Choice uncertainty and the endowment effect

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Abstract
We experimentally test for the role of choice uncertainty in generating “endowment effects” - the robust empirical finding that endowing participants with an item raises their reported valuation relative to participants being asked to purchase it instead. While there is some compelling evidence concerning trade uncertainty in the literature, there is substantially less evidence regarding the importance of choice uncertainty. This paper provides novel support for the significance of choice uncertainty in the context of both trading and stated valuations. In a primary set of studies, we find that reducing choice uncertainty eliminates under-trading in the exchange setting and decreases (but does not eliminate) the difference in average valuations reported by buyers and sellers, mainly by decreasing the number of extreme valuations by sellers. Interestingly, our treatment does not lead to a significant increase in the number of mutually acceptable trades implied by stated valuations. Comparing the results from our two primary experiments therefore suggests that value uncertainty continues to play a role in generating valuation asymmetries even after relevant product uncertainty has been resolved. A set of follow-up studies with modified designs replicates this finding in the exchange setting but fails to generate a valuation asymmetry in the control condition, possibly due to pandemic-related mitigation measures and less participant time with the endowed item.

Keywords Choice uncertainty · Value learning · Endowment effect · Exchange asymmetry

JEL Classification D01 · D81 · Q51

1 Introduction

We contribute to the recent literature highlighting the role of uncertainty in driving “endowment effects” - the robust empirical finding that endowing participants with an item raises their reported valuation relative to participants being asked to

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purchase it instead. This finding has important policy implications since stated valuations are often used to value non-market goods (or “bads”) for which no market price can be observed. For example, in environmental economics, stated valuations may factor into cost-benefit analyses or the estimation of damages or externalities.

The observed difference in reported valuations violates basic assumptions of standard expected utility theory and suggests that, counter to the Coase theorem, initial assignments of property rights may affect final allocations. In most cases of empirical interest, the setting may be subject to several different types of uncertainty. Participants may be unsure about (i) details of the market (institutional uncertainty), (ii) the exact properties of the good in question (product or object uncertainty), (iii) the conditions under which the good will be consumed (extrinsic uncertainty), or (iv) features of their preferences for the good given its attributes (value or intrinsic uncertainty).\(^1\) We follow Engelmann and Hollard (2010) in referring to the former as trade uncertainty (unfamiliarity with the risks or costs associated with trading), while grouping the latter three effects under choice uncertainty (uncertainty in consumption utility).

Most of the literature on uncertainty and the endowment effect has been focused on either inexperience with market procedures (Coursey et al., 1987; Engelmann & Hollard, 2010; List, 2011), or the role of uncertainty over monetary outcomes (Loomes & Weber, 1997; Schmidt & Traub, 2009; Eisenberger & Weber, 1995). The latter differs from the current setting in that it does not seek to establish a potential cause for the effect itself (which was originally established under certain outcomes), but to understand its magnitude under different degrees of uncertainty. We argue that choice uncertainty deserves closer attention as a potential driver of endowment effects due to its prevalence in settings of empirical relevance to economists: for example, contingent valuation is often used in the context of public or environmental economics to elicit preferences for abstract or unfamiliar goods such as environmental quality. Earlier endowment effect studies provide suggestive evidence that choice uncertainty may play a role. For example, Horowitz and McConnell (2002), in a survey of the existing literature, document that valuation asymmetries for public or non-market goods are far higher than for ordinary goods: sellers tend to ask on average 3 times as much as buyers are willing to pay for ordinary goods (n=59 studies), with the ratio rising above 10 for public or non-market goods (n = 46 studies).\(^2\)

This study seeks to make the relevance of choice uncertainty explicit by manipulating the degree of familiarity with the good in question in a controlled laboratory environment. To our knowledge, this is one of the first studies to document the role of choice uncertainty in this context. In the first set of experiments, we randomly endow participants with one of two types of chocolate, identified only

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\(^1\) This classification combines the definitions of institutional and value learning proposed in Braga and Starmer (2005) with the distinction between extrinsic and intrinsic uncertainty put forward in Loomes et al. (2009).

\(^2\) This effect might be partly driven by trade uncertainty if participants perceive markets for public goods to be more opaque or complicated. However, experimental instructions are likely to be similar across different choice contexts, reducing the importance of this channel in the lab setting.
by a square or a circle stapled to otherwise unmarked bags. Participants in the control condition receive a verbal description (“rich” versus “luxurious”), while participants in the treatment condition receive a small sample of both types of chocolate. Participants then have the opportunity to exchange their current bag of chocolate for chocolate of the other type with the experimenter. The second set of experiments tests for the same effect in a valuation setting: we randomly endow some participants with an unmarked bag of chocolate and then elicit participants’ stated willingness to accept (WTA) or willingness to pay (WTP) depending on their endowment status. Participants in the control condition receive no additional information about the type or quality of the chocolate, while participants in the treatment condition receive a small sample of the chocolate to taste before providing their valuations.

The first set of experiments directly tests for exchange asymmetries (under-trading) while the second set of experiments provide a quantitative measure of valuation asymmetries in the form of a WTA/WTP ratio. The former has the advantage of being conceptually simpler, avoiding the language of buying and selling which may be psychologically charged, and ruling out income effects (Ericson & Fuster, 2014).

Our primary experiments confirm that choice uncertainty is an important driver of exchange and valuation asymmetries. In the valuation setting, we find that choice uncertainty produces valuation asymmetries and reduces the number of mutually acceptable trades by inflating sellers’ stated WTA for their item. The WTA/WTP ratio for participants who taste the chocolate is more in line with the residual valuation asymmetries we find for financial lotteries. In the exchange setting, we find that allowing participants to taste the chocolate fully eliminates under-trading. This result is striking since previous studies such as Knetsch (1989) and Plott and Zeiler (2007) document exchange asymmetries in the context of known, familiar goods like mugs and pens. We suspect that this difference is driven by the relative ease of forming preferences over two known types of chocolate relative to choosing between two less directly related goods.

While we postulate that attribute or object uncertainty is the most likely driver of our results, we cannot rule out that uncertainty in preferences is also at play. In fact, we find some evidence for uncertainty in preferences by comparing results across the two experimental paradigms: while revealing the attributes of the good in question leads to the predicted number of trades in a choice setting, the ratio between the average stated WTA of sellers and buyers’ stated WTP decreases but remains different from parity in the valuation study. In addition, the implied number of mutually acceptable trades in this context increases only slightly with the treatment, suggesting that the mapping to preferences may explain at least part of the valuation asymmetries observed in the literature.

To rule out that our findings are driven by experimental design choices, we conduct follow-up studies using the control designs outlined in Plott and Zeiler (2005) and Plott and Zeiler (2007) respectively. Once again, the taste treatment fully dissipated the exchange asymmetries observed in the control. The follow-up valuation study did not produce the expected valuation asymmetry in the control treatment, possible due to a combination of COVID-related precautions and the short time subjects spent endowed with their item.
This paper is organized as follows: in the next section, we provide a brief overview of the existing literature on uncertainty and the endowment effect. The third section describes our experimental designs, while the fourth section presents a discussion of our findings. The final section concludes.

2 Previous literature

Contingent valuation studies in environmental settings were among the first papers to note the incompatibility of stated valuations with the predictions from standard expected utility theory (Hammack & Brown, 1974; Heberlein & Bishop, 1986). Counter to the implications of the Coase theorem, their findings suggested that the assignment of initial property rights has important implications for final allocations. Knetsch (1989) and Kahneman et al. (1990) interpreted these results as evidence for loss aversion and established the use of valuation and exchange experiments to formally test for the existence of endowment effects in the lab. The term endowment effect itself, which was introduced by Thaler (1980), connotes the idea that “losses loom larger than gains” (Kahneman & Tversky, 1979, p. 279), a key aspect of prospect theory (Kahneman & Tversky, 1979). To avoid confounding the empirical finding and its cause, we follow Plott and Zeiler (2007) in referring to it more neutrally as an exchange or valuation asymmetry, depending on the setting. The seminal work by Knetsch (1989) and Kahneman et al. (1990) spawned a series of studies documenting the existence of this effect for various market and non-market goods (see Horowitz and McConnell (2002) for an overview).

As highlighted by Ericson and Fuster (2014), a second wave of research began to question the existence and interpretation of the effect. Two studies by Plott and Zeiler postulated that the empirical finding was an artifact of experimental methodology and resulting subject misconceptions in the valuation setting (Plott & Zeiler, 2005; henceforth PZ2005) or resulting procedure-driven preferences in the case of exchange setting (Plott & Zeiler, 2007; henceforth PZ2007). A series of replications and extensions of Plott and Zeiler’s work, however, finds that while misconceptions do seem to contribute to valuation asymmetries, they are not the sole driver and in particular do not account for the observed impact of familiarity on stated WTAs (Georgantzis & Navarro-Martínez, 2010; Landesberg, 2007).

Evidence on loss aversion as a driver for valuation asymmetries remains mixed. Viscusi and Huber (2012) show that in the context of health risks, reference dependence exists both with respect to the risk probability and the avoidance costs. Bateman et al. (1997) find evidence in favor of reference-dependence in a setting.

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3 The considered controls to mitigate subject misconceptions include incentive-compatible elicitation, subject anonymity, and practice and training in the elicitation mechanism.

4 The considered procedure-driven theories include signaling theory, other-regarding preferences and information cascades due to lack of subject anonymity.

5 Johnson et al. (2021) continue to find valuation asymmetries using a novel elicitation method (Prince) that tries to make incentive-compatibility more salient to participants.
which controls for income and substitution effects. However, in light of prospect theory, the formation of reference points raises a potential concern with interpreting the observed asymmetries. Köszegi and Rabin (2006) formalized reference points under prospect theory as expectations about future outcomes. This raises the question that there may not be enough time in the lab for expectations to sink in, i.e. for the endowed item to become the new reference point. Ericson and Fuster (2011) find additional evidence supporting expectation-based reference points by testing the contention that WTA should rise if the (perceived) likelihood of trading is higher. Heffetz and List (2014) on the other hand fail to detect significant changes in WTA in a similar setting. A recent working paper by Chapman et al. (2017) finds no relation between participants’ reported valuations and their estimated degree of loss aversion.

Alternative explanations for valuation and exchange asymmetries include an aversion to bad deals (Weaver & Frederick, 2012); the presence of commitment costs in dynamic settings (Zhao & Kling, 2001, 2004); the psychological difference between buying and selling in a query theory framework (e.g. Carmon & Ariely, 2000); substitutability (Hanemann, 1991); failing to account for the selectivity in consumers’ own past market experiences (Tsur, 2008); incomplete preferences (Bewley, 2002); and the role of uncertainty. To our knowledge, the literature on choice uncertainty remains fairly sparse. Bateman et al. (2009) manipulate the “evaluability” of a non-market good in a choice experiment by presenting proposed land use changes either in terms of quantitative information or in the form of a virtual reality representation. Similar to our results, they find that providing participants with more tractable information reduces the marginal valuation of giving up a current endowment. Kingsley and Brown (2013) focus on uncertainty in preferences over goods with known attributes: they provide participants with a value learning opportunity by subjecting them to a series of hypothetical choices between the object of interest (a mug) and several other goods and monetary amounts. They find a subsequent reduction in WTA and an increase in WTP under the treatment condition, leading to a reduction in the WTA/WTP ratio from 1.97 to 1.27 which is indistinguishable from one given their relatively small sample size (n=42). A study by Humphrey et al. (2017) is closest in design to our exchange experiments: they endow participants with bundles of unfamiliar crisps and lemonade and manipulate choice uncertainty by providing a taste experience to a subset of participants before deciding whether or not to trade their items. However, they do not find a statistically significant exchange asymmetry in the control (no-taste) condition, possibly because subjects are more willing to trade even unfamiliar goods if the specific item they are trading is not the only good of this type in their bundle.

The experimental literature on trade uncertainty is more developed, starting with work by List (2003) suggesting that exchange asymmetries over sports cards vanish with the amount of trading experience in this space. List (2011) shows that

6 Inder and O’Brien (2003) propose a theoretical framework in which anxiety (defined as a negative psychological reaction to uncertainty) due to uncertain market opportunities creates such a trade-uncertainty driven wedge between stated WTAs and WTPs.
this result carries over to a context in which market experience is made exogenous by inducing a random sample of participants to enter the sports card market rather than relying on existing levels of experience. Engelmann and Hollard (2010) extend List’s analysis by explicitly forcing participants to gain market experience through trading. They study the effect of trade uncertainty on exchange asymmetries in a two-stage experiment: three interactive trading rounds in a first stage followed by a standard exchange asymmetry experiment in the second stage. Unlike in the control group, participants in the treatment group are required to trade in each round of the first stage. They find that exchange asymmetries completely disappear among subjects who had been forced to trade in the first stage. An interesting counterpoint to these studies is work by Apicella et al. (2014) who show that among a hunter-gatherer population in Northern Tanzania, increased exposure to markets coincides with increased exchange asymmetries.

Understanding the dominant drivers of exchange and valuation asymmetries has important practical implications. As pointed out by Kim et al. (2015), absent behavioral anomalies, the choice of WTA or WTP in contingent valuation depends only on the direction of the proposed changes (improvement vs. deterioration), as well as the prevailing property rights. Assuming the proposed change is relatively small, WTA or WTP in this case represent appropriate estimates of the Hicksian constructs of equivalent or compensating variation as demonstrated by Willig (1976). In the presence of valuation asymmetries on other hand, the close relationship between the stated preference measures and their Hicksian equivalent breaks down. One common recommendation is to rely only on WTP measures in practice (Arrow et al., 1993; OMB, 2003). Kim et al. (2015) update this recommendation to provide context-specific guidance on the preferred measure to use depending on the relevant deviation from the standard model.

This study contributes to this debate by shedding light on one potential source of significant distortions in stated valuations. While there is some compelling evidence regarding trade uncertainty, there is substantially less evidence for choice uncertainty. This paper provides novel support for the significance of choice uncertainty, advancing the case that this type of uncertainty is an important driver for observed behavioral anomalies. Our results suggest that subjects’ familiarity with the choice context plays a crucial role in determining whether WTP should be preferred even when WTA would be more appropriate from a conceptual perspective, and thereby contributes to the debate outlined in Kim et al. (2015) and Johnston et al. (2017) on best practices for contingent valuation.

3 Design

We test for the effect of choice uncertainty under both the exchange and the valuation paradigm. In each case, we implemented a primary design, which we experimentally tested at Cornell University in 2018 and 2019, and a follow-up design with modified procedures that replicates the control designs considered in PZ2005 and PZ2007 respectively. The follow-up studies were implemented at the University of Delaware in the Fall of 2021.

This section lays out the experimental procedures and relevant hypotheses for each of the experiments.
3.1 Exchange paradigm

The first set of studies tests for the effect of choice uncertainty on exchange asymmetries in a between-subject setting. In exchange asymmetry experiments, participants are randomly endowed with one of two items at the start and are given the opportunity to exchange their item with the experimenter at the end. Since the random endowment is independent of preferences, 50% of participants should want to exchange their item for the other good on average.\(^7\) Our main hypothesis in the exchange paradigm setting is the following:

**Hypothesis 1** Reducing choice uncertainty decreases exchange asymmetries, bringing the number of desired exchanges closer to the expected 50%.

Our primary design, which we will refer to as Experiment EP1, and which we conducted at Cornell University in Spring 2018 and 2019, draws on the exchange asymmetry procedure outlined in PZ2007, but (i) provides anonymity of exchange to avoid social contagion and (ii) randomizes endowment at the participant rather than the session level. We chose this modified design to create stronger parallels between our primary exchange and valuation paradigm studies.

Our follow-up design, which we will refer to as Experiment EP2, and which we conducted at the Center for Experimental and Applied Economics at the University of Delaware in Fall 2021, replicates the “Baseline” procedure outlined in PZ2007. Panels a and b of Fig. 1 summarize the sequence of events for these two respective experiments. Detailed experiment instructions can be found in Appendix A1.

3.1.1 Primary experiment design (Experiment EP1)

Participants were randomly assigned seats upon entering the lab. Each participant was endowed with one of two varieties of chocolate based on their seat number, identified only by a square or circle stapled to the bags (see Appendix A1 for pictures of the chocolate bags).\(^8\) Participants were only told that both varieties of chocolate were manufactured by the same company. The assignment of the chocolate was randomized to ensure that participants did not take the gift of their variety of chocolate as a signal of its relative value. The bag was placed immediately in front of participants to ensure

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\(^7\) Note that exchanges are made with the experimenter rather than with other participants. Participants wanting to exchange their item therefore do not depend on finding another participant willing to make the opposite trade. An alternative version of this experiment in which participants directly trade with one another is sometimes also used in the literature, see e.g. Thaler (2015).

\(^8\) The “circle” variety bags contained half of a Ghiradelli “Milk Chocolate & Caramel” bar, while the “square” variety bags contained half of a Ghiradelli “Intense Dark: Twilight Delight” bar. The brand and name of the chocolate bars were not given to the participants. The two items were of equal retail value: both chocolate bars were available at $3.95 through Ghiradelli’s website at the time of the experiment.

\(^9\) We endowed participants with the bag before allowing treated participants to taste the chocolate in order for the endowment to “sink in”. Starting the experiment with the tasting could lead participants to make up their mind regarding their preferred type of chocolate before even being endowed with a random bag.
that participants had a feeling of ownership over the chocolate. Participants were told that the bag of chocolate was theirs, that it was a gift, and that they owned it.

The experiment was conducted in pen and paper format. In the treatment sessions, the participants were given the option of tasting a small amount of each variety of chocolate before making their decision. In the control sessions, the participants were told that the “circle” variety chocolate was described as “rich” and the 

Panel a  Primary exchange-paradigm study EP1

Panel b  Exchange-paradigm follow-up study EP2

Fig. 1  Sequence of events for the exchange-paradigm studies
“square” variety of chocolate was described as “luxurious.” The two scripts were otherwise identical. Before making their trade decisions, participants were asked to complete a short five-minute survey (see Appendix A1). This survey was included to increase a feeling of endowment by extending the time that participants had ownership over their chocolate. The questions on the survey were modeled after a similar survey used in PZ2007, which includes many of the same questions. The surveys were not connected to the participants and provide no useful data for this study.

Once all participants had completed the survey, they were given a small piece of paper on which to make their trade decision. These trade decisions were made privately to avoid any possible contamination caused by public trades. Once the sessions concluded, each participant was given a $10 participation fee and participants traded their chocolate at the front of the room, if they had chosen to do so on their trade sheet.

Six exchange asymmetry sessions were conducted between early 2017 and early 2018 at Cornell’s LEEDR lab. Subjects included Cornell staff and students. Of the six conducted exchange asymmetry sessions, half were treatment sessions and the other half served as control sessions. The treatment sessions included 59 total participants, compared to 64 participants in the control sessions. Each session lasted less than 30 minutes.

3.1.2 Follow-up design (Experiment EP2)

To provide a second test of the effect of choice uncertainty on exchange asymmetries, we completed a follow-up study which replicates the PZ2007 “Baseline” design. Compared to EP1, experiment EP2:

- required participants to make trades publicly rather than anonymously by raising their hand to indicate the desire to keep the endowed item; and
- endowed every participant in a given session with the same item rather than using random assignment of items.

3.2 Valuation paradigm

The second set of studies tests for the effect of choice uncertainty on valuation asymmetries in a between-subject setting. Our primary hypothesis is the following:

**Hypothesis 2** Reducing choice uncertainty decreases valuation asymmetries measured using WTA/WTP ratios.

Our primary design, which we will refer to as VP1, was conducted at Cornell University in Spring 2018 and 2019. Our follow-up design, which we will refer to as Experiment VP2 and which we conducted at the University of Delaware in Fall 2021, replicates the baseline “KKT Replication” design of PZ2005 (which in turn

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10 These descriptions were drawn directly from Ghiradelli’s advertising of the two products and were given to the participants to provide a difference (albeit a minor one) between the two varieties.
replicated Study #5 presented by Kahneman et al., 1990). Panels a and b of Fig. 2 summarize the sequence of events for these two respective experiments. The experiment instructions for the two different designs can be found in Appendix A2.

3.2.1 Primary experiment design (Study VP1)

Our primary experiment design combined language and approaches from various designs outlined in PZ2005 and PZ2007 to create more symmetry between our primary valuation and exchange paradigm studies:

Upon entering the lab, participants received a $5 participation fee and were assigned random seats. Based on their seat number, half of the participants were endowed with an unmarked bag of chocolate. The assignment of chocolate was randomized to ensure that participants did not interpret the assignment as a signal of value. The bag was placed immediately in front of participants to ensure that participants had a feeling of ownership over the chocolate. As in our primary exchange paradigm study EP1, participants given the chocolate were told that the bag of chocolate was theirs, that it was a gift, and that they owned it.

The experiment was conducted using a web-based survey programmed in oTree (2016). Participants were instructed on the Becker-deGroot-Marschak mechanism (BDM; Becker et al., 1964) and completed one unpaid practice round and five paid rounds valuing assets with random returns. The asset rounds served both as training for the BDM mechanism and to allow sellers to spend a similar amount of time endowed with their bag of chocolate as in experiment EP1.

Table 1 summarizes the asset choices. After each participant submitted a value for the asset, they were informed whether they bought or sold the asset, how much they paid or were paid, and whether the asset yielded a return. Participants were also given a running tally of their current earnings, including their participation fee. In order to avoid wealth effects, participants in the WTP group received an additional $5 for the asset valuation rounds, as well as $4 for the chocolate task. This information was given to them privately on their screens.

After the asset valuation stage, participants were asked to provide a value for the unmarked bag of chocolate, again using BDM. In half of the sessions, participants were given a small piece of the chocolate to taste before making their decisions. The instructions were otherwise identical across the two treatments. All payments as well as the final allocation of chocolate were realized privately at the end of the session.

The sessions for Experiment VP1 were conducted in Cornell’s LEEDR lab. Subjects included Cornell staff and students. Four valuation asymmetry sessions were conducted in Spring 2018, followed by two additional sessions in Spring 2019. Of the six conducted valuation asymmetry sessions, half were treatment sessions and the other half served as

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11 Each bag contained half of a Ghiradelli “Milk Chocolate & Caramel” bar.
12 This roughly corresponds to the total expected value across the five paid asset rounds ($5.18) and the retail price of the chocolate on Ghiradelli’s website ($3.95 at the time of the experiment). Note that particularly in the presence of (heterogeneity in) risk aversion, this approach represents an imprecise way of eliminating wealth effects. However, the remaining differences are likely to be second order compared to the we care about.
Panel a  Primary valuation-paradigm study VP1

Panel b  Valuation-paradigm follow-up study VP2

Fig. 2  Sequence of events for valuation-paradigm studies
control sessions. The treatment sessions included 53 total participants, compared to 59 participants in the control sessions. Each session lasted less than 45 minutes.

### 3.2.2 Follow-up design (Study VP2)

To provide a second test for the effect of choice uncertainty on valuation asymmetries, we conducted a follow-up study at the Center for Experimental and Applied Economics at the University of Delaware in Fall 2021. This study, which we will refer to as experiment VP2, follows the baseline “KKT Replication” treatment of Plott and Zeiler (2005) (which itself replicated an earlier design presented as Study #5 in Kahneman et al., 1990). Compared to VP1, experiment VP2

- removed the “gift” language;
- implemented the BDM elicitation task using a price list rather than a text entry box;
- trained participants on the elicitation mechanism using two hypothetical token rounds rather than an unpaid asset valuation;
- removed the paid asset valuations;
- did not endow sellers with chocolate until after the token rounds, which substantially shortens the period during which participants are endowed with the item relative to experiment VP1;
- required buyers to use their own money; and
- implemented payments and transactions publicly at the end.

### 4 Results

#### 4.1 Exchange paradigm (Experiments EP1 and EP2)

Table 2 summarizes the observed number of trades across the two treatment arms. In the control condition, participants were reluctant to give up their initial endowment, with only 8% of subjects choosing to trade their unmarked bag of chocolate for a bag of the alternative kind. In contrast, participants who were given the opportunity to taste the chocolate before making their trading decisions exhibited an average trade rate of 49%, much closer to the theoretically predicted level of 50%.

| Round | Asset | EV  |
|-------|-------|-----|
| Practice | ($3, 60% ; $0, 40%) | $1.80 |
| 1     | ($1.50, 90% ; $0, 10%) | $1.35 |
| 2     | ($2, 40% ; $0, 60%) | $0.80 |
| 3     | ($1.50, 50% ; $0, 50%) | $0.75 |
| 4     | ($1.25, 75% ; $0, 25%) | $0.88 |
| 5     | ($2, 70% ; $0, 30%) | $1.40 |
The results from a series of different hypothesis tests support the dissipation of exchange asymmetries under the taste treatment. First, we ran an exact binomial test to assess whether the number of trades under treatment and control was equal to 50%. This null hypothesis was rejected for the control group in which we only observed five realized trades (p-value < 0.001). In the treatment group, in which 29 out of 59 subjects traded, the null hypothesis could not be rejected (p-value = 1.000).\(^\text{13}\) Similarly, a Pearson’s Chi-Squared test for homogeneity rejects that the proportion of items traded is equal across treatment groups (p-value < 0.001).\(^\text{14}\)

The taste treatment thus had a significant impact under the exchange paradigm, fully dissipating the large asymmetry observed in the control group. This result is striking since earlier exchange paradigm designs such as the one used in PZ2007 find exchange asymmetries even when participants are presented with familiar goods such as university-branded mugs and pens. To rule out the possibility that the absence of an exchange asymmetry is an artefact of our experiment design, we conducted follow-up study EP2 which directly mirrors the “Baseline” condition of PZ2007.

Table 3 reports the results from these additional sessions. Once again, participants in the control condition were reluctant to give up their initial endowment, with only 13% of subjects choosing to trade their unmarked bag of chocolate for a bag of the alternative kind. In contrast, participants who were given the opportunity to taste the chocolate before making their trading decisions again exhibited an average trade rate of 49%. Experiment EP2 thus successfully replicates the full dissipation of the exchange asymmetries in the treated groups.

We speculate that the observed difference to the exchange asymmetry found in the PZ2007 baseline condition is driven by the relative ease of ranking preferences for two varieties of the same type of product compared to preferences over less related products such as mugs and pens. That is, we hypothesize that while mugs and pens are relatively familiar goods, there still exists some uncertainty over the

| Table 2 | Summary statistics (Experiment EP1) |
|---------|------------------------------------|
|         | Treatment | Endowment | N  | # Traded | Trade Rate |
|         | Circle    | 31        | 3  | 10%      |
|         | Square    | 33        | 2  | 6%       |
|         | Total     | 64        | 5  | 8%       |
| Taste treatment | Circle    | 30        | 13 | 43%      |
|         | Square    | 29        | 16 | 55%      |
|         | Total     | 59        | 29 | 49%      |

\(^\text{13}\) Note that we did not use Fisher’s exact test in this setting since the expected frequency under the null hypothesis was greater than 5 in each cell.

\(^\text{14}\) We also used a Pearson’s Chi-Squared test of independence to assess whether the type of chocolate participants chose depends on their initial endowment. In the control group, in which most participants chose to keep the bag of chocolate they were given by the experimenter, the null hypothesis of independence between endowments and final choices was rejected (p-value < 0.001). Among participants who had tasted the chocolate, we were not able to reject that the chocolate they left with was independent of the chocolate they were initially given (p-value = 1.000).
relative preferences for those two items while that there is no comparable intrinsic uncertainty over the two types of chocolate.

4.2 Valuation paradigm (Experiments VP1 and VP2)

Table 4 summarizes participants’ asset decisions during the 6 BDM practice rounds of study VP1. The difference in means between WTA and WTP is statistically significant for several of the lottery valuations. This finding as well as the magnitude of the observed WTA/WTP ratios is in line with data reported in the PZ2005 design using their full set of controls for subject misconceptions, as well as the PZ2005 replication by Isoni et al. (2011).

Table 5 provides summary statistics for the stated chocolate valuations. Participants in the control group exhibited a larger WTA/WTP ratio (3.47) than participants who had the opportunity to taste the chocolate before stating their valuations (1.73). Even

| Treatment     | Endowment | N  | # Traded | Trade Rate |
|---------------|-----------|----|----------|------------|
| Control Circle| 30        | 6  | 20%      |            |
| Square        | 30        | 2  | 7%       |            |
| Total         | 60        | 8  | 13%      |            |
| Taste treatment Circle | 28 | 11 | 39%      |            |
| Square        | 27        | 16 | 59%      |            |
| Total         | 55        | 27 | 49%      |            |

Table 4 Asset choice results (Experiment VP1)

| Round | EV  | Avg. WTA | Avg. WTP | WTA/WTP Ratio | p-value (Difference in Means) |
|-------|-----|----------|----------|---------------|-------------------------------|
| Practice | $1.80 | $2.34   | $1.95   | 1.20          | 0.672                         |
| 1     | $1.35 | $1.47   | $1.26   | 1.17          | 0.012                         |
| 2     | $0.80 | $1.27   | $0.88   | 1.44          | <0.001                        |
| 3     | $0.75 | $1.17   | $0.70   | 1.67          | 0.001                         |
| 4     | $0.88 | $1.20   | $1.03   | 1.16          | 0.365                         |
| 5     | $1.40 | $1.69   | $1.34   | 1.26          | <0.001                        |

15 Falsification tests show that the treatment has no significant effect on stated WTA or WTP for any of the asset choices.

16 Isoni et al. (2011) use this finding to contest that valuation asymmetries *in general* are created by subject misconceptions as they posit PZ2005 claim, while Plott and Zeiler (2011) argue that the valuation asymmetries in this lottery setting are explained by contamination such as through differential participant beliefs about lottery outcomes for WTP and WTA tasks. Since our treatment effect of interest concerns a good (chocolate) rather than a financial asset involving risk, we remain agnostic as to the drivers of the residual valuation asymmetries for lotteries in this setting. However, the valuation asymmetries we find in the lottery task provide an interesting benchmark for the valuation asymmetries we find in the chocolate round of our study.
in the treatment group, the WTA/WTP ratio remains larger than one, but now looks more like some of the larger valuation asymmetries we find for the 5 lottery tasks.

Figure 3 graphically breaks down this difference between the average stated WTA and WTP in the treatment vs. control group. Most of the difference appears to be driven by a reduction in the average WTA under the taste treatment, while the average WTP increases slightly when participants are given the opportunity to sample the chocolate before providing their valuations. To formally test for significance of the observed changes, we employ a series of parametric and non-parametric tests for differences in means and distributions respectively. We also ran a series of two-sided Wilcoxon-Mann-Whitney rank sum tests for differences in distributions. Test results are similar to the parametric case, although the remaining valuation asymmetry in the treatment group is more statistically significant under the non-parametric tests. While alleviating choice uncertainty leads to a lower WTA/WTP ratio overall, the lower ratio remains close to statistically significant even after the treatment.

Table 6 summarizes the test results.\(^{17}\)

Table 5  Summary statistics (Experiment VP1)

| Treatment       | Endowment               | N  | Mean (Standard Error) |
|-----------------|-------------------------|----|-----------------------|
| Control         | Endowed (WTA)           | 29 | 3.26 (0.490)          |
|                 | Not endowed (WTP)       | 30 | 0.94 (0.241)          |
|                 | Avg. WTA/Avg. WTP       |    | 3.47                  |
| Taste treatment | Endowed (WTA)           | 25 | 2.25 (0.275)          |
|                 | Not endowed (WTP)       | 28 | 1.30 (0.266)          |
|                 | Avg. WTA/Avg. WTP       |    | 1.73                  |

\(^{17}\) We implemented the non-parametric Kruskal-Wallis equality-of-populations rank test in order to ensure that pooling data across sessions is appropriate. This test represents an extension of the Mann-Whitney U test to more than two independent groups. The null hypothesis posits that the observed levels of WTA (WTP) across sessions are drawn from identical populations. We were not able to reject the null hypothesis for WTA (WTP) across sessions in the control (treatment).
10% level respectively could therefore instead be evaluated at the Bonferroni-corrected significance levels of 0.25%, 1.25% and 2.5%. Even applying these more stringent significance levels, the WTA/WTP disparity remains statistically significant in the control group but is no longer significant in the treatment group at the 5%-equivalent level. While the t-tests indicate that stated WTA is higher in the control group, this effect is not significant at the Bonferroni-corrected levels. The difference in WTP is not statistically significant even under uncorrected significance cutoffs.

The large drop in stated WTA in the treatment sessions suggests that more trades may have been mutually acceptable as a result of the taste treatment. To examine this possibility, we can sort participants’ stated valuations and calculate the implied number of people who would have been willing to buy (or sell) at a given price. Figure 4 plots the corresponding implied inverse supply and demand functions. The horizontal dashed line indicates the implied equilibrium number of trades for each group. Interestingly, this graph suggests that the drop in average WTA is driven by a lower number of extreme valuations rather than a general downward shift in WTA. As a result, the number of mutually acceptable trades increases by only 8% under the treatment: in the control, seven out of 29 possible trades would have been mutually acceptable (24%), compared to eight out of 25 under the treatment (32%). This breakdown shows that the usual metric summarizing valuation asymmetries in terms of the average WTA/WTP ratio conceals some important underlying dynamics.

Finally, since participants in the WTP group were given additional money for their asset and chocolate purchases, we need to ensure that there is no relationship between stated valuations and existing earnings that could explain their higher valuations. One argument against this effect is that participants in the treatment group

| Hypothesis testing (Experiment 1) |
|----------------------------------|
| **Parametric: Two-sample t-test** | (Null hypothesis: equal means) |
| $t$ | $p$-value |
| WTA vs. WTP (Control) | 4.32 | 0.0001 |
| WTA vs. WTP (Treatment) | 2.53 | 0.0145 |
| WTA Control vs. Treatment | 1.81 | 0.0766 |
| WTP Control vs. Treatment | -1.03 | 0.3056 |
| **Non-Parametric: Wilcoxon-Mann-Whitney rank sum test** | (Null hypothesis: identical distributions of WTA, WTP) |
| $z$ | $p$-value |
| WTA vs. WTP (Control) | 4.66 | 0.0000 |
| WTA vs. WTP (Treatment) | 2.95 | 0.0032 |
| WTA Control vs. Treatment | 1.44 | 0.1505 |
| WTP Control vs. Treatment | -1.45 | 0.1481 |

Note that unlike in Experiment 2, we should not expect to see 50% of items traded in this case since we are comparing trade between participants, rather than a simple exchange with the experimenter as in Experiment 2.
were provided with identical cash balances as subjects in the control group but exhibited a much lower valuation asymmetry. In addition, we follow PZ2005 in running a linear regression of WTA and WTP on participants’ cumulative earnings in order to explicitly test for this so called “House Money Effect”. The coefficient on existing earnings was not significant at the 10% level in either specification.

Saturation is one possible concern with Experiment VP1’s experimental design: participants in the treatment group might exhibit lower valuations due to already having tasted a sample of the chocolate and satisfied their present desire to consume the chocolate. However, we find that while stated WTA in the treatment group decreases, stated WTP actually rises slightly (although the difference is not statistically significant). A saturation explanation should lead to a decrease in both measures.

Once again, it is striking that the taste treatment in study VP1 leads to valuation asymmetries that, while statistically significant, are closer to those for financial lotteries than those found in other valuation asymmetry studies using familiar goods such as PZ2005.

Experiment VP2 was meant to provide a second test of the treatment effect using an experimental design replicating the control condition used in PZ2005. However, the experiment did not produce a sizable endowment effect in the control condition (the WTA/WTP ratio in the control condition was 1.31 for study VP2 compared to a WTA/WTP ratio of 3.47 in the control condition of study VP1). An analysis of the results in the token rounds suggests that this cannot be explained by a lack of understanding of the price list elicitation mechanism (see Appendix B1 for detailed results).

Since the design we borrow from PZ2005 is itself a (successful) replication of the design presented in Kahneman et al. (1990), we suspect that our unsuccessful replication most likely reflects the unique circumstances under which these experiments were conducted: due to concerns regarding COVID-19 in Fall 2021, we tried to minimize the shared touching of chocolate bags and regularly provided hand sanitizer and disinfecting wipes during the session. Buyers were handed separate bags.
rather than being able to explore the chocolate bag of neighboring sellers as in VP1. In addition, all participants were required to wear masks throughout the experiment, except when tasting the chocolate. It is possible that these necessary changes prevented, or contributed to, the failed replication, but we cannot be certain.

4.3 Combining evidence from both experimental paradigms

Figure 5 summarizes the headline results of our two primary experiments side by side. The dashed lines in the two figures indicate the theoretically predicted levels in the absence of valuation or exchange asymmetries (a WTA/WTP ratio of 1 and a 50% trade rate respectively). While the exchange asymmetry effectively disappears under Experiment EP1, we continue to observe a valuation asymmetry under Experiment VP1 that is similar in magnitude to the valuation asymmetries we observe in the lottery task of Experiment VP1.

We argue that the differential attenuation of the “endowment effect” across the two study designs may be due to value or intrinsic uncertainty. Under Experiment EP1, participants in the taste treatment are asked to provide a direct comparison between two known types of chocolate without being required to map their preferences over the two types into utility or value terms. Treated participants in Experiment 1 on the other hand are required to map their preference for the sampled type of chocolate into money. The residual valuation asymmetry could indicate that subjects struggle to know with precision how much they value the offered chocolate in dollars, and that this value uncertainty differentially effects the stated valuations of buyers and sellers. This idea is in line with the findings by Kingsley and Brown (2013) that providing participants in valuation paradigm settings with value learning opportunities reduces valuation asymmetries. The finding also aligns with predictions from the model of imprecise preferences presented in Dubourg et al. (1994).

While our experiment does not directly distinguish between object or product uncertainty (being unsure about the attributes of the product itself) and preference

![Fig. 5 Summary of findings (Experiment VP1 vs. Experiment EP1)]
uncertainty (being unsure about how much you value a product with given attributes), the difference in findings between the two experimental procedures may shed some light on this distinction and suggests an interesting avenue for future research on the role of different types of uncertainty on valuation asymmetries.

5 Discussion

This study uses experiments to test for the effect of choice uncertainty on value and exchange asymmetries. Despite its ubiquity in stated preference settings outside of the laboratory, this type of uncertainty has received relatively little attention in the endowment effect literature so far. We find that a reduction in product uncertainty alleviates valuation asymmetries by decreasing the number of extreme valuations by sellers, and fully dissipates exchange asymmetries in our setting. At the same time, our treatment has little effect on the number of implied mutually acceptable trades under the valuation paradigm, and we failed to replicate any valuation asymmetry in a follow-up study, possibly due to COVID-19 related precautions.

Shogren et al. (1994) argue that the WTA/WTP asymmetry for nonmarket goods such as health or environmental quality can be driven by a lack of close substitutes. In their study, repeated exposure to the market eliminated valuation asymmetries for common private goods (including a known, name-brand candy bar), but did not eliminate it for a private nonmarket good without close substitutes. Our results suggest choice uncertainty as an alternative explanation for their experimental finding.

In addition, it is striking to note that both our choice uncertainty intervention and the forced trading in Engelmann and Hollard (2010) are effective in eliminating the large exchange asymmetries observed under the control. Engelmann and Hollard “conjecture that trade uncertainty is most important for exchange asymmetry” (p. 2005) because exchange asymmetry completely disappears in a setting where choice uncertainty is held constant. Our setting on the other hand manipulates product uncertainty while holding trade uncertainty constant. One possible explanation is that forced trade not only increases familiarity with the market mechanism, but also serves as an implicit value learning exercise as participants in the treated group are required to experience the emotions generated by an exchange between two products.

In general, we believe that more than one single factor may be at play in generating exchange and valuation asymmetries. We hope to add to our understanding of these effects by highlighting an additional driver with significant practical relevance, particularly in environmental valuation settings. Our results suggest that, while most practical applications rely on stated valuations and are therefore most interested in factors that may create a wedge between WTA and WTP, there may be much to learn by comparing results under the two experimental paradigms side by side.

19 The nonmarket good considered was the possibility to upgrade from a lunch from a local restaurant with a typical chance of being contaminated with food-borne pathogens to similar food that had undergone a stringent screening.
An important area for future research is to explore the mechanisms through which choice uncertainty affects valuations and choices. Possible frameworks that might be able to generate the observed behavior include incomplete preferences, ambiguity aversion and regret. Future work in this area should therefore try to derive and test unique predictions from each of these candidate models in order to determine which mechanism may dominate in this setting.

Another potential area of interest concerns the potential difference in the effect of choice uncertainty in the case of goods versus “bads”. While our results show that a reduction in choice uncertainty decreases the average WTA/WTP ratio for a good, Coursey et al. (1987) find the opposite effect in the case of an unpleasant, bitter tasting substance. While the taste treatment in their case was administered within subject and its effect captured by hypothetical (non-incentivized) valuations, it would be interesting to replicate their study under our experimental framework. Such a differential effect could be particularly relevant in practice since most empirical applications of contingent valuation approaches apply to the valuation of environmental damages or negative externalities.

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Data availability The de-identified data generated and analysed during the current study are available in the OSF.io repository, https://osf.io/g7bu3/?view_only=280a50d8f11943d6a90cfa6934c74201.

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