Known Unknowns in Judgment and Choice

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In six studies we explore metacognitive knowledge in consumer judgment and choice. Differences in awareness of known unknowns is related to Cognitive Reflection Test (CRT) scores and predicts biases such as overconfidence and the comparative ignorance effect. Consumers can be nudged to consider known unknowns for better judgments and decisions.

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The Uncertain Consumer  
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**Paper #1: Distinguishing Two Forms of Consumer Uncertainty**  
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**Paper #2: Known Unknowns in Judgment and Choice**  
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**Paper #3: (Over-)Optimism in Two-stage Choice**  
Y. Charles Zhang, Boston College, USA  
Rajesh Bhargave, University of Texas San Antonio, USA  
Abhijit Guha, Wayne State University, USA  
Amitav Chakravarti, London School of Economics, UK

**Paper #4: The Unlikely Middle: Overestimation of Most and Least Likely Outcomes**  
Oleg Urminsky, University of Chicago, USA

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**SESSION OVERVIEW**

Consumers are frequently called on to make choices without knowing in advance what their consequences will be. For example, when deciding whether to purchase a mutual fund or a product warranty, or whether to budget, financial decision making, and simple games of chance. Across four papers, we discuss theoretical questions including a) mechanisms underlying subjective judgment biases such as over/underestimation, overconfidence, and hindsight biases, and b) how consumer knowledge, meta-knowledge, and attributions of predictability affect biases in consumer judgment and choice.

The first paper by Ülkümen, Tannenbaum, and Fox proposes that, in the context of two-stage choice, they find that merely anticipating to know extra information before the 2nd stage decision, people would become optimistic about the uncertainty and consequently prefer more uncertain options when making the decision for the 1st stage. The final paper by Oleg Urminsky documents a basic bias in probability estimates for uncertain events. Specifically, his finding shows that, in coin flip games, low probability outcomes get overestimated and high probability outcomes get underestimated.

Opening remarks will introduce the pivotal role of uncertainty in various contexts of consumer choice and preview papers to be presented; the session will close with an open integrative discussion. Consistent with the theme of “Making a Difference,” the primary goal of this session is to develop it to explore how consumers perceive uncertainty, how this affects their important judgments and choices, and how various interventions can make a difference in improving consumer welfare.

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**Distinguishing Two Forms of Consumer Uncertainty**

**EXTENDED ABSTRACT**

Probability is a janus-faced concept. Probability can be conceptualized either as the quantification of stochastic events (aleatory uncertainty) or as subjective degrees of beliefs (epistemic uncertainty) (Fox & Ülkümen, 2011). In this talk, we develop a novel Epistemic and Aleatory Uncertainty Scale (EARS), demonstrating that consumers meaningfully distinguish between these two variants of uncertainty. Along the way, we show that these representations of uncertainty have important consequences for various facets of consumer judgment and choice, including attributions of credit and blame, hindsight bias, and budgeting decisions.

**EARS Development and Attributions of Credit and Blame**

Many consumption activities require an explicit or implicit evaluation of expert forecasting. For example, consumers trust financial advisors to manage their savings partly because they believe advisors can skillfully predict market conditions in ways that help grow their investments. In our first study, we examined if people reliably distinguish between epistemic and aleatory uncertainty, and if these variants of uncertainty are differentially implicated in judgments of praise and blame.

We presented 116 participants with four scenarios that varied in their degree of epistemic and aleatory uncertainty: (i) predicting the answer to a trivia question (High Epistemic, Low Aleatory), (ii) predicting the outcome of two dice rolls (Low Epistemic, High Aleatory), (iii) an predicting where a hurricane will first make landfall (High Epistemic, High Aleatory), and (iv) predicting whether the US will elect a gay president within the next 30 years (Low Epistemic, Low Aleatory). For each scenario, participants learned that the protagonist either made a successful or unsuccessful prediction, and subsequently rated how much credit/blame and luck/unluckiness should be attributed to the correct/incorrect forecast. Lastly, participants rated each scenario in terms of epistemic and aleatory uncertainty (EARS). For epistemic uncertainty participants were asked to rate each forecast along dimensions such as the degree the outcome was “in principle knowable in advance” or “something that becomes more predictable with additional knowledge or skills”. For aleatory
uncertainty they rated items such as the degree that the outcome “could play out in different ways on similar occasions” or had “an element of randomness.”

First, people appeared to distinguish between epistemic and aleatory uncertainty. Both scales showed adequate reliability (Cronbach’s alpha ranged from .72 to .94) and differentially predicted attributions of praise/blame and luck/unluckiness. For both successful and unsuccessful forecasts, perceptions of epistemic uncertainty uniquely predicted judgments of credit (epistemic: p < .001; aleatory: p = .395) while perceptions of aleatory uncertainty uniquely predicted judgments of luck (aleatory: p < .001; epistemic: p = .957). Furthermore, judgments of epistemic and aleatory judgments were not merely opposites of one another. For example, participants viewed the task of forecasting the location of where a hurricane first makes landfall as both high in epistemic and aleatory uncertainty, and thus attribute both credit and luck to the forecaster.

### Hindsight Bias

One of the most robust judgmental biases is that outcomes appear more predictable in retrospect than in prospect. This hindsight bias has been shown to have important implications for consumer choice, such as how policymakers and consumers evaluate equipment malfunctions and product recalls (Ben-Shahar, 1998; Hastie, Schkade, & Payne, 1999). We speculated that the hindsight bias might result from a shift in how uncertainty is represented over time. In particular, we expected that once an outcome is known, perceptions of aleatory uncertainty would become less salient while epistemic uncertainty would become more salient. To examine this hypothesis, we recruited a sample of 118 participants two days prior to the U.S. presidential election and asked them to estimate the likelihood of Barack Obama, Mitt Romney, or some other third candidate winning the election. Two days after the election, we sampled a new group of 202 participants to postdict each candidate’s chances of winning (i.e., what their likelihood estimates would have been two days prior to the election). Both before and after the election, participants also completed our EARS measuring the degree of epistemic and aleatory uncertainty associated with predicting a presidential election.

We find that prior to the election, the average likelihood of Obama winning was 59%; after the election, the average likelihood of Obama winning was 68%, t = 5.08, p < .001 (hindsight bias). Importantly, representations of uncertainty also shifted over time. Participants viewed the prediction as more epistemic, and considerably less aleatoric, once the outcome was known (epistemic ratings: M = 4.31 vs 4.05, t = 1.96, p = .051; aleatory ratings: M = 3.91 vs. 4.47, t = 2.25, p < .001). In other words, the outcome felt more inevitable in hindsight than in foresight. Also note that the shift in uncertainty was larger for aleatory uncertainty, consistent with Fischhoff’s notion of “creeping determinism.” Both perceptions of epistemic and aleatory uncertainty mediated the hindsight bias, together accounting for 23% of the increase in likelihood judgments from time 1 to time 2.

### Budgeting Decisions

One of the most important consumption domains influenced by uncertainty is budgeting. Uncertainty regarding future spending involves both a predictable (epistemic) component that is based on consumers’ plans, and a stochastic (aleatory) component that is due to external influences that are mostly unpredictable from the consumers’ point of view. Consistent with prior work on prediction in general (Kahneman and Lovallo 1993), and specifically on budget estimates (Ülkümen et al 2008), budget estimates rely disproportionately on plans and do not spontaneously incorporate the necessary adjustment for unplanned expenses. If this is the case, then budget estimates should be influenced by epistemic uncertainty, but not by aleatory uncertainty.

Eighty-nine undergraduate students were asked to estimate their total budget for the month of April (the study was conducted in the beginning of March). Participants also completed a version of EARS modified to assess uncertainty regarding expenses. We counterbalanced the order of the two tasks. We regressed log transformed budget estimates on epistemic and aleatory ratings. The results suggest that budget estimates were influenced positively by epistemic uncertainty (b = .24, t = 2.13, p < .05), but were independent from aleatoric certainty ratings (b = -.04), t = -.40, p > .50).

Taken together, these studies show that epistemic and aleatory components of uncertainty, as measured by EARS, have important downstream consequences for consumer judgment and choice, including attributions of credit and blame, hindsight bias, and budgeting decisions.

### Known Unknowns in Judgment and Choice

#### EXTENDED ABSTRACT

Many consumer judgments and choices are made under conditions of uncertainty—from budgeting, planning and contracting to investing and insuring. Such activities require not only predictions of relevant outcomes, but also metacognitive awareness of the adequacy of such predictions. In this presentation I’ll review a series of studies that investigate various illusions of understanding in which consumer metacognition fails, and explore interventions designed to improve consumer judgment and choice.

Rozenblit and Keil (2002) report that people tend to be overconfident in how well they understand how everyday objects like toilets and combination locks work. Inducing them to generate a detailed mechanistic explanation shatters this sense of understanding and leads judges to decrease their rated confidence in their own understanding (see also Alter, Oppenheimer, & Zemla 2010; Keil 2003). We argue that this illusion of understanding reflects a more general tendency for consumers to focus on known facts and present information and ignore or underweight unknown facts and missing information, similar to the What You See Is All There Is (WYSIATI) phenomenon discussed by Kahneman (2011). We find that the Cognitive Reflection Test (CRT, Frederick, 2005) is a valid indicator of the tendency to spontaneously consider “known unknowns”.

In Study 1 we find that the illusion of explanatory depth only affects consumers with lower CRT scores. We adapted Rozenblit and Keil’s (2002) method in which participants rate their understanding of a number of common household objects (e.g. a toilet). Next they are asked to generate mechanistic explanations for a subset of the objects and then re-rate understanding. An illusion of explanatory depth exists if the pre-explanation rating of understanding is higher than the post explanation rating. We find a highly significant interaction between timing of the judgment and CRT score. The effect was driven by low CRT scorers providing higher ratings of understanding pre-explanations. Because all participants showed the same understanding after the task, it appears that this effect is driven by differences in metacognitive awareness, rather than differences in actual knowledge about how these products work.

In Study 2 we sought to confirm CRT is an indicator of metacognitive awareness by measuring it directly. We asked participants to estimate various quantities (e.g. the number of visitors in 2010 to the Great Wall of China) and then to give a range for their estimate such that they were 90% sure the true answer lay within the range. Soll & Klayman (2004) provide an analysis that allows for the dissociation of two sources of overconfidence: failures of knowledge
and failures of meta-knowledge. A failure of knowledge refers to providing an estimate that is far from the true value. A failure of meta-knowledge refers to generating a range that is too small. We also expected that low CRT participants would be more susceptible to failures of knowledge, i.e. they would provide estimates further from the truth, though this was not our main interest. Confirming our hypothesis, high CRT scorers showed greater knowledge, and significantly greater meta-knowledge.

In Study 3 we explore awareness of known unknowns in the context of the comparative ignorance effect (Fox & Tversky, 1995). A recent study of consumer financial decisions, from willingness to participate in a 401(k) program to willingness to invest in mutual funds, can be diminished by asking consumers difficult question about investment or providing them with information that is more difficult to process (Hadar, Sood, & Fox, 2012). In this study we explored whether individuals with a greater tendency toward cognitive reflection would exhibit more stable assessments of their subjective knowledge and be less affected by spurious attempts to manipulate their subjective knowledge. Following Fox and Weber (2002), we asked participants whether they wanted to gamble on the inflation rate in Chile (or receive a certain return). One group of participants were provided economic data that in principle could be used to predict the inflation rate (GDP growth, interest rates, unemployment). Fox and Weber (2002) found that people were less willing to gamble when provided the objectively useful economic data, presumably because it made them feel subjectively less knowledgeable. Consistent with our hypothesis we find that this effect is significantly more pronounced among low CRT scorers than high CRT scorers.

In Study 4, we investigated whether we could nudge participants to more actively consider known unknowns when assessing 90% confidence intervals. We attempted to shatter the illusion of understanding for one group of participants by asking them to describe the causal mechanisms influencing outcomes of complex policies (e.g. cap-and-trade policy for curbing carbon emissions). In prior work (Fernbach, Rogers, Fox & Sloman, in press) this manipulation was found to reduce confidence in the understanding of relevant policies, and pilot work indicated that this shaken confidence may extend beyond the focal topic. In Study 4 we found, consistent with our prediction, that this manipulation reduced overconfidence when assessing 90% confidence intervals on unrelated topics. Again, using the method of Soll & Klayman (2004), we found that shattering the illusion of understanding improved metacognitive knowledge (i.e., width of confidence intervals relative to their accuracy) rather than merely improving knowledge (i.e. accuracy of the center of confidence intervals). Also, the benefactors of increased metacognitive knowledge were higher CRT scorers, suggesting meta-knowledge improvements may be facilitated by a greater capacity for cognitive reflection.

In Study 5 we found that piercing the illusion of understanding (by inducing mechanistic explanations of household objects as in Rozenblit & Keil, 2002) eliminated the comparative ignorance effect for all participants, both high and low in CRT.

In summary, we find the failures in metacognitive knowledge are linked to increases in overconfidence, the illusion of understanding, and the comparative ignorance effect. We propose that increasing metacognitive awareness (e.g. by inducing detailed causal explanation) will increase attention to known unknowns and can provide a useful tool to improving consumer judgment and choice.

**EXTENDED ABSTRACT**

When facing multiple choice options, decision-makers often adopt a two-stage choice strategy. Specifically, they first select some options to form a consideration set (the screening stage), and then make a final choice among this set (the choice stage). Past research has shown that a piece of information may receive different weights in the screening stage versus the choice stage (Beach 1993; Chakravarti, Janiszewski, and Ulkûmen 2006). However, past work has not examined how screening influences decision makers' weighting of uncertainty. Many everyday decisions involve uncertainty, from choosing among new restaurants, to choosing among a set of risky investment plans. We investigate how anticipating to receive information during a two-stage decision process affects people's preference for uncertain options.

In two-stage decision processes, consumers may utilize and attend to different information in the choice stage versus the screening stage (Chakravarti, Janiszewski, and Ulkûmen 2006). Additionally, decision-makers may search extra information after forming the consideration set (Ge, Haübl and Elrod 2012). In cases where the choice options include uncertainty (such as new restaurants, investment plans, etc.), sometimes – but not always – the extra information obtained between the screening and the choice stage could (partially) resolve the uncertainty of the options. Thus, during a screening stage, decision-markers may feel that they will resolve uncertainty in the final choice stage.

People are generally averse to uncertainty during decision making. In Ellsberg’s two-urn problem (Ellsberg 1961), people win a prize by drawing a certain colored ball from an urn. In this setup, people prefer to draw balls from an urn containing 50 red and 50 black balls than from an urn containing a total of 100 red and black balls, with exact split unknown. In other words, people feel more optimistic about obtaining a positive outcome (e.g., drawing the preferred color) when the situation is less uncertain (or, per Ellsberg’s term, less ambiguous). Past research has focused on how presenting information can reduce perceived uncertainty, leading to greater optimism. However, we contend that merely anticipating additional information could also lead to greater optimism, thereby influencing decision-makers’ preferences. More specifically, we argue that because decision-makers feel that they have an opportunity to resolve uncertainty later by acquiring additional information, they are less averse to uncertainty during screening.

In our investigation, we compare people’s chosen options in a direct choice versus two-stage choice. We show that people are more optimistic about uncertain outcomes in screening than in direct choice (study 3). Moreover, and consistent with this notion, they prefer options that have a greater range of possible outcomes (study 1-3) in two-stage (vs. direct choice). We further demonstrate that this reduced aversion to uncertainty is not driven by the number of options to select (single vs. multiple; study 2 and 3), and only occurs when people believe that there will be extra information before they make their final choice (study 3).

In study 1, participants (n = 202) chose to trade in their computer among four shops, which provided price quotes with the same midpoint but different ranges. Some participants made final choices directly; others (two-stage choice condition) were told that the two shops with smaller-range quotes were in location A and the two shops with wider-range quotes were in location B. They would decide on the location first, get a final quote from both shops at that location, and then decide between them. Consistent with our predic-
tion, the choice share of the two wider-range shops (i.e. location B) was significantly higher in the two-stage condition.

Study 2 replicated the effect in a real choice context. Participants (n = 98) in a lab were required to complete a tedious word recognition task, but could choose among four versions of this task. For two versions, the task was estimated to contain 80-120 words; for the other two versions, the task was estimated to contain 50-150 words. As a between-subject manipulation, participants were asked either a) to choose one version of the task directly, or b) to shortlist two versions between which they would make the final choice after seeing both versions, or c) to shortlist two versions of the task but with the final assignment between the two determined by other people. We found that participants preferred the wider range versions (50-150-word documents) in screening than in direct choice, but only when the final choice would be made by themselves instead of others. This study further confirmed that the tendency for choosing more uncertain options in screening was not due to the act of picking multiple options (vs. a single in direct choice), but due to participants’ expected opportunity to make a final choice in the second stage.

In study 3, participants (n = 152) were asked to choose among four 50-50 lotteries, each having a different combination of high and low payoffs. They were told that the outcome of the lottery would be determined by drawing a ball (white vs. red) from a bag containing 100 balls, with exact color split unknown. In a three-condition between-subjects design, some participants were asked to choose one lottery directly; the rest were instructed to shortlist two lotteries, with or without being told that the exact color split would be revealed before their final (2nd-stage) choice. As a result, shortlisting shifted the general preference toward the more uncertain lotteries (the lottery with higher and lower probabilistic payoffs), but only among participants who expected to learn the exact color split later. To maximize the potential payoff in this condition, one should go for the most uncertain options plus the most certain option in the first stage. However, in our study, only the choice share of the former, but not the latter, was higher when comparing by whether participants knew the color split in advance. Further, these participants expected to earn more from this lucky draw than participants in other conditions expected by predicting higher likelihood to draw the high-payoff ball, reflecting a pure optimism without rational bases.

Taken together, this research shows that anticipating information during decision-making affects sensitivity to uncertainty. These findings are important for advancing existing knowledge on how people respond to uncertainty and how decision structure affects preferences.

The Unlikely Middle: Overestimation of Most and Least Likely Outcomes

EXTENDED ABSTRACT

Assessing the probability of future outcomes is central to most forward-looking behaviors, from an investor assessing the risk of a portfolio to a consumer assessing how a currently available price is likely to compare to future prices. There is a large literature on how people make probability judgments and risk estimates and the degree to which such estimates are biased (Tversky and Kahneman 1973, Gigerenzer 1994, Slovic 2000, Loewenstein et al 2001, Krizan and Windschitl 2007, etc.). One limitation in this literature has been that probabilities are often estimated in isolation or merely rated based on subjective risk. In this paper, we present a new task in which participants jointly estimate the probability of mutually exclusive events that can be objectively calculated, but which is difficult to do so. The goal is to test the accuracy of people’s probability judgments and whether biases in perceived probability would extend to this context.

In the studies, a simple and intuitive situation is described to participants, e.g. “In the game, you would flip a fair coin 10 times and you would show the experimenter the result each time. Each time that it comes up heads, you win $1, and each time it comes up tails, you get nothing.” Participants are then asked to estimate (using different elicitation methods) the probability of each of the possible outcomes (getting $0 to $10) simultaneously. By jointly eliciting the probabilities, and enforcing the provision that they must add up to 100%, we avoid the separate issue of subadditivity in probability judgments (Tversky and Koehler 1994).

In Study 1, attendees at the 2012 Judgment and Decision Making Conference read the game scenario and either were asked to draw a histogram (N=58) or to choose one of six histograms (N=31). Participants’ drawn histograms differed significantly from the actual binomial distribution, overestimating the probability of unlikely outcomes (0,1,2,8,9,10) and underestimating the more likely outcomes (3,4,5,6). Of participants presented with six histograms, only 42% chose the correct one.

In Study 2 (N=85), MBA students in a marketing research course read about a population in which exactly half the people preferred Coke to Pepsi, and half preferred Pepsi to Coke. They were asked to estimate, for a randomly drawn sample of 10 people, the probability of each of the eleven possible outcomes (from none prefer Coke over Pepsi to all ten prefer Coke). If their estimates did not sum to 1 their estimates were divided by the total such that the standard estimates summed to 1. The elicited distributions significantly from a binomial distribution, significantly over-estimating both the least likely outcomes (0,1,2,8,9 or 10 Coke choosers) as well as the most likely outcome (5) and underestimating the intermediate outcomes (3,4,6 and 7).

In Study 3 (N=200) participants did one of four tasks: (a) the coin flipping game, estimating probabilities, (b) the same game, but estimating frequencies among 100 players, (c) a soccer scenario equivalent to the coin game, estimating probabilities or (d) the coin flipping game where participants could either win or lose a dollar, estimating probabilities. All estimates were made using a bar chart slider tool. Overall, we again find significant overestimation of low probability outcomes (0,1,2,8,9,10) and underestimation of intermediate probability outcomes (3,4,6,7). We find no differences based on probabilities vs. frequencies (a vs. b) or framing the game as coin flips vs. soccer (a vs. c). However, we do find an optimism bias, with significantly higher average estimates when the outcomes could involve losses (i.e. less estimates of losses than of equivalent small gains). In this study, participants were also asked to estimate the distribution of height in the US, using the same tool. Their height estimates, unlike their probability estimates, are approximately normally distributed, suggesting that the elicitation method is not suppressing beliefs about normal-shaped distributions.

In Study 4 (N=355) we replicate our findings and test both the optimism bias and illusion of control (Langer 1975). Participants read the scenario with the same outcomes framed as either starting with $0 and winning $1 for each tails (gain frame) or starting with $10 and losing $1 for each tails (loss frame). In addition, each scenario either described the respondent flipping the coins while the experimenter observed (high control) or the experimenter flipping the coins while the respondent observed (low control). Combining the four conditions, we find significant overestimation of low probability outcomes (0,1,2,8,9,10) and underestimation of intermediate probability outcomes (3,4,6,7) as well as underestimation of the most likely outcome (5). Comparing across conditions, we
find that participants are more optimistic about avoiding losses than about getting gains when control is low (p < .01). However, there is no difference in the mean of the reported distributions when control is high (interaction p=.12). For accuracy, we find a main effect, such that estimated distributions are closer to the actual binomial probabilities in the loss versions (both p’s < .001). We also find an interaction, such that people are the least accurate in the low control, gain-framed version (p = .05).

In the last study (N=88), participants completed the task in an online survey with either a more arousing red background or a less arousing blue background (Vosgerau 2010). Overall, we find significant overestimation of low probability outcomes ($0, $1, $2, $9 and $10) and underestimation of intermediate outcomes ($3, $4, $6, $7). We find directionally higher (and more accurate) mean estimates from distributions elicited in the lower arousal blue background condition ($4.42 vs. $4.11). More importantly, we find that the distributions in the blue condition have significantly higher variance than the distributions in the red condition.

We discuss the implications of our findings for research on probability estimation as well as, more broadly, how inferences about people’s choices may be distorted by biased in their subjective likelihood judgments.

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