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Reversing the endowment effect

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Abstract

When given a desirable item, people have a tendency to value this owned item more than an equally-desirable, unowned item. Conversely, when the endowed item is undesirable, in some circumstances people have a tendency to swap it for an equally undesirable item, a phenomenon known as the reversed endowment effect. The fact that the endowment effect can reverse for undesirable items has been taken as evidence against loss aversion being the underlying cause of the endowment effect. This study represents the first time that the reversed endowment effect has been observed for choices with real consequences. However, we find that the reversed endowment effect occurs only when participants' ability to compare the available choice options is limited. We further show that these endowment reversals can also be induced for choices between desirable options and removed for choices between undesirable options by manipulating the expectations participants have when making a choice. Finally, we show that our data, including endowment reversals, can in principle be explained by loss aversion.

Keywords: endowment effect, endowment reversal, prospect theory, loss aversion, undesirable, bads, gambles, prior expectations, comparisons, time pressure, reference points

1 Introduction

The endowment effect, the finding that mere ownership of an item tends to increase the value assigned to it, has maintained consistent research interest for decades (Thaler, 1980). Valuation paradigms have found that people often require more money to give up ownership of an object than they would be willing to pay to acquire that same object (Kahneman, Knetsch & Thaler, 1990). Furthermore, preferential choice paradigms have found that preference for an item tends to be greater when it is owned than when an alternative item is endowed. Interestingly, Brenner, Rottenstreich, Sood and Bilgin (2007) found that this preference for keeping endowed items reverses when the items are undesirable. For example, they found that when choosing between a speeding fine and attending traffic school, participants preferred to switch to whichever option they were not endowed with.

Brenner et al.'s (2007) results are particularly interesting from a theoretical perspective because they argue against the most prominent explanation of the endowment effect, prospect theory. Prospect theory, and related theories, propose that people assign greater value to items they own because they evaluate other options relative to their endowed state (Kahneman & Tversky, 1979). Thus, an equivalently-valuable, non-endowed alternative will have some advantages (gains) and some disadvantages (losses) relative to the endowed option. Importantly, prospect theory assumes that people are loss averse such that the relative losses of the non-endowed alternative loom larger than that alternative's relative gains. Thus, people perceive that switching to the non-endowed alternative has a net negative value and consequently choose to keep the endowed option. As Brenner et al. point out, this explanation focuses only on the gains and losses of an alternative relative to the endowed option, meaning whether the options are both desirable or both undesirable should be irrelevant. As a result, under these assumptions, prospect theory cannot explain why the endowment effect reverses for undesirable options.

An explanation of the reversed endowment effect, proposed by Brenner et al. (2007), revolves around the idea that *all* attitudes towards the endowed option are amplified. When both options are desirable, the endowed option becomes more desirable and thus favoured; when both options are undesirable, the endowed option becomes less desirable and less favoured. Brenner et al. (2007) suggested that this amplification occurs because losing the endowed option itself is weighted more than gaining an alternative item. Thus, losing a desirable option that you own is particularly negative (explaining the endowment effect) whilst losing an undesirable option that you own is particularly positive (explaining the endowment reversal). Attentional theories such as salience theory have a similar interpretation, suggesting that we amplify the valence of the endowed option because we process it first, making the desirable or undesirable features of the endowed option stand out more (Bordalo, Gennaioli & Shleifer, 2012, 2013). Amplification effects may contribute towards a number of other judgement biases such as the

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omission bias (Baron & Ritov, 1994) and serial presentation effects (Houston, Sherman & Baker, 1989).

Whilst Brenner et al.'s (2007) observed endowment reversals have been taken as support for this amplification effect, recent research suggests the story is not so simple. Dertwinkel-Kalt and Köhler (2016) looked at whether the reversed endowment effect, which was previously observed for hypothetical choices, generalised to incentivised choices. Participants chose between tedious, undesirable tasks that they subsequently either had to complete (incentivised condition) or did not have to complete (hypothetical condition). Under the hypothetical condition, they found data consistent with Brenner et al.'s endowment reversal. However, when the choices were incentivised they found that participants returned to preferring the endowed task. While amplification effects can explain an endowment reversal in the hypothetical condition, they cannot explain the preference for undesirable endowments in the incentivised condition.

Dertwinkel-Kalt and Köhler (2016) explained their observed difference between incentivised and hypothetical choices with a dual-process model. They suggested that, in line with salience theory, the endowed option is processed first. For hypothetical choices, people are not motivated to engage in any further processing. This leads to favouring desirable endowments or avoiding undesirable endowments in the manner predicted by salience theory. However, when participants are sufficiently incentivised, they will engage in the more effortful process of comparing the options. These direct comparisons engage loss aversion, which then shifts preference towards the endowed option regardless of desirability.

Dertwinkel-Kalt and Köhler's (2016) explanation of their results suggests that endowment reversals should tend to occur when one's ability to process and compare the choice stimuli is limited. The first aim of this paper is to explicitly test this prediction by limiting comparisons between the choice options during incentivised choices. We do this in two ways: by hiding information about the non-endowed alternative to explicitly replicate the lack of processing of the non-endowed options hypothesized by Dertwinkel-Kalt and Köhler, and by enforcing response deadlines in order to limit the time available to compare the choice options. If limited comparisons between the options are important to the occurrence of endowment reversals, then the endowment effect should reverse between desirable and undesirable choice settings under these limited-comparison conditions while no such reversal should occur when comparisons are freely allowed. We found that endowment reversals occurred only when comparisons were limited.

The second aim of this paper is to test an alternative explanation of the reversed endowment effect. If the reversed endowment effect is dependent on comparisons with the non-endowed alternative being limited, an interesting implication is that these reversals could be due to people evaluating the endowed option relative to their expectations rather than due to amplification of the endowed item. For example, people have a tendency to not update their beliefs and expectations entirely, when presented with new information (Anderson, 1983; Nissani & Hoefler-Nissani, 1992). Thus, people may not perfectly update their reference point when endowed with an item and instead, continue to be influenced by the relatively neutral reference state they had prior to being presented with the choice scenario. When comparisons with the non-endowed alternative are limited, desirable endowments would exceed these more neutral expectations and therefore be preferred (the endowment effect) while undesirable endowments would be inferior to these more neutral expectations and therefore tend to be avoided (the reversed endowment effect).

This explanation of the reversed endowment effect based on imperfect updating of the reference point makes an interesting prediction. Previous theories based on amplification of the endowed option have suggested that reversals of the endowment effect occur specifically when the choice options are undesirable. However, the theory we present here suggests that endowment reversals are not based on the absolute desirability of the options but instead on their value relative to one's previous reference point. This leads to the prediction that it will be possible to prevent the endowment effect reversing for undesirable options or even induce a reversed endowment effect for desirable options by shifting people's previous reference points in certain ways. Specifically, if someone had a previous reference point that was superior to the subsequently endowed option (regardless of whether that endowed option is desirable or undesirable) then this will tend to bias their reference point at the time of making a decision such that they expect an outcome that is superior to the endowed option if they switch away from the endowed option. This leads to the prediction that endowment reversals will occur both for desirable and undesirable choices if participants have a previous reference state that is superior to the endowed option. Conversely, it is predicted that the endowed option will be preferred, regardless of whether it is desirable or undesirable, if someone had a previous reference point that was inferior to the subsequently endowed option.

In Experiment 3 we tested this prediction using a practice gamble to induce a superior or inferior reference point prior to the choice of interest. We found that regardless of whether the endowed option was desirable or undesirable, the endowment effect would reverse if the reference point was superior to the endowed option but would not reverse if it were inferior to the endowed option. We also found that a model based on prospect theory that incorporates these assumptions could, in principle, explain our data. This shows that endowment reversals cannot, in principle, be taken as evidence against prospect theory, as has previously been claimed. Of course, this does not mean that prospect theory *is* necessarily the best explanation of our data and to emphasise this point we concluded by considering a number of alternative explanations for our data.

2 Experiment 1A

This experiment directly tested the hypothesis that whether the endowment effect reverses or not depends on the extent to which the two options are compared (Dertwinkel-Kalt & Köhler, 2016). It did this by sometimes showing the non-endowed alternative (thereby allowing it to be compared to the endowed option) but other times hiding it so as prevent comparisons. This design thus forced participants to process the stimuli in the manner that the dual-process model of Dertwinkel-Kalt and Köhler (2016) assumed occurs for hypothetical vs incentivised choices.

We used risky gambles, traditionally referred to as "prospects", as the choice stimuli. This was done for two reasons. First, it allowed us to present incentivised choices by informing participants that the outcome of the gambles could influence their payment. Second, with gambles it is easy to create directly equivalent desirable and undesirable choices. Previous studies have used undesirable scenarios that do not have a clear equivalent desirable scenario. For example, the undesirable tasks used by Dertwinkel-Kalt and Köhler (2016) consisted of sorting confetti or filling a grid with '1's and '0's. For neither of these tasks is there an obvious equivalent desirable task to compare to. Gambles allow desirable options (a probability of winning a certain amount) to be precisely matched to equivalent undesirable options (the same probability of losing the same amount). Finally, it is worth noting that we presented choices between two gambles rather than one gamble and a non-risky (certain) alternative simply to reduce the biases people have been found to show towards increasingly certain outcomes (Kahneman & Tversky, 1979), which might otherwise have overpowered any effect of the endowment manipulation.

Given that the choices we presented were incentivised, the dual-process model proposed by Dertwinkel-Kalt and Köhler (2016) predicted that the endowed option would be preferred for both desirable and undesirable gambles when comparisons were allowed. When comparisons were prevented by hiding information about the non-endowed gamble, it was predicted that a regular endowment effect would be observed for desirable gambles, but a reversed endowment effect would be observed for undesirable gambles.

2.1 Method

200 participants (mean age = 32, 51% female) were recruited online through Microworkers.com and completed the experiment in a web browser. All participants in all experiments presented here were from English-speaking countries and provided informed consent before participating. The task was advertised as paying US$0.20 plus a potential additional bonus. However, upon completion, all participants were paid $0.80, corresponding to the best possible outcome that could be expected based on bonuses offered during the experiment. The experiment took around 2 minutes to complete.

Upon beginning the experiment, participants were informed that they were currently earning $0.50 for participation in the experiment but had to choose a gamble which could affect their payout. The gambles could win them up to $0.30 or lose them up to $0.30 (reducing their payout to as low as $0.20). Participants were presented with a screen that was completely empty except for two boxes labelled "Gamble A" and "Gamble B" respectively. They were asked to choose one of the boxes before any information about the gambles was presented. Whichever box they chose was designated as the endowed gamble.

After choosing a box, participants were then shown a gamble and endowed with this gamble. To be clear, their choice of box was, in reality, irrelevant because whichever box they chose was then assigned the values associated with the endowed gamble allocated to them. The endowed gamble was chosen from the following two gambles with equivalent expected value: 40% chance of $0.30 or 80% chance of $0.15, such that half of participants were endowed with the former gamble and half were endowed with the latter. In the DESIRABLE condition, participants were told they had a chance of winning the stated amount. In the UNDESIRABLE condition, they were told they had a chance of losing the stated amount. Participants then clicked a button to continue.

If the participant was in an ALLOWED comparison condition, then they were now shown the non-endowed gamble alongside the endowed gamble. If the endowed gamble was a 40% chance of $0.30 then the alternative gamble was an 80% chance of $0.15, and vice versa. Alternatively, if the participant was instead in the HIDDEN condition then the alternative gamble was not shown and instead was represented by a question mark, making them unable to compare the endowed gamble to the non-endowed alternative. The dependent variable of interest was whether participants then chose to keep the endowed gamble or swap to the non-endowed gamble.

These conditions amounted to a 2x2x2 between-subjects design crossing **desirability** (DESIRABLE or UNDESIRABLE) x **comparisons** (ALLOWED or HIDDEN) x **endowed gamble** (40% of $0.30 or 80% of $0.15). The latter variable was included to control for possible biases in the sample such as risk seeking or risk aversion, and we therefore collapsed across it.[1] Through controlling for such biases, we could expect that if participants were unaffected by the endowing of an item

[1]A chi-square test looking at endowment preference based on which option was endowed found no significant difference in overall endowment preference between when the 40% chance of $0.30 gamble or the 80% chance of $0.15 gamble was endowed ($\chi^2(1, 200) = 0.33$, $p = .565$, $OR = 1.18$, 95%$CI[0.67, 2.07]$).

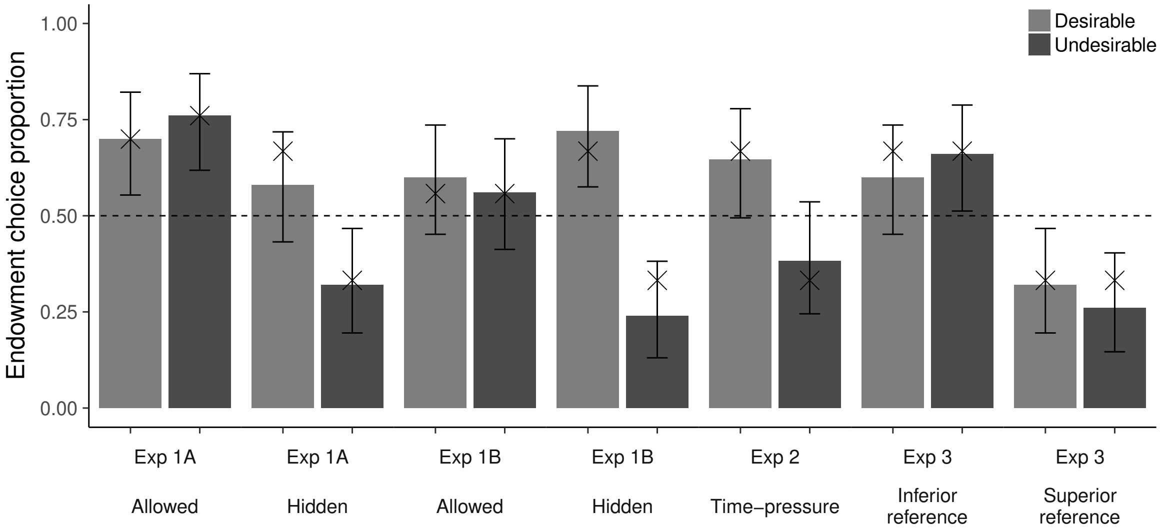

Figure 1: Bar chart of observed **endowment preference** (error bar's represent 95% CIs) across the different conditions of the experiments reported here. The crosses (Xs) represent the predicted **endowment preference** when the model of loss aversion described later in this paper was simultaneously fit to our different experimental conditions.

then **endowment preference** (the percentage of participants choosing the endowed item) should be approximately 50%. Endowment share greater than 50% would reflect preference for the endowed gamble over the non-endowed alternative.

2.2 Results

The average **endowment preference** and 95%CI for each condition is shown in Figure 1. How were people's choices affected by the desirability of the options and whether comparisons were possible? We addressed this question with a 2x2 logistic regression with **desirability** (undesirable = 0, desirable = 1) and **comparisons** (hidden = 0, allowed = 1) as predictors and **endowment preference** (non-endowed alternative chosen = 0, endowment chosen = 1) as the outcome variable. There were significant main effects of both **desirability** (OR = 2.93, p = .013, 95%CI[1.31, 6.77]) and **comparisons** (OR = 6.73, p < .001, 95%CI[2.96, 16.78]). Importantly, there was also a significant interaction (OR = 0.25, p = .025, 95%CI[0.07, 0.83]) with the endowed gamble being significantly more likely to be chosen in the desirable condition compared to the undesirable condition when the non-endowed alternative was hidden ($\chi^2(1, 100) = 6.83$, p = .009, OR = 2.93, 95%CI[1.30, 6.65]). On the other hand, in the allowed condition, no significant difference was found between the desirable and undesirable conditions ($\chi^2(1, 100) = 0.46$, p = .50, OR = 0.74, 95%CI[0.30, 1.79]). Consistent with the proposition of Dertwinkel-Kalt and Köhler (2016), the desirability of the gamble affected choices only when the comparisons were hindered. Experiment 1B looks at whether these results generalise to non-risky choice stimuli.

3 Experiment 1B

3.1 Method

200 English-speaking participants (mean age = 35, 53% female) were recruited online through Amazon's Mechanical Turk. The design of Experiment 1B was exactly the same as Experiment 1A except for the changes outlined below.

Participants were informed that they would have to complete a button-pressing task during this experiment. Participants in the desirable condition were initially informed that they would "be paid $0.40 for completing the task on the next page, which takes about 1.5 minutes and requires clicking on very small buttons". However, they were then asked to choose one of two boxes which might change the task involved or the monetary payout. For half of the participants in the desirable condition, their chosen box endowed them with a "20 second task instead, which requires clicking on large buttons". The other half of participants in the desirable condition were endowed with an additional $0.10 for completing the experiment. We collapsed across these endowed gamble conditions when analysing the data to control for possible biases towards a shorter task or higher payout affecting **endowment preference**.[2]

Participants in the allowed comparison condition were shown the other possible option (e.g. participants endowed with an additional $0.10 were shown that the other box offered the 20 second task). As in Experiment 1A, all participants were then informed that they had the option to switch

[2]Whether the shorter task or higher payout was endowed did not significantly affect **endowment preference** ($\chi^2(1, 200) = 0.32$, p = .57, OR = 1.17, 95%CI[0.67, 2.05]).

to the other box if they wished and asked to choose which they would prefer.

The procedure for participants in the UNDESIRABLE condition was exactly the same and had the same potential endpoints as those in the DESIRABLE condition, but the available options were phrased as being undesirable. Specifically, participants were initially informed that they would be "paid $0.50 for completing the task on the next page, which takes about 20 seconds and involves clicking on large buttons". The two boxes either endowed participants with completing "a tricky 1.5 minute task instead, which requires clicking on very small buttons" or a reduction in their payout of $0.10.

Regardless of their allocated condition or decision, upon deciding which option to keep, participants were presented with a debriefing statement and informed that the choice was actually only hypothetical and that they did not have to complete any additional task. They were paid $0.50 for participation, which took around 1 to 2 minutes.

3.2 Results

Figure 1 shows the average endowment preference and 95% CI for each experimental condition in Experiment 1B.

A 2x2 logistic regression found a significant main effect of **comparisons** ($OR = 4.03$, $p = .001$, $95\% CI[1.75, 9.76]$) and of **desirability** ($OR = 8.14$, $p < .001$, $95\% CI[3.42, 20.69]$) on **endowment preference**. Consistent with the finding from Experiment 1A, a significant interaction between **desirability** and **comparisons** was observed ($OR = 0.14$, $p = .002$, $95\% CI[0.04, 0.47]$). Specifically, the endowed option was chosen significantly more in the DESIRABLE than the UNDESIRABLE condition for the HIDDEN comparison condition, ($\chi^2(1, 100) = 23.08$, $p < .001$, $OR = 8.14$, $95\% CI[3.32, 19.94]$), but not for the ALLOWED comparison condition ($\chi^2(1, 100) = 0.16$, $p = .685$, $OR = 1.18$, $95\% CI[0.53, 2.61]$).

4 Experiment 2

Experiments 1A and 1B limited comparisons by hiding the non-endowed alternative. This manipulation represents the most extreme extent to which participants could fail to compare options when making a choice, and, indeed, responses could be explained in terms of expectations about what the alternative might be. Experiment 3 looks at this latter concern. Experiment 2 looks at whether the findings from the previous experiments generalise to a setting in which both options are presented, and comparisons are instead limited simply by enforcing a response deadline.

4.1 Method

100 English-speaking participants (mean age = 36, 50% female) were recruited online through Amazon's Mechanical Turk. Experiment 2 used the same design as the DESIRABLE and UNDESIRABLE ALLOWED comparison conditions of Experiment 1A except participants were now instructed at the start of the experiment that a countdown timer might appear during the experiment.[3] To encourage rapid responding, they were instructed that failure to make a choice before the timer reached zero might reduce their potential bonus payout. When participants were offered the option to swap their endowed gamble with the non-endowed alternative, a timer always appeared on the screen counting down from ten seconds.

Five participants (three from the UNDESIRABLE condition and two from the DESIRABLE condition) were excluded from the analysis due to failing to respond within the ten second deadline. These participants were still paid the full bonus for participating. The conclusions drawn from this experiment remained the same when these participants were included in the following analyses.

4.2 Results

Figure 1 shows the mean **endowment preference** share and 95%CI for the DESIRABLE and UNDESIRABLE conditions.

To test the prediction that there should be a greater difference between desirable and undesirable choices in terms of endowment preference when decisions are made under time pressure, we compared the TIME-PRESSURE condition of Experiment 2 to the ALLOWED comparison condition of Experiment 1A. A 2x2 logistic regression predicted **endowment preference** based on **desirability** and **comparisons** (TIME-PRESSURE = 0, ALLOWED = 1). A significant main effect of **comparisons** was found ($OR = 5.1$, $p < .001$, $95\% CI[2.17, 12.63]$), though not of **desirability** ($OR = 0.74$, $p = .500$, $95\% CI[0.30, 1.79]$). Of key interest, there was a significant interaction between **desirability** and **comparisons** ($OR = 0.25$, $p = .026$, $95\% CI[0.07, 0.84]$) with the endowed gamble being significantly more likely to be chosen in the DESIRABLE condition compared to the UNDESIRABLE condition when the choice was made under TIME-PRESSURE ($\chi^2(1, 100) = 6.57$, $p = .010$, $OR = 0.34$, $95\% CI[0.15, 0.78]$). Taken together, the interaction between desirability and whether comparisons are encouraged or limited observed across Experiments 1A, 1B and 2 provides support for the hypothesis that endowment rever-

[3]As in the earlier experiments, we collapsed across which option was endowed when testing our key research questions. An exploratory analysis did not find a significant difference in **endowment preference** based on whether the 40% chance of $0.30 or 80% chance of $0.15 gamble was endowed in the TIME-PRESSURE conditions of Experiment 2 ($\chi^2(1, 100) = 0.50$, $p = .478$, $OR = 0.75$, $95\% CI[0.33, 1.68]$).

sals are more likely to occur when comparisons between the options are limited.

5 Experiment 3

Given the important role of comparison processes implied by our previous experiments, Experiment 3 tested our hypothesis that the expectations participants hold prior to a choice influence the occurrence of endowment reversals.

5.1 Method

200 participants (50 per condition, mean age = 32, 102 females) were recruited via Microworkers. The task was advertised as paying US$0.25 however, all participants were subsequently paid $0.75 for participation. Experiment 3 was a 2x2 between-subjects design crossing **desirability** (DESIRABLE or UNDESIRABLE) x **prior reference point** (SUPERIOR or INFERIOR reference point relative to the endowed gamble). Experiment 3 followed essentially the same design as the HIDDEN condition of Experiment 1A except for a few key changes. Firstly, the values of gambles shifted slightly. The endowed gamble was now a 50% chance of winning (losing) US$0.20 for all participants in the DESIRABLE (UNDESIRABLE) condition. The base rate that participants were told they were earning before partaking in the gamble was also shifted up slightly to $0.55. These changes were made to avoid the practice gamble approaching ceiling or floor levels in terms of percentage and payout amounts while remaining within certain payout limitations implemented by Microworkers.

Secondly, and of key importance, Experiment 3 included an initial 'practice' trial that participants took part in before they were then offered a choice of gambles. As in our previous experiments, participants were presented with two empty boxes, chose one and were presented with the supposed gamble corresponding to that box. However, participants did not choose whether they would want to keep that gamble. Instead, participants were now reminded that this choice was purely meant as practice; it was irrelevant to the subsequent choice and would not affect their payout in any way. The practice gamble was not resolved, meaning it had no effect on participants' payments and participants were not shown any outcome of the practice gamble. This practice trial was actually used to induce a higher or lower reference point. Specifically, for half of the participants, this practice trial presented a gamble that was SUPERIOR to the endowed gamble in the following trial. In the DESIRABLE condition, this superior gamble was a 75% chance of winning $0.30. In the UNDESIRABLE condition, this superior gamble was a 25% chance of losing $0.10. For the other half of participants, this practice trial was INFERIOR to the subsequently endowed gamble. For DESIRABLE choices, the inferior gamble was a 25% chance of winning $0.10 and for UNDESIRABLE choices the inferior gamble was a 75% chance of losing $0.30.

To summarise, participants were first presented with a practice trial and were instructed that it was just an example and would not influence their payout. In this practice trial, participants were presented with a screen that was completely empty except for two boxes labelled "Gamble A" and "Gamble B" respectively. They were asked to choose one of the boxes before any information about the gambles was presented. Regardless of which box they chose, they were then presented with the practice gamble. They were not told the gamble corresponding to the other box. The practice trial then ended, without resolving the practice gamble, and the participants were invited to do the main experiment. As before, participants were presented with two boxes labelled "Gamble A" and "Gamble B" respectively and were invited to choose one of them. Regardless of which one they chose, they would be shown a gamble of 50% chance of winning (losing) $0.20. They were not shown the gamble corresponding to the other box. Based on this information alone, they were then asked which gamble (i.e. A or B) they wished to take.

5.2 Results

Figure 1 shows the observed **endowment preference** share and 95% confidence intervals for each of the conditions in Experiment 3. Were preferences towards the endowment influenced by the desirability of the options and the relative value of the practice gamble? A logistic regression was run predicting **endowment preference** (non-endowed gamble chosen = 0, endowed gamble chosen = 1) based on **desirability** (UNDESIRABLE = 0, DESIRABLE = 1) and **prior reference point** (INFERIOR = 0, SUPERIOR = 1). As predicted, a significant main effect of the **prior reference point** was found, with the odds of choosing the endowed gamble being significantly higher when the practice gamble was INFERIOR than when it was SUPERIOR to the endowment ($OR = 5.25$, $p < .001$, $95\% CI[2.39, 13.46]$). We found no significant main effect of **desirability** ($OR = 1.34$, $p = .509$, $95\% CI[0.56, 3.23]$) and no significant interaction between **desirability** and **prior reference point** ($OR = 0.58$, $p = .365$, $95\% CI[0.17, 1.89]$). The data are consistent with our prediction that the participants' choices would be determined by the value of the gamble in the practice trial relative to the endowed gamble.

6 Modelling the data

We present here a computational model based on prospect theory (Kahneman & Tversky, 1979). The goal is not to show that such a model offers the best explanation of our results, especially given we do not have sufficient data to verify a number of the model's more flexible assumptions. Instead, we wish to assess the extent to which, under reasonable assumptions, a model based on loss aversion can, in principle, quantitatively explain the existence of both the endowment effect and its reversal. This is especially important given previous claims that endowment reversals are inconsistent with loss aversion (Brenner et al., 2007). The key addition to prospect theory in the model presented here is that we assume people's reference points are influenced not only by their current endowed state but also their previous reference state.

Prospect theory assumes that each option has a value associated with it representing the subjective evaluation of any potential outcomes weighted as a function of the probability of each outcome occurring (Kahneman & Tversky, 1979). Preference for one option over another is based on the difference in weighted value between these two options,where an option with a higher value will be preferred to one with a lower value (Kahneman & Tversky, 1979). To arrive at quantitative predictions of choice proportions we include noise, σ, as a free parameter in the model such that the final difference is logistically distributed with a mean equal to the difference in value between options and a standard deviation equal to the noise parameter (Wang & Fischbeck, 2004). Following Wang and Fischbeck (2004), Equation 1 shows the probability of preferring an endowed option, ϵ, over an alternative option, a, using a logistic function of the difference of the value of the two options:

$$P(\varepsilon|a) = \frac{1}{1 + e^{-\frac{V(\varepsilon)-V(a)}{\sigma}}} \tag{1}$$

Here, V is the overall subjective value of an option across its different possible outcomes. We define any option, x, as a set of outcomes, o^x, with a corresponding set of probabilities, p^x. V is defined as the sum of the subjective value v of each of the possible n outcomes of an option, weighted as a function π of the probability of each outcome occurring, as shown in Equation 2 (Kahneman & Tversky, 1979).

$$V(x) = \sum_{i=1}^{n} \pi(p_i^x) v(o_i^x|r) \tag{2}$$

Equation 2 acknowledges that the outcomes of x are evaluated relative to a reference point, r. The function $\pi(p_i^x)$ was proposed in prospect theory to weight the different possible outcomes of x by a nonlinear function of the probability of the outcome occurring (Kahneman & Tversky, 1979). For simplicity, we follow the lead of Kõszegi and Rabin (2006) and assume that people's evaluations of gambles is such that $\pi(p_i^x) = p_i^x$. This assumption is likely to breakdown for very small or very large probabilities, but should be reasonable for all other values (Kahneman & Tversky, 1979). In our gamble experiments, we avoided extremely large or extremely small probabilities for this reason. The function $v(o_i^x|r)$ calculates the subjective value of an outcome relative to the reference point, as outlined in Equation 3.

$$v(o_i^x|r) = \mu(o_i^x - r) \tag{3}$$

Equation 4 specifies the value function, μ. Specifically, as seen in Equation 4, we utilise the piecewise power function proposed by Tversky and Kahneman (1992), along with the median values they estimated for both the loss aversion parameter (2.25) and the exponent of the power function (0.88). These parameter estimates are used given their status as reasonable defaults to allow for model fitting in the absence of information to the contrary (e.g. Barberis & Xiong, 2009; Hens & Vlcek, 2011; Koop & Johnson, 2012).

This function satisfies the criteria for a value function set out by Kahneman and Tversky (1979) and Tversky and Kahneman (1991). In particular, it is a negatively accelerating function (due to the exponent of the power function being less than 1) for both gains and losses, but steeper in the losses domain than in the gains domain (due to the loss aversion parameter being greater than 1) to reflect loss aversion.

$$\mu(z) = \begin{cases} z^{0.88}, & \text{if } z \geq 0 \\ -2.25(-z)^{0.88}, & \text{if } z < 0 \end{cases} \tag{4}$$

To ensure our model was not reliant on the exact specification of the value function, we also fit the model with the value function used by Usher and McClelland (2004) in their Leaky Competing Accumulator model. Despite differences between the two value functions, they each provided essentially equivalent fits to our data (see Appendix A).

Equation 3 assumes that the reference point is certain but the option being considered can be risky. In the case that the reference point also has uncertainty, we must consider each of the possible outcomes of the choice option as well as each of the possible outcomes of the reference point in order to determine the value of the choice option relative to the reference point. Kõszegi and Rabin (2006, p. 1137) provide a general equation for such a case, which allows for integration across continuous probability distributions of different outcomes. Given we are only dealing with discrete probabilities in this study, and we have assumed that $\pi(p_i^x) = p_i^x$, we can simplify the equation used by Kõszegi and Rabin (2006) to represent the value of an option, x, with n possible outcomes relative to a risky reference point (r) with m possible outcomes to that shown in Equation 5.

$$V(x|r) = \sum_{i=1}^{n} \sum_{j=1}^{m} p_i^x p_j^r v(o_i^x|o_j^r) \tag{5}$$

In prospect theory, the value of an option is determined relative to the reference point. A common assumption for choice tasks where one option is endowed is to assume that the reference point is equivalent to the endowed option, ε (Brenner et al., 2007; Koop & Johnson, 2012). In this paper we argue that the reference point may not be determined entirely by the current endowed state. Instead, it may also be influenced by prior expectations.

In terms of how multiple pieces of reference information can be incorporated into the current reference state, Ordónez, Connolly and Coughlan (2000) found data consistent with the idea that people treat separate pieces of reference information as independent rather than averaging that information into a single reference point. Thus, a simple way in which the current reference state could incorporate information from both the previous reference state and the current endowed state is if people compare options to their current endowed state some of the time and compare options to the previous reference state the rest of the time. We can represent this with a discrete probability distribution where, at any point in time, the reference state r is set equal to the endowed option ε with probability γ, and is set equal to the previous reference state s otherwise. This is shown in Equation 6, where γ is a free parameter and $0 < \gamma < 1$.

$$\begin{aligned} P(r = \varepsilon) &= \gamma \\ P(r = s) &= 1 - \gamma \end{aligned} \tag{6}$$

Though Ordónez et al. (2000) favoured the approach of having independent reference points, Appendix B shows that, in our case, essentially equivalent fits can be obtained if we incorporate the previous reference state and current endowed state into a single reference point. Specifically, the model in Appendix B assumes that the current reference state is represented as a probability distribution across possible outcomes, where beliefs about the probabilities of outcomes are updated based on previous expectations and the current endowment. Our goal is not to distinguish between such approaches but simply to show that loss aversion can explain the endowment reversals under various reasonable assumptions.

In Experiments 1A, 1B and 2 participants did not have any basis for forming strong prior expectations of attaining non-zero outcomes. Thus, for these experiments, we set the previous reference state s as a 100% chance of winning \$0.00 (i.e. not expecting to win or lose any money) and, in the case of Experiment 1B, expecting no change in the time required to complete the task either. In Experiment 3 participants viewed a practice gamble before completing the experimental choice in order to influence their previous reference state, s. Consequently, for Experiment 3, s in Equation 6 is set equal to the relevant practice gamble. For example, for the SUPERIOR DESIRABLE CONDITION of Experiment 3, s is set as a 75% chance of winning \$0.30 and a 25% chance of winning nothing.

We assume that participants treated the non-endowed alternative as equal to the reference point whenever the non-endowed option was hidden, or choices were made under time pressure. We made this assumption because the reference point represents the participant's expectations. If the non-endowed alternative was not processed, the participant had to decide whether or not to accept the endowed option based purely on whether it exceeded what they expected to get from switching.

To accommodate the fact that Experiment 1B used non-risky choice options, we firstly set $p_i^x = 1$ for these non-risky options given their outcomes were certain. Given the options in Experiment 1B could vary along two attributes (changes in the time commitment of the task and changes to monetary payout) we also included an additional free parameter, δ, to approximately equate these two attributes. Specifically, if an outcome i related to changes in the time commitment, the value presented to participants, $o_i^{x_{presented}}$, was multiplied by δ, as shown in Equation 7.

$$o_i^x = \begin{cases} \delta o_i^{x_{presented}}, \\ \quad \text{when } o_i^{x_{presented}} \text{relates to time commitment} \\ o_i^{x_{presented}}, \\ \quad \text{when } o_i^{x_{presented}} \text{relates to monetary payout} \end{cases} \tag{7}$$

6.1 Model fitting

When fitting the model to our data, we set γ, σ and δ as free parameters and simultaneously fit the model to the endowment preference share across our experimental conditions. Values of the free parameters were found that maximised the likelihood of the data using the Nelder-Mead algorithm implemented by the "optim" function in R (R Core Team, 2016). The specific parameter values obtained were: $\gamma = 0.664$, $\sigma = 0.510$ and $\delta = 0.136$. The endowment preference share predicted by the model for each of the experimental conditions is presented in Figure 1. A chi-square test failed to find a significant difference between the predicted endowment preference count based on the model and the observed endowment preference count, $\chi^2(9,\ N = 495) = 7.58$, $p = .870$. Our model can therefore adequately describe the data.

7 Discussion

In previously published papers, the reversal of the endowment effect for undesirable options had been observed only for hypothetical choices. To our knowledge, this paper represents the first time that such reversals have been observed for incentivised choices that have real consequences. However, we found that such reversals occurred only when comparisons between the endowed and non-endowed alternative were limited, whether that occurred by reducing the time available to compare the options or by hiding information about the non-endowed alternative. On the other hand, when comparisons were allowed and encouraged, participants generally preferred the endowed option regardless of desirability. We replicated these findings for non-risky (more money vs. easier task) choices. We also showed that whether or not the endowment effect reversed depended on the participant's prior experience. In particular, when comparisons were limited we showed that the endowment effect reversed for both desirable and undesirable gambles if the participant had previously been shown a more desirable practice gamble. Conversely, when shown a less desirable practice gamble, participants preferred the endowed gamble regardless of whether it was desirable or undesirable.

7.1 Theories of the endowment effect and endowment reversal

One of the theoretical points we wished to address in this paper was whether, as has been previously proposed, endowment reversals are inconsistent with prospect theory. We found that we were able to model all of the above findings using a straight-forward extension of prospect theory. While we cannot show whether the assumptions of this model are true, we were able to demonstrate that endowment reversals are, at least in principle, consistent with prospect theory.

In applying prospect theory to endowment reversals, we made the assumption that people have expectations that are influenced both by their current endowed state and their previous reference state. However, this explanation is not restricted to prospect theory and loss aversion. This assumption could also be incorporated into other theories of the endowment effect. For example, Gal (2006) suggests that people show inertia, in that they will not change their current state of affairs without sufficient motivation to do so. Gal proposes that it is this inertia, and the general difficulty in determining which option is best in order to motivate change, that leads to the endowment effect. If participants are comparing the endowed option to their more neutral expectations, it may be that an undesirable endowed option is sufficiently inferior to these more neutral expectations to motivate switching. While we have focused primarily on loss aversion in order to address previous claims that the reversed endowment effect is evidence against this explanation of the endowment effect, it is worth emphasising that such other mechanisms also provide viable explanations for our results.

We assumed above that participants' expectations (or reference points) were a function of their current endowed state and their previous reference state. However, it is worth considering the other reference points people could have held. A large number of these possible reference points, such as the expected value of the gambles, the best possible outcome or expecting an outcome of zero, are independent of the endowment and therefore do not help us explain the effect of endowing an option. Research into ambiguity aversion, the finding that people tend to favour known risks over unknown risks, might suggest that people are generally pessimistic, expecting outcomes that are worse than their known endowed state (Becker & Brownson, 1964; Camerer & Weber, 1992; Keren & Gerritsen, 1999). Counter to our results though, this would mean that participants will tend to prefer the known endowed option, regardless of desirability. Thus, our results cannot simply be explained by ambiguity aversion.

One alternative assumption about participants' expectations that could explain endowment reversals is that participants may perceive the non-endowed alternative to be riskier. For example, during the HIDDEN condition of Experiment 1A and the TIME-PRESSURE condition of Experiment 2, participants may have expected the non-endowed gamble to have approximately the same expected value as the endowed gamble but expected that the non-endowed gamble could just as likely have small potential outcomes as extreme potential outcomes. Importantly, there is evidence that people are risk-seeking for losses and risk-averse for gains (Kahneman & Tversky, 1979). This means that risk seeking during undesirable scenarios could explain preference for the non-endowed gamble while aversion to this risk might explain the observed preference for the endowment in the DESIRABLE condition. Thus, it is possible that perception of the non-endowed option as riskier could explain, or have contributed to, the endowment reversals we observed in Experiments 1 and 2. It should be noted that additional mechanisms would be needed to explain why the endowment effect occurs when comparisons are encouraged and why a previous gamble can affect whether or not the endowment effect reverses, as observed in Experiment 3.

7.2 Implications

The occurrence of endowment reversals shows that endowing an item can have completely opposite effects on preference for that item; potentially either increasing or decreasing its perceived value. Understanding when these endowment reversals are likely to occur is particularly important whenever trying to use ownership as a way of manipulating behaviour, either in laboratory studies or as part of real-world nudging strategies. We have shown that these endowment effect reversals can occur for choices with real consequences and that they can occur for both desirable and undesirable options depending on people's expectations. Our observation that endowment reversals occur when comparisons are limited also has interesting implications for when we might expect the endowment effect to reverse. For example, the mode in which choice information is presented could be expected to influence the extent to which options are compared and the subsequent likelihood of endowment reversals occurring. Choice information presented in tables tends to elicit detailed comparisons (Noguchi & Stewart, 2014) while information presented in blocks of text is difficult to extract and compare (Kelly, 1993; Smerecnik et al., 2010). Thus, for example, presenting choices in text may increase the potential for endowment reversals to occur compared to when options are presented in a table.

Individuals may also systematically differ in their tendency to show endowment reversals. People with high need for cognition, for example, tend to engage in deeper and broader comparisons in decision situations (Levin, Huneke & Jasper, 2000). Thus, low need for cognition may be associated with a greater tendency to show endowment reversals due to a tendency not to compare the options. Individual differences can be crucial to our understanding of how manipulations are affecting choice (e.g. Liew, Howe & Little, 2016). Need for cognition offers a potentially interesting individual-level variable that could explain variation in how endowments affect choice.

7.3 Conclusion

In this study, we set out to provide a greater understanding of when the endowment effect is likely to reverse and, thus, the theoretical implications of these reversals. Two factors were found to influence whether endowments increased or decreased preference: how the choice options were being compared and the likely expectations held when going into the choice. We emphasise the importance of considering these two factors both when studying the endowment effect and if attempting to implement endowment manipulations in real-world nudging strategies. Simple changes in the extent to which options are compared and the expectations people carry into a decision situation can determine whether ownership increases or decreases preference for an option.

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Appendix A

In order to assess the extent to which the predictions of the model outlined in this paper were dependent on the specific value function used, we refit the model using the value function employed by Usher and McClelland (2004) in their Leaky Competing Accumulator (LCA) model, as shown in Equation A1. As can be seen in Figure A1, the predictions of the model with the LCA value function were essentially equivalent to the predictions of the model presented in this paper. The parameter estimates obtained in this case were $\gamma = 0.637$, $\sigma = 0.792$ and $\delta = 0.172$.

$$\mu(z) = \begin{cases} log(1+z), & \text{if } z \geq 0 \\ -\{(log(1+|z|) + [log(1+|z|)]^2\}, & \text{if } z < 0 \end{cases} \tag{A1}$$

Appendix B

In this paper we presented a model that set the current reference point to either the current endowed option or the previous reference state with a certain probability. We present here an alternative method of combining the previous reference state and current endowed state to assess whether the predictions of our model are consistent across assumptions about how information is integrated.

Here we treat both the previous reference state and the current endowed state as probability distributions of different outcomes. We then set the current reference state equal to a weighted average of the probabilities in each of these probability distributions. Thus, the current reference point, r, is equal to a probability distribution across all of the possible outcomes in both the current endowed state, ε, and the previous reference state, s, where the probability of each possible outcome is simply equal to the weighted average of the probability of that outcome in the previous reference state and the current reference state. This is shown in Equation B1, where p_i^x represents the probability of outcome i in probability distribution x and γ represents the impact that the current endowment has on expectations relative to the impact that the previous referent point has, with the restriction that $0 < \gamma < 1$. The parameter estimates obtained when this model was fit to our data were $\gamma = 0.899$, $\sigma = 1.921$ and $\delta = 0.198$.

$$p_i^r = \gamma p_i^\varepsilon + (1-\gamma)p_i^s \tag{B1}$$

As an example, assume the current endowment is a 50% chance of winning \$0.20 and a 50% chance of winning nothing, whilst the previous reference state was a 25% chance of winning \$0.10 and a 75% chance of winning nothing. If $\gamma = 0.5$, then the current reference state would be a 25% chance of winning \$0.20, a 12.5% chance of winning \$0.10 and a 62.5% chance of winning nothing. As can be seen from Figure B1, this model fits our data approximately as well as the previous model, which provides further evidence that our results can be explained in terms of loss aversion across a number of reasonable model assumptions.

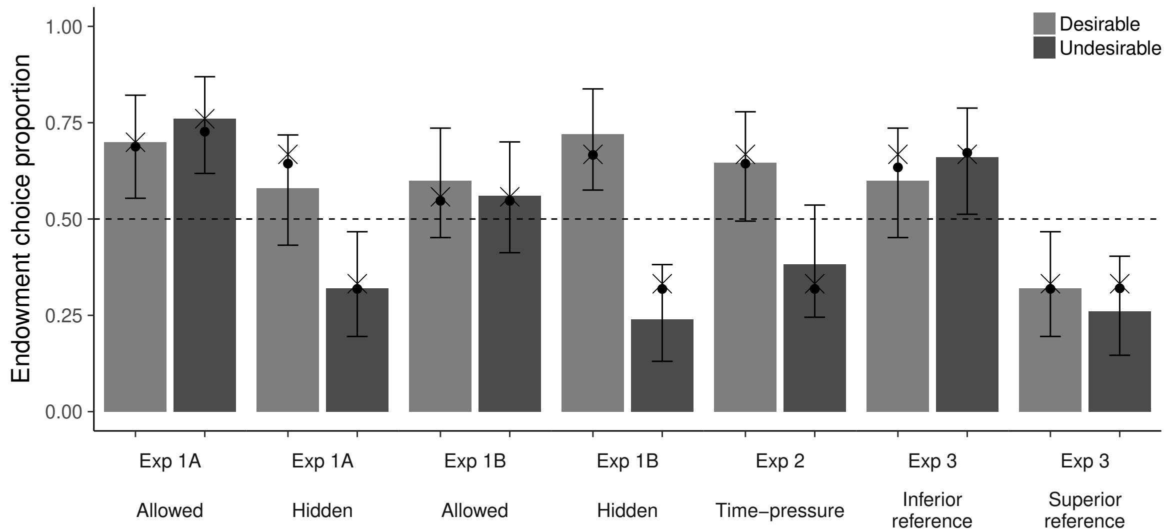

Figure A1: Observed endowment preference share (error bars represent 95%CIs) for Experiments 1A, 1B, 2 and 3. The crosses represent the predicted endowment preference share of the model using the value function from Equation 4. The dots represent the predicted endowment preference share of the model using the LCA value function from Equation A1.

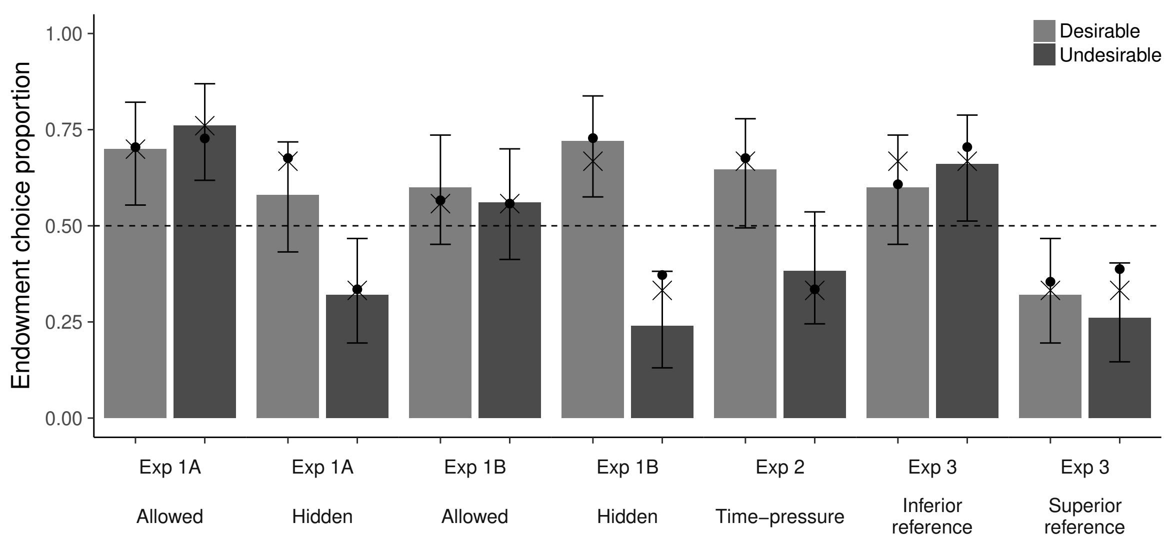

Figure B1: Observed endowment preference share (error bars represent 95% CIs) across Experiments 1A, 1B, 2 and 3. The crosses represent the predicted endowment preference share of the model described in this paper. The dots represent the predicted endowment preference share of the model presented in this appendix, which combines the previous reference state and the current endowed state according to Equation B1