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Focusing on what you own: Biased information uptake due to ownership

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Abstract

The endowment effect has been debated for over 30 years. Recent research suggests that differential focus of attention might play a role in shaping preferences. In two studies we investigated the role of biased attention in the emergence of endowment effects. We thereby derive predictions from an extended version of evidence accumulation models by additionally assuming a bias in attentional allocation based on one's endowment status. We test these predictions against an alternative account in which the endowment effect is the result of initial anchoring and adjustment differences (Sequential Value Matching model; Johnson & Busemeyer, 2005). In both studies we add deliberation time constraints to a standard Willingness-to-Accept/Willingness-to-Pay paradigm and consistently find that the endowment effect grows as deliberation time increases. In Study 2 we additionally use eye tracking and find that buyers focus more on value decreasing attributes than sellers (and vice versa for value increasing attributes). This shift in attention plays a pivotal role in the construction of value and partially mediates the endowment effect.

Keywords: endowment effect, attention, evidence accumulation models, eye tracking.

1 Introduction

One of the major goals of behavioral decision making research is to improve our understanding of the processes underlying judgments and decisions. In what is now considered classic work, fundamental biases in judgment and choice, and systematic deviations from rational behavior have been demonstrated (Kahneman & Tversky, 1972, 1979; Kahneman, et al., 1982) . In recent research the focus has shifted towards investigations of the underlying cognitive processes driving such effects (see Schulte-Mecklenbeck, et al., 2011a, 2011b, for recent reviews of methods). The way information is attended to and used to construct preferences and values has increasingly become of primary interest (e.g., Armel, et al., 2008; Armel & Rangel, 2008; Innocenti, et al., 2010; Krajbich, et al., 2011; Willemsen, et al., 2011; see also Franko-Watkins & Johnson, 2011).

One effect that has been studied in great detail across a variety of domains is the endowment effect, which violates one of the cornerstones of economic theory. The basic assumption of the Coase theorem (1960) is that a persons' willingness-to-pay (WTP) and willingness-to-accept (WTA) for a good should be nearly equivalent (under the assumption of zero transaction costs). Nevertheless, it has repeatedly been shown that WTA for a good is considerably higher than WTP for the same good, leading to reduced trading. This effect appears to be related to aspects of losing an endowment and has thus been coined the endowment effect (Thaler, 1980; Kahneman, Knetsch & Thaler, 1990, 1991; see also Birnbaum & Stegner, 1979).

The endowment effect is a robust, although culturally influenced (Maddux et al., 2010), phenomenon (see Horowitz & McConnell, 2002 for a review; but see also Plott & Zeiler, 2005, 2007) that has been observed using various methodological approaches including non-incentivized price estimations (e.g., Birnbaum & Stegner, 1979) and also incentive-compatible preference elicitation mechanisms (e.g., Johnson, et al., 2007). It has been found to occur with both tangible goods such as mugs and pens (e.g., Brown, 2005; Nayakankuppam & Mishra, 2005) and goods with uncertain values such as lottery tickets (e.g., Knetsch & Sinden, 1984; van Dijk & van Knippenberg, 1998; Cook & Wu, 2001; Peters, Slovic & Gregory, 2003). Although there is no dearth of research on the endowment effect, more work is needed to understand the underlying processes, which are still under heavy debate (for recent commentary see Isoni, et al., 2011; Plott & Zeiler, 2005, 2007).

Several theories have been put forward to provide an explanation for the endowment effect (see Johnson & Busemeyer, 2005 and Korobkin, 2003, for discussions). The classic explanation is based on prospect theory (Kahneman & Tversky, 1979) and assumes that loss aversion leads to an increased valuation of the good in the selling perspective as compared to the buying perspec-

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tive, "because removing a good from the endowment creates a loss while adding the same good (to an endowment without it) generates a gain" (Thaler, 1980; p. 44). Research has expanded the loss-aversion explanation (Brown, 2005; Morewedge, et al., 2009) indicating that mechanisms such as differences in attentional focus (Carmon & Ariely, 2000; Johnson, et al., 2007), the level of personal attachment (Beggan, 1992; Strahilevitz & Lowenstein, 1998), and self-association with the good in question (Maddux et al., 2010) can also explain parts of the effect (for a more fundamental critique of the loss aversion account derived from prospect theory and for alternative approaches see also Birnbaum & Zimmermann,1998; Birnbaum & Sutton, 1992; Johnson & Busemeyer, 2005).

Cognitive mechanisms have often been suggested as alternative or supplementary explanations to the classic loss-aversion account. Carmon and Ariely (2000), for example, argue that the endowment effect is caused by a stronger focus on the forgone, which differs between buyers (i.e., money) and sellers (i.e., the good). Query Theory (QT) (Johnson, et al., 2007; Weber, et al., 2007) suggests a different process behind the effect in transactional situations in which information has to be retrieved from memory. Individuals start with a memory query for aspects that support the status quo (e.g., for keeping the good vs. the money) which are weighted heavier than later queries and also act to inhibit subsequent queries for information which speaks against the status quo. In several experiments Johnson and colleagues (2007) showed that the order of queries into a good's worth were influenced by perspective and could explain endowment effects. Furthermore, by manipulating the query order they found that the endowment effect was attenuated to non-significance, suggesting a strong role for information search and uptake in the endowment effect. In line with the QT account, Nayakankuppam and Mishra (2005) showed that, "sellers appear to have a better representation of positive features and a worse representation of negative features [of the traded good], compared to buyers." (p. 393), and that both groups spontaneously list more features in favor of their position (see also Johnson, et al., 2007; Weber, et al., 2007). Nevertheless, because of its reliance on memory retrieval and inhibition processes QT does not make direct predictions in decision tasks in which relevant information about the good in question (e.g., the attributes, probabilities and outcomes, that make up a gamble) is provided during the valuation and construction phase. Based on the findings by Nayakankuppam and Mishra (2005), however, one might predict that for such description-based-decisions there should be a similar imbalance in attention as well. In the following, we will refer to the application of concepts from QT to such tasks as description-based Query Theory (dbQT).

One class of process models that can explain the emergence of endowment effects in both kinds of tasks (i.e., decisions-from-descriptions and from memory) are evidence accumulation approaches. In particular the Sequential Value Matching model (SVM; Johnson & Busemeyer, 2005; see also Busemeyer & Goldstein, 1992)—which is an extension of Decision Field Theory (Busemeyer & Townsend, 1993; Busemeyer & Johnson, 2004)—has been developed to model the process of constructing monetary valuations for objects that can be understood as gambles (e.g., lottery tickets & risky prospects). Conceptually, the SVM model assumes that persons compare the gamble against a set of possible prices in a dynamic stochastic process. First, persons pick one possible price, which can be anywhere between the maximum and the minimum outcome of the gamble. If the gamble is worth more than the currently considered price, the price is increased by a small amount. If the gamble is worth less, the price is decreased by a small amount. This updating process is repeated until indifference is reached. The starting point of the search process differs for different price elicitation methods and context conditions. Specifically, sellers start with a high price, whereas buyers start with a low price. Over time both prices are adjusted towards a price in the middle of the price range. This adjustment to the middle is insufficient, however, which results in the well-established disparity between WTA and WTP.[1]

The SVM model has been shown to explain several specific phenomena related to the disparity between WTA and WTP. Most notably, it can account for observed preference reversals (Birnbaum & Beeghley, 1997), which the classic loss aversion explanation cannot accommodate (Johnson & Busemeyer, 2005). Furthermore, the SVM model has been shown to be able to qualitatively and quantitatively predict choices observed in previous

[1]Technically, the SVM model consists of two layers: a value search layer and a comparison layer. The value search layer describes a process of considering an ordered list of prices and moving upwards and downwards with certain probabilities (i.e., a discrete Markov chain). The comparison layer describes a stochastic evidence accumulation process for comparing whether the gamble is worth more or less than the currently considered price. The comparison layer of the SVM model postulates that outcomes for both options (i.e., the gamble and the currently considered price) are concurrently sampled according to their stated probabilities and the affective evaluations of these outcomes are added up. The preference state changes over time due to this process of evidence accumulation until reaching one of the two alternative decision thresholds for either the gamble or the considered price being worth more (Busemeyer & Goldstein, 1992; Johnson & Busemeyer, 2005). A third indifference option is included in the comparison in that the search process is probabilistically terminated if the valuation for both options is equally strong. The considered price at termination is used for the response. Thereby, the SVM model defines an exit rate r which is the probability for termination of price search for any time the momentary preference state generated by the comparison process in the second layer is at zero (i.e., both options are considered to be of equal value).

studies as well as decision times and process tracing data (Johnson & Busemeyer, 2005). The SVM model can readily account for endowment effects *without* the assumption of biased attention by assuming differential starting points (e.g., anchoring) within the feasible price range for buyers and sellers, with sellers starting higher in the range than buyers

Recent studies, however, indicate that in decisions-from-descriptions attention both reflects and modulates preferences (Armel, et al., 2008; Armel & Rangel, 2008; Shimojo, et al., 2003; Glöckner & Herbold, 2011). This suggests that in place or on top of the mechanisms suggested by the SVM model there are likely shifts in attention to the positive (value increasing) vs. negative (value decreasing) aspects of an option based on one's perspective leading to overweighting of these aspects and resulting in pricing differences as found in the endowment effect. Adding this assumption of a biased shift in attention based on one's perspective we formulate a set of related hypotheses, the Biased Evidence Accumulation (BEA) hypotheses.

If biased sampling based on perspective (i.e., BEA) is a contributing factor to endowment effects, the difference between WTA-WTP should increase over time, because a constant or heavily weighted earlier bias in sampling increases the absolute difference between the sum of pro and con arguments for the considered good. This should be the case at least in the early stage of the decision process, while prices are still being adjusted and price search has not yet been completed. This forms our first specific BEA hypothesis:

H1) Growing endowment effect hypothesis. Due to a bias in accumulating evidence the disparity between WTA and WTP will increase with increases in deliberation time.

If, in contrast, endowment effects are driven solely by differential anchoring and adjustment, as suggested by SVM (Johnson & Busemeyer, 2005), increased deliberation time should instead lead to decreases in the size of endowment effects, as pricing adjustments presumably will (on average) go down for sellers and up for buyers. This hypothesis provides us with our alternative prediction in Study 1.[2]

Using eye-tracking methodologies in Study 2 we test directly whether attentional focus is influenced by perspective and whether this affects valuations as our second and third BEA-hypotheses.

H2) Biased sampling hypothesis. Sampling of evidence will differ based on perspective such that buyers will focus more on value decreasing attributes than sellers.

[2]If increased time pressure is not sufficiently strong for disrupting the price search process, the SVM model would predict no systematic influence of time on the size of endowment effect.

H3) Attentional impact hypothesis. Sampling of evidence biased towards either the value increasing/decreasing attribute will lead to corresponding increases/decreases in valuations.

Additionally, we explore whether the allocation of attention is dependent on probabilities of outcomes as predicted by the evidence accumulation mechanism in general that is also central to the SVM model (Johnson & Busemeyer, 2005; see Footnote 1 above, for further explanations), as our fourth BEA-hypothesis.

H4) Probability based sampling hypothesis. Sampling of outcomes will be in part dependent on the stated probability of those outcomes occurring.

Furthermore, although QT is a memory based account we abstract it to dbQT and apply two of its underlying information processing concepts (i.e., query direction switches as deliberations continue, and early queries have a greater impact than later queries) to online information queries via attention, which we test as two further BEA-hypotheses in Study 2. We do so based on the finding that visual attention has been found to reflect internal processing of online information as well as memories (e.g., Just & Carpenter, 1980; Richardson & Spivey, 2000).

H5) Shift in focus hypothesis. Buyers will begin to accumulate more value decreasing and sellers more value increasing evidence, but there will be an increased focus on the opposite kind of information over time.

H6) Early weighting hypothesis. Earlier accumulated evidence will have a greater impact on subsequent valuations than will later evidence.

In the following we present and discuss results from two studies. In Study 1 we find that the WTA/WTP disparity grows with increasing deliberation time, as predicted by our first specific BEA-hypothesis, but counter to the prediction of the SVM model. Study 2 provides a replication with the inclusion of eye tracking methodologies and finds support for all but one of the BEA-hypotheses.

2 Study 1

2.1 Methods

2.1.1 Participants and design

Eighty-four participants (71% female) from the University of Oregon human subject pool (age range 17–55 years) attended both sessions of the study and were included in the data analyses. The experiment was designed as a 2 (Perspective: Buyer vs. Seller) X 3 (Deliberation Time: 5, 10, vs. 15 seconds) repeated measures. The experiment consisted of two sessions with a two-week delay between them, one for each perspective. In each session,

participants evaluated 20 lottery tickets under three deliberation time conditions. The order of the perspectives (i.e., Seller vs. Buyer first) and the order of the times that were available for deliberation (i.e., 5, 10, 15 seconds or 15, 10, 5 seconds) were counterbalanced between and within subjects, respectively. Buying and selling prices were recorded as the dependent variable.

2.1.2 Materials and procedure

The stimulus set consisted of 20 lottery tickets each representing a gamble paying outcome o with a probability p and zero otherwise. The lotteries represented all combinations of outcomes $o \in$ \$8.67, \$17.33, \$26, and \$34.67 and probabilities $p \in$ 5%, 25%, 50%, 75%, and 95%. Participants were randomly assigned to take the perspective of either a buyer (i.e., instructed to imagine the lottery ticket was available for purchase) or seller (i.e., instructed to imagine they owned the lottery ticket and could sell it) for the first half of the study. Participants were told that they should provide valuations that reflected their true value of the lottery tickets. That is, they should make valuations that do not inflate or deflate the actual value of the lottery ticket but instead make valuations in which receiving the indicated amount, or playing the lottery ticket, would be equivalent (i.e., a certainty equivalent). After participants indicated they understood how to make such valuations they were shown several example trials with lottery tickets not used in the actual experiment.

Lottery tickets were then presented in fixed random order with half of the lotteries being evaluated at a time limit of 5, 10, then 15 seconds and the other half being evaluated at 15, 10, and then 5 seconds (i.e., counterbalancing deliberation time within and between subjects). To help mitigate carry-over effects each valuation was separated by a simple change detection task known to occupy a large proportion of attention and working memory resources (e.g., Luck & Vogel, 1997). During each trial an image of the lottery ticket and its qualifying information (i.e., p and o) was displayed. Valuations (range \$0-\$50 in \$0.05 increments) of the lottery tickets were indicated using a computer mouse. At the bottom of the screen a horizontal red line represented the amount of deliberation time left and shrunk as time passed (see Appendix). At the center point of the time line text directly above it read "|Make Response Now|". When the line entered the bars encompassing the text one second remained for deliberation and participants were to finalize their valuations (see the appendix for an example trial). Two weeks later participants returned and went through the experiment again, but in the opposite perspective (i.e., sellers became buyers and vice versa). The two week interval was used in an attempt to reduce possible carry-over effects from each perspective.

2.2 Results and discussion

We first tested whether our counterbalancing factors order of perspective (i.e., being a buyer or seller first) or order of time (i.e., whether valuations were made first at 5 or 15 seconds) had a significant impact on valuations by regressing valuation on perspective order and deliberation time order. In this and all the following analyses of valuations we used log-transformed values to reduce skew and the influence of outliers.[3] Furthermore, all regressions were conducted using cluster-corrected standard errors at the level of participants to account for the repeated measure design (Rogers, 1993).[4] We found neither of the counterbalancing factors to be significant predictors for valuations, both p's > .77. That is, there was no significant effect of being a buyer or seller first, nor did it matter what the deliberation time order was.

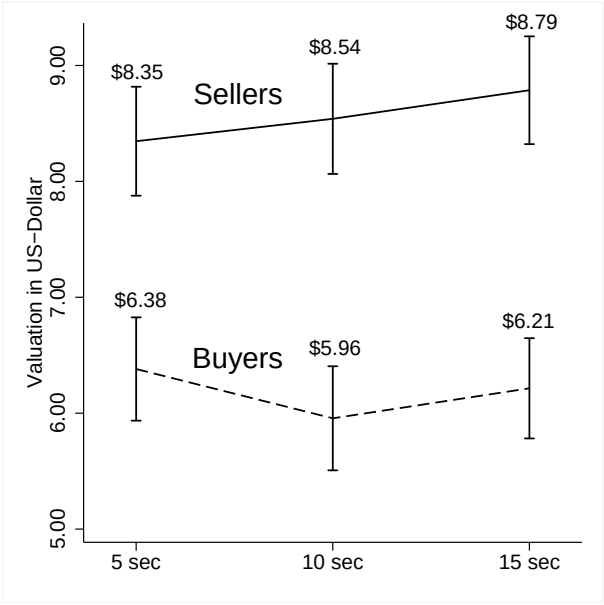
To test our first hypothesis stating that the endowment effect increases with deliberation times, we regressed valuations on an interaction between deliberation time (coded: 5sec = 1, 10sec = 2, 15sec = 3) and perspective (buyer =1, seller = 0; both variables centered). Participants indicated significantly higher selling prices than buying prices, $b = –0.33$, $t(83) = –6.84$, $p < .001$, replicating the classic endowment effect. The main effect of time was not significant, $b = 0.01$, $t(83) = 1.45$, $p = .15$. Furthermore, as predicted, the size of the endowment effect increased with deliberation time as indicated by a significant interaction between deliberation time and perspective, $b = –0.06$, $t(83) = –3.91$, $p < .001$ (see Figure 1). Within each perspective valuations from the 5 second deliberation condition differed significantly from the 10 and 15 second deliberation condition in the predicted directions (all $t > 2$, all $p < .05$).

A possible alternative explanation for the effect of constrained deliberation times on the endowment effect is that under shorter deliberation times a greater degree of noise is present in the data, which leads to a regression to the mean effect. This noise might decrease with longer deliberation times allowing participants to reveal their "true" valuations. Increasing noise should be reflected in higher variance in valuations in the low deliberation time

[3] The data were found to be positively skewed (2.96; $\chi^2(1) = 4{,}974.56$, $p < .001$), prompting us to transform the data using the formula: ln(valuation + 0.6055427), which reduced the skew to non-significance (.00; $\chi^2(1) = 0$, $p = .98$). We also double-checked all results using untransformed valuation scores. These analyses lead to the same conclusions.

[4] We used a cluster-corrected regression approach (Rogers, 1993), which corrects for autocorrelation, that is the fact that residuals can be correlated within each cluster (i.e., subject) due to the repeated measurement design. The analyses drops the standard Gauss-Markow-assumption that errors are uncorrelated (i.e., that the expected variance-covariance matrix of the residuals is a diagonal matrix $\Omega = \sigma^2 * I$), and allows intercorrelations for errors within each cluster that are estimated from the residuals. Doing so results in a correction of the degrees of freedom to the number of independent clusters (i.e., subjects) -1.

Figure 1: Valuations for sellers (WTA) and buyers (WTP) by deliberation time for Experiment 1with error bars reflect cluster-corrected SEs.



treatment. This was not the case according to a robust test for differences in variance (Brown & Forsythe, 1974). The variance of the valuation did not decrease with increasing deliberation time overall (*SDs* equal .975, .969, and .978, at deliberation times of 5, 10, and 15 seconds respectively) and there were only two out of 84 persons for which a significant difference ($p < .05$) in the expected direction was found (and three participants showed a significant effect in the opposite direction). Hence, the data speak against an increased noise explanation to account for the current results.

To further investigate the regression to the mean explanation, we tested whether probabilities and outcomes systematically influence valuations and whether they had a smaller effect on valuations made under the short compared to the long deliberation times. The influence of outcomes on valuations was overall very strong ($b = 0.03$, $t(83) = 25.04$, $p < .001$) and it did not differ between deliberation time conditions (IE: $b = 0.001$, $t(83) = 1.02$, $p = .31$). There was also a strong overall effect of probability on valuation ($b = 1.55$, $t(83) = 22.00$, $p < .001$) that increased with deliberation time (IE: $b = 0.04$, $t(83) = 2.68$, $p < .01$). Note, however, that the main effect of probability on valuation was more than 30 times larger than the interaction effect. Overall, this indicates that behavior was highly systematic and probabilities and outcomes were taken into account under all deliberation time constraints.

2.3 Discussion

In line with the first BEA-hypothesis, endowment effects increase with deliberation time. This effect runs counter to the SVM model which predicts a reduction of endowment effects with increasing deliberation time since high (i.e., sellers) and low (i.e., buyers) starting values should be corrected towards intermediate valuations over time. However, given that we find a significant disparity between buying and selling prices at even five seconds of deliberation it is quite possible that different starting values for price comparisons may also have played a role, as suggested by the SVM model.

It is also worth noting that if the principles of QT were applied to online information uptake (i.e., dbQT) one could also explain our findings; if the amount of value-increasing or value decreasing queries grew over time, so would the endowment effect. Thus the data found here are not inconsistent with QT, which could suggest that QT may not be strictly limited to queries into memory, but may be applied to online information uptake as well.

While Study 1 provides evidence that is in line with the first BEA-hypothesis and dbQT explanations, Study 2 was designed to test their underlying process assumptions and predictions more directly using eye-tracking. We thereby rely on the simplifying assumption that gaze is an indicator for accumulating evidence (Raab & Johnson, 2007). Both, BEA-hypotheses and dbQT would predict that sellers should focus more on the positive, value increasing, aspects of the gambles (i.e., the higher outcomes) and buyers more on the negative, value decreasing, aspects (i.e., the lower outcomes). According to SVM, the proportion of attention directed at a single outcome should reflect the probability of that outcome and should not differ between buyers and sellers. Additionally, if the principles of QT were applied to decisions from descriptions, one would expect; a) a particularly strong bias in attention at the beginning of the decision process, and b) that at some point during deliberations the bias in attention allocation should reverse (see H5). Furthermore, we would expect that earlier attention allocation would have a greater impact on valuations than later queries, as predicted by the early weighting hypothesis (see H6).

3 Study 2

3.1 Methods

3.1.1 Participants and apparatus

Fifty-three individuals recruited from the MPI Decision Lab Subjects Pool (59.4% female, age range 17–58) par-

ticipated in Study 2.[5] Participants received on average 15 Euro for the experiment which lasted approximately 45 minutes. Eye movements were recorded using the Eyegaze binocular system (LC Technologies) with a remote binocular sampling rate of 120Hz and an accuracy of approximately 0.45°. The threshold for detecting fixations was set to 50msec.

3.1.2 Design and procedure

The experiment was a 2 (Perspective: Buyer or Seller) X 2 (Deliberation Time: 5 or 15 seconds) mixed design with perspective as between subjects factor and stated prices being the dependent variable. Participants determined selling (buying) prices for 80 lottery tickets under each deliberation time constraint. Choices were incentivized and we used the standard BDM (Becker, DeGroot & Marschak, 1964) procedure to elicit price values.

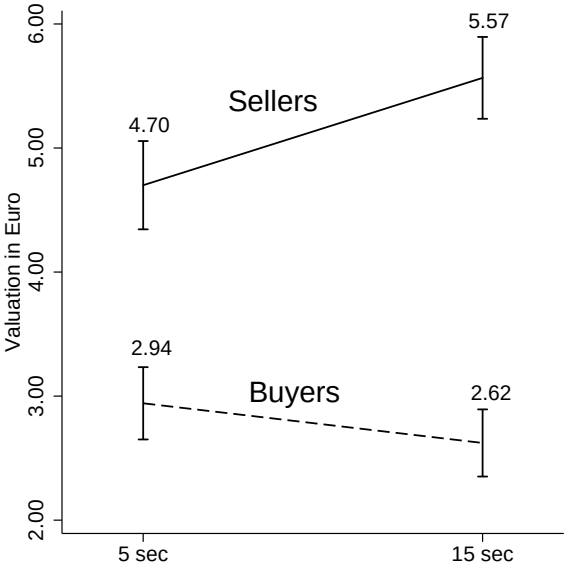
Buyers were informed that they had been given 15 Euro and sellers were informed that they had been given 5 Euro plus one of the lottery tickets which was selected randomly. The BDM procedure was explained to the participants and each participant answered test questions to ensure proper understanding of the mechanism. Participants made valuations of the 80 lottery tickets under the 5 second and the 15 second deliberation time constraint. For pragmatic reasons the ten second deliberation time constraint was not included in Study 2. Finally, participants were informed which lottery ticket was selected, whether they bought (sold) it, and their resulting total payoff.

The 80 lottery tickets consisted of gambles with two outcomes. A pool of gambles was randomly generated using an outcome range of 0 to 15 Euro with a maximum EV of 10 Euro. From this pool the first 80 gambles were selected that fulfilled the criterion that one outcome was high (>= 5 Euro) and the other was low (<= 0.50 Euro) (see Table S1 in the Appendix for all 80 gambles).

Gambles were presented in a fixed random order and spaced using a one-second fixation trial. The high or low outcome and probability was always presented on the left or right hand side of the display which was constant within subject, but counterbalanced across subjects and conditions. The participant's valuation was shown in the center of the screen and could be adjusted in one-cent increments up to a maximum of 15.00 Euro; this change in the incrimination of value was done to allow for more detailed estimations. Each of the outcomes was surrounded by a blue box that changed to red when one second of deliberation time remained; again to remind participants they were almost out of time. The 100 x 100 pixel areas centered on the gambles served as our regions of interest (ROI's) for the analysis of eye-fixations (see the Appendix for an example trial).

[5]One subject was removed from the analysis as more than 30% of trials did not have corresponding eye tracking data. For recruiting the online database ORSEE was used (Greiner, 2004).

Figure 2: Valuations in Euros for sellers (WTA) and buyers (WTP) by deliberation time for Experiment 2 with error bars reflecting cluster corrected SEs.



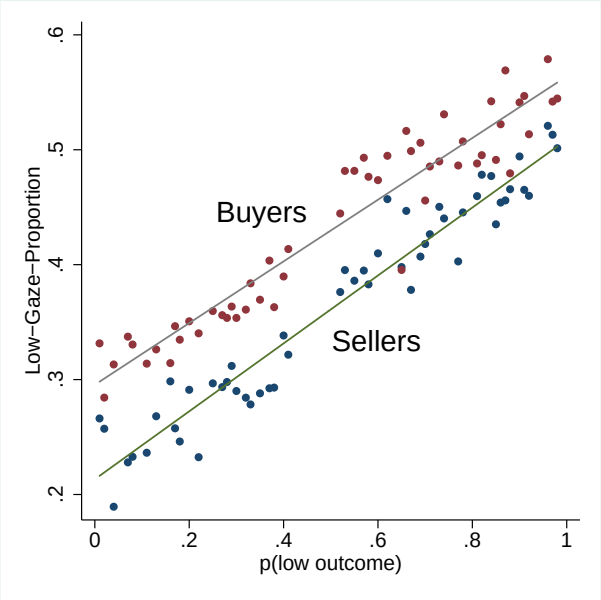
4 Results

4.1 Growing endowment effect hypothesis (H1)

To test the first behavioral hypothesis, we regressed log-transformed valuations[6] on perspective (buyer =1, seller = 0) and deliberation time (5sec = 1 or 15sec = 2) and their interaction (variables centered). We replicate the classic endowment effect, b = –0.46, $t(51)$ = –6.07, p < .001, with selling prices significantly exceeding buying prices. Again the main effect of deliberation time did not reach conventional significance levels, b = 0.06, $t(51)$ = 1.82, p = .08. More importantly, the significant interaction between perspective and deliberation time was replicated, b = –0.25, $t(51)$ = –3.83, p < .001 (see Figure 2). As in the first study, the WTA-WTP difference is lower at 5 seconds than at 15 seconds (see Figure 2).

[6]As in Study 1, the data were significantly skewed (.95; $\chi^2(1)$ = 1,315.48, p < .001). We therefore transformed the data using the formula: ln(valuation+1.75499), which reduced the skew to non-significance (.00; $\chi^2(1)$ = 0, p = .98). In all the analyses that follow we use the transformed data.

Figure 3: Fixations to the low outcome by probability and perspective (values collapsed across subjects and regression lines per perspective).



4.2 Biased sampling hypothesis (H2)

Furthermore, according to the BEA-hypotheses, perspective should influence attention, such that buyers look relatively more at the low, value decreasing, outcome and sellers look more at the high, value increasing, outcomes. To analyze this and the following hypotheses concerning attention, we calculated the proportion of fixation time to the low outcome relative to the fixation time directed at both the low and the high outcome of the gamble. The resulting Low-Gaze-Proportion can have values between 0 and 1 with higher values indicating a stronger focus on value decreasing aspects of the gamble (i.e., low outcomes). We find that Hypothesis 2 is supported by the data (see also the main effect of perspective in Figure 3, below). Buyers (p = .44) attended 7% more to the low outcome than sellers (p = .37), b = .07, $t(51)$ = 2.03, p = .048.[7]

4.3 Attentional impact hypothesis (H3)

A further BEA-hypothesis is that more attention to the high (vs. low) outcome will increase (vs. decrease) valuations. To test this assumption, we regressed valuations on Low-Gaze-Proportion scores (i.e., the proportion of time fixating on the low outcome). In line with the assumption, the valuation of a gamble decreased if attention to the low outcome increased, b = –1.33, $t(51)$ = –12.33, p < .001. According to the regression on untransformed monetary valuations (not reported), an increase in the proportion of time attending to the low of 10% goes along with a decrease in valuation of 0.67€.

4.4 Probability based sampling hypothesis (H4)

Assuming that attention is related to gaze, we investigated whether the proportion of time attending to the outcomes was related to the probability of the outcome. Using our ROIs we calculated the proportion of fixations to each outcome for each decision and person. We then regressed Low-Gaze-Proportion on the probability of the low outcome. In line with the general evidence accumulation account underlying the SVM model and our forth specific BEA-hypothesis, we found that the proportion of time spent attending to the low outcome increases with the probability of the outcome, b = 0.29, $t(51)$ = 12.52, p < .001, but that there is also a significant intercept, b = 0.25, $t(51)$ = 11.93, p < .001, suggesting a basic level of attention to all outcomes independent of probability.[8] Hence, two basic assumptions underlying BEA-hypotheses and SVM seem to be fulfilled: proportion of gaze duration and outcome probability are correlated and valuations increase (decrease) with increased attention to the high (low) outcomes. Figure 3 shows that the influence of probability on attention holds for both perspectives, which mainly differ concerning general focus on the low outcome as indicated by the difference in intercept as predicted by our second BEA-hypothesis.

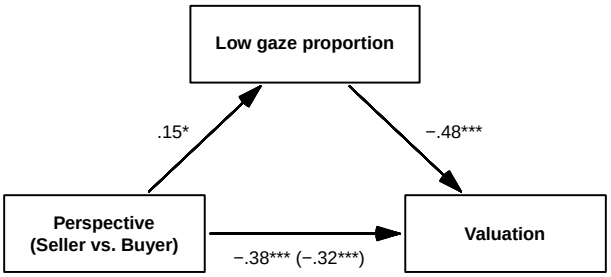
4.5 Shift in focus hypothesis (H5)

To test the BEA-prediction derived from QT that attention should shift over the deliberation process we ran logistic regressions predicting the direction of gaze (Low Outcome = 1, High Outcome = 0) by the relative time of the fixation in the trial (in seconds), perspective (Buyers vs. Sellers), and their interaction separately for the 5 seconds and 15 seconds deliberation time condition. Attention shifts in the opposite directions over time for the two perspectives are estimated by the interaction term. The interaction, however, failed to reach conventional significance levels in the15 second deliberation time condition, $odds$ = .99, z = –1.02, p = .31, as well as in the 5 second deliberation time condition, $odds$ = .99, z = –.21, p = .83, failing to support the shift in focus hypothesis.

[7] In this and all the analysis that follow using Low-Gaze-Ratio (duration to low / duration to high) leads to the same conclusions.

[8] Including both the outcome and probability of the low outcome simultaneously into the regression we find both to be predictive (p's < .01).

Figure 4: Standardized regression coefficients for the relationship between perspective and valuation as partially mediated by the proportion of time spent attending to the low outcome (i.e., Low-Gaze-Proportion). The standardized regression coefficient between perspective and valuation controlling for Low-Gaze-Proportion is shown in parentheses; * $p < .05$, *** $p < .001$



4.6 Early weighting hypothesis (H6)

To test our sixth BEA-hypothesis we regressed valuations simultaneously on the Low-Gaze-Proportion from the first half ($b = –1.12$; $SE_{adj} = 0.10$) of the trial and from the second half ($b = –0.37$; $SE_{adj} = 0.05$) of the trial using only the 15 second deliberation time constraint trials, and found both to be significant predictors of valuation, ps < .001. Testing for the equivalency of their coefficients we find that fixation asymmetries in the first half of the trial have a stronger effect on valuations than those from the second half, F (1, 51) = 61.82, $p < .001$ as would also be predicted by dbQT.

4.7 Perspective, attention, and the endowment effect

To provide a direct test of whether the endowment effect is in fact partially explained by differences in attentional focus between buyers and sellers, we performed a mediation analysis clustering across subjects and using bootstrapping to estimate standard errors (Preacher & Hayes, 2008). This analysis revealed a mediation effect, $b = –0.07$, $z = –2.05$, $p = .04$. Approximately 17% of the total effect of perspective on valuation was explained by Low-Gaze-Proportion. That is, the difference in the bias of attentional focus between buyers and sellers partially mediates the endowment effect, lending direct support to the BEA-hypotheses (and also the dbQT account), but also making it clear that attention related to information uptake can only be one of many factors driving the endowment effect (see Figure 4).

To test the regression to the mean alternative explanation in the second study, we again tested for differences in variance of valuation between the 5 second (SD = .613) and 15 second (SD = .599) deliberation time conditions. The overall effect was significant, $p < .01$, with variance being higher in the five second deliberation time constraint compared to the 15 second deliberation time constraint. A considerable portion of participants also showed the effect at the individual level (n = 19) although others (n = 7) showed a difference in the opposite direction. It is, however, possible that occasionally increased and decreased variance was driven by some other factors as well. To more directly test whether this increase in variance was caused by participants less systematically taking into account probabilities and outcomes, we again tested whether both factors had increasing influence on valuations as deliberation times increased. The main effect of probability ($b = –1.10$; $SE_{adj} = 0.09$) and of outcome ($b = 0.55$; $SE_{adj} = 0.04$) were both significant predictors of valuation (p's < .001), but we fail to find a significant interaction between deliberation times and the outcome or the probability of the low outcome, both p's > .51. This suggests that both features of the gambles were taken into account at even the shortest of deliberation times speaking against the alternative explanation that our result was simply due to regression to the mean.

4.8 Discussion

Study 2 constitutes a replication of the influence of deliberation time on the difference between WTA and WTP found in the previous study and provides further support for our first BEA-hypothesis. Using randomly generated gambles and full incentivization we find further evidence for the robustness of the endowment effect increasing with deliberation time. More importantly, Study 2 provides insight into the cognitive processes behind this common effect. In line with the SVM model, the proportion of time spent attending to a given outcome increases as the attached probability increases and valuations increase with more fixations to the high outcome relative to the low outcome. The general mechanism assumed by the BEA-hypothesis (i.e., that perspective influences attentional focus and information uptake which impacts later valuations) is supported by our mediation analysis. These findings are also roughly in line with dbQT with earlier accumulated evidence appearing to be weighted heavier, and thus having a greater impact on valuations than evidence acquired later as predicted by the early weighting hypothesis.

5 General discussion

In one hypothetical and one incentivized study we investigated a novel and somewhat counterintuitive effect of deliberation time on valuations of consumer goods. Instead of a decrease in the endowment effect, as predicted

by the Sequential Value Matching (SVM) model, we find the effect to be the smallest at the shortest of deliberation times; growing as increased deliberation time is afforded. This finding is in line with our first Biased Evidence Accumulation (BEA) hypothesis. This increase in the endowment effect could eventually be explained by Query Theory (QT) or other established models (e.g., Krajbich, et al., 2011; Willemsen, et al., 2011; Birnbaum, 1997) although additional assumptions and further model specifications would be needed to do so.

With the aid of eye-tracking methodology we found that the growing endowment effect over time can be partially explained by differential attentional focus and information seeking that differs based on one's perspective. Sellers tended to focus more on the positive aspects (e.g., the highest outcome) while the focus of buyers is mixed with attention being placed more equally between the two aspects (e.g., the high and the low outcome). Furthermore, the amount of attention placed on the high outcome, relative to the low outcome, increased valuations significantly. These findings speak against the anchoring explanation put forth by the SVM model being the only mechanism driving differences in the construction of valuations of goods between buyers and sellers. These results also suggest that some principles of QT could potentially be expanded beyond memory retrieval processes to online information uptake processes (i.e., what we have referred to as description-based QT (dbQT)).

5.1 Caveats

The lack of a reversal in sampling proportions to low outcomes over time is not fully consistent with a BEA-hypothesis derived from QT, which would predict that sellers look more at value-increasing aspects first and at value-decreasing aspects later. It also has to be kept in mind that the suggested attention account explained "only" 17% of the variance of the endowment effect in a mediation analysis. The assessment whether this proportion is stable over contexts and samples is due to further research. Nevertheless, considering these results it would be an overstatement to suggest that the attentional aspects captured in the BEA-hypotheses are the only factors underlying the emergence of endowment effects.

One further criticism of the studies presented here is that the short deliberation time of five seconds may be too short for subjects to form clear and stable valuations. Adding noise could cause a regression to the mean at low deliberation time, which might be an alternative explanation for the growing endowment effect. However, in both experiments there are strong significant effects of probability and outcome on the valuation of the gambles even for the low deliberation time constraint. This indicates that participants had sufficient time to value gambles systematically in the 5 second deliberation time condition. Thus, we feel relatively confident that, although the five second deliberation condition may have increased pressure on participants, it was not too fast for them to take into account the attributes of the lotteries when forming their valuations.[9]

Other possible criticisms are that the use of gambles instead of tangible goods may indicate that we are not capturing the common endowment effect and that we find an endowment effect that is a bit lower than usual. However, many studies of the endowment effect have used gambles (e.g., Eisenberger & Weber, 1995; Peters, et al., 2003; Roca & Maule, 2009) and not all studies finding the endowment effect have consistently reported a 2:1 ratio for WTA to WTP (e.g., Lerner, et al., 2004; Morewedge, et al., 2009; Roca & Maule, 2009). Furthermore, one might speculate that the repeated-measurement design contributed to a decrease in the effect; but this would have to be substantiated by further empirical testing.

A related concern, and one that cannot be so easily dismissed, is that the attributable make-up of gambles differs in complexity and the ability to form strong emotional attachments (see Horowitz & McConnell, 2002) from consumer goods such as mugs, pens, and candy bars. As such we cannot conclusively say that the results we find here would be mirrored in valuations of such goods. While we think it is likely that the effects of deliberation time would be similar with tangible consumer goods it might be hard to capture the attention effects found in Study 2 in a natural way using such items.

6 Conclusions and further research

The studies reported here move a step forward in our understanding of the time course of, and the processes behind, the endowment effect. It is clear that attention plays a major role in the endowment effect and that attentional focus can be altered by one's perspective (Shafir, 1993; Houston & Sherman, 1995; Cameron & Ariely, 2000). The BEA-hypotheses derived on the basis of previous models and findings seem to capture parts of these mechanisms. However, some (null) findings are not in line with the predictions and need further investigation. Although the data reported here mainly support the BEA-hypotheses, the finding that the WTA/WTP disparity does not shrink as deliberation times increase does not necessarily negate the mechanism proposed by the SVM model (Johnson & Busemeyer, 2005; see also Busemeyer & Goldstein, 1992). The current results suggest that initial

[9] This can, of course, be possible only if individuals can partially rely on automatic-intuitive processes and do not have to use slow deliberate integrations of value and probability only. This view is supported by multiple studies on risky choice in different contexts (e.g., Glöckner & Betsch, 2008; Glöckner & Herbold, 2011; Hilbig & Glöckner, 2011).

anchoring cannot be the sole factor in the formation of the endowment effect. As such, future models or extensions of existing ones should take into account both differential anchoring and biases in attention allocation.

Taking a broader view, the influences of perspective on attention and attention on valuation are not relevant only for studies of the endowment effect. Rather, the intertwined nature of perspective and attention and our reliance on them in daily decisions is likely to have a measurable impact on behavior. Besides influencing our valuations of consumer goods it is likely that they also influence our preferences in other domains (e.g., Armel, et al., 2008; Busemeyer & Townsend, 1993; Dickert & Slovic, 2009; Glöckner, Heinen, Johnson, & Raab, 2012; Glöckner, et al., 2012; Hilbig & Glöckner, 2011; Willemsen, Böckenholt & Johnson, 2011). As such, we strongly encourage further study of the role and interaction of perspective and attention in other areas where information search and uptake are likely influencing many behavioral aspects of life.

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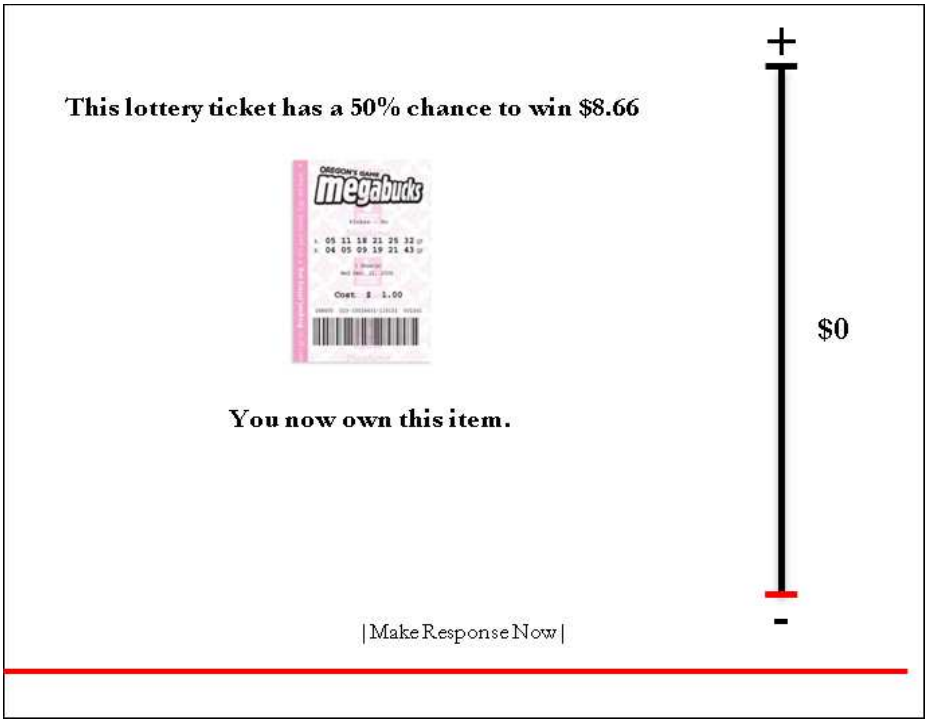
Appendix

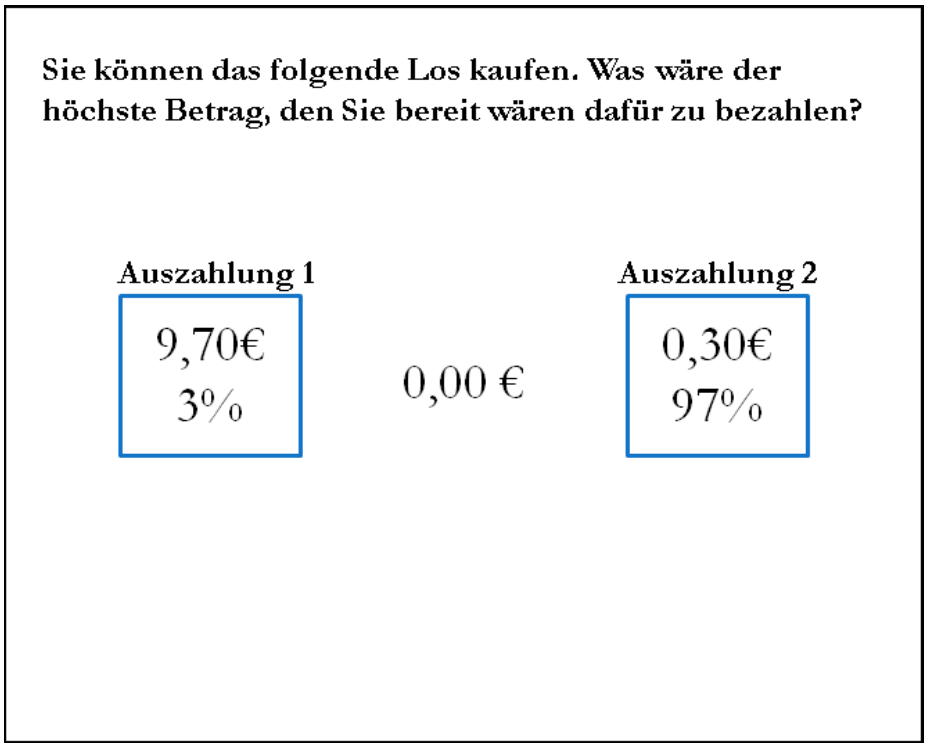
Table S1. List of randomly generated gambles used in Study 2 ordered by EV.

Gamble	High outcome	High probability	Low outcome	Low probability	EV	Gamble	High outcome	High probability	Low outcome	Low probability	EV
1	5.10 €	2%	0.00 €	98%	0.10 €	41	14.50 €	30%	0.10 €	70%	4.42 €
2	6.10 €	2%	0.10 €	98%	0.22 €	42	6.30 €	71%	0.10 €	29%	4.50 €
3	9.70 €	3%	0.30 €	97%	0.58 €	43	13.10 €	33%	0.30 €	67%	4.52 €
4	9.30 €	4%	0.40 €	96%	0.76 €	44	10.30 €	43%	0.20 €	57%	4.54 €
5	10.50 €	8%	0.00 €	92%	0.84 €	45	5.50 €	82%	0.30 €	18%	4.56 €
6	9.30 €	10%	0.20 €	90%	1.11 €	46	10.00 €	45%	0.30 €	55%	4.67 €
7	12.00 €	9%	0.20 €	91%	1.26 €	47	5.60 €	83%	0.30 €	17%	4.70 €
8	5.10 €	22%	0.20 €	78%	1.28 €	48	6.30 €	73%	0.50 €	27%	4.73 €
9	14.90 €	8%	0.10 €	92%	1.28 €	49	8.10 €	59%	0.10 €	41%	4.82 €
10	8.40 €	14%	0.20 €	86%	1.35 €	50	6.80 €	71%	0.10 €	29%	4.86 €
11	11.90 €	10%	0.20 €	90%	1.37 €	51	5.10 €	99%	0.20 €	1%	5.05 €
12	11.10 €	10%	0.30 €	90%	1.38 €	52	10.30 €	47%	0.40 €	53%	5.05 €
13	11.40 €	12%	0.30 €	88%	1.63 €	53	11.80 €	43%	0.10 €	57%	5.13 €
14	7.70 €	16%	0.50 €	84%	1.65 €	54	7.20 €	71%	0.40 €	29%	5.23 €
15	8.80 €	16%	0.30 €	84%	1.66 €	55	12.60 €	40%	0.40 €	60%	5.28 €
16	5.70 €	26%	0.50 €	74%	1.85 €	56	9.00 €	59%	0.50 €	41%	5.52 €
17	12.90 €	13%	0.30 €	87%	1.94 €	57	11.70 €	48%	0.30 €	52%	5.77 €
18	12.80 €	15%	0.10 €	85%	2.01 €	58	5.90 €	98%	0.40 €	2%	5.79 €
19	6.70 €	27%	0.50 €	73%	2.17 €	59	8.40 €	68%	0.40 €	32%	5.84 €
20	5.40 €	38%	0.40 €	62%	2.30 €	60	6.70 €	87%	0.20 €	13%	5.86 €
21	6.20 €	34%	0.40 €	66%	2.37 €	61	8.20 €	73%	0.00 €	27%	5.99 €
22	5.00 €	48%	0.00 €	52%	2.40 €	62	8.10 €	75%	0.40 €	25%	6.18 €
23	7.30 €	29%	0.40 €	71%	2.40 €	63	8.80 €	73%	0.40 €	27%	6.53 €
24	11.00 €	22%	0.10 €	78%	2.50 €	64	7.10 €	92%	0.10 €	8%	6.54 €
25	5.30 €	48%	0.00 €	52%	2.54 €	65	10.10 €	65%	0.30 €	35%	6.67 €
26	11.80 €	19%	0.40 €	81%	2.57 €	66	8.80 €	80%	0.20 €	20%	7.08 €
27	6.10 €	42%	0.20 €	58%	2.68 €	67	12.00 €	60%	0.10 €	40%	7.24 €
28	13.80 €	18%	0.40 €	82%	2.81 €	68	11.50 €	63%	0.20 €	37%	7.32 €
29	9.20 €	30%	0.30 €	70%	2.97 €	69	8.60 €	89%	0.00 €	11%	7.65 €
30	12.30 €	23%	0.30 €	77%	3.06 €	70	9.10 €	84%	0.50 €	16%	7.72 €
31	10.90 €	27%	0.20 €	73%	3.09 €	71	12.80 €	62%	0.30 €	38%	8.05 €
32	14.20 €	22%	0.10 €	78%	3.20 €	72	13.40 €	62%	0.30 €	38%	8.42 €
33	11.20 €	27%	0.50 €	73%	3.39 €	73	8.80 €	96%	0.40 €	4%	8.46 €
34	5.50 €	63%	0.00 €	37%	3.47 €	74	10.80 €	78%	0.40 €	22%	8.51 €
35	5.60 €	63%	0.40 €	37%	3.68 €	75	12.10 €	72%	0.30 €	28%	8.80 €
36	14.30 €	27%	0.00 €	73%	3.86 €	76	12.90 €	70%	0.40 €	30%	9.15 €
37	9.20 €	42%	0.00 €	58%	3.86 €	77	14.00 €	67%	0.40 €	33%	9.51 €
38	11.30 €	35%	0.00 €	65%	3.96 €	78	13.80 €	70%	0.50 €	30%	9.81 €
39	12.30 €	31%	0.30 €	69%	4.02 €	79	13.40 €	73%	0.40 €	27%	9.89 €
40	9.00 €	45%	0.20 €	55%	4.16 €	80	10.70 €	93%	0.40 €	7%	9.98 €

Example Trial Study 1



Example Trial Study 2



(You can buy the following lottery ticket. What is the highest amount you would be willing to pay for it?)