Wallis, $\chi^2(2) = 10.92$, $p = 0.004$). However, the distribution of final offers differs significantly between treatments among donors with a low CRT score (Kruskal-Wallis, $\chi^2(2) = 20.93$, $p < 0.01$) but not among donors with a high CRT score (Kruskal-Wallis, $\chi^2(2) = 3.99$, $p = 0.14$). A Wilcoxon Signed-Ranks Test reveals that initial offers do not differ significantly from final offers among donors with a low CRT score (Z = -1.33, p = 0.18). However, among donors with a high CRT score final offers are significantly lower than initial offers (Z = -2.91, $p < 0.01$). These findings support the hypothesis that donors with a high CRT score are less likely to suffer from the dilution illusion, especially after receiving feedback.

Figure 4.4: Mean initial and final offer per treatment and CRT score



Note. $N = 383$.

FINDING 5 *Recipients' responses to donors' final offers do not differ across treatments*

recipients were able to indicate to what extent they liked or disliked the offer made by the donor, which reflects recipients' response to the final offer. Considering that the distribution of this scale is highly skewed (Skewness = 2.65, S.E. of Skewness = 0.125), we dichotomize the responses between negative and nonnegative scores for further analysis. A logistic regression reveals that a lower donors' final offers significantly increases the likelihood that the recipient's response is negative (B = -0.49, S.E. = 0.05, p < 0.01). However, we do not find any evidence that recipients' responses are affected by the Dilution treatment (p = 0.90) or the Destruction treatment (p = 0.16). This strongly suggests that the differences between treatments did not result in a change in recipients' perceptions about the likability of the outcome. Similarly, donors expect on average that a lower final offer significantly increases the likelihood that the recipient's response is negative (B = -1.07, S.E. = 0.10, p < 0.01). A possible explanation of these findings is that the dilution illusion is the result of intuitive decision-making and, thus, not the result of deliberate strategic behavior.

4.6. Discussion

This study investigates to what extent the nominal representation affects interpersonal decision-making. Separate streams of research show that increasing the nominal value of a choice while keeping the real value constant makes that choice more attractive in an individual decision-making setting (Hsee *et al.* 2003; Kirkpatrick and Epstein 1992; Shafir *et al.* 1997). We find that disentangling the nominal representation of an endowment from its distribution in real terms can also introduce a bias in an interpersonal setting. Specifically, the reported experiment provides strong evidence for the existence of more selfish decision-making if the other is not affected nominally, which we dub the dilution illusion. The inverse effect can be obtained if the nominal endowment of the decision-maker cannot be changed.

We hypothesized that a higher cognitive ability mitigates the effect of disentanglement between the nominal representation and the outcome in real terms. We find, indeed, that the differences across treatment cease to be significantly different among donors with a higher cognitive ability. Interestingly, donors with a higher cognitive ability are more selfish across treatments. This finding conforms to recent studies that show that conscious deliberation increases the likelihood of selfish decision-making (e.g., Rand, Greene and Nowak 2012).

The effect of changing the nominal representation on donors' offers seems quite robust. As part of the experimental design, donors were provided the opportunity to reconsider their initial offers and at the same were provided unambiguous information about the real consequences of their offer. Although we find evidence that donors tend to revise their initial offer if it is presented in real terms, the distribution of final offers still significantly differ between treatments. This shows that removing the burden of mental arithmetic problem-solving is not sufficient to prevent the dilution illusion. Furthermore, note that the endowment in the experiment can be considered windfall wealth. Studies show that earned wealth, which can be established as such with the use of effort tasks, can magnify perceptions of ownership (Oxoby and Spraggon 2008). Arguably, the found effects might have been more pronounced if participants were required to exert effort to earn their initial endowment.

A relevant question is whether the dilution illusion is in reality strategic behavior or a psychological bias. Donors might reason that recipients care more about the nominal distribution of the endowment than the outcome in real terms. As a result, socially considerate donors might appropriate more in the end because they think that recipients experience less harm due to a lack of nominal harm (Dana, Cain and Dawes 2006). The findings, however, seem to support an explanation based on the existence of a psychological bias. The dilution illusion is less pronounced in the final offers compared to the initial offers. This highlights donors' preference to 'undo' the bias after receiving information about the real consequences of their offer. Furthermore, we find that donors with a higher cognitive ability decide similarly across treatments. Arguably, donors with a higher cognitive ability are more likely to process the presented information accordingly to align the outcome of the experiment with their actual preferences. This is line with previous studies that show that decision-makers with a higher cognitive ability are able to make decisions that are less susceptible to framing effects (LeBoeuf and Shafir 2003) and take into account obfuscating rules (Abeler and Jäger 2015).

We argue that the psychological bias that underpins the dilution illusion is based primarily on perceptions of property rights. To determine who owns what, decision-makers often rely on the heuristic that the distribution of property rights follows the distribution of possessions (Gächter and Riedl 2005; Reb and Connolly 2007). The found bias arises if possessions, which reflect the nominal distribution, are separated from the underlying value. Because possessions are salient and are used as a heuristic to determine the distribution of property rights, possessions are given more weight than standard economic theory would predict (Brenner *et al.* 2007). Arguably, this bias is difficult to overcome because it is practically difficult to assign property rights to value with using any mediums.

Our findings also contribute to the literature on theft aversion. Studies in this literature show that decision-makers tend to respect claims of moral ownership (Gächter and Riedl 2005). To induce moral ownership participants are required to exert effort to earn an endowment (e.g., List 2007). However, there little evidence that changes in framing alone can change claims of moral ownership. For example, Dreber *et al.* (2013) investigate to what extent changing the framing of transfers, which imply a certain distribution of property rights, affected offers in the DG. Donors can obtain the full endowment by taking the endowment from the recipient assuming that the recipient is the initial holder. In a different framing the same outcome can be obtained if donors give nothing assuming that the donor is the initial holder. Dreber *et al.* (2013) find that framing an offer as giving money to recipients did not result in a different outcome from framing an offer as taking money from recipients. Our study, however, provides evidence that the degree of theft aversion can be manipulated through disentangling the nominal endowment from the real endowment.

The policy implications of our contributions apply to a broad range of contexts. First, our findings have implications for corporate governance. Johnson *et al.* (2000) describe how in even economically advanced countries controlling shareholders can expropriate value from minority shareholders. They mention that the leading example is share dilution. In these cases majority shareholders issue new shares to themselves while preventing minority shareholders receiving any shares to protect the value of their stake. As a result, value is unjustly expropriated without the consent of shareholders who are not issued any new shares. Interestingly, Johnson *et al.* (2000) argue that the law often insufficiently protects minority shareholders from this type of expropriation, which can hurt the attractiveness of the investment environment. In these cases the law does not provide a sufficient deterrence against exploitive share dilution. Our study shows that the ability to dilute can lead to a higher degree of appropriation. Therefore, our study can provide a basis for policy recommendations that strengthen the protection of minority shareholders to anticipate the effects of dilution illusion.

Second, a subtler example is the effect of dilution illusion in the insurance industry. Profit-maximizing insurance agents do not have an incentive to disclose the implications of inflation on the purchasing power of the maximum amount that can be claimed (Power 1959). Insurance agents can generate a higher profit rate through adjusting parameters such as by advancing the expiration date without affecting the nominal amounts. Our findings suggest that insurance sales agents are likely to make use of this possibility for self-gain. Requiring agents to present all information in real terms using a single expected inflation rate might nudge agents to offer insurance policies that are more aligned with market prices.

4.7. Appendix: Instructions

In this experiment you will be paired randomly and anonymously with another worker.
Each worker will hold tokens that determine how you will share $2.40 at the end of the experiment. One of the two workers in your pair will be able to change the allocation of tokens.
The worker who can change the allocation is called X. The worker who cannot change the allocation is called Y. There is one X and one Y in your pair.

In your pair you are: Y

X and Y receive each 60 tokens. X can create or destroy her/his own tokens but cannot change the number of tokens for Y. X will choose one of the following options:

	[Taking treatment]	[Dilution treatment]	[Destruction treatment]
a	X takes 50 tokens from Y	X creates 600 tokens for him or herself	X destroys 55 tokens of Y
b	X takes 40 tokens from Y	X creates 240 tokens for him or herself	X destroys 48 tokens of Y
c	X takes 30 tokens from Y	X creates 120 tokens for him or herself	X destroys 40 tokens of Y
d	X takes 20 tokens from Y	X creates 60 tokens for him or herself	X destroys 30 tokens of Y
e	X takes 10 tokens from Y	X creates 24 tokens for him or herself	X destroys 17 tokens of Y
f	X neither takes nor gives tokens to Y	X neither creates nor destroys tokens of him or herself	X neither creates nor destroys tokens of Y
g	X gives 10 tokens to Y	X destroys 17 tokens of him or herself	X creates 24 tokens for Y
h	X gives 20 tokens to Y	X destroys 30 tokens of him or herself	X creates 60 tokens for Y
i	X gives 30 tokens to Y	X destroys 40 tokens of him or herself	X creates 120 tokens for Y
j	X gives 40 tokens to Y	X destroys 48 tokens of him or herself	X creates 240 tokens for Y
k	X gives 50 tokens to Y	X destroys 55 tokens of him or herself	X creates 600 tokens for Y

The final allocations of tokens between X and Y will determine how the $2.40 will be divided. Each token will give the same share of $2.40. To compute the value of each token we will first count the total number of tokens by both X and Y. Then we will divide $2.40 with this total, and this will give us the value of one token. In this way the total value of all tokens together will always be $2.40.

For example, if X has 60 tokens and Y has 60 tokens, then the total number of tokens is 60 + 60 = 120.

Each token is then worth $0.02 = ($2.40 / 120). X has 60 tokens and will then earn 60 * $0.02 = $1.20. Y also has 60 tokens and, thus, earns $1.20.

After the end of the experiment, the tokens are exchanged for money and provided as a bonus for this task.

Control question
It is necessary that you answer the following question correctly to receive any bonus. You will not be informed if you provide an incorrect answer. Make sure you get the right answer the first time.

If the total number of tokens is 240, what is the value of a single token?

- $0.01
- $0.02
- $0.03
- $0.04