Willingness to Accept and Meta-cognitive Uncertainty Aversion

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1 Introduction

Traditionally, consumer theory predicts that willingness to pay (WTP) and willingness to accept (WTA) should not meaningfully diverge from each other (Willig, 1976). This prediction follows from the assumption that an individual's indifference curves are defined independently of their initial endowment and budget constraint, a property known as preference–budget independence. Empirically, however, WTA is often substantially higher than WTP, leading to fewer trades than what orthodox models, articulated in the Coase Theorem, predict. For instance, Horowitz and McConnell (2002), who aggregated evidence from 45 WTP–WTA studies, reported a median ratio of 2.6 between mean WTA and mean WTP. To account for this gap, many economists have proposed theories that relax the preference–budget independence assumption. One prominent explanation is reference dependence, which is the idea that individuals evaluate outcomes relative to a reference point where they exhibit asymmetric sensitivity to gains and losses (Kőszegi & Rabin, 2006). Behavioural economists have highlighted another mechanism underlying this asymmetry: the endowment effect, being a cognitive bias in which individuals assign higher value to objects simply because they own and use them (Kahneman et al., 1990). This proposal has faced much criticism and even countervailing evidence: Plott and Zeiler (2005) argue that the endowment effect is due to participants not understanding the procedures of Kahneman et al.'s (1990) experiment. We propose a modification of this theory that both embraces the counter-evidence and elucidates on the relationship between riskless choices and risk and ambiguity aversion. We posit that the endowment effect observed in Kahneman et al. (1990) was primarily driven by meta-cognitive uncertainty aversion.

2 Literature Review

With respect to the endowment effect, Kahneman et al. (1991) conducted an experiment to determine whether this bias contributes to the WTP-WTA gap. They argued that experimental tokens, which participants typically exchange for money at the end of a study, should not trigger the endowment effect because they are acquired purely for resale rather than consumption. In this setting, buyers and sellers should value tokens solely based on their assigned monetary redemption value. In contrast, everyday consumption items, such as mugs, should elicit the endowment effect, since their utility extends beyond resale value: consumers own and use the mugs. To test this prediction, the researchers randomly assigned subjects to buyer or seller roles across multiple simulated markets. Sellers were then given goods that differed in whether their value derived purely from resale potential (i.e. tokens) or from "genuine" consumer use (i.e. mugs). For the mug markets, the experimenters elicited truthful WTP and WTA from buyers and sellers, respectively, by using the Becker-DeGroot-Marschak (BDM) mechanism: each participant stated whether they are (willing to buy)/(sell) a mug at each price with a fixed interval β, then, the experimenter chose a price at random for the actual transaction. Therefore, all buyers who indicated a WTP greater than or equal to the randomly selected price bought an item at that price and all sellers who indicated a WTA lower than or equal to the randomly selected price sold their item at that price. Because the random price selection process eliminated the participants' influence on the market price, it discouraged the strategic misrepresentation of valuations (Becker et al., 1964). However, for the token markets, the experimenters did not use a random price (i.e. absence of the BDM mechanism): Kahneman et al. (1990) used a market clearing price instead. To discourage strategic misrepresentation of valuations, they simply told participants that "it is in your best interest to answer these questions truthfully." Consistent with their hypothesis, Kahneman et al. (1990) found a WTP–WTA gap for the mugs, but not for tokens, suggesting that the endowment effect explains this discrepancy.

2.1 The Standard Model

Kahneman et al. (1991) state that the endowment effect aligns with prospect theory, which states that losses hurt more than gains given a certain reference point. In this case, a seller who owns a mug may perceive the act of selling the mug as a major loss; thus, they set a higher WTA to compensate for said loss. Broadly speaking, this endowment effect implies that preference orderings are not defined independently of endowments: good A may be preferred to B when A is an original endowment, but the reverse may be true. Because the endowment serves as a reference point, the indifference curve is no longer smooth and instead displays a "kink" at that point. As a result, an indifference curve that reflects acceptable trade-offs when moving in one direction can actually intersect with a different indifference curve representing acceptable trades in the opposite direction (Knetsch, 1989).

2.2 The Rebuttal

Nevertheless, critics have argued that the WTP-WTA gap for consumption goods may instead arise from procedural misunderstandings (Plott & Zeiler, 2005). Plott and Zeiler (2005) hypothesized that, if the participants do not truly understand why it is in their best interest to truthfully state how much they value an item, then they may default to familiar strategies associated with auctions: as a seller, a participant may announce an amount higher than their actual valuation to extract more consumer surplus. This critique originates from Kahneman et al. (1990) not explicitly explaining to participants why truthfully valuations were in their best interest under the BDM mechanism: they only mentioned to participants that "1) Your decision can have no effect on the price actually used because the price will be selected at random. (2) It is in your interest to indicate your true preferences at each of the possible prices listed below." Replicating the design of Kahneman et al. (1990), they added extensive training to ensure participants fully understood why providing truthful valuations is the best response to the BDM mechanism; they also incorporated two unpaid "practice" rounds. Under this revised protocol, they were unable to reproduce the original findings, leading them to claim that the observed gap is largely due to misunderstandings of the experimental procedures. However, these authors have pushed a serious issue under the rug: why did the BDM mechanism lead to the mugs being overvalued by the sellers, rather than any number of possible alternatives? At first sight, this may appear to be a question of little theoretical significance, but dissecting its inner workings would truly shed light on how the "endowment effect" functions. As preliminary, we introduce the proper background needed to understand our "meta-cognitive uncertainty aversion" theory.

3 Our General Framework

In this section, we will discuss the broad literature surrounding meta-cognitive uncertainty judgments, being how uncertain an agent is about their decision(s). De Martino et al. (2013) state that we can experimentally elicit how certain an agent is about their choices. In addition, these judgments are often made independent from the decision themselves (Flaming & Daw, 2017). Mathematically-speaking, they are best modeled as a second-order Bayesian inference about the match between the state of the world and the decision (Flaming & Daw, 2017). Crucially, meta-cognitive uncertainty attenuates the extent to which preferences predict choice (De Martino et al., 2013; Enke & Graeber, 2023). In other words, if you are more uncertain about your choices, then you are more likely to exhibit inconsistent preferences, making it harder to predict your choices. Finally, agents can exhibit meta-cognitive uncertainty even in systems without any first-order risk or ambiguity (Enke and Graeber, 2023). Please note that systems in this paper describe the environments that determine a person's outcomes. This observation is of deep theoretical significance, as it posits that meta-cognitive uncertainty is present in decisions made in systems that are not inherently uncertain. For example, picture an economics student who is tasked with solving for the Nash Equilibria of the Prisoner's dilemma, they may still be uncertain about their answer despite the problem and the solution derivation process being well-defined. Therefore, choices in effectively certain environments are still influenced by meta-cognitive uncertainty aversion.

Given this information, we will construct our theory's general framework. We know that agents tend to exhibit ambiguity aversion in first-order ambiguity scenarios (Ellsberg, 1961). We extend this notion by postulating that agents exhibit uncertainty aversion in systems that elicit meta-cognitive uncertainty. Again, these systems do not have to be inherently uncertain. By definition, agents should avoid options associated with high meta-cognitive uncertainty. Concerning how our theory applies to Kahneman et al.'s (1990) experiment, we must remember that the authors did not explicitly explain to the participants why truthful valuations were the best response to the BDM mechanism; thus, participants may have been skeptical about their claim. Therefore, we posit that participants were essentially given a choice: either manually solve for the best response to the BDM mechanism (i.e. convince yourself that truthful valuations are the best response to BDM mechanism) or maintain your current state (i.e. role that they were randomly assigned to). Regarding the former, manually solving for the best response to the BDM mechanism may result in even greater cognitive uncertainty: when solving a system, you must rely upon a set of assumptions and steps where one error permeates across the remainder of the approach so, in a sense, uncertainty about each step compounds across steps. Thus, assuming that these participants were uncertainty averse, we postulate that they would prefer to maintain their current state to avoid incurring more uncertainty when solving for the best response to the BDM mechanism. To maintain their current state, participants would have to exhibit a WTA/WTP that is strongly congruent with their assigned role (i.e. seller stating an inflated WTA or a buyer stating a deflated WTP). In addition, our theory also explains Plott and Zeiler's (2005) results: through market experience, Plott and Zeiler's (2005) participants properly understood why truthfully responding to the BDM mechanism is the best response, resulting in no meta-cognitive uncertainty being incurred, ultimately culminating in no WTA-WTP discrepancy. In addition, our theoretical account of the endowment effect can thoroughly explain Kahneman et al.'s (1990) findings: the authors observed a WTA-WTP discrepancy in the mug markets, but not in the token markets. In our view, this observation stems from the token markets not using a BDM mechanism, meaning there is no meta-cognitive uncertainty that would render the buyers and sellers averse to trading. We thus find ourselves with a rectified and restricted version of the endowment effect: this effect is predicated upon meta-cognitive uncertainty aversion.

Thus far, we have the following causal chain:

$$\text{Meta-cognitive Uncertainty} \xrightarrow{\text{Meta-cognitive Uncertainty Aversion}} \text{WTA-WTP gap} \tag{1}$$

To provide our reader with a higher resolution account for the WTA-WTP gap, we must acknowledge the relationship between meta-cognitive uncertainty and cognitive complexity. Luckily for us, Enke and Graeber (2023) have posited a link between cognitive complexity and uncertainty. They found that tasks with higher cognitive complexity resulted in higher levels of cognitive uncertainty. Concerning measurements of cognitive uncertainty, Enke and Graeber (2023) measured it by asking participants how certain (in %) they were that their decision was somewhere between $(x - \alpha)$ and $(x + \alpha)$ where x is the participant's decision and α is a margin of error. Participants responded to this question by using a 5% interval slider that ranges from 0% to 100%. Regarding manipulations of cognitive complexity, Enke and Graeber (2023) modulated it by using complicated mathematical expressions to express simple numbers. For example, an experimenter could mention that a mug is worth $\frac{6*9}{3} - 7\$$ instead of 11\$. These authors went on to show that complexity, via meta-cognitive uncertainty, induced participants to choose what they call "middle of the road" responses—equivalent to, in our framework, the responses associated with less complexity and, hence, less meta-cognitive uncertainty. For example, one task had two bags with differing compositions of red and blue balls, then the experimenter randomly sampled some balls from one of the bags; afterward, the participant had to guess which bag the sample came from. Obviously, the "middle" response would be $P(Bag|Data) = 50\%$.

Thus far, we posit that the following causal pathway accounts for the discrepancy between WTA and WTP:

$$\text{Cognitive Complexity} \rightarrow \text{Meta-cognitive Uncertainty} \xrightarrow{\text{Meta-cognitive Uncertainty Aversion}} \text{WTA-WTP Discrepancy}$$

Again, Enke and Graeber (2023) have found evidence supporting the first causal link. Ergo, our experiment focuses on finding support for the second link. In what follows, we provide an experimental test that teases apart our account, Kahneman et al.'s (1990), and Plott and Zeiler's (2005). We shall examine the interaction between the complexity of the elicitation procedure and the type of goods traded (mugs or tokens). Kahneman et al. (1990) would predict that the endowment effect arises from the ownership of a useful good (the mugs) rather than one that will immediately be traded in (the tokens). We predict that the endowment effect is the product of the complex procedure, irrespective of the type of goods traded. Plott and Zeiler (2005) argue that incomprehension results in the endowment effect, and we show that mere uncertainty (about one's factually correct understanding) is a sufficient condition for it.

4 Experimental Design

To design an experiment that can substantiate a causal link between meta-cognitive uncertainty and the WTP-WTA gap, we need to address a few issues: 1) we want our experiment to have an incentive-compatible elicitation mechanism that can be easy for participants to understand, and 2) we want to manipulate the cognitive complexity associated with deriving the best response to said elicitation mechanism (i.e. modulate the uncertainty surrounding the best response to the elicitation mechanism).

Regarding the former, Plott and Zeiler (2005) simplified the BDM mechanism by allowing participants to do many practice rounds where they understood, through market experience, that not stating the true value of their items resulted in suboptimal outcomes. However, the behavioural literature surrounding market experience argues that their simplification procedure may have induced a trader mode in their participants: an increased market experience itself resulted in the absence of a WTA-WTP discrepancy (List, 2011). Therefore, we want our incentive-compatible elicitation mechanism to be simpler without resorting to higher levels of market experience. To achieve this objective, we will use the multiple price list with random row selection (MPL): each participant will state whether they are (willing to buy)/(sell) a mug at each price with a fixed interval β across prices, then, the experimenter will choose a row at random for the actual transaction. The BDM mechanism used in Kahneman et al. (1990) also uses a similar multiple price list; however, they mention that a random price will be selected instead of a random row. Crucially, the BDM mechanism is harder to understand than the MPL mechanism: it requires participants to associate each price with its respective row and then, intuit that, when a random price is selected, this means that a random row will be selected. In essence, the MPL and BDM mechanisms function the same but one is more intuitive to understand than the other.

In addition, the reasoning behind why truthful revelations are the best response is considerably simpler to explain (Andersen et al., 2006): essentially, we can mention to our participants: "you don't know which row will count, so the safest thing to do is to answer each one honestly." Importantly, participants will intuitively associate each row with its respective transaction. Conversely, Kahneman et al.'s (1990) explanation is more muddled: they only mention to participants that "1) Your decision can have no effect on the price actually used because the price will be selected at random. 2) It is in your interest to indicate your true preferences at each of the possible prices listed below"; they do not explicitly explain how it is in the participant's best interest to state their true valuations.

Concerning our cognitive complexity manipulation, we will incorporate/exclude the explanation behind why truthful valuations are the best response to the elicitation mechanism. To test whether our complexity manipulation was successful, we will ask participants whether they should overstate or understate the value of their item given their assigned role. Our theory predicts that if we omit this explanation, the participants will have the option to derive the best response to the elicitation mechanism or to maintain their current state. The former option would lead to participants incurring higher meta-cognitive uncertainty behind their decisions. Assuming that they are uncertainty averse, then they would prefer to maintain their current state by stating a WTA/WTP that converges with their randomly assigned role (i.e. sellers overstate their value and buyers understate their value). On the other hand, participants who were explained how truthful responses are the best response to the elicitation mechanism would provide a WTA/WTP that is more consistent with their item's true value; this observation would provide evidence against the notion that ownership itself drives the WTA-WTP gap.

Again, we seek to substantiate our causal channel (3). Thus far, we have developed an incentive-compatible elicitation mechanism that is simpler than the one used in Kahneman et al. (1990) without resorting to market experience. In addition, we have designed a cognitive complexity manipulation that modulates how easy it is for participants to understand why truthful valuations are the best response to our elicitation mechanism. Now, to provide strong evidence against the "traditional" interpretation of the endowment effect, being that an individual's valuation of an objects increases substantially when they gain ownership, we need our experimental design to allow for the manifestation of said effect. Therefore, we employ a 2×2 factorial design as it will allow us to disentangle the main effects of treatment A and treatment B, as well as their interactions:

Table 1 2×2 Factorial Design: Goods $\times$ Cognitive Complexity

	Low Cognitive Complexity	**High Cognitive Complexity**
Mugs	Cell 1: Mugs $\times$ Low CC	Cell 2: Mugs $\times$ High CC
Tokens	Cell 3: Tokens $\times$ Low CC	Cell 4: Tokens $\times$ High CC

Each participant will be randomly assigned to one cell in the factorial design. For example, in cell 1, participants will be randomly assigned to a buyer/seller role, they will have to complete the MPL mechanism, and we will thoroughly explain why truthful valuations are the best response to the elicitation mechanism. Finally, the participants in this market will be trading mugs. Under the endowment-effect hypothesis, we would expect a divergence between WTA and WTP in cells 1 and 2, and no such divergence in cells 3 and 4. By contrast, our causal pathway (3) predicts that the WTA–WTP gap should arise specifically in cells 2 and 4, whereas no discrepancy should emerge in cells 1 and 3. Crucially, this design allows for the demonstration of an endowment effect that is not predicated upon participants' levels of cognitive uncertainty. For the mugs market, we will provide participants with \$6 mugs from the University of Toronto Bookstore whilst for the tokens market, we will give them tokens that can be exchanged for \$6. Following Kahneman et al.'s (1990) experiment 4 design, each market will have 37 sellers and 37 buyers; we would expect around 18.5 trades. Regarding the experimental stimuli that the participants will see, it will depend on their randomly assigned role. For mug markets, participants will read the following:

> You now {own}/{do not own} a \$6 mug {which you can bring home}/{}. {You have the option of selling it and receiving money for it}/{You have the option to buy one to take home}. For each of the possible prices listed below, please indicate whether you wish to: (1) {Receive}/{Pay} that amount of money and {sell your mug}/{buy a mug}, or (2) {Not sell your mug}/{Not buy a mug} at this price. After you have finished, one of the rows listed below will be selected at random and the transaction specified in that row will occur. If you have indicated that you will {sell}/{buy} at this price, then you will receive {this amount of money and will give up the mug}/{receive a mug and pay this amount of money}; if you have indicated that {you will keep the mug at this price then no exchange will be made and you can take the mug home with you}/{not buy a mug at this price and do not need to pay for anything}. [Importantly, notice the following that you don't know which row will count, so the safest thing to do is to answer each one honestly]/[]. For each price, indicate your decision by marking an X in the appropriate column.

For token markets, participants will see the following:

> You now {own}/{do not own} a \$6 token. {You have the option of selling it and receiving money for it or redeem it to an experimenter for \$6}/{You have the option to buy one and redeem it to the experimenter for \$6}. For each of the possible prices listed below, please indicate whether you wish to: (1) {Receive}/{Pay} that amount of money and {sell your token}/{buy a token}, or (2) {Not sell your token}/{Not buy a token} at this price. After you have finished, one of the rows listed below will be selected at random and the transaction specified in that row will occur. If you have indicated that you will {sell}/{buy} at this price, then you will receive {this amount of money and will give up the token}/{receive a token and pay this amount of money}; if you have indicated that {you will keep the token at this price, then you can redeem it to the experimenter for \$6}/{you will not buy a token at this price, then you do not need to pay for anything}. [Notice the following that you don't know which row will count, so the safest thing to do is to answer each one honestly]/[]. For each price indicate your decision by marking an X in the appropriate column.

where [low cognitive complexity, high cognitive complexity] is a cognitive complexity manipulation and seller, buyer is a seller/buyer random assignment. Participants will have to fill out the following sheet:

If the Price is...	I Will {Sell}/{Buy} the Mug	I Will {Keep}/{Not Buy} the Mug
\$0		
\$0.5		
...		
\$9.5		

Regarding cognitive uncertainty, we will ask participants how certain they were that their valuation of the mug/token was somewhere between [x - \$1, x + \$1] where x is the participant's reservation price. They will respond using a 5% interval slider that ranges from 0% to 100%. In addition, we will evaluate the average cognitive uncertainty exhibited in each cell to ensure the validity of our manipulations: we expect higher average cognitive uncertainty in cells 2 and 4 relative to cells 1 and 3. We will use an ANOVA and the appropriate pairwise comparisons to examine how statistically significant the differences across cells are. Regarding the factorial analyses, we will compute the ratio between mean WTA and mean WTP for each cell. Then, we will conduct a 2 × 2 between-subjects factorial ANOVA, with good type (Mugs vs. Tokens) and cognitive complexity (Low vs. High) as our independent variables. The ANOVA will allow us to examine (1) the main effect of Good Type, testing whether mugs elicit larger ratios of WTA-WTP means than tokens; (2) the main effect of cognitive complexity, testing whether increased cognitive complexity amplifies the ratio between mean WTA and mean WTP; and (3) the interaction effect, assessing whether cognitive complexity disproportionately increases the ratio between mean WTA and mean WTP for consumption goods relative to tokens. Significant effects will be followed by planned pairwise comparisons with appropriate multiple-comparison corrections. Effect sizes and confidence intervals will be reported alongside all test statistics. We do not expect an interaction effect between cognitive uncertainty and the types of goods used.

5 Limitations of Our Approach

There is one feature of our design that can bias the results. Notice that, on the sheet where participants indicate their WTP and WTA, the prices are listed in ascending order. Existing work already shows that arranging the bid amounts in ascending order depresses WTP. This is an effect that is especially strong amongst uncertain respondents (Voltaire et al., 2017). One can understand this effect in terms of anchoring and adjustment. The low terms present a low anchor, and insufficient adjustment, which the uncertain respondents are especially susceptible to, result in an underestimation of their WTP (Lieder et al., 2018). This confound is especially worrying, given the current study is investigating precisely the effect of uncertainty on

WTP. Future work can address this issue by, e.g., reversing the bid amounts, randomizing it, or even having participants put down their bid amounts in numbers.

There is another, more conceptual, concern. The current analysis, like all publications on the endowment effect, focus on the sellers. There is the implicit assumption that the buyers appraise the price accurately, while the sellers do not. Assuming the opposite, however, is just as sensible. One can construe the WTP-WTA gap as the buyer's underestimation of how much they will enjoy a good if they happen to possess it. In fact, this perspective suggests a straightforward psychological explanation of these findings. There is a well-established phenomena in the psychological literature termed cognitive dissonance. It describes how people tend to bring their attitudes into alignment with the state of the world (Festinger, 1957). For someone who does not happen to own a mug, even if they like the mug, they may modify their preferences to value the mug less. Naturally, this has its limits. When the value of a good, e.g., a token, is explicitly given, the effect of cognitive dissonance would only be modest. Ambiguity about a good's value, however, gives cognitive dissonance free reign (Festinger, 1957). Thus, despite the brilliance that has been applied to this question of the endowment effect, perhaps economists are getting it all wrong. It might be a bias of the have-nots, not the haves.

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