

A NOTE ON “WHEN ARE DECISIONS IMPROVABLE? AN EVALUATION OF DIAGNOSTIC METHODS”*

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Abstract

In their study of various improvability diagnostics, Bernheim, Lucia, Nielsen, and Sprenger (2026) argue that experimental subjects often interpret the elicitation of cognitive uncertainty (*CU*)—which asks them to report the likelihood that they made the best decision for themselves—as instead asking about the presence of ex-post outcome (payoff) uncertainty. First, we amend Bernheim et al.’s survey to disambiguate the interpretation of their results. Subjects may either misconstrue the *CU* elicitation as asking about outcome uncertainty, or they may report uncertainty about their best decision—in line with the intended meaning of the question—*because* outcome uncertainty makes the choice subjectively difficult. Our results support the latter interpretation. This conclusion is corroborated by both a literature review and an analysis of large-scale data on choice inconsistencies. Second, we study whether responses to the *CU* elicitation are predictive of choices in line with Bernheim et al.’s interpretation. In a standard multiple price list experiment, we find that, in the sub-sample that—according to Bernheim et al.’s methodology—understands the elicitation as asking about outcome uncertainty, *CU* predicts probability weighting (behavioral attenuation) just as strongly as in the rest of the sample. This is a pattern implied by the intended meaning of the *CU* question but not by Bernheim et al.’s interpretation.

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1 Cognitive Uncertainty

In our prior work, cognitive uncertainty (*CU*) is defined as people’s uncertainty about their best ex-ante decision, given whatever preferences they have (Enke and Graeber, 2023; Enke et al., 2024, 2025). Such uncertainty could have multiple potential origins, including preference uncertainty, uncertainty about how to aggregate problem components into a choice, and others. Introspection provides a simple motivation: most people can readily identify economic decisions in which they are uncertain about their best course of action. For instance, we ourselves are not fully certain about what our expected-utility-maximizing equity share is, trading off expected return and risk. Similarly, we are not fully certain that our health insurance plans are actually the best ones from an ex-ante perspective, given our risk profiles, preferences and information.

CU appears to be present not only in high-dimensional field decisions but also in lab experiments. For example, we are not fully certain that we can specify what exactly our certainty equivalents for a lottery are that pays \$80 with probability 75% and nothing otherwise (are you?). Multiple authors have measured *CU* or related constructs in experiments or surveys (e.g., Butler and Loomes, 2007; Cubitt et al., 2015; Arts et al., 2024; de Clippel et al., 2024; Yang, 2023; Shubatt and Yang, 2024; Augenblick et al., 2025; Musolff and Zimmermann, 2025).

This note concerns contexts in which experimental subjects choose between a safe payment and a risky, binary lottery. In this context, *CU* is measured as follows (Enke et al., 2024). After subjects make a choice, they are asked: “*How certain are you that choosing X is actually your best decision, given your preferences and the available information?*” Subjects respond by navigating a slider (or selecting a radio button) that specifies a percent chance. Subjects are instructed on the meaning of the question. To check that they correctly understand the question as asking about their best ex-ante decision rather than about the ex-post outcome uncertainty inherent in the binary lottery, subjects need to pass the following comprehension check: “Which one of the following statements is true? (a) When I’m asked to indicate my certainty about my decision, the people running this study are interested in how certain I am that the decision I made is actually my best decision, given my personal preferences and the available information. (b) When I’m asked to indicate my certainty about my decision, the people running this study are interested in how certain I am that I will actually receive the money from the lottery.”

2 The Study of Bernheim et al. (2026)

Bernheim et al. (2026) (henceforth BLNS) implement binary lottery choice experiments to study improvability / mistake diagnostics (we refer readers to BLNS for definitions of

these concepts). Among other objectives, they evaluate whether responses to confidence questions similar to our *CU* elicitation are diagnostic of objective and / or subjective improvability. To this effect, BLNS implement a post-experimental survey to decompose stated *CU* into multiple potential reasons for being uncertain. The most important reason subjects select from BLNS's pre-defined menu is "Can't Know For Sure What You'll Get: You lack certainty in your decision because, based on the information you've received, you can't be sure what you will receive given your chosen option." BLNS interpret this as evidence that subjects often construe confidence questions as pertaining to ex-post outcome uncertainty rather than to uncertainty about one's best ex-ante decision.

Improvability and *CU* are distinct concepts, as BLNS note. *CU* concerns uncertainty about one's best ex-ante decision, which may or may not imply (subjective or objective) improvability. For instance, in BLNS's terminology, 'normative ambiguity' concerns a situation in which a decision maker does not have stable preferences. A person may exhibit *CU* in this scenario (they don't know their best ex-ante decision), yet the decision is not objectively or subjectively improvable in BLNS's sense.

At the same time, our work on *CU* does overlap with BLNS's investigation. Specifically, their interpretation that experimental subjects often interpret *CU* elicitations as asking about ex-post outcome uncertainty would—if correct—also cast doubt on the ways in which we use and interpret *CU* elicitations in our work.

Broader context. We believe it may be helpful for readers to understand the broader context in which the present discussion takes place. In recent years, a growing number of papers have argued that various empirical behavioral economics regularities—chiefly in the context of lottery choice—that are traditionally ascribed to non-standard preferences instead partly reflect decision uncertainty, heuristics, complexity, cognitive frictions or noise (e.g., Enke and Graeber, 2023; Oprea, 2024; Frydman and Jin, 2023; Shubatt and Yang, 2024; Qiu et al., 2026). Other work has instead interpreted 'non-standard' choice patterns as revealing true non-standard risk preferences (e.g., Sprenger, 2015; Bernheim and Sprenger, 2020; McGranaghan et al., 2024b,a). The question of how to interpret *CU* elicitations is naturally connected to this broader debate.

Purpose of this note. This note comments on (i) the proposed use of *CU* as a general mistake-detection technology; and (ii) BLNS's interpretation that subjects understand the *CU* elicitation as asking about outcome uncertainty.

We present two pieces of additional evidence that bear on BLNS's results and the general interpretation of *CU* elicitations. First, we report on a follow-up survey that disambiguates two readings of why BLNS's subjects rate "Can't know for sure what you'll get" as their top reason for being uncertain: (i) that they interpret the elicitation as ask-

ing about outcome uncertainty, or (ii) that outcome uncertainty makes the choice subjectively difficult and therefore generates uncertainty about the best decision. The data we present, together with direct evidence that lottery choice is more error-prone when outcome uncertainty is higher, are in line with the second reading.

Second, we test whether BLNS’s proposed interpretation is consistent with choice data. We report on a standard multiple price list experiment¹ to study whether *CU* continues to predict probability weighting also in the sub-sample that BLNS interpret as asking about outcome uncertainty. It does, with magnitudes nearly identical to the rest of the sample. This is a pattern that is predicted by the intended meaning of the *CU* question but not by BLNS’s interpretation.

In addition to providing this evidence, we also remark on two features of the extant evidence relating to the interpretation BLNS have put forward. First, the *CU* elicitation includes a comprehension check (see Section 1) that explicitly distinguishes the best-decision interpretation from the lottery-outcome interpretation, and that all subjects pass before making any choices. BLNS’s post-experimental survey, by contrast, is administered with a substantial time lag after choices and uncertainty elicitation are complete. In our view, it is difficult to set aside an ex-ante comprehension check that all subjects passed in favor of a post-experimental survey administered with a substantial time lag.

Second, *CU* has repeatedly been shown to be strongly correlated with behavioral attenuation in choices, in both our own work and that of others. This is a pattern that is directly implied by imperfect-information models in which the decision maker is uncertain about their best ex-ante decision, but it is not obviously implied by BLNS’s interpretation. It is not immediately clear under BLNS’s interpretation why *CU* would predict attenuated decisions when subjects interpret the elicitation as asking about ex-post outcome uncertainty. This question seems particularly pertinent because *CU* is present and predictive of attenuated decisions also in choice contexts in which no ex-post outcome uncertainty is present (e.g. Enke et al., 2024).

3 Is *CU* a General Mistake-Detection Technology?

BLNS write that “This literature [in psychology] establishes that self-reported confidence often provides a good indicator of performance in objective perceptual tasks. . . Whether low confidence is actually a good proxy for perceived improvability in . . . settings [without objective performance benchmarks] is an open question.”

To our knowledge, the literature has not proposed *CU* elicitation as a general-purpose

¹BLNS’s study concerns binary choice, but their post-experimental survey can readily be applied to a multiple price list setting. Multiple price lists are also an established elicitation method in this literature (McGranaghan et al., 2024a,b).

mistake-detection technique. Rather, the central empirical claims in the recent literature are (i) behavioral attenuation, i.e., a link between *CU* and an insensitivity of decisions to fundamentals (e.g., Enke and Graeber, 2023; Enke et al., 2025, 2024; Yang, 2023; Toma and Bell, 2024; Augenblick et al., 2025), and (ii) a link between *CU* and cautious behavior (e.g., de Clippel et al., 2024; Chakraborty and Henkel, 2025). Our own published work emphasizes that subjective confidence measures will not, in general, be a sensible mistake-detection technology. For instance, Enke et al. (2023) note that “...it is conceivable that the confidence-performance correlation varies markedly across types of errors.” and show that, indeed, in several standard decision tasks the correlation between confidence and performance is zero or even negative. Enke et al. (2023) thus ask “Why do sometimes the ‘right’ and other times the ‘wrong’ people believe that they are getting things wrong?” Similarly, psychologists have long documented that there are objective tasks in which people exhibit low decision confidence yet perform pretty well (see Green and Swets, 1966, for a classic reference). The abstract of the widely cited review on metacognition and confidence by Fleming (2024) notes that “Metacognitive judgments are inferential and sometimes diverge from task performance because they are informed by the observer’s models of the world and their cognitive system, which may be more or less accurate.” Also see Fleming and Lau (2014) and the many references in Enke et al. (2023) on similar results in the psychology literature on meta-cognition and confidence.

In light of this evidence, we conclude that the relationship between confidence and performance appears to be task-dependent in both objective and subjective settings, with well-documented cases of miscalibration in both.

We also want to be clear about the scope of our prior claims. Our intended claim has been that the attenuation patterns described above (e.g., probability weighting in the elicitation of certainty equivalents) do not reflect stable preferences—a claim we continue to endorse. Whether these patterns constitute a mistake (or an improvable decision) in BLNS’s sense is a separate question. The link between probability weighting and *CU* is consistent, for example, with subjects not having stable risk preferences, which BLNS would not classify as a mistake. Our maintained claim concerns the source of attenuation effects as not reflecting stable, true preferences, not whether a social planner could improve the decisions.

We acknowledge that our writing has sometimes been imprecise. Because BLNS prominently quote from Enke et al. (2025), some readers may take away the impression that we proposed *CU* elicitation as a general mistake-detection tool. We reiterate that this is not the case, as already emphasized in Enke et al. (2023). At the same time, we should have articulated more clearly that we drew our conclusion that certain behaviors reflect a “mistake” based on several different independent methods that provide converging evidence with *CU*. For instance, in Enke et al. (2025), our conclusion that the hyperbolic

shape of the empirical discount function (in the elicitation of present values for delayed monetary payments) is a mistake was based on four independent pieces of evidence: strong correlations of hyperbolicity (i) with *CU*; (ii) with across-trial variability in repetitions of the same choice list; and (iii) with behavior in computationally similar atemporal mirror problems; as well as (iv) increased hyperbolicity under experimental complexity manipulations. Based on this body of evidence (and several related papers such as Ebert and Prelec, 2007), we continue to endorse the position that the hyperbolic response pattern in the elicitation of present values in valuation tasks does not reflect true, stable preferences. We endorse the same position about probability weighting in the valuation of risky lotteries.

4 Disambiguating BLNS's *CU* Decomposition

BLNS's design and results. BLNS proceed in four steps. First, subjects are instructed on binary lottery choice problems and a *CU* elicitation. Second, they complete a series of binary choices and, for each decision, indicate their *CU* by answering the question: "How certain are you that choosing Option [A/B] is actually your best decision, given your preferences and the available information?" Third, subjects receive instructions on a decomposition of the uncertainty statements. Subjects are familiarized with eight potential reasons, including through examples. Finally, for each of three decisions, subjects are reminded of their choice and their *CU*, and are asked to rate the importance of each potential reason for why they were uncertain on a 1–7 Likert scale.

The potential reasons BLNS asked subjects to rate are:

1. Can't Know For Sure What You'll Get: You lack certainty in your decision because, based on the information you've received, you can't be sure what you will receive given your chosen option.
2. Didn't Think Carefully About What You Want: You lack certainty in your decision because you haven't thought through what you want to achieve as carefully as you could.
3. Not Sure What Each Option Means: You lack certainty in your decision because you're not sure you interpreted the available options correctly or understood their consequences.
4. Worried About Mental Shortcuts: You lack certainty in your decision because you're worried about having used a mental shortcut that might have given the wrong answer.

5. Didn't Apply Your Decision Criterion Correctly: You lack certainty in your decision because you think the criterion you decided to use and any simplifying assumptions you made may actually favor an alternative other than the alternative that you chose.
6. Multiple Views About What You Want: You lack certainty in your decision because, in your view, there's probably more than one right way to think about what you want to achieve.
7. Don't Know How You'll Feel: You lack certainty in your decision because you aren't sure how you will feel about each of the possible outcomes.
8. It's Nearly a Toss-Up: You lack certainty in your decision because you think the choice is close to a toss-up.
9. Other Reasons: You lack certainty in your decision for other reasons.

A central finding from BLNS's decomposition exercise is that a modal group of subjects rate the "Can't Know For Sure What You'll Get" reason most highly.

Concerns with BLNS's design. Before turning to interpretation, we briefly note several features of BLNS's design that may bear on how the decomposition results are read.

First, given the motivation behind the CU elicitation, one reason we would have considered natural to include is: "You lack certainty in your decision because you find it difficult to think through and determine which option you actually prefer."

Second, BLNS's design involves a substantial time lag between stating *CU* for a given decision and the decomposition exercise, raising the question of whether the decomposition reflects the decision process at the time the choice was made or, rather, post-hoc reasoning. Subjects make multiple other decisions in the meantime, are instructed on an entirely new component of the study, and need to pass comprehension checks. This raises the question whether subjects even remember why they were uncertain in a particular decision 15-20 minutes ago. One possible procedure would be to ask subjects to first reproduce their decision and *CU*, but no such checks are reported in BLNS. One possibility is thus that the decomposition partly reflects subjects' post-hoc reasoning that is not informative about the decision process at the time the decision was taken.

Third, in our view, BLNS's follow-up survey is demanding for subjects. Subjects are required to work through several abstract concepts, to apply them to a new decision situation (a person Chris who decides which of two social events to attend), and to link these concepts to the lottery choice context. We note that introspective decomposition of this kind is demanding, and it is an open question how reliably subjects can perform it.

Fourth, some of the wording in BLNS’s follow-up survey is open to multiple readings. For example, BLNS introduce their decomposition exercise as “Understanding your overall certainty,” and the phrase “overall certainty” recurs throughout the survey. In the lottery choice context, this phrasing leaves room for interpretation, in particular as (also) referring to outcome uncertainty. An alternative phrasing such as “Understanding your certainty about your best decision” would have been more closely aligned with the wording of the *CU* elicitation itself.

In what follows, we set these concerns with BLNS’s design aside and focus purely on interpretation.

Potential interpretations. BLNS interpret their result as documenting that many subjects interpret the *CU* elicitation as asking about ex-post outcome uncertainty, contrary to our intended meaning. Under this interpretation, subjects asked about certainty in their best ex-ante decision would instead be reporting certainty about what payoff they would receive.

We take seriously the possibility that subjects misunderstand the *CU* question in the way BLNS posit. In particular, we agree that such a misunderstanding is a potential interpretation of the specific decomposition survey BLNS implement. However, there is a second interpretation of BLNS’s decomposition. This interpretation follows a long line of work on contingent reasoning and randomness in both psychology and economics: that subjects rate this reason highly because the presence of outcome uncertainty makes subjects uncertain about their best ex-ante decision. In other words, subjects might report that the presence of outcome uncertainty makes the decision subjectively difficult. After all, choosing between \$8 for sure and \$10 for sure is typically straightforward – decisions are difficult primarily when they involve uncertainty and the need to aggregate and trade off different contingencies. The wording of the BLNS question (“You lack certainty in your decision because [...] you can’t be sure what you will receive [...]”) is consistent with both readings: that the subject reports the existence of outcome uncertainty, or that outcome uncertainty is the *reason* they are uncertain about their best decision.

This argument has at least three antecedents in the literature. First, a voluminous and influential literature on hypothetical or contingent reasoning in economics shows that decision problems are more difficult when they involve the need to reason through multiple contingencies (e.g., Esponda and Vespa, 2014, 2024; Charness and Levin, 2009). Martínez-Marquina et al. (2019) directly show that the presence of outcome uncertainty increases the frequency of decision anomalies. Second, a related literature on lottery choice has documented that choice inconsistencies are considerably more pronounced when the lotteries in the menu are more dissimilar from each other state-by-state (Agra-

nov and Ortoleva, 2017; Enke and Shubatt, 2023; Shubatt and Yang, 2024). In the choice between a non-degenerate lottery and a safe payment (studied by BLNS), this insight implies that choices are more difficult the more uncertain the outcome of the lottery is, because the dissimilarity between a safe payment and a lottery increases in the variance of the lottery. Third, the idea that the presence of outcome uncertainty makes decision problems more difficult and increases information-processing demands is also present in a long line of work in psychology going back at least to Slovic and Lichtenstein (1968) and Lichtenstein and Slovic (1971) who explicitly discuss the cognitive difficulty of processing outcome uncertainty.

While the literature has used various techniques to document the cognitive difficulty of reasoning about outcome uncertainty, we here illustrate this body of work by studying how choice inconsistencies (a potential proxy for choice errors) vary as a function of the magnitude of outcome uncertainty. We leverage the dataset of Peterson et al. (2021), who implement thousands of unique binary lottery choice problems in a large-scale study. Each subject that confronts a given choice problem does so five times (consecutively), allowing for an analysis of across-trial variability (choice inconsistencies) in repetitions of the same choice problem. To make our results directly comparable to BLNS, we restrict the sample of choice problems to problems in which (i) subjects choose between a binary lottery and a safe payment; and (ii) the absolute EV difference is in $[0.1, 1.9]$. This leaves us with 948 unique choice problems, though the results look very similar in the full sample of problems.²

We compute—separately for each choice problem—the fraction of subjects who are inconsistent at least once. Following Enke and Shubatt (2023), we then assess how this problem-level measure of choice inconsistencies varies as a function of the magnitude of outcome uncertainty. Figure 1 illustrates the results. The left panel shows that choice inconsistencies strongly increase in the variance of the lottery ($r = 0.53$, $p < 0.01$). The right panel shows that these results are partly driven by the extremity of the probability of the lottery upside, as interior probabilities (more outcome uncertainty) are associated with more frequent choice inconsistencies. These results suggest that greater outcome uncertainty makes decisions more difficult.

These results are a special case of the notions of tradeoff complexity and dissimilarity discussed in the recent literature on lottery choice (e.g., Enke and Shubatt, 2023; Shubatt and Yang, 2024). Intuitively, a safe payment is more dissimilar state-by-state from a binary lottery when the lottery payouts have high variance and / or when the payout probability is more interior. Such dissimilarity means that the tradeoffs involved are more pronounced, making the choice more difficult. The general idea that dimension-by-

²The results also look very similar if we restrict the sample to problems in which all payouts are weakly positive. This may be of interest because Peterson et al. (2021) did not incentivize losses.

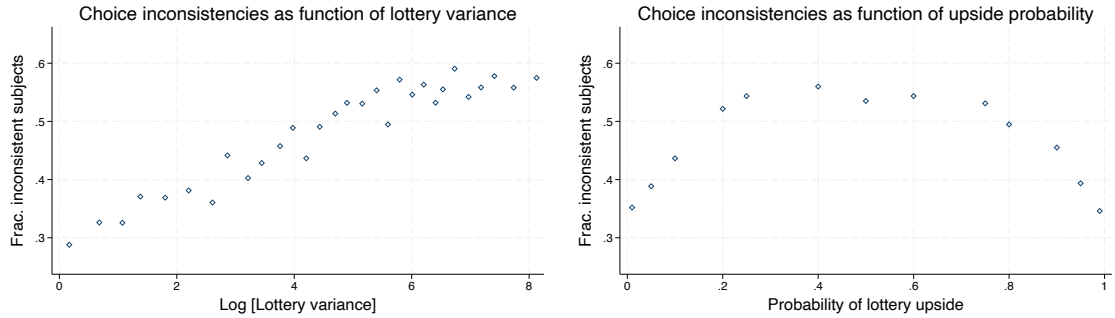


Figure 1: Choice inconsistencies in repeated elicitations of the same binary lottery choice problem in the data of Peterson et al. (2021). The left panel shows a binned scatter plot of the fraction of subjects who are inconsistent at least once as a function of the log variance of the lottery. The right panel shows a binned scatter plot of choice inconsistencies as a function of the payout probability of the lottery upside. For comparability with BLNS, the sample is restricted to choice problems involving a binary lottery and a safe payment, and where the absolute EV difference is in $[0.1, 1.9]$, for a total of 948 unique choice sets.

dimension dissimilarity and the resulting tradeoffs contribute to making choice difficult goes back at least to Tversky and Russo (1969).

In summary, multiple lines of prior work suggest that outcome uncertainty contributes to making decisions difficult. An alternative interpretation of BLNS’s results is thus that subjects exhibit uncertainty about their best ex-ante decision (in line with the question’s intended meaning) precisely *because* there is outcome uncertainty.

Experiment to disambiguate interpretations. To disambiguate these results, we implemented an experiment that replicates BLNS’s uncertainty decomposition protocol, see Appendix A.1 for screenshots of the study. We use BLNS’s instructions and comprehension checks verbatim to introduce the *CU* decomposition. Moreover, we use the same wording and layout to allow subjects to rate the importance of the different potential reasons for why they reported to be uncertain. Our only tweak is that, after subjects rate the importance of each reason, we ask the simple follow-up question displayed in Figure 2 whenever the “Can’t know for sure how much you’ll get” reason was rated at least 2 out of 7. This question directly contrasts BLNS’s interpretation—that subjects understand their reason as asking about the presence of payoff uncertainty—with the interpretation that subjects are uncertain about their best choice because the lottery involves payoff uncertainty. The order of response options was randomized.

206 subjects completed the experiment on Prolific and made five decisions each, for a total of 1,030 data points on *CU*. 646 observations reflect strictly positive *CU*. Following BLNS, we only collect data on the uncertainty decomposition for these observations. One in five subjects was eligible for a bonus.

Appendix A.2 provides an analysis of the results. The main results are twofold. First, we replicate BLNS’s results on the uncertainty decomposition itself. Subjects, on average,

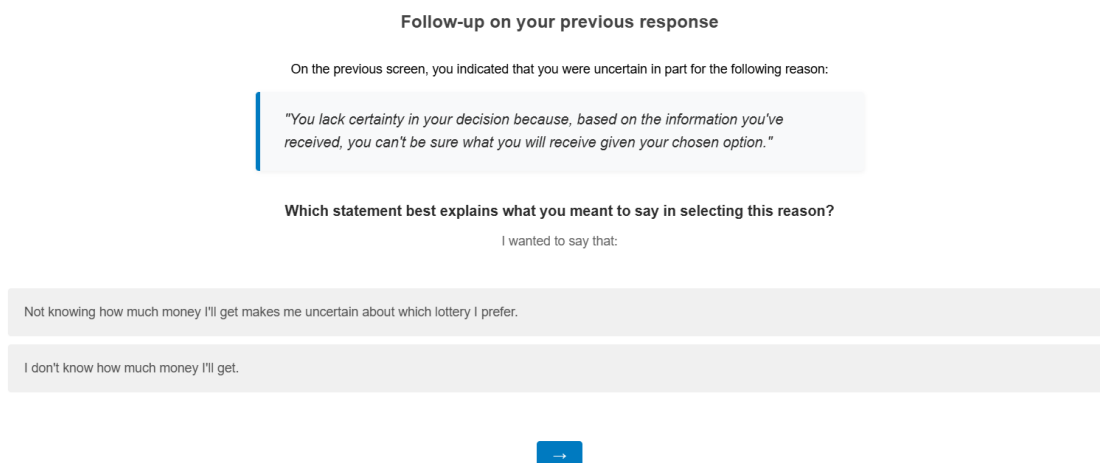


Figure 2: Screenshot of follow-up survey question

assign the highest ratings to the reason “Can’t Know For Sure What You’ll Get,” and for 315 observations (49%) this is the most important reason, almost exactly as in BLNS’s data.³

Second, in our follow-up question, focusing on the sample of 303 observations in which “Can’t Know For Sure What You’ll Get” is the most important reason (BLNS’s preferred sample), 74% select the reason suggesting decision rather than outcome uncertainty. If we instead look at the sample of all observations who rated this reason at least 2/7 ($N = 443$), the corresponding number is 75%. Taking into account that inattention, measurement noise and rushed answers mechanically push response fractions towards 50%, these results suggest that even subjects who pick “Can’t Know For Sure What You’ll Get” as reason do not typically construe the *CU* elicitation as asking about ex-post outcome uncertainty but that, instead, the presence of outcome uncertainty makes subjects uncertain about their best ex-ante decision.⁴

³Of these 315 observations, 12 rated all reasons as 1/7, meaning that they were not asked our follow-up question (which required a rating of at least 2).

⁴To assess robustness against changes in wording, we also ran the following variant with 100 subjects:

You indicated that you were uncertain because based on the information you’ve received, you can’t be sure what you will receive given your chosen option. You rated the importance of this reason as 5 out of 7 (where 7 is ‘Very Much’).

Regarding this reason, which statement best clarifies what you meant?

- *This reason was relevant for me because I wanted to say that I don’t know how much money I’ll get.*
- *This reason was relevant for me because I wanted to say that not knowing how much money I’ll get makes me uncertain about how much I value an option.*

80% of BLNS’s preferred sample select the second reason.

5 Linking BLNS’s Decomposition to Choices

BLNS argue that survey questions designed to elicit *CU* (or other subjective confidence measures) are inherently vague, making their interpretation difficult. We agree with BLNS that the gold standard is to better understand and predict choices. Our position is thus that the plausibility of any interpretation of *CU* elicitation (including BLNS’s) turns, in part, on its consistency with choice data.

A robust empirical regularity is that *CU* is strongly correlated with probability weighting in the elicitation of certainty equivalents (e.g., Enke and Graeber, 2023; Enke et al., 2024; Qiu et al., 2026). Our interpretation of this pattern is that in such valuation tasks, subjects exhibit uncertainty about how much they value the lottery, and that this uncertainty is associated with an attenuation (or ‘pull-to-center’) effect, generating apparent probability weighting. Other authors, in contrast, interpret elicited certainty equivalents as expressions of true preferences (Sprengrer, 2015; Bernheim and Sprengrer, 2020; McGranaghan et al., 2024a,b, e.g.).

Under BLNS’s interpretation of how experimental subjects understand the *CU* question, there is no particular reason to expect *CU* to be correlated with probability weighting.⁵ In contrast, the interpretation that the *CU* question elicits uncertainty about one’s best ex-ante decision immediately *predicts* attenuation effects such as probability weighting, see Enke and Graeber (2023), Enke et al. (2024), Gabaix (2019), Khaw et al. (2021) and Shubatt and Yang (2024) for corresponding imperfect-information models.

Of course, the available evidence does not allow us to draw conclusions from observed choice patterns about how subjects interpret the *CU* question. The reason is that, in principle, the correlation between *CU* and probability weighting documented by Enke and Graeber (2023), Enke et al. (2024) and Qiu et al. (2026) could be driven by that subset of the sample that understands the question according to its intended meaning.

Design. We implement standard multiple price list experiments to measure certainty equivalents for binary lotteries, amended by BLNS’s post-experimental uncertainty decomposition survey. In each choice list, subjects make a series of binary choices between

⁵If anything, the perspective that subjects report their ex-post payoff uncertainty would predict an *asymmetric* relationship between *CU* and pull-to-center effects in the payout probability, p . As we discuss in Appendix C, the total outcome variance of a subject’s payoff in a multiple price list is determined both by the riskiness of their chosen options and by the computerized random draw of a particular row of the choice list. The slope of total payoff variance with respect to the switching point c , evaluated close to the risk-neutral benchmark $c = p$, is strictly positive for every $p \in (0, 1)$. Pull-to-center—moving c toward 0.5—therefore *increases* total outcome variance when $p < 0.5$ but *decreases* it when $p > 0.5$. Under BLNS’s interpretation, in which higher *CU* reflects higher perceived outcome variance, one would thus expect higher *CU* to be associated with pull-to-center effects for $p < 0.5$ but with pull-away-from-center effects for $p > 0.5$. The symmetric pull-to-center pattern documented in Figure 3 is inconsistent with this prediction but is exactly what the intended interpretation of *CU* (uncertainty about the best ex-ante decision) predicts.

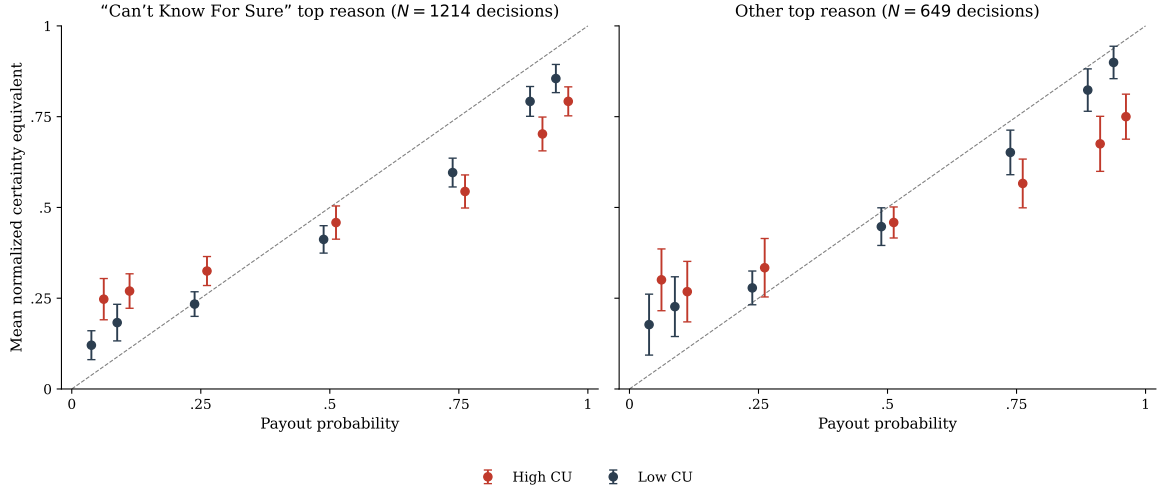


Figure 3: Mean normalized certainty equivalents as a function of the payout probability of the lottery upside, separately for decisions in which the “Can’t Know For Sure What You’ll Get” reason was the most important reason (left, $N = 1,214$ decisions) versus decisions in which some other reason was most important (right, $N = 649$ decisions). Within each panel, the sample is split at the median of CU within each probability bucket. Error bars represent 95% confidence intervals. The dashed 45-degree line denotes risk neutrality. $N = 305$ subjects, 2,112 decisions.

(i) a fixed binary lottery that pays \$18 with probability p and (ii) varying safe payments. In our experiment, $p \in \{0.05, 0.1, 0.25, 0.5, 0.75, 0.9, 0.95\}$. The design of the experiment is standard and follows, for example, Enke et al. (2024) and Bernheim and Sprenger (2020). On each price list screen, we elicit CU by asking: “How certain are you that you actually value this lottery ticket somewhere between \$X and \$Y?”, where \$X and \$Y reflect the switching interval in the choice list.

We append BLNS’s decomposition survey to this experiment. This only requires very minor modifications of BLNS’s wording, such as the need to speak of “choices” rather than “choice.” Appendix B.1 reproduces the full experiment. Again, one in five subjects was eligible for a bonus.

Results. Appendix B.2 summarizes the results from the uncertainty decomposition exercise. We again find that the “Can’t know for sure what you’ll get” reason is the most highly rated reason, on average, and is the most highly rated reason for 65% of decisions.

Figure 3 summarizes the results of how this uncertainty decomposition is linked to actual choices. As is standard in the literature, we plot average certainty equivalents (normalized by the lottery upside amount) as a function of the payout probability. As in Enke and Graeber (2023), we visualize the results by splitting the sample at median CU within each probability bucket. We conduct this analysis in two separate samples: decisions for which “Can’t know for sure what you’ll get” is the most important stated reason in BLNS’s decomposition survey (including ties), and those decisions for which some other reason was more important.

	Dependent variable: Normalized certainty equivalent		
	(1) Full sample	(2) “Can’t Know” top	(3) Other top reason
Payout probability	0.839*** (0.024)	0.824*** (0.037)	0.797*** (0.048)
<i>CU</i>	-0.042 (0.029)	-0.058 (0.038)	-0.071 (0.064)
Payout probability \times <i>CU</i>	-0.587*** (0.083)	-0.554*** (0.122)	-0.520*** (0.135)
Constant	-0.023** (0.010)	-0.023 (0.014)	0.005 (0.023)
Observations	2,112	1,214	649
Subjects	305	254	187
R^2	0.573	0.555	0.493

Table 1: OLS regressions of normalized certainty equivalents on payout probability, *CU*, and their interaction. Standard errors clustered at the subject level in parentheses. $N = 305$ subjects. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

We find strikingly similar patterns across these two samples. In both panels, higher *CU* is strongly correlated with more pronounced probability weighting (or, more adequately, with more pronounced pull-to-center effects). Table 1 provides associated regression evidence, which confirms that the magnitude of the *CU*-linked attenuation effect is nearly identical in the two samples.⁶

These results are consistent with subjects interpreting the *CU* question as asking about one’s best ex-ante decision: in both sub-samples, subjects exhibit the behavioral pattern that imperfect-information models of decision uncertainty directly predict. Reconciling these results with the interpretation that the left-panel sub-sample understands the *CU* question as asking about ex-post outcome uncertainty would require an additional account of why probability weighting tracks perceived outcome uncertainty so closely in this sub-sample, and why the magnitude of the relationship is essentially identical in the other sample.

To us, the near-identical findings across sub-samples leave two readings on the table: either the “Can’t know for sure what you’ll get” reason actually picks up decision uncertainty for the reasons elucidated by our survey follow-up question, or the uncertainty decomposition exercise itself does not separate the two readings cleanly, perhaps because subjects are reasoning post-hoc after a substantial time lag.

⁶We view these results as consistent with the large body of work that—using different experimental techniques—shows that valuation tasks such as multiple price lists give rise to systematic “pull-to-center” biases, see for example Andersen et al. (2006), Beauchamp et al. (2019), Andersson et al. (2016, 2020), Oprea (2024) and Qiu et al. (2026).

6 Conclusion: What Does Cognitive Uncertainty Capture?

A growing body of evidence shows that *CU* partly reflects the strength of tradeoffs across dimensions or payout states. For instance, Shubatt and Yang (2024) show that across three domains—multi-attribute choice, lottery choice and intertemporal choice—*CU* strongly increases in a formal measure of the strength of tradeoffs. Related, Enke et al. (2024) document across many different applications that *CU* systematically increases away from points at which no tradeoffs are present. The pattern encountered by BLNS—that *CU* increases in ex-post outcome uncertainty—appears to be one special case of this general phenomenon because higher outcome uncertainty implies more pronounced tradeoffs.

What, then, drives the link between measures of *CU* and phenomena such as probability weighting in the elicitation of certainty equivalents or hyperbolic discounting over money in the elicitation of present values? One strand of the literature has attributed the existence of these ‘anomalies’ to non-standard preferences. According to this perspective, correlations with *CU* are spurious. A second strand of the literature has instead sometimes attributed the ‘anomalies’ to mistakes. According to this perspective, correlations with *CU* are suggestive evidence. BLNS’s discussion has helpfully clarified that the terminology of mistakes is sometimes imprecise. Instead, a more helpful interpretation may be that *CU* and the associated ‘anomalies’ reflect imperfect information. For instance, various imperfect-information models show that preference uncertainty in combination with ‘Bayesian’ updating (broadly understood) can produce phenomena such as probability weighting, hyperbolic discounting over money, and other special cases of behavioral attenuation.⁷ If *CU* partly captures such preference uncertainty, then the ‘anomalies’ may not reflect choices that maximize latent true preferences, yet neither would they reflect suboptimal behavior. Instead, akin to the influential literature on the ‘Bayesian brain’ in cognitive science, they would reflect ‘reasonable’ responses to uncertainty in the mind.

⁷This perspective is also consistent with outcome uncertainty (tradeoffs) producing higher *CU*. For instance, Shubatt and Yang (2024) show in a model that preference uncertainty is less relevant for decisions when the choice options involve less pronounced tradeoffs.

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Appendix

A Binary Choice Experiment

A.1 Screenshots

Instructions 1/2

Please read these instructions carefully. There will be comprehension checks.

In this study, you will make multiple decisions.

Your payment will consist of two components:

- Completion fee:

If you **complete the study**, you will receive a **completion fee**.

- Additional bonus:

On each of 5 decision screens, you will make a decision. One of the decision screens will be selected at random by the computer, with equal probability, and will determine your **bonus**. The **maximal bonus** you can earn in this study is **\$30**. One in five participants will be paid a bonus.

Instructions 2/2

Your task

In this study, you will decide which of two lotteries you prefer.

In total, you will complete 5 rounds of this task. Across these rounds, the lotteries you can choose between will vary. These rounds are completely independent from one another. If one of the rounds is selected to determine your bonus, only your choice in this one round will determine your bonus.

Example screen:

Which lottery do you choose?
Please select one.

Lottery A	Lottery B
Probability 50% Get \$30 Probability 50% Get \$0	Probability 100% Get \$14

How certain are you that choosing Lottery A is actually your best decision, given your preferences and the available information?

Very uncertain | Fully certain

50% 55% 60% 65% 70% 75% 80% 85% 90% 95% 100%

Here is how your bonus would be determined in this example:

- If you chose **Lottery A** on the selected decision, the computer will **play that lottery for real** to determine your bonus (for example, \$30 with the shown probability, \$0 otherwise).
- If you chose **Lottery B**, you receive the **sure amount** shown for B as your bonus.
- Each participant has the same chance to be paid. If you are selected, you receive the **full bonus amount** determined above (in addition to the completion fee).

Your choices always matter: if you are selected for payment, the selected decision is paid exactly as described.

Your certainty

In each round, we will ask you two questions:

1. You will decide which lottery you prefer.
2. We will ask you how certain you are about your decision. Specifically, we are interested in how likely you think it is (in percentage terms) that the decision you made is actually your best decision, given your personal preferences and the available information.

Once you click the next button, the comprehension check questions will start!

Comprehension check

To verify your understanding of the instructions, please answer the comprehension questions below. You have to get all questions right before you're allowed to proceed. In each question, exactly one response option is correct.

You can review the instructions [here](#).

1. Which one of the following statements is true?

I will choose between the same lotteries in each round.

The lotteries I can choose between will vary across rounds.

2. Which one of the following statements is true?

When I'm asked to indicate my certainty about my decision, the people running this study are interested in how certain I am that the decision I made is actually my best decision, given my personal preferences and the available information.

When I'm asked to indicate my certainty about my decision, the people running this study are interested in how certain I am that I will actually receive the money from the lottery.



Please focus now! The main part of the study begins on the next page.

On each screen, you will choose a lottery and indicate your certainty.

Click "Next" when you read all the above text carefully and are ready to start.



Which lottery do you choose?
Please select one.

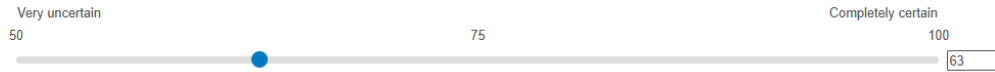
Lottery A

Lottery B

Probability 90% Get \$30
Probability 10% Get \$0

Probability 100% Get \$26

How certain are you that choosing this lottery is actually your best decision, given your preferences and the available information?



Understanding Your Overall Certainty

We asked you to report your level of certainty in each of the tasks you have completed so far in this study. In some tasks, you reported a certainty level of less than 100%, indicating less-than-complete certainty in your decisions.

Next, we will ask you to explain some possible reasons for your less-than-complete certainty in your previous choices.

Understanding Your Overall Certainty

In the next pages, we list nine possible reasons for having less-than-complete certainty in your decisions. For each reason, we also provide an illustration. It's important to keep in mind that these are just illustrations. In a few minutes we will ask you to classify similar examples, so please review these reasons carefully.

All these examples concern an individual named Chris who must choose between attending two social events with two different groups of friends.

Understanding Your Overall Certainty

1. **Can't Know For Sure What You'll Get:** You lack certainty in your decision because, based on the information you've received, you can't be sure what you will receive given your chosen option.

Here's an example of why Chris might report less-than-complete certainty for this reason:

Some of Chris's friends told him they might attend his chosen event or they might just stay home. He might express less-than-complete certainty in his decision because he can't be sure what his chosen option will yield since he doesn't know which friends will actually turn up to the event.



Understanding Your Overall Certainty

2. **Didn't Think Carefully About What You Want:** You lack certainty in your decision because you haven't thought through what you want to achieve as carefully as you could.

Here's an example of why Chris might report less-than-complete certainty for this reason:

Chris values experiences with different friends for different reasons but hasn't seriously considered whether one set of reasons is more important than another. He might express less-than-complete certainty in his decision because he hasn't carefully thought through what he wants from this social event.



Understanding Your Overall Certainty

3. **Not Sure What Each Option Means:** You lack certainty in your decision because you're not sure you interpreted the available options correctly or understood their consequences.

Here's an example of why Chris might report less-than-complete certainty for this reason:

Chris was told weeks ago which friends were attending which event, but he found some of their messages confusing and isn't sure he understood them properly. He might express less-than-complete certainty in his decision because he isn't sure he understands the consequences of choosing to attend one event vs. the other.



Understanding Your Overall Certainty

4. **Worried About Mental Shortcuts:** You lack certainty in your decision because you're worried about having used a mental shortcut that might have given the wrong answer.

Here's an example of why Chris might report less-than-complete certainty for this reason:

Chris' enjoyment of social events depends on who else is there, but it's hard for him to think through the pluses and minuses of being with one large group of friends rather than another. Instead, he makes his decision based entirely on which event his friend Parker plans to attend. He might express less-than-complete certainty in his decision because he's worried that the mental shortcut he used — to only think about Parker — isn't a good one.



Understanding Your Overall Certainty

5. **Didn't Apply Your Decision Criterion Correctly:** You lack certainty in your decision because you think the criterion you decided to use and any simplifying assumptions you made may actually favor an alternative other than the alternative that you chose.

Here's an example of why Chris might report less-than-complete certainty for this reason:

To simplify his choice, Chris assumed he would have the most fun at the event with the largest number of friends, so he listed the friends planning to attend each event and counted them. Right after committing to the event with the larger count, he worried that he might have miscounted. He might express less-than-complete certainty in his decision because he now thinks the criterion he decided to use and the simplifying assumption he made might actually favor an alternative other than the one he chose.



Understanding Your Overall Certainty

6. **Multiple Views About What You Want:** You lack certainty in your decision because, in your view, there's probably more than one right way to think about what you want to achieve.

Here's an example of why Chris might report less-than-complete certainty for this reason:

Chris values experiences with different friends for different reasons and, after careful consideration, doesn't think one set of reasons is necessarily more or less important than another. He might express less-than-complete certainty in his decision because he doesn't think there's just one right way to think about what he wants from either social event.



Understanding Your Overall Certainty

7. **Don't Know How You'll Feel:** You lack certainty in your decision because you aren't sure how you will feel about each of the possible outcomes.

Here's an example of why Chris might report less-than-complete certainty for this reason:

Chris enjoys different friends in different moods and is uncertain what his mood will be when the event arrives. He might express less-than-complete certainty in his decision because he isn't sure how he will feel about being with each group of friends.



Understanding Your Overall Certainty

8. **It's Nearly a Toss-Up:** You lack certainty in your decision because you think the choice is close to a toss-up.

Here's an example of why Chris might report less-than-complete certainty for this reason:

After assessing the desirability of each event, Chris concludes that he would enjoy them about the same. However, because he is slightly unsure about each assessment, either one might be slightly better. He might express less-than-complete certainty in his decision because he thinks it is nearly a toss-up.



Understanding Your Overall Certainty

9. **Other Reasons:** You lack certainty in your decision for other reasons.

Here's an example of why Chris might report less-than-complete certainty for this reason:

Chris may have other reasons for expressing less-than-complete certainty in his decision that we haven't mentioned.



Explaining the Reasons for your Overall Certainty

When you reported your overall certainty in each choice, any answer below 100% indicated that you had less-than-complete certainty. We want to understand your reasons for reporting less-than-complete certainty.

For each reason on the previous screens, you will indicate the degree to which it accounted for your less-than-complete certainty. For example, if you rated your certainty as 60%, we want to know the extent to which each reason was responsible for you answering 60% rather than 100%.

In each case, you will answer on a scale of **1 (Very Little) to 7 (Very Much)**. So if you rated your overall certainty as 60%, you would give a 1 for a particular reason if it had very little to do with saying your certainty was 60% rather than 100%, and you would give a 7 if it had a great deal to do with saying your certainty was 60% rather than 100%.

Please proceed to see an example of how the questions will look.



Imagine your overall certainty in a choice was 60% rather than 100%. You would then face the following question:

Your overall certainty was 60% rather than 100%. For each reason listed below, please indicate the degree to which it accounted for your less-than-complete certainty (in other words, the fact that you reported 60% rather than 100%). In each case, select a number from 1 (Very Little) to 7 (Very Much).

1. **Can't Know For Sure What You'll Get:** You lack certainty in your decision because, based on the information you've received, you can't be sure what you will receive given your chosen option.

Click [here](#) to reread a clarifying example.

1 2 3 4 5 6 7

Very Little Very Much

2. **Didn't Think Carefully About What You Want:** You lack certainty in your decision because you haven't thought through what you want to achieve as carefully as you could.

Click [here](#) to reread a clarifying example.

Very Little Very Much

3. **Not Sure What Each Option Means:** You lack certainty in your decision because you're not sure you interpreted the available options correctly or understood their consequences.

Click [here](#) to reread a clarifying example.

Very Little Very Much

4. **Worried About Mental Shortcuts:** You lack certainty in your decision because you're worried about having used a mental shortcut that might have given the wrong answer.

Click [here](#) to reread a clarifying example.

Very Little Very Much

5. **Didn't Apply Your Decision Criterion Correctly:** You lack certainty in your decision because you think the criterion you decided to use and any simplifying assumptions you made may actually favor an alternative other than the alternative that you chose.

Click [here](#) to reread a clarifying example.

Very Little Very Much

6. **Multiple Views About What You Want:** You lack certainty in your decision because, in your view, there's probably more than one right way to think about what you want to achieve.

Click [here](#) to reread a clarifying example.

Very Little Very Much

7. **Don't Know How You'll Feel:** You lack certainty in your decision because you aren't sure how you will feel about each of the possible outcomes.

Click [here](#) to reread a clarifying example.

Very Little Very Much

8. **It's Nearly a Toss-Up:** You lack certainty in your decision because you think the choice is close to a toss-up.

Click [here](#) to reread a clarifying example.

Very Little Very Much

9. **Other Reasons:** You lack certainty in your decision for other reasons.

Click [here](#) to reread a clarifying example.

Very Little Very Much



Check your Understanding

We will now check your understanding of the different reasons for expressing less-than-complete certainty, and of how you should report the importance of different reasons.

If you answer at least 3 of 4 questions correctly, you will receive an extra \$1 payment, so it is in your interest to take them seriously!



Test your Understanding

Question 1:

Susan is deciding between two options. Option A is an apple. Option B is either a pear or an orange depending on whether Yellow comes before Blue on the color spectrum (i.e., the order of the rainbow). If Yellow comes before Blue then Option B is definitely a pear. If Yellow comes after Blue then Option B is definitely an orange.

Susan doesn't recall the color spectrum precisely but remembers learning the acronym "ROY G BIV" for the colors of the rainbow. She thinks the "Y" stands for Yellow and the "B" stands for Blue, which would imply that Yellow comes before Blue. But she really isn't sure. She makes her decision as if Option B is a pear. She likes pears much more than apples so she chooses the pear.

However, she reports an overall certainty in her decision of less than 100% because she is not that sure about the accuracy of the "ROY G BIV" acronym she used when making her choice.

Which of the following reasons should Susan mark as contributing "Very Much" to her less-than-complete certainty?

Didn't Think Carefully About What You Want: You lack certainty in your decision because you haven't thought through what you want to achieve as carefully as you could.

It's Nearly a Toss-Up: You lack certainty in your decision because you think the choice is close to a toss-up.

Worried About Mental Shortcuts: You lack certainty in your decision because you're worried about having used a mental shortcut that might have given the wrong answer.



Test your Understanding

Question 2:

Edward is deciding between two options. Option A is a box of oatmeal cookies, while Option B is a box of assorted chocolates. For Option B, he won't know which types of chocolates are in the box until he opens it.

He knows he likes all types of chocolate more than oatmeal cookies, so he chooses Option B. He expresses an overall certainty in his decision of less than 100% because there's no way for him to know which chocolates are in the box.

Which of the following reasons should Edward mark as contributing "Very Much" to his less-than-complete certainty?

Can't Know For Sure What You'll Get: You lack certainty in your decision because, based on the information you've received, you can't be sure what you will receive given your chosen option.

Didn't Apply Your Decision Criterion Correctly: You lack certainty in your decision because you think the criterion you decided to use and any simplifying assumptions you made may actually favor an alternative other than the alternative that you chose.

Worried About Mental Shortcuts: You lack certainty in your decision because you're worried about having used a mental shortcut that might have given the wrong answer



Test your Understanding

Question 3:

Samantha is deciding between two boxes. Box A contains either an apple or a pear, while Box B contains either one dollar or ten cents. The boxes are labeled with their exact contents, but the labels are written in a foreign language that Samantha has not studied.

She does her best to guess what the words mean based on similarities to words in languages she knows. She concludes that Box A probably contains an apple while Box B probably contains one dollar. She chooses Box A because she prefers an apple to one dollar. She expresses an overall certainty in her decision of less than 100% because she's not sure she correctly translated the labels on the boxes.

Which of the following reasons should Samantha mark as contributing "Very Much" to her less-than-complete certainty?

Didn't Think Carefully About What You Want: You lack certainty in your decision because you haven't thought through what you want to achieve as carefully as you could.

Not Sure What Each Option Means: You lack certainty in your decision because you're not sure you interpreted the available options correctly or understood their consequences.

Worried About Mental Shortcuts: You lack certainty in your decision because you're worried about having used a mental shortcut that might have given the wrong answer.



Test your Understanding

Question 4:

Jude is deciding between the same two boxes as Samantha in the previous problem. Box A contains either an apple or a pear, while Box B contains either one dollar or ten cents. The boxes are labeled with their exact contents but the labels are written in a foreign language.

Unlike Samantha, Jude can read the language and is fairly certain Box A contains an apple while Box B contains one dollar. An apple is worth more than a dollar to him, so he intends to select Box A. But after making his choice, he thinks he may have accidentally recorded his selection as Box B, containing the dollar. For that reason, he expresses an overall certainty in his decision of less than 100%.

Which of the following reasons should Jude mark as contributing "Very Much" to his less-than-complete certainty?

Not Sure What Each Option Means: You lack certainty in your decision because you're not sure you interpreted the available options correctly or understood their consequences

Didn't Apply Your Decision Criterion Correctly: You lack certainty in your decision because you think the criterion you decided to use and any simplifying assumptions you made may actually favor an alternative other than the alternative that you chose.

It's Nearly a Toss-Up: You lack certainty in your decision because you think the choice is close to a toss-up.



Explaining the Reasons for your Overall Certainty

We will now ask you to provide the reasons for your overall certainty in the decisions that you made in this study.



On the next screen you will explain your certainty in **round 1/5**.



Additional Questions about your certainty in round 2 / 5

On a previous screen you faced the following decision:

<p>Lottery A</p> <div style="border: 1px solid gray; padding: 5px; width: fit-content; margin: auto;"> <p>Probability 50 % Get \$30 Probability 50 % Get \$0</p> </div>	<p>Lottery B</p> <div style="border: 1px solid gray; padding: 5px; width: fit-content; margin: auto;"> <p>Probability 100% Get \$14</p> </div>
--	--

You selected **Lottery B** and reported a 67% certainty in your decision.

For each reason listed below, please indicate the degree to which it accounted for your less-than-complete certainty (in other words, the fact that you reported 60% rather than 100%). In each case, select a number from **1 (Very Little)** to **7 (Very Much)**.

	Very Little						Very Much
<p>Multiple Views About What You Want: You lack certainty in your decision because, in your view, there's probably more than one right way to think about what you want to achieve.</p>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<p>Not Sure What Each Option Means: You lack certainty in your decision because you're not sure you interpreted the available options correctly or understood their consequences.</p>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<p>Worried About Mental Shortcuts: You lack certainty in your decision because you're worried about having used a mental shortcut that might have given the wrong answer.</p>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<p>Don't Know How You'll Feel: You lack certainty in your decision because you aren't sure how you will feel about each of the possible outcomes.</p>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
<p>Didn't Think Carefully About What You Want: You lack certainty in your decision because you haven't thought through what you want to achieve as carefully as you could.</p>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<p>It's Nearly a Toss-Up: You lack certainty in your decision because you think the choice is close to a toss-up.</p>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<p>Didn't Apply Your Decision Criterion Correctly: You lack certainty in your decision because you think the criterion you decided to use and any simplifying assumptions you made may actually favor an alternative other than the alternative that you chose.</p>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<p>Can't Know For Sure What You'll Get: You lack certainty in your decision because, based on the information you've received, you can't be sure what you will receive given your chosen option.</p>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
<p>Other Reasons: You lack certainty in your decision for other reasons.</p>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>

Follow-up on your previous response

On the previous screen, you indicated that you were uncertain in part for the following reason:

"You lack certainty in your decision because, based on the information you've received, you can't be sure what you will receive given your chosen option."

Which statement best explains what you meant to say in selecting this reason?

I wanted to say that:

Not knowing how much money I'll get makes me uncertain about which lottery I prefer.

I don't know how much money I'll get.



You are almost at the end of the survey.

Before you finish, please share a few details about yourself.

What is your sex?

Male
Female

How old are you?

What is your annual household income before taxes?

Less than \$10,000
\$10,000 to \$19,999
\$20,000 to \$29,999
\$30,000 to \$39,999
\$40,000 to \$49,999
\$50,000 to \$59,999
\$60,000 to \$69,999
\$70,000 to \$79,999
\$80,000 to \$89,999
\$90,000 to \$99,999
\$100,000 to \$149,999
\$150,000 or more

What is your highest level of education?

Less than high school degree
High school graduate (high school diploma or equivalent including GED)
Some college but no degree
Associate degree in college (2-year)
Bachelor's degree in college (3-year or 4-year)
Master's degree
Doctoral degree
Professional degree (JD, MD)



Congratulations! You earned the following bonuses:

- Decision Bonus: \$30
- Quiz Reward: \$

Total Bonus: 30



Thank you for your participation! You have completed this study entirely, and you will receive a completion payment.

If you were eligible for a bonus it will be paid out to you once all the responses are collected.



A.2 Results

A.2.1 Replication of BLNS's Results

206 subjects completed the experiment on Prolific and made five decisions each, for a total of 1,030 data points on *CU*. Figure A.1 shows the distribution of reported certainty in the full sample of decisions. 646 observations reflect strictly positive *CU*.

Figure A.2 shows the average importance of each of the BLNS reasons and Figure A.3 the fraction of decisions (pooled across subjects and rounds) for which a reason was the most highly rated one (including ties). Our results are very similar to those reported in BLS, with around 50% of all data points suggesting that the most important reason for being uncertain is “Can’t know for sure what you’ll get.”

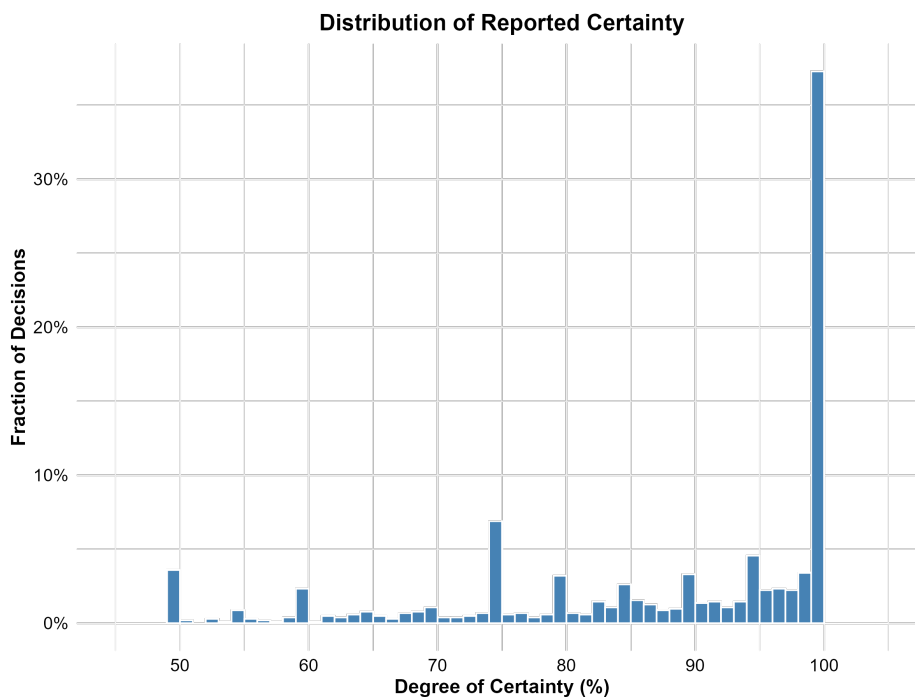


Figure A.1: Distribution of self-reported certainty across all decisions (pooled). The histogram displays the fraction of total decisions falling into each certainty bin (bin width = 1).

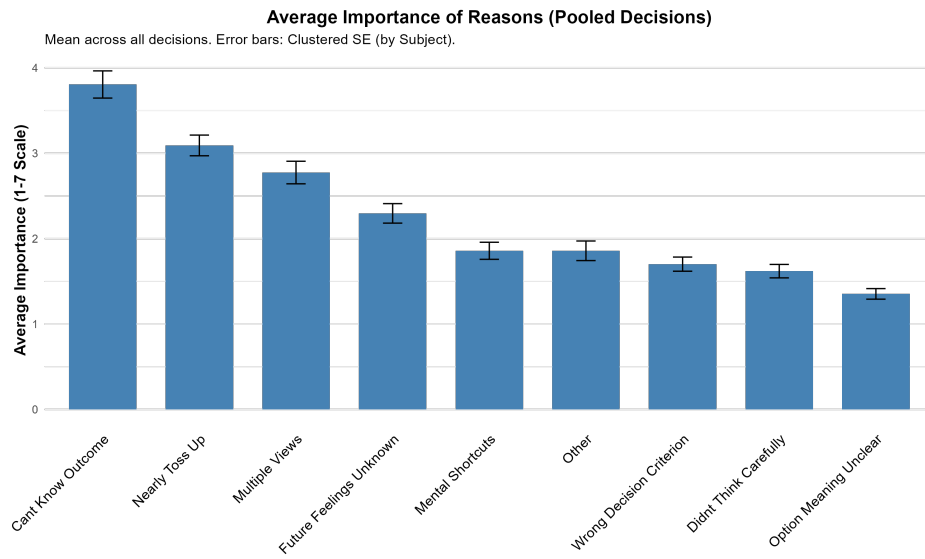


Figure A.2: Average importance ratings for each potential BLNS reason for being uncertain. The means are calculated by pooling all decisions across all subjects. Error bars represent ± 1 standard error (SE), clustered at the subject level.

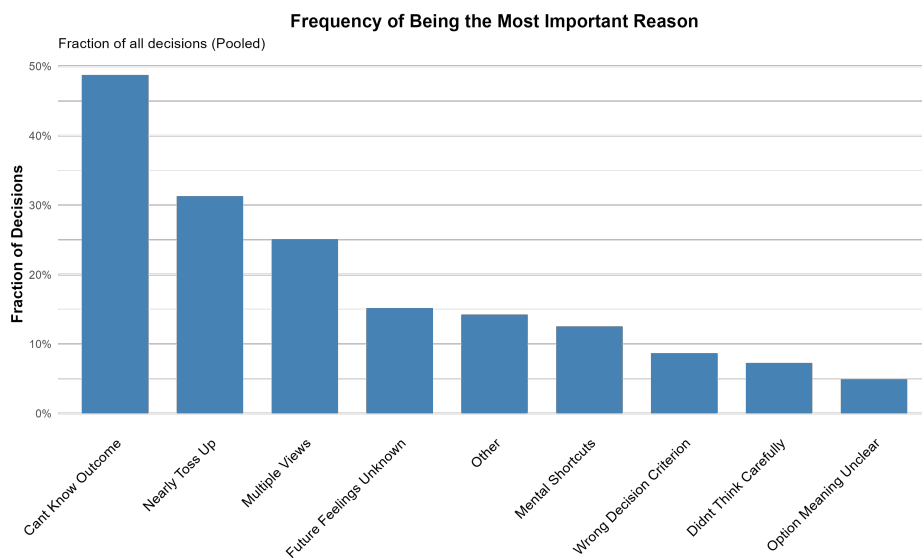


Figure A.3: Fraction of decisions for which each reason was rated as most important (including ties). Fractions are calculated by pooling all decisions across all subjects.

A.2.2 Follow-Up Question to Disambiguate Interpretations

Figures A.4 and A.5 show the results for our follow-up question. Focusing on the sample of 303 observations in which “Can’t Know For Sure What You’ll Get” is the most important reason (BLNS’s preferred sample), 74% select the reason suggesting decision rather than outcome uncertainty. If we instead look at the sample of all people who indicated non-zero importance for this reason ($N = 443$), the corresponding number is 75%.

Finally, Figure A.6 provides a subject-level analysis (rather than decision level analysis as in the other figures). We classify subjects according to how consistently they answered in our follow-up question. We see that a large majority of subjects either always or mostly selects the reason that indicates cognitive uncertainty in line with the question’s intended meaning.

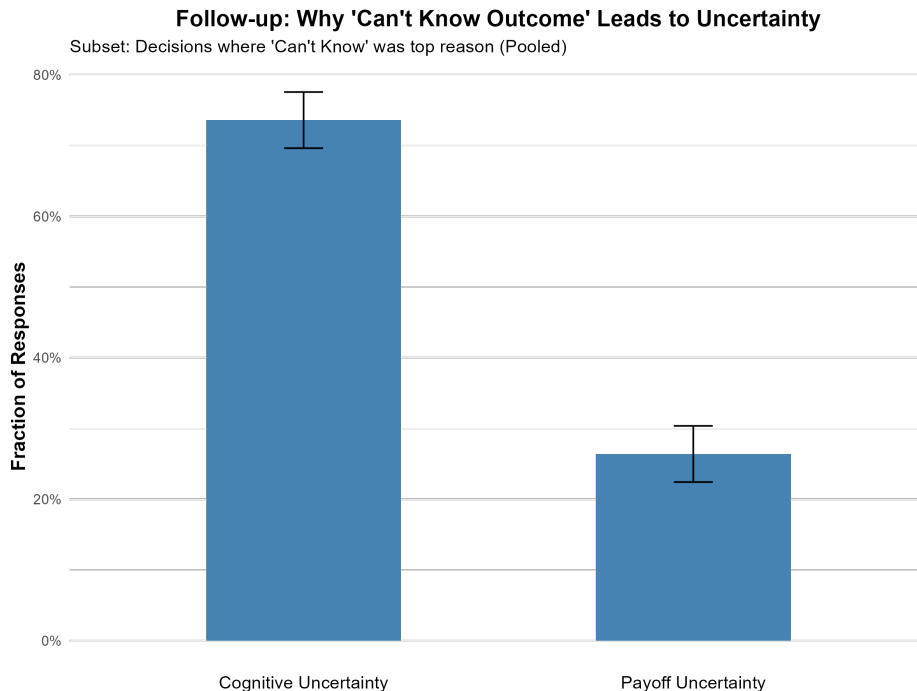


Figure A.4: Interpretation of “Can’t know for sure what I will get” (Top Reason Subset). This figure displays the distribution of responses to the follow-up question across the sample of observations for which the “Can’t know for sure what you’ll get” reason was the top reason (including ties). “Cognitive Uncertainty” refers to the response: “*Not knowing how much money I’ll get makes me uncertain about which lottery I prefer.*” “Payoff Uncertainty” refers to: “*I don’t know how much money I’ll get.*” Fractions are calculated by pooling decisions. Error bars represent ± 1 standard error (SE), clustered at the subject level.

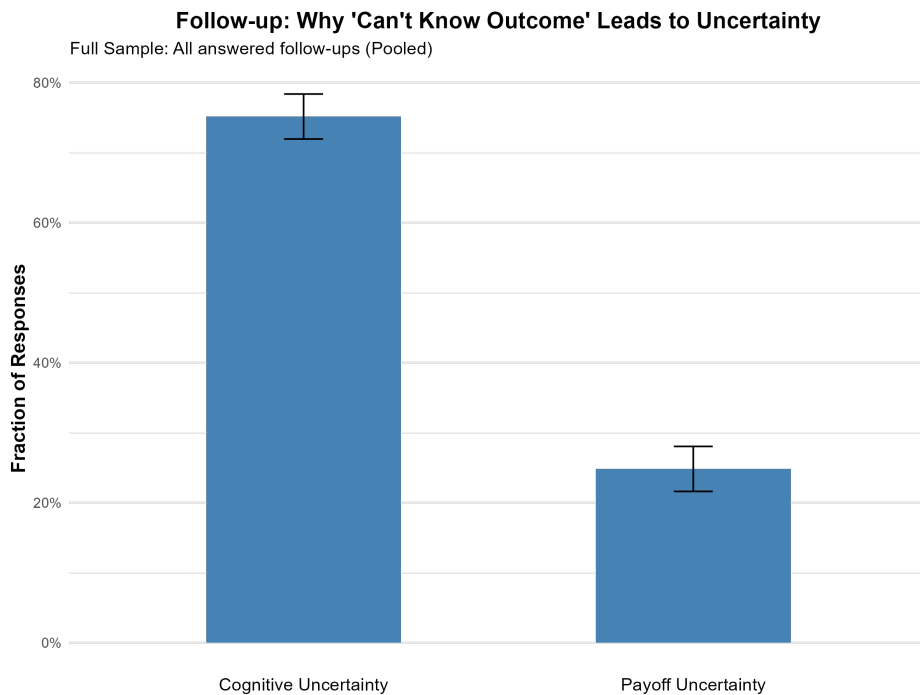


Figure A.5: Interpretation of “Can’t know for sure what I will get” (Full Sample). This figure displays the distribution of responses to the follow-up question across the full sample of observations who reported that the importance of the “Can’t know for sure what you’ll get” reason was at least 2/7. “Cognitive Uncertainty” refers to the response: “Not knowing how much money I’ll get makes me uncertain about which lottery I prefer.” “Payoff Uncertainty” refers to: “I don’t know how much money I’ll get.” Fractions are calculated by pooling decisions. Error bars represent ± 1 standard error (SE), clustered at the subject level.

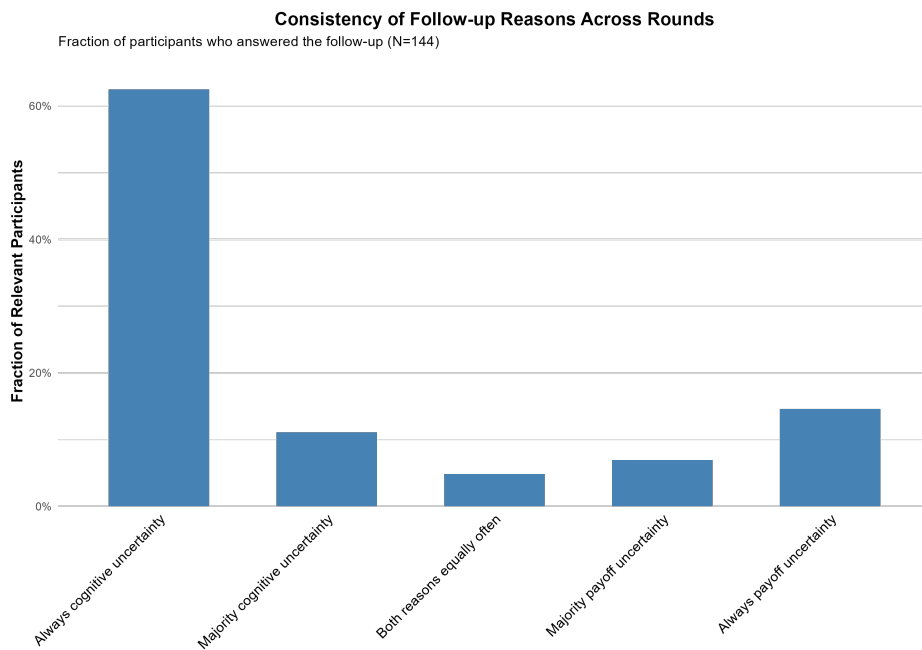


Figure A.6: Consistency of follow-up interpretations across rounds. This figure classifies participants based on the consistency of their follow-up responses across the 5 rounds. “Always” indicates that the participant chose that interpretation in all rounds in which they encountered the follow-up question. “Majority” indicates the participant chose that interpretation in the majority of rounds. The y-axis shows the fraction of relevant participants (those who answered the follow-up question at least once). “Cognitive Uncertainty” refers to the response: *“Not knowing how much money I’ll get makes me uncertain about which lottery I prefer.”* “Payoff Uncertainty” refers to: *“I don’t know how much money I’ll get.”*

B Certainty Equivalents Experiment

B.1 Screenshots

The following screenshots reproduce the full sequence of screens shown to subjects in the certainty-equivalents experiment. Several screens—in particular the BLNS instructions on the nine reasons, the Chris vignettes, and the Bernheim comprehension questions—are essentially identical to those of the binary-choice experiment, while others (such as the per-round rating screen) closely follow the same template with adjustments to the CE-specific wording. To allow the reader to follow the flow without consulting Appendix A.1, all screens are reproduced here in full.

For data-quality reasons this study must be taken in Firefox, Edge, Safari or another non-Chrome browser. If you are using Chrome, please copy the survey link into a supported browser and return. Continuing in Chrome will exit the survey. We apologize for any inconvenience caused.

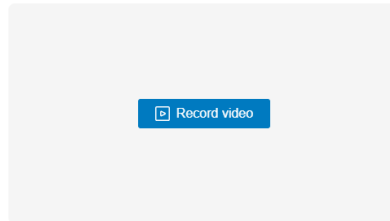


Welcome!

This study is designed for **computer (PC or Mac) users only (desktop, laptop, etc.)**. If you are accessing this study on a smartphone, a tablet or any other non-PC device, please switch to PC and enter the study again, or return the submission on Prolific.

Verify that you are a real person

We ask you to record a short video of yourself providing **your opinion about tipping culture in the United States**. The recording can be very short and will automatically stop if you talk more than 30 seconds. It serves to verify that you are a real person. Please ensure your room is well-lit for this recording so that you're clearly visible. No one will ever watch your recording—it will be analyzed automatically and will then be deleted.



Your task:

In this study, you will **decide between a lottery ticket and a safe payment**.

- A lottery ticket pays **\$18 with some percentage chance, and \$0 otherwise**.
 - A safe payment is paid with certainty.
 - In each round, you will be told the **percentage chance of getting \$18 from the lottery ticket**. You will then decide between the lottery ticket and different safe payment amounts.
 - In total, you will complete 7 rounds of this task. Across these rounds, the percentage chance the lottery ticket pays \$18 varies. These rounds are completely independent from one another. If one of the rounds of this task is selected to determine your bonus, only your decision in this one round will determine your bonus.
-

Your bonus payment:

Your decisions may affect your bonus.

- If you picked the lottery ticket, you will receive the outcome of the lottery, implemented by the computer.
- If you picked the safe payment, you will receive that payment.

This means that it is in your best interest to **choose the option (lottery ticket or safe payment) you actually prefer in each case**.

Next

Example:

Lottery		Safe payment
With 80% chance: Get \$18 With 20% chance: Get \$0	<input checked="" type="radio"/> <input type="radio"/>	\$1
	<input checked="" type="radio"/> <input type="radio"/>	\$2
	<input checked="" type="radio"/> <input type="radio"/>	\$3
	<input checked="" type="radio"/> <input type="radio"/>	\$4
	<input checked="" type="radio"/> <input type="radio"/>	\$5
	<input checked="" type="radio"/> <input type="radio"/>	\$6
	<input checked="" type="radio"/> <input type="radio"/>	\$7
	<input checked="" type="radio"/> <input type="radio"/>	\$8
	<input checked="" type="radio"/> <input type="radio"/>	\$9
	<input checked="" type="radio"/> <input type="radio"/>	\$10
	<input checked="" type="radio"/> <input type="radio"/>	\$11
	<input checked="" type="radio"/> <input type="radio"/>	\$12
	<input checked="" type="radio"/> <input type="radio"/>	\$13
	<input type="radio"/> <input checked="" type="radio"/>	\$14
	<input type="radio"/> <input checked="" type="radio"/>	\$15
	<input type="radio"/> <input checked="" type="radio"/>	\$16
	<input type="radio"/> <input checked="" type="radio"/>	\$17

- In this example, the percentage chance of winning \$18 is 80%.
- You then need to decide whether you prefer this lottery ticket or a given safe payment.
- You will make your decisions in a choice list, **where each row is a separate choice**.
 - In every list, the left-hand option is a lottery that is identical in all rows. The right-hand option is a safe payment. The safe payment increases as you go down the list.
 - To make a choice just click on the radio button you prefer for each choice (i.e. for each row).
 - **An effective way to complete these choice lists is to determine in which row you would prefer to switch from choosing the lottery to choosing the safe payment.** You can click on the radio button in that row and we will automatically fill out the rest of the list for you, by selecting the lottery in all rows above and safe payment in all rows below your selected row.
 - Based on where you switch from the lottery to the safe payment in this list, we assess which safe payment you value as much as the lottery.
 - For example, in the choice list above, your choice suggests that you value the lottery as much as a safe payment between \$13 and \$14 because this is where you switched.
 - If a round in this study is selected for bonus payment, the computer will randomly select one of your choices from that choice list, and you will receive the option you selected in that choice.

Your certainty:

In each round, we will ask you two questions:

- You will decide between a lottery ticket and different safe payments. We will use these decisions to assess how much you value the lottery ticket.
- We will ask you **how certain** you are about your decisions. Specifically, we are interested in how likely you think it is (in percentage terms) that your decisions actually reflect how much you value the lottery ticket.

Comprehension check

You have to answer all comprehension questions correctly within the first two trials in order to receive your completion reward and keep your chance of winning a bonus.

You can review the instructions [here](#).

Suppose the third row from the top gets randomly selected to determine the outcomes of this experiment. Which one of the following statements is **NOT** correct?

Lottery		Safe payment
	<input checked="" type="radio"/> <input type="radio"/>	\$1
	<input checked="" type="radio"/> <input type="radio"/>	\$2
	<input checked="" type="radio"/> <input type="radio"/>	\$3
	<input checked="" type="radio"/> <input type="radio"/>	\$4
	<input checked="" type="radio"/> <input type="radio"/>	\$5
	<input checked="" type="radio"/> <input type="radio"/>	\$6
	<input checked="" type="radio"/> <input type="radio"/>	\$7
With 80% chance: Get \$18	<input checked="" type="radio"/> <input type="radio"/>	\$8
With 20% chance: Get \$0	<input checked="" type="radio"/> <input type="radio"/>	\$9
	<input checked="" type="radio"/> <input type="radio"/>	\$10
	<input checked="" type="radio"/> <input type="radio"/>	\$11
	<input checked="" type="radio"/> <input type="radio"/>	\$12
	<input checked="" type="radio"/> <input type="radio"/>	\$13
	<input type="radio"/> <input checked="" type="radio"/>	\$14
	<input type="radio"/> <input checked="" type="radio"/>	\$15
	<input type="radio"/> <input checked="" type="radio"/>	\$16
	<input type="radio"/> <input checked="" type="radio"/>	\$17

I will get a lottery which pays \$0 with 20% probability.

I will get a lottery which pays \$18 with 80% probability.

I will get \$3.

Which one of the following statements is true?

When I'm asked to indicate my certainty about my decision, the people running this study are interested in how certain I am that I will actually receive the lottery payment of \$18.

When I'm asked to indicate my certainty about my decision, the people running this study are interested in how certain I am that my decisions actually reflect how much I value the lottery ticket.

Which one of the following statements is true?

I should always switch in the first row of the choice list so that I get the highest possible bonus.

I should complete the choice lists by thinking carefully about the row in which I would like to switch from preferring the lottery ticket to preferring the safe payment.

I should always switch in the last row of the choice list. This increases the chance of the lottery ticket determining my bonus and will thus maximize my bonus.

Round 1/7

Click [here](#) to re-read the instructions.

Lottery		Safe payment
With 95% chance: Get \$18 With 5% chance: Get \$0	<input checked="" type="radio"/> <input type="radio"/>	\$1
	<input checked="" type="radio"/> <input type="radio"/>	\$2
	<input checked="" type="radio"/> <input type="radio"/>	\$3
	<input checked="" type="radio"/> <input type="radio"/>	\$4
	<input type="radio"/> <input checked="" type="radio"/>	\$5
	<input type="radio"/> <input checked="" type="radio"/>	\$6
	<input type="radio"/> <input checked="" type="radio"/>	\$7
	<input type="radio"/> <input checked="" type="radio"/>	\$8
	<input type="radio"/> <input checked="" type="radio"/>	\$9
	<input type="radio"/> <input checked="" type="radio"/>	\$10
	<input type="radio"/> <input checked="" type="radio"/>	\$11
	<input type="radio"/> <input checked="" type="radio"/>	\$12
	<input type="radio"/> <input checked="" type="radio"/>	\$13
	<input type="radio"/> <input checked="" type="radio"/>	\$14
	<input type="radio"/> <input checked="" type="radio"/>	\$15
	<input type="radio"/> <input checked="" type="radio"/>	\$16
	<input type="radio"/> <input checked="" type="radio"/>	\$17

How **certain** are you that you actually value this lottery ticket somewhere between **\$4** and **\$5**?

Very uncertain


0

50

Completely certain

100

Please complete this reCAPTCHA to confirm you are human.

 I'm not a robot 
reCAPTCHA

Understanding Your Overall Certainty

We asked you to report your level of certainty in each of the tasks you have completed so far in this study. In some tasks, you reported a certainty level of less than 100%, indicating less-than-complete certainty in your decisions.

Next, we will ask you to explain some possible reasons for your less-than-complete certainty in your previous choices.



Understanding Your Overall Certainty

In the next pages, we list nine possible reasons for having less-than-complete certainty in your decisions. For each reason, we also provide an illustration. It's important to keep in mind that these are just illustrations. In a few minutes we will ask you to classify similar examples, so please review these reasons carefully.

All these examples concern an individual named Chris who must choose between attending two social events with two different groups of friends.



Understanding Your Overall Certainty

1 **Can't Know For Sure What You'll Get:** You lack certainty in your decision because, based on the information you've received, you can't be sure what you will receive given your chosen option.

Here's an example of why Chris might report less-than-complete certainty for this reason:

Some of Chris's friends told him they might attend his chosen event or they might just stay home. He might express less-than-complete certainty in his decision because he can't be sure what his chosen option will yield since he doesn't know which friends will actually turn up to the event.



Understanding Your Overall Certainty

2. **Didn't Think Carefully About What You Want:** You lack certainty in your decision because you haven't thought through what you want to achieve as carefully as you could.

Here's an example of why Chris might report less-than-complete certainty for this reason:

Chris values experiences with different friends for different reasons but hasn't seriously considered whether one set of reasons is more important than another. He might express less-than-complete certainty in his decision because he hasn't carefully thought through what he wants from this social event.



Understanding Your Overall Certainty

3. **Not Sure What Each Option Means:** You lack certainty in your decision because you're not sure you interpreted the available options correctly or understood their consequences.

Here's an example of why Chris might report less-than-complete certainty for this reason:

Chris was told weeks ago which friends were attending which event, but he found some of their messages confusing and isn't sure he understood them properly. He might express less-than-complete certainty in his decision because he isn't sure he understands the consequences of choosing to attend one event vs. the other.



Understanding Your Overall Certainty

4. **Worried About Mental Shortcuts:** You lack certainty in your decision because you're worried about having used a mental shortcut that might have given the wrong answer.

Here's an example of why Chris might report less-than-complete certainty for this reason:

Chris' enjoyment of social events depends on who else is there, but it's hard for him to think through the pluses and minuses of being with one large group of friends rather than another. Instead, he makes his decision based entirely on which event his friend Parker plans to attend. He might express less-than-complete certainty in his decision because he's worried that the mental shortcut he used — to only think about Parker — isn't a good one.



Understanding Your Overall Certainty

5. **Didn't Apply Your Decision Criterion Correctly:** You lack certainty in your decision because you think the criterion you decided to use and any simplifying assumptions you made may actually favor an alternative other than the alternative that you chose.

Here's an example of why Chris might report less-than-complete certainty for this reason:

To simplify his choice, Chris assumed he would have the most fun at the event with the largest number of friends, so he listed the friends planning to attend each event and counted them. Right after committing to the event with the larger count, he worried that he might have miscounted. He might express less-than-complete certainty in his decision because he now thinks the criterion he decided to use and the simplifying assumption he made might actually favor an alternative other than the one he chose.



Understanding Your Overall Certainty

6. **Multiple Views About What You Want:** You lack certainty in your decision because, in your view, there's probably more than one right way to think about what you want to achieve.

Here's an example of why Chris might report less-than-complete certainty for this reason:

Chris values experiences with different friends for different reasons and, after careful consideration, doesn't think one set of reasons is necessarily more or less important than another. He might express less-than-complete certainty in his decision because he doesn't think there's just one right way to think about what he wants from either social event.



Understanding Your Overall Certainty

7. **Don't Know How You'll Feel:** You lack certainty in your decision because you aren't sure how you will feel about each of the possible outcomes.

Here's an example of why Chris might report less-than-complete certainty for this reason:

Chris enjoys different friends in different moods and is uncertain what his mood will be when the event arrives. He might express less-than-complete certainty in his decision because he isn't sure how he will feel about being with each group of friends.



Understanding Your Overall Certainty

8. **It's Nearly a Toss-Up:** You lack certainty in your decision because you think the choice is close to a toss-up.

Here's an example of why Chris might report less-than-complete certainty for this reason:

After assessing the desirability of each event, Chris concludes that he would enjoy them about the same. However, because he is slightly unsure about each assessment, either one might be slightly better. He might express less-than-complete certainty in his decision because he thinks it is nearly a toss-up.



Understanding Your Overall Certainty

9. **Other Reasons:** You lack certainty in your decision for other reasons.

Here's an example of why Chris might report less-than-complete certainty for this reason:

Chris may have other reasons for expressing less-than-complete certainty in his decision that we haven't mentioned.



Explaining the Reasons for your Overall Certainty

When you reported your overall certainty in each choice, any answer below 100% indicated that you had less-than-complete certainty. We want to understand your reasons for reporting less-than-complete certainty.

For each reason on the previous screens, you will indicate the degree to which it accounted for your less-than-complete certainty. For example, if you rated your certainty as 60%, we want to know the extent to which each reason was responsible for you answering 60% rather than 100%.

In each case, you will answer on a scale of **1 (Very Little) to 7 (Very Much)**. So if you rated your overall certainty as 60%, you would give a 1 for a particular reason if it had very little to do with saying your certainty was 60% rather than 100%, and you would give a 7 if it had a great deal to do with saying your certainty was 60% rather than 100%.

Please proceed to see an example of how the questions will look.



Imagine your overall certainty in a choice was 60% rather than 100%. You would then face the following question:

Your overall certainty was 60% rather than 100%. For each reason listed below, please indicate the degree to which it accounted for your less-than-complete certainty (in other words, the fact that you reported 60% rather than 100%). In each case, select a number from 1 (Very Little) to 7 (Very Much).

1. Can't Know For Sure What You'll Get: You lack certainty in your decision because, based on the information you've received, you can't be sure what you will receive given your chosen option.

Click [here](#) to reread a clarifying example.

1 2 3 4 5 6 7

Very Little Very Much

2. Didn't Think Carefully About What You Want: You lack certainty in your decision because you haven't thought through what you want to achieve as carefully as you could.

Click [here](#) to reread a clarifying example.

Very Little Very Much

3. Not Sure What Each Option Means: You lack certainty in your decision because you're not sure you interpreted the available options correctly or understood their consequences.

Click [here](#) to reread a clarifying example.

Very Little Very Much

4. Worried About Mental Shortcuts: You lack certainty in your decision because you're worried about having used a mental shortcut that might have given the wrong answer.

Click [here](#) to reread a clarifying example.

Very Little Very Much

5. Didn't Apply Your Decision Criterion Correctly: You lack certainty in your decision because you think the criterion you decided to use and any simplifying assumptions you made may actually favor an alternative other than the alternative that you chose.

Click [here](#) to reread a clarifying example.

Very Little Very Much

6. **Multiple Views About What You Want:** You lack certainty in your decision because, in your view, there's probably more than one right way to think about what you want to achieve.

Click [here](#) to reread a clarifying example.

Very Little Very Much

7. **Don't Know How You'll Feel:** You lack certainty in your decision because you aren't sure how you will feel about each of the possible outcomes.

Click [here](#) to reread a clarifying example.

Very Little Very Much

8. **It's Nearly a Toss-Up:** You lack certainty in your decision because you think the choice is close to a toss-up.

Click [here](#) to reread a clarifying example.

Very Little Very Much

9. **Other Reasons:** You lack certainty in your decision for other reasons.

Click [here](#) to reread a clarifying example.

Very Little Very Much



Check your Understanding

We will now check your understanding of the different reasons for expressing less-than-complete certainty, and of how you should report the importance of different reasons.

If you answer at least 3 of 4 questions correctly, you will receive an extra \$1 payment, so it is in your interest to take them seriously!



Test your Understanding

Question 1:

Susan is deciding between two options. Option A is an apple. Option B is either a pear or an orange depending on whether Yellow comes before Blue on the color spectrum (i.e., the order of the rainbow). If Yellow comes before Blue then Option B is definitely a pear. If Yellow comes after Blue then Option B is definitely an orange.

Susan doesn't recall the color spectrum precisely but remembers learning the acronym "ROY G BIV" for the colors of the rainbow. She thinks the "Y" stands for Yellow and the "B" stands for Blue, which would imply that Yellow comes before Blue. But she really isn't sure. She makes her decision as if Option B is a pear. She likes pears much more than apples so she chooses the pear.

However, she reports an overall certainty in her decision of less than 100% because she is not that sure about the accuracy of the "ROY G BIV" acronym she used when making her choice.

Which of the following reasons should Susan mark as contributing "Very Much" to her less-than-complete certainty?

Didn't Think Carefully About What You Want: You lack certainty in your decision because you haven't thought through what you want to achieve as carefully as you could.

It's Nearly a Toss-Up: You lack certainty in your decision because you think the choice is close to a toss-up.

Worried About Mental Shortcuts: You lack certainty in your decision because you're worried about having used a mental shortcut that might have given the wrong answer.



Test your Understanding

Question 2:

Edward is deciding between two options. Option A is a box of oatmeal cookies, while Option B is a box of assorted chocolates. For Option B, he won't know which types of chocolates are in the box until he opens it.

He knows he likes all types of chocolate more than oatmeal cookies, so he chooses Option B. He expresses an overall certainty in his decision of less than 100% because there's no way for him to know which chocolates are in the box.

Which of the following reasons should Edward mark as contributing "Very Much" to his less-than-complete certainty?

Can't Know For Sure What You'll Get: You lack certainty in your decision because, based on the information you've received, you can't be sure what you will receive given your chosen option.

Didn't Apply Your Decision Criterion Correctly: You lack certainty in your decision because you think the criterion you decided to use and any simplifying assumptions you made may actually favor an alternative other than the alternative that you chose.

Worried About Mental Shortcuts: You lack certainty in your decision because you're worried about having used a mental shortcut that might have given the wrong answer.



Test your Understanding

Question 3:

Samantha is deciding between two boxes. Box A contains either an apple or a pear, while Box B contains either one dollar or ten cents. The boxes are labeled with their exact contents, but the labels are written in a foreign language that Samantha has not studied.

She does her best to guess what the words mean based on similarities to words in languages she knows. She concludes that Box A probably contains an apple while Box B probably contains one dollar. She chooses Box A because she prefers an apple to one dollar. She expresses an overall certainty in her decision of less than 100% because she's not sure she correctly translated the labels on the boxes.

Which of the following reasons should Samantha mark as contributing "Very Much" to her less-than-complete certainty?

Didn't Think Carefully About What You Want: You lack certainty in your decision because you haven't thought through what you want to achieve as carefully as you could.

Not Sure What Each Option Means: You lack certainty in your decision because you're not sure you interpreted the available options correctly or understood their consequences.

Worried About Mental Shortcuts: You lack certainty in your decision because you're worried about having used a mental shortcut that might have given the wrong answer.



Test your Understanding

Question 4:

Jude is deciding between the same two boxes as Samantha in the previous problem. Box A contains either an apple or a pear, while Box B contains either one dollar or ten cents. The boxes are labeled with their exact contents but the labels are written in a foreign language.

Unlike Samantha, Jude can read the language and is fairly certain Box A contains an apple while Box B contains one dollar. An apple is worth more than a dollar to him, so he intends to select Box A. But after making his choice, he thinks he may have accidentally recorded his selection as Box B, containing the dollar. For that reason, he expresses an overall certainty in his decision of less than 100%.

Which of the following reasons should Jude mark as contributing "Very Much" to his less-than-complete certainty?

Not Sure What Each Option Means: You lack certainty in your decision because you're not sure you interpreted the available options correctly or understood their consequences

Didn't Apply Your Decision Criterion Correctly: You lack certainty in your decision because you think the criterion you decided to use and any simplifying assumptions you made may actually favor an alternative other than the alternative that you chose.

It's Nearly a Toss-Up: You lack certainty in your decision because you think the choice is close to a toss-up.



Explaining the Reasons for your Overall Certainty

We will now ask you to provide the reasons for your overall certainty in the decisions that you made in this study.



On the next screen you will explain your certainty in **round 1/7**.



Additional Questions about your certainty in round 1 / 7

On a previous screen you made the following decision:

Lottery

With 95% chance: **Get \$18**

With 5% chance: Get \$0

Your responses indicated that you value this lottery ticket somewhere between \$4 and \$5.

You reported a 71% certainty in this valuation.

For each reason listed below, please indicate the degree to which it accounted for your less-than-complete certainty (in other words, the fact that you reported 71% rather than 100%). In each case, select a number from 1 (**Very Little**) to 7 (**Very Much**).

	Very Little							Very Much
It's Nearly a Toss-Up: You lack certainty in your decisions because you think some choices are close to a toss-up.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Don't Know How You'll Feel: You lack certainty in your decisions because you aren't sure how you will feel about each of the possible outcomes.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Not Sure What Each Option Means: You lack certainty in your decisions because you're not sure you interpreted the available options correctly or understood their consequences.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Multiple Views About What You Want: You lack certainty in your decisions because, in your view, there's probably more than one right way to think about what you want to achieve.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Didn't Think Carefully About What You Want: You lack certainty in your decisions because you haven't thought through what you want to achieve as carefully as you could.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Can't Know For Sure What You'll Get: You lack certainty in your decisions because, based on the information you've received, you can't be sure what you will receive given your chosen options.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Worried About Mental Shortcuts: You lack certainty in your decisions because you're worried about having used a mental shortcut that might have given the wrong answer.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Didn't Apply Your Decision Criterion Correctly: You lack certainty in your decisions because you think the criterion you decided to use and any simplifying assumptions you made may actually favor an alternative other than the alternative that you chose.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other Reasons: You lack certainty in your decisions for other reasons.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

You are one question away from completing this survey. Describe a specific decision you made recently where you compared two options — what went through your mind? Please write at least 50 words — the Next button will unlock automatically.

Words written: 0 / minimum 50



B.2 Results

B.2.1 Uncertainty Decomposition

306 subjects completed the experiment on Prolific and made seven decisions each (one for each probability $p \in \{0.05, 0.1, 0.25, 0.5, 0.75, 0.9, 0.95\}$), for a total of 2,142 data points on *CU*. Figure A.7 shows the distribution of reported certainty in the full sample of decisions. 2,106 observations reflect strictly positive *CU*.

Figure A.8 shows the average importance of each of the BLNS reasons and Figure A.9 the fraction of decisions (pooled across subjects and rounds) for which a reason was the most highly rated one (including ties). As in the binary choice study, our results are very similar to those reported in BLNS, with the “Can’t know for sure what you’ll get” reason receiving the highest average importance and being the most highly rated reason for 65% of decisions.

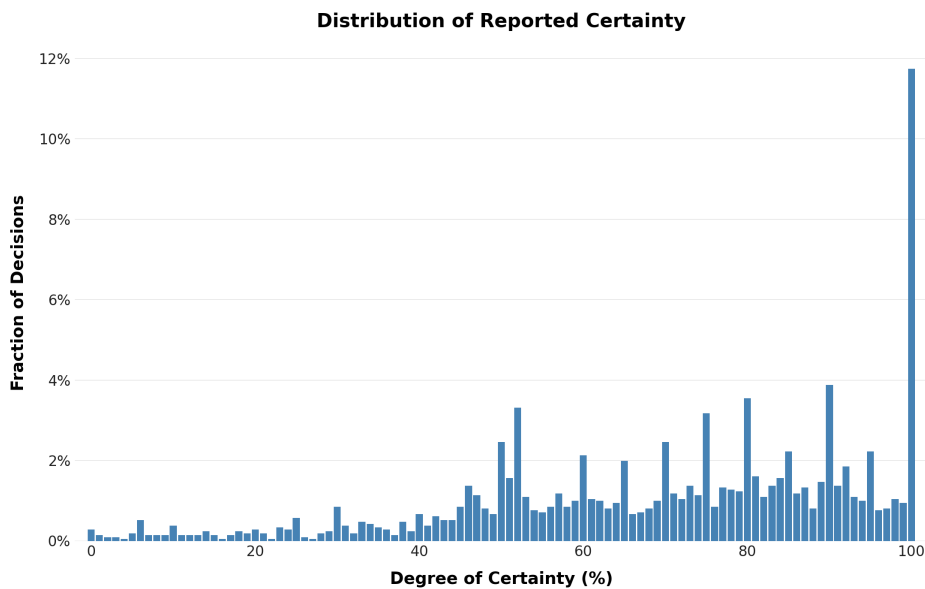


Figure A.7: Distribution of self-reported certainty across all decisions (pooled). The histogram displays the fraction of total decisions falling into each certainty bin (bin width = 1).

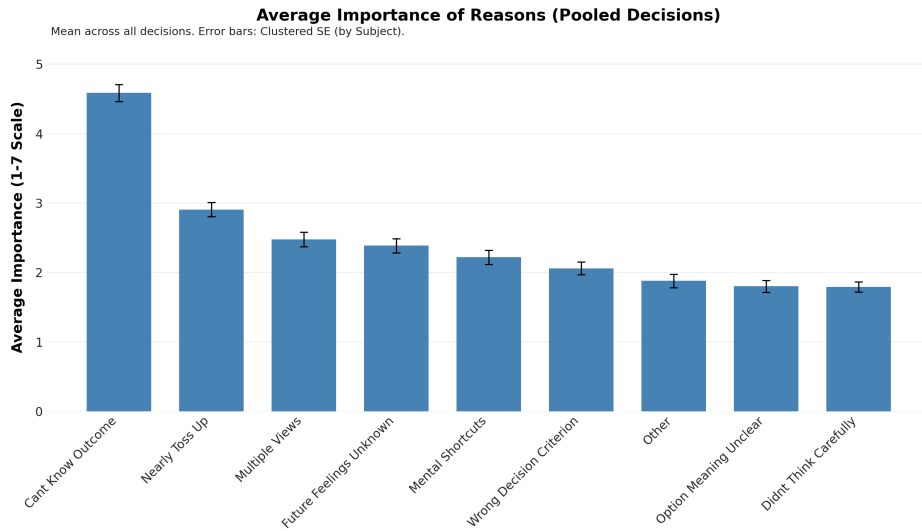


Figure A.8: Average importance ratings for each potential BLNS reason for being uncertain. The means are calculated by pooling all decisions across all subjects with strictly positive *CU*. Error bars represent ± 1 standard error (SE), clustered at the subject level.

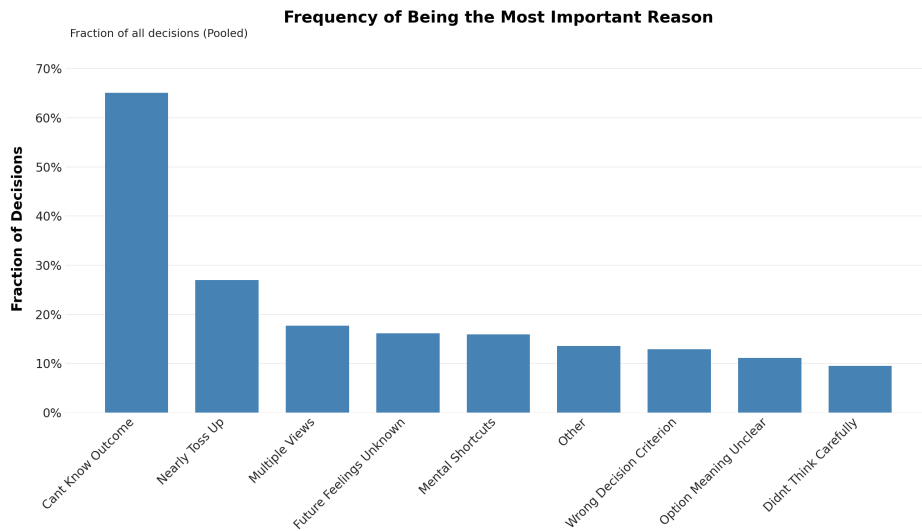


Figure A.9: Fraction of decisions for which each reason was rated as most important (including ties). Fractions are calculated by pooling all decisions across all subjects with strictly positive *CU*.

C Pull-to-Center Effects and Total Outcome Uncertainty in Multiple Price Lists

This appendix asks how a behavioral pull-to-center in the switching point of a multiple price list (MPL) affects the ex-post outcome uncertainty of a subject's randomly-implemented payoff. The motivation is the following. Under the interpretation considered by BLNS, a subject's response to the *CU* elicitation reflects the ex-post payoff uncertainty associated with their choices. Formally, denoting the realized payout by X , this means

$$CU_i = f(\text{Var}(X|c_i, p)), \quad f \text{ strictly increasing,} \quad (1)$$

where $c_i \in [0, 1]$ is subject i 's switching point on the multiple price list (MPL) with payout probability p , where we normalize the upside of the lottery to one. For example, the true certainty equivalent of a risk-neutral subject is $c = p$.

Under BLNS's interpretation of what the *CU* elicitation captures, higher *CU* should be associated with a higher switching point c whenever $\text{Var}(X | c, p)$ is increasing in c . We will show that the total outcome variance generally increases in the stated certainty equivalent (holding fixed the lottery to be evaluated).

This prediction is counterfactual because, as shown in Figure 3, the familiar attenuation pattern implies that certainty equivalents that are associated with higher *CU* are not generically larger but, instead, more compressed towards the center (intermediate values). In other words, while the logic of behavioral attenuation spelled out in Enke and Graeber (2023); Enke et al. (2025, 2024) predicts that the correlation between *CU* and certainty equivalents flips sign at some intermediate threshold, as it does, BLNS's interpretation would generally predict that the link between *CU* and certainty equivalents is monotone.

Below, we characterize the region in which $\text{Var}(X|c, p)$ is increasing in c (Proposition 1, illustrated in Figure A.10). We show that a neighborhood around $c = p$ lies inside this region for every $p \in (0, 1)$.⁸

Suppose the MPL has $N+1$ rows indexed by safe payments $s_i = 0, 1, \dots, H$. In each row the subject chooses between a lottery paying H with probability p (else 0) and the safe payment s_i . One row is implemented uniformly at random. Under monotone switching at $k^* \in [0, H]$, let $c := k^*/H$ denote the subject's normalized switching point.

In the continuous-row approximation, the implemented payoff X has the following

⁸This neighborhood is large enough to accommodate not just risk-neutral subjects (whose true certainty equivalent equals $c = p$) but also subjects with non-linear utility, e.g. whose true certainty equivalent sits close to p rather than exactly at p . Figure A.10 makes the size of this neighborhood explicit.

structure:

- with probability c : a lottery row is drawn, and $X = H$ with probability p , else $X = 0$;
- with probability $1 - c$: a safe row is drawn, and X is uniform on $[cH, H]$.

By the law of total variance, conditioning on which row is drawn,

$$\text{Var}(X) = E[\text{Var}(X \mid \text{row})] + \text{Var}(E[X \mid \text{row}]).$$

Lottery rows have conditional variance $p(1-p)H^2$ and conditional mean pH . Each specific safe row has zero conditional variance and conditional mean equal to its own safe payment. Substituting and normalizing by H^2 ,

$$\frac{\text{Var}(X)}{H^2} = cp(1-p) + cp^2 + (1-c)\frac{1+c+c^2}{3} - \left[cp + (1-c)\frac{1+c}{2}\right]^2. \quad (2)$$

The right-hand side depends only on (c, p) .

Proposition 1 (Sign of $\partial \text{Var} / \partial c$). *For every $c \in (0, 1]$ and every $p \in (0, 1)$,*

$$\frac{\partial \text{Var}(X)}{\partial c} \frac{1}{H^2} > 0 \iff p \in (p_-(c), p_+(c)),$$

where

$$p_{\pm}(c) := \frac{3c \pm \sqrt{c^2 - 8c + 8}}{4}.$$

In particular, the diagonal $c = p$ lies strictly inside this positive-derivative region for every $p \in (0, 1)$, and at $c = p$ the slope equals $p(1-p) > 0$.

Proof. Differentiating (2) in c (using $(1-c)(1+c+c^2) = 1-c^3$ and $(1-c)(1+c) = 1-c^2$) gives the closed-form derivative

$$\frac{\partial \text{Var}(X)}{\partial c} \frac{1}{H^2} = c \cdot \beta(c, p), \quad \beta(c, p) := 1 - c - c^2 + 3pc - 2p^2.$$

For $c > 0$ the sign is determined by $\beta(c, p)$. As a quadratic in p with negative leading coefficient,

$$\beta(c, p) = -2p^2 + 3cp + (1 - c - c^2),$$

$\beta(c, \cdot)$ is positive between its roots. The discriminant in p equals $9c^2 + 8(1 - c - c^2) = c^2 - 8c + 8 = (c-4)^2 - 8$, which is at least 1 throughout $c \in [0, 1]$. The roots are therefore real and given by $p_{\pm}(c)$ as stated.

For the diagonal: $\beta(p, p) = 1 - p - p^2 + 3p^2 - 2p^2 = 1 - p > 0$ for every $p \in (0, 1)$, so $(c, p) = (p, p)$ lies strictly inside the positive-derivative region. Specializing the closed-form derivative to $c = p$ gives slope $p(1-p)$. \square

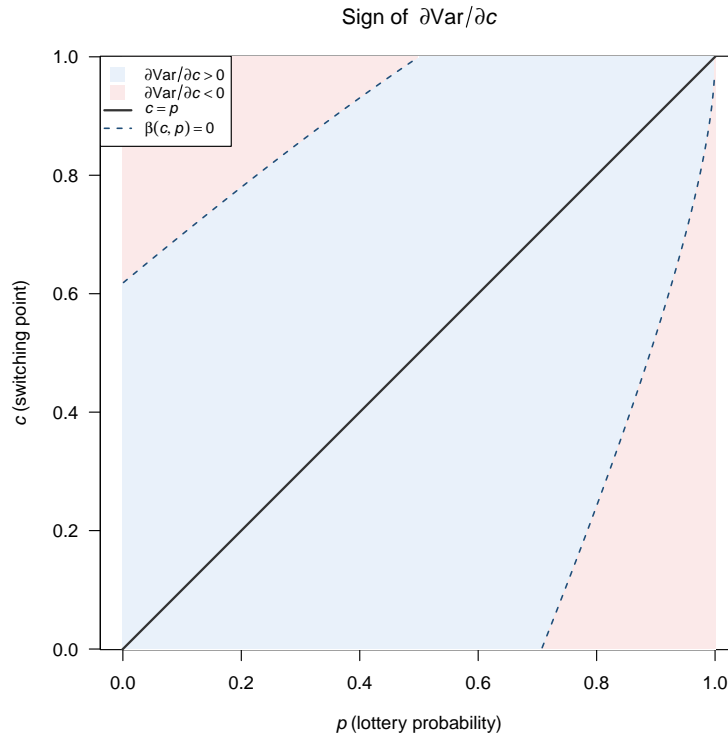


Figure A.10: Sign of $\partial \text{Var} / \partial c$ on the (p, c) plane. Blue: positive. Pink: negative. The boundary is the conic $\beta(c, p) = 0$ (dashed), with roots $p_{\pm}(c) = (3c \pm \sqrt{c^2 - 8c + 8})/4$ in p (Proposition 1) or equivalently $c_{\pm}(p) = ((3p - 1) \pm \sqrt{(1-p)(5-p)})/2$ in c . The diagonal $c = p$ (solid) lies strictly inside the positive-derivative region for every $p \in (0, 1)$, and a generous neighborhood around the diagonal does too.

The sign of $\partial \text{Var} / \partial c$ as a function of (c, p) is plotted in Figure A.10. Within the region where the derivative is positive (blue), higher c corresponds to higher $\text{Var}(X)$ and hence, by (1), to higher CU . Attenuation, however, has opposite implications on the two sides of the relevant crossing point: it raises c relative to p on the low-probability side, but lowers c relative to p on the high-probability side. Thus, under BLNS's interpretation, the association between CU and attenuation should flip sign across the crossing point. Figure 3 of the main text shows the opposite: reported CU increases in the certainty equivalent c for $p < 1/2$ and decreases in c for $p > 1/2$.