Intrinsic Information Preferences and Skewness

By Yusufcan Masatlioglu, Yeşim Orhun, and Collin Raymond*

We examine whether people have an intrinsic preference for negatively skewed or positively skewed information structures and how these preferences relate to intrinsic preferences for informativeness. The results from lab experiments show a strong intrinsic preference for positively skewed information and suggest that providing such information can improve information uptake. Evidence from field studies in decision- and ego-relevant contexts replicate these findings. We discuss our findings through the lens of existing theories and the potential trade-offs in information provision policies.

Imagine that you have recently submitted a paper to a top journal. You are attending a conference where two of your previous mentors, Paul and Nell, are also present. You are considering asking them their opinions about the fate of your paper in this journal. Neither can have any influence on the outcome, and you cannot make any changes to the paper; therefore, their views are entirely non-instrumental at this time. They tend to have equally informative opinions but differ in how they communicate them. Paul likes to be quite certain of a good outcome before he gives you a thumbs-up, whereas Nell gives a thumbs-down only if she is quite certain of a bad outcome. Would you talk to either of them at the conference, and if so, to whom would you prefer to talk? The type of information you seek, and thus whether you talk to either, is likely driven by how you think it would make you feel. As previous work in economics and psychology has discussed, the desire to regulate emotions regarding a self-relevant outcome may lead to intrinsic preferences for information—that is, a desire for, or an aversion to, certain types of information beyond any preferences for the information's instrumentality with respect to the person's future actions.[1]

Until now, most of the theoretical and experimental work in this domain has

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[1] See Bénabou and Tirole (2016), Golman, Hagmann and Loewenstein (2017), and Molnar and Loewenstein (2021) for reviews regarding anticipatory utility and Kőszegi and Rabin (2009) and Gul (1991) for contributions regarding forms of disappointment aversion.

focused on preferences regarding the timing of information.[2] When only a single signal is provided before the outcome is realized, the signals that resolve more uncertainty earlier are signals that are more informative. However, information sources differ not only in their informativeness but also, and often, in the *type* of information they can provide. We focus on this important, and less-understood, dimension of intrinsic preference for information, referring to it as a preference for the *skewness* of information. Some information sources are negatively skewed: they eliminate more uncertainty about an undesired outcome if they generate a bad signal, but they are unlikely to generate a bad signal (e.g., Nell's feedback). Other signals are positively skewed: they eliminate more uncertainty about the desired outcome if they generate a good signal, but they are unlikely to generate a good signal (e.g., Paul's feedback).

There are two main reasons why examining preferences for skewed signals is crucial for a complete understanding of intrinsic information preferences. First, many information sources in the real world are inherently skewed. For example, medical tests vary in their ability to rule in or to rule out disease, human resource departments vary in their style of feedback, companies systematically differ as to when they provide optimistic earnings guidance, and news outlets covering highly anticipated election results differ in their interim predictions. Second, skewness is closely related to the emotional impact of expectations, which prior literature identifies as a driver of non-standard information preferences. Receiving a bad signal from a positively skewed information source does not diminish hope as much as getting a bad signal from a negatively skewed source does. Receiving a good signal from a positively skewed information source carries a higher risk of eventual disappointment unless it fully reveals the outcome. Therefore, examining preferences for skewness and their relationship with preferences for informativeness is useful for gaining a deeper understanding of intrinsic information preferences, which in turn influences information demand even when information is instrumental.

In this paper, we explore (1) whether people prefer negatively or positively skewed information structures when they are equally informative, (2) whether they prefer more or less informative structures, and (3) how individual preferences for skewness and informativeness are related. Our investigation reveals two main findings, which have important implications for models of intrinsic information preferences and for optimal information design policy in contexts where information avoidance is a concern. First, the results reveal a widespread preference for positive versus negative skewness. In other words, individuals prefer

[2]Theoretical work in this domain includes research focusing on preferences for earlier versus later resolution of information (e.g., Kreps and Porteus (1978); Grant, Kajii and Polak (1998); Caplin and Leahy (2001)), and preferences for gradual versus one-shot/clumping of information (e.g., Ely, Frankel and Kamenica (2015); Kőszegi and Rabin (2009); Dillenberger (2010)). Examples of experimental work that focus on the timing of information include Chew and Ho (1994); Ahlbrecht and Weber (1997); Arai (1997); Lovallo and Kahneman (2000); Von Gaudecker, Van Soest and Wengström (2011); Brown and Kim (2014); Falk and Zimmermann (2016); Kocher, Krawczyk and van Winden (2014); Zimmermann (2014), and Ganguly and Tasoff (2017).

ruling out more uncertainty about the desired outcome (and tolerating uncertainty about an undesired outcome) than ruling out more uncertainty about an undesired outcome (and tolerating uncertainty about the desired outcome). In our running example, these preferences suggest that most people would prefer talking to Paul, the advisor whose positive feedback, while rare, is more informative than his negative feedback. Preferences for positive skewness are strongly held. Individuals exhibit an average informational premium (i.e., a willingness to pay) for positively skewed signals that is higher than not only other signal structures with the same variance (but lower skewness) but even compared with full information.

Second, the results suggest that policymakers might be able to convince information avoiders to acquire some information by providing very informative signals when delivering good news and sufficiently noisy signals to preserve hope when delivering bad news. There has been a concern in the literature that some people may avoid information even when it is free.[3] Our results show that this concern has merit: a sizable proportion (ranging from 11% to 30% across five studies) of individuals avoid the most informative signals. However, we also find that a significant minority of these individuals are willing to acquire information if it is positively skewed (and will continue to reject it if negatively skewed). Several models, such as Caplin and Eliaz (2003), Eliaz and Spiegler (2006*b*); Schweizer and Szech (2013), and Dillenberger and Segal (2017), hypothesize that providing positively skewed information may help reduce information avoidance. Our results provide concrete evidence for this idea and suggest that skewness should be considered in policy design, especially where information avoidance is of policy concern.

We provide evidence from three lab experiments with a total of 1,182 participants and two field studies with 1,226 individuals. The lab experiments, presented in Section I, ask individuals to choose among information structures that reveal clues about whether or not they won a $10 lottery, which would be revealed at the end of the experiment. The design rules out any instrumental value of information and exogenously sets (common) priors. This allows us to construct choices among signals with tightly controlled properties to identify intrinsic preferences for skewness independent of preferences for informativeness. Experiment 1 examines these informational preferences and the associated monetary premia in a between-subject design, while Experiment 2 replicates these patterns in a within-subject design and speaks directly to how an individual's preferences for informativeness and skewness are related. In an extension, we also examine how preferences for skewness and informativeness vary across priors.

The field studies, presented in Section II, examine informational preference in

[3]Economists have discussed the potential impact of intrinsic information preferences on information demand and the implications for the design of information structures across many domains, such as health (Kőszegi (2003); Caplin and Eliaz (2003); Caplin and Leahy (2004); Oster, Shoulson and Dorsey (2013*b*); Schweizer and Szech (2013)), media consumption (Mullainathan and Shleifer (2005)), and finance (Andries and Haddad (2014)).

contexts in which individuals are known to avoid information even when information has instrumental value: medical tests (see, e.g., Oster, Shoulson and Dorsey (2013*a*); Golman, Hagmann and Loewenstein (2017); Ganguly and Tasoff (2017)) and intelligence tests (see, e.g., Eil and Rao (2011)). Naturally, it is difficult to control for the informational properties or instrumental value of signals in the field. We choose domains in which providing both informative signals and skewed (but less informative) signals are not only possible but also natural: genetic test results regarding a person's likelihood of developing Alzheimer's disease and feedback about one's relative performance on an IQ test. We design the field studies to extend our findings to context-rich environments and clarify trade-offs relevant to determining how and when providing positively skewed information can improve welfare. Overall, the results suggest that skewing the information provided can increase both the extensive margin (how many people are willing to acquire information) and the intensive margin (how much they value the information).

In Section III, we discuss our main findings in the context of the existing experimental literature and through the lens of extant theories of intrinsic information. This discussion highlights our empirical contributions and offers conditions on utility functions that can rationalize the observed behavior for the benefit of future theory work in this domain. This section also discusses how and when providing positively skewed information can improve welfare. When providing informative signals is costly, our results suggest that a social planner should maximize skewness subject to any constraint on informativeness that can be achieved. Independent of cost considerations, when it is possible to provide multiple signals, our results suggest that offering positively skewed signals in addition to a fully revealing signal may improve welfare under certain conditions.

We focus on a particular environment where uncertainty about whether or not a prize has been won has already been resolved by the time subjects make a choice over information must be made, and where there is a delay between observing information and the final resolution of uncertainty. While such a framework is reasonable for some situations (e.g., medical testing for genetic diseases), there are other situations where the determination of the outcome occurs simultaneously with the resolution of information (e.g., stock movements) and where there may be little to no delay between receiving information and the final resolution of uncertainty. In Section IV we conclude by discussing when and why our results may generalize to these kinds of environments, highlight the implications of our findings for adjacent fields, and point out avenues for future research.

I. Experimental Investigations

In this section, we first provide an overview of the theoretical preliminaries that inform our experimental design and discuss common features of our lab experiments that allow us to identify intrinsic preferences for information. We then present the experiments and their results.

A. Identification of Intrinsic Preferences for Information

We consider a situation in which there are three periods $(0, 1,$ and $2)$. In Period 0, individuals have a prior probability distribution over payoff-relevant outcomes that will be realized in Period 2. In Period 1 they receive a signal that might cause them to update their priors. In Period 2 the outcomes are revealed and individuals receive their payoff. There are two possible outcomes, H and L, H is more desirable than L, and the prior probability of outcome H is f.

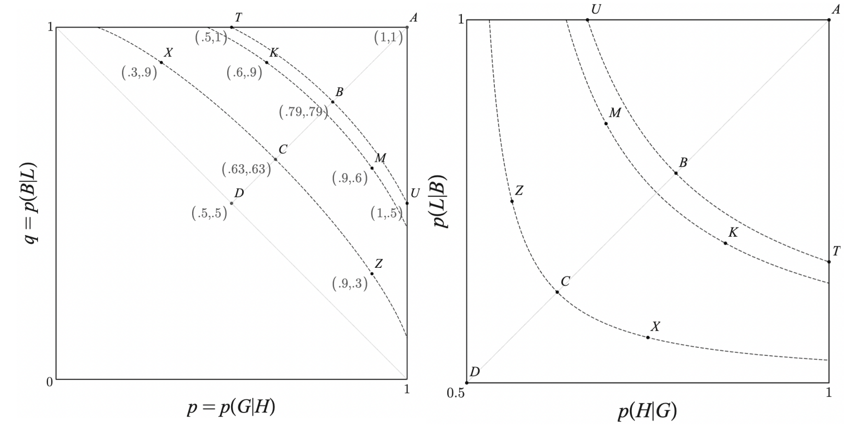
The decision-maker has access to a set of binary information structures: the realizations are G (good) or B (bad). A good (bad) signal is one that increases (decreases) the beliefs about the outcome being H relative to the prior. The information structures in this context are fully characterized as points in $[0, 1]^2$: (p, q), where the probability of a good signal conditional on the H outcome is $p = p(G|H)$ and the probability of a bad signal conditional on the L outcome is $q = p(B|L)$.

We suppose that individuals have preferences for information structures (p, q) given the prior f, denoted by $\succsim_f$. Individuals cannot take any actions conditional on information; thus all preferences for information must come from intrinsic rather than instrumental motivations. Given the domain of all possible signal structures represented as points in the (p, q) space, we only consider preferences for those in $\mathbb{S} := \{(p, q)|\ p + q > 1\} \cup (0.5, 0.5)$, which corresponds to the shaded upper triangle in Figure 1A.[4] We describe this as the Blackwell experiment representation of the experiment, as p, q can be thought of as representing the diagonal entries of the Blackwell experiment that corresponds to our information structure. We can equivalently envision any information structure p, q in the space of posteriors that it induces. Here, we think of the induced posterior regarding H after a good signal and the induced posterior regarding L after a bad signal as being the space information structures operate in. Figure 1B shows the equivalent posterior space representation for each point in Figure 1A when the prior is equal across the two states $(f = 0.5)$. The relationship between these two figures will change as the prior changes since any given p, q combination will map to a distinct set of posteriors.

The information structure $(1, 1)$, denoted by A in Figure 1A, resolves all information at once, and in contrast, information structure $(0.5, 0.5)$, denoted by D, conveys no information at all. Information structures $(0.63, 0.63)$ and $(0.79, 0.79)$, denoted by C and B, resolve some interim uncertainty. Given that uncertainty is fully resolved in Period 2, receiving a signal from A (D) in Period 1 is equivalent to an early (late) resolution of uncertainty, whereas receiving a signal from B or C in Period 1 is equivalent to a gradual resolution of uncertainty. We refer to signals along the diagonal $p = q$ as *symmetric*. These signals are increasingly Blackwell more informative going from D to A.[5] Our experiments

[4] All points in $\mathbb{S}$ have a natural interpretation: a good (bad) signal is good (bad) news. Also, $\mathbb{S}$ is the minimal set that allows us to capture all possible posterior distributions.

[5] See Appendix F for details on the formal definition of Blackwell informativeness in our setting.



(A) Blackwell Experiment (B) Posterior Space

Figure 1. : Examples of Information Structures when $f = 0.5$

present choices between symmetric structures to examine individuals' preferences for informativeness.

The main focus of this paper is to document whether individuals have preferences for skewness — that is, in Period 1, do individuals prefer to resolve more uncertainty about H or L? We define the skewness of an information structure as the standardized third moment of the posterior distribution it induces.[6] Intuitively, positively (negatively) skewed information structures resolve more (less) uncertainty about H than they do about L. For example, the information structure $(0.5, 1)$ denoted by T is positively skewed. It always delivers bad news if the outcome is L and delivers a good signal 50% of the time if the outcome is H. Therefore, T resolves all uncertainty in favor of H when a good signal is observed and delivers worse-than-before (but not fully revealing) news when a bad signal is observed. Conversely, U is negatively skewed: it can resolve all uncertainty in favor of L when a bad signal is observed and delivers better-than-before (but not fully revealing) news when a good signal is observed.

In Figure 1A, structures to the left of the diagonal are positively skewed (e.g., T, K, and X), and those to the east of the diagonal are negatively skewed (e.g., U, M, and Z). Proposition 1 in Section III shows that considering choices among equivariant signal structures that vary in their degree of skewness identifies pref-

Intuitively, the posteriors under the Blackwell more-informative structure are a mean-preserving spread of the posteriors under the Blackwell less-informative one.

[6]There are other notions related to preferences for skewness, including the central third moment, third-order stochastic dominance, third-degree risk order, and Dillenberger and Segal (2017)'s notion of skewness. Given a 50% prior and signal structures that are reflections of one another across the diagonal, all these orderings coincide. Moreover, holding variance fixed across information structures, as we do when testing for skewness, implies that the ordering imposed by the third central moment and our notion coincide.

erences for skewness. When presenting a choice between two skewed structures (p, q) and (p', q') to identify whether individuals prefer a negative or positive skew, we pick pairs for which $mean(p, q) = mean(p', q')$, $var(p, q) = var(p', q')$, and $skew(p, q) = -skew(p', q')$. These conditions ensure that elicited strict preferences cannot be attributed to preferences for earlier or later resolution but rather only to preferences for skewed information structure. When $f = 0.5$, as in Experiments 1 and 2, any symmetric pair of information structures across the diagonal in Figure 1A have the same mean and variance and absolute level of skewness (e.g., T and U, K and M, or X and Z).

We also examine the relationship between preferences for informativeness and preferences for skewness via three approaches. First, we test whether information uptake in the aggregate is increased by the provision of partially informative signals and whether this increase depends on the skewness of the signal, keeping variance the same given prior f. The dashed equivariance lines in Figure 1 are plotted for $f = 0.5$. Information structures X, C, and Z and structures T, B, and U have the same variance. Experiment 1 compares choices between D and options in these triplets to evaluate changes in information demand as skew increases. Second, using within-person choices in Experiment 2, we explore the extent to which individuals who exhibit a preference for more or less informative signals exhibit different preferences for skewness. Third, and again relying on within-person data, we provide choices conditional on preferences for informativeness that directly ask individuals to trade off skewness and informativeness. To construct choices that involve such a trade-off, we pair a skewed signal (e.g., X) with a symmetric information structure that is Blackwell ranked with respect to the skewed signal given f, which we detail in the context of Experiment 2.

B. *Experiment 1: Between-Subject Evidence for Timing and Skewness Preferences*

Protocol

Seven hundred subjects participated in an in-person experiment at the Ross Behavioral Lab of the University of Michigan's Ross Business School for a \$7 compensation for showing up and a 50% of winning a raffle with a \$10 reward (to be paid privately to each participant).[7] Every participant was given a raffle ticket from a roll of tickets as they entered the lab. The experimenter rolled a 10-sided die at a distance in front of the seated participants and covered it quickly with a cup. The participants could not see the outcome of the die roll but could see that the cup was undisturbed during the experiment. The experimental instructions informed them that if the die outcome was an odd (even) number and the last digit of the ticket they were holding was also odd (even), they would win \$10; otherwise, they would not win any additional money. Having observed the die roll, the experimenter instructed them to enter a code in the computer

[7]This information is clearly stated in the instructions ensuring that subjects understand the payoffs and priors.

program and their ticket number so that the program would know whether they won or lost. The experimental instructions explained that the computer knew the outcome and could generate informative clues and that participants would need to choose between two clue-generating options, observe the clue, and then work on unrelated hypothetical questions for about 30 minutes until the die outcome would be announced to everyone in the room at the very end of the experiment. The experiment lasted 60 minutes and is reproduced in Appendix A.

Each participant indicated their preference among a pair of information structures, and each information structure (p, q) was presented as containing two boxes with 100 balls inside. The first box contained $100p$ red balls and $100(1-p)$ black balls, while the second box contained $100(1-q)$ red balls and $100q$ red balls. Figure 2 shows the visual illustration participants saw when picking between $(0.3, 0.9)$ as Option 1 and $(0.9, 0.3)$ as Option 2.

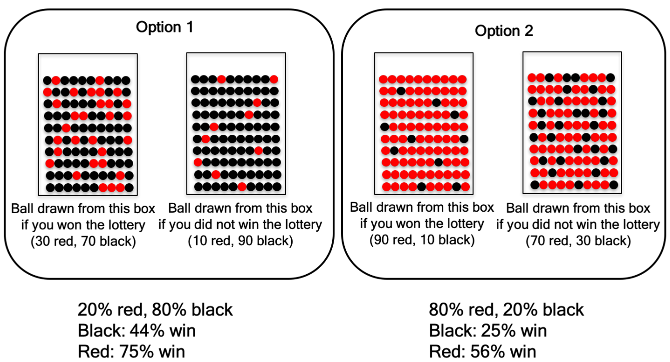


Figure 2. : Graphical Presentation of Information Structures

Before choosing between the two information structures, the participants watched another instructional video that explained both information structures. The instructions clarified that the computer would draw a ball from the first box if the participant won the lottery and from the second box if they lost and that participants could observe the color of the ball but not which box it was drawn from; thus, the color of the drawn ball would serve as a signal regarding the state of the world. The instructions also specified the likelihood of observing a ball color and the posterior probability of winning associated with a color for each information structure, which were also visually summarized under each information structure (as Figure 2 illustrates) to ensure that choices reflect informational preferences and not cognitive-processing constraints or flaws in Bayesian updating.

After answering comprehension questions, participants chose between the two information structures; they always had to choose between information structures even if one of them was uninformative (i.e., $(p, q) = (0.5, 0.5)$). The participants then indicated their preference intensity on a scale from 0 (indicating indifference between the two options) to 10 (indicating an extremely strong preference for the preferred option over the alternative). To measure preference strength in terms of information premia, we also asked subjects whether they would agree to see a ball drawn from their non-preferred information structure rather than a ball drawn from their preferred information structure in exchange for x cents, where x ranged from 1 to 50. We set the minimum compensation required to switch (MCTS) to be $x.1$ cents based on the largest rejected x in the list.[8] Based on the participants' choices, the program drew a ball from the appropriate information structure and displayed the ball's color to them. For the rest of the time, participants answered non-consequential questions.[9] At the end of the study, one participant was invited to lift the cup and announce the die outcome.

Design

The experiment features 10 between-subject treatments. Table 1 lists the information structure pairs that subjects evaluated in each treatment. Treatments T1 and T5–T10 feature comparisons of an informative structure to $(0.5, 0.5)$, which provides no information. The informative options in T1, T9, and T10 are symmetric (denoted as A, B, and C in Figure 1) and decreasingly less informative. The informative options in T5 and T6 are positively skewed (T and X in Figure 1), and the informative options in T7 and T8 are negatively skewed (U and Z in Figure 1). Note that the informative options across the T5–T7–T9 triple (as well as the T6–T8–T10 triple) have (approximately) the same variance. Treatments T2, T3, and T4 pit a negatively skewed structure against its positively skewed equivariant counterpart. These 10 treatments, therefore, allow us to examine preferences for informativeness, preferences for skewness, and the relationship between the two.

We examine choice proportions to assess preference and examine information premia to assess preference strength. We define the information premium for (p, q) with respect to (p', q') given f as the amount of money that an individual would require to move from (p, q) to (p', q'). To calculate the average information premium for $(p, q) \succ (p', q')$ across all subjects in a given treatment, we aggregate over the MCTS values for (p, q) choosers and the negative of the MCTS values for (p', q') choosers (for whom the MCTS was framed in the opposite direction). This weighted average therefore also accounts for the fraction of people choosing each structure.

[8]To provide familiarity with this list-price elicitation, Experiment 1 included a seemingly unrelated initial warm-up task. Appendix A, and Figures A1, A2, and A3 provide further details.

[9]They explained the reason for why they preferred the information structure of their initial choice, indicated their choices in a hypothetical monetary gamble if the risk was realized today, wrote short essays regarding the difference between motives and intentions behind an action, and indicated their choices in a hypothetical monetary gamble if the risk was realized a week from today.

Table 1—: Treatments and Results from Experiment 1

Treatment	N	Preferences	Percentage	p-value	Info. Premia
Early vs. Late					
T1	79	$(1,1) \succ (0.5,0.5)$	70%	0.001	7.6¢
Positively Skewed vs. Negatively Skewed					
T2	78	$(0.5,1) \succ (1,0.5)$	79%	0.000	20.5¢
T3	83	$(0.3,0.9) \succ (0.9,0.3)$	67%	0.002	7.5¢
T4	78	$(0.6,0.9) \succ (0.9,0.6)$	74%	0.000	12.3¢
Positively Skewed vs. Late					
T5	75	$(0.5,1) \succ 0.5,0.5)$	87%	0.000	24.2¢
T6	68	$(0.3,0.9) \succ (0.5,0.5)$	82%	0.000	15.5¢
Negatively Skewed vs. Late					
T7	57	$(1,0.5) \succ (0.5,0.5)$	72%	0.001	11.3¢
T8	60	$(0.9,0.3) \succ (0.5,0.5)$	77%	0.000	7.6¢
(Symmetric) Gradual vs. Late					
T9	63	$(0.79,0.79) \succ (0.5,0.5)$	81%	0.000	16.3¢
T10	59	$(0.63,0.63) \succ (0.5,0.5)$	75%	0.000	13.8¢

For each treatment of Experiment 1, the table reports the total number of subjects who participated in each treatment (N), lists the most prevalent preference ordering, reports the percentage of subjects who indicated this preference, and the associated $p-$values from two-sided binomial tests of the null hypothesis that the aggregate choice proportions are 50%. It also reports the information premia associated with the indicated preferences.

Results

Table 1 reports the fraction of individuals with preferences $(p,q) \succ (p',q')$, where (p,q) is the majority choice, the p-value from two-sided binomial tests against the null hypothesis of random choice, and the average information premia associated with preference $(p,q) \succ (p',q')$.[10] We first examine preferences for informativeness and find that 70% of individuals in T1 prefer (one-shot) early resolution to (one-shot) late resolution.[11] The results from T5–T10 show that most participants prefer partially informative structures (i.e., those that resolve uncertainty gradually over time in this context) to late resolution. In total, the choice proportions reveal a preference for informativeness (relative to no information) for the typical participant. Looking across T1 and T5–T10, the information premia ranges from 7.6 to 24.2 cents regarding an outcome with an expected

[10]The data indicate that there is a strong preference behind *all* elicited choices, as reflected by substantial MCTS levels reported in Table A3 in Appendix A. We also elicit preference intensity. The full distribution of this metric appears in Table A2 in Appendix A. We focus our discussion here on the monetary measure because preference intensity questions were unincentivized. In Experiment 2, to limit the increased complexity of elicitations that comes with a within-subject design, we only ask for preference intensity. The preference intensity metric and MCTS are positively correlated ($\rho = 0.35$).

[11]As in Dillenberger (2010), one-shot resolution here means that all information is learned at once.

value of \$5 that will be revealed in approximately 30 minutes. Even at the lowest level, this implies an average strength of preference for information (relative to no information) ranging from 1.5% to 4.8% of the expected value of the lottery. That said, a substantial proportion of the participants (30%) avoid fully revealing information, a group we further examine more closely below.

We then look at the results from T2, T3, and T4, which show that most individuals prefer the positively skewed information structure to the negatively skewed information structure, independent of preferences for the timing of uncertainty resolution. The message from the aggregate choice proportions is echoed when looking at the informational premia in these treatments: the average premia for the positively skewed structures over negatively skewed ones are large, and at least as large as the premium for full early resolution over full late resolution (two-sample Wilcoxon rank-sum tests for T1 vs. T2: $p = 0.013$; T1 vs. T3: $p = 0.950$; T1 vs. T4: $p = 0.369$). Overall, the results suggest that individuals prefer signals that are more accurate at predicting the better outcome than those that are more accurate at predicting the worse outcome.

Looking across choice percentages and the information premia of the informative options in T5–T10 in Table 1 allows us to evaluate how information demand changes as the skewness of the information structure goes from negative to zero and then to positive (holding variance constant). First, we see that among the equivariant triplets (e.g., $(0.5, 1)$, $(0.79, 0.79)$, and $(1, 0.5)$), individuals have a greater demand for information (vs. no information) when it is positively skewed: 87% of individuals demand (positively skewed) information in T5 whereas only 72% of individuals demand (negatively skewed) information in T7 (two-sided χ^2 test, $p = 0.035$).[12] Also, the information premia for the positively skewed structures are the highest, while the premia for the negatively skewed signals are the lowest (two-sample Wilcoxon rank-sum tests, T5 vs. T7: $p = 0.007$, T6 vs. T8: $p = 0.067$). To make this point more elaborately, Figure 3 shows the inverse demand curves constructed from the cumulative distribution of informational premium for $(p, q) \succ (0.5, 0.5)$. Panel (A) shows the inverse demand curves for a set of equivariant signal structures $[(0.5, 1), (0.79, 0.79), (1, 0.5)]$ as well as $(1, 1)$; Panel (B) shows the same for a set of less informative equivariant signals $[(0.3, 0.9), (0.63, 0.63), (0.9, 0.3)]$ where informational preferences are expected to be more muted. At almost all potential prices, the demand is highest for positively skewed information. Overall, these results indicate a preference for positively skewed over negatively skewed signals.

Last, we assess whether providing positively skewed information structures instead of fully informative signals may increase information uptake. The fraction of individuals choosing not to obtain any information is lower when positively skewed signals are offered compared to when individuals can learn the outcome with certainty: information avoidance falls from 30% in T1 to 13% in T5 (two-

[12] The proportion in T9 falls in the middle (T9 vs. T5: $p = 0.361$; T9 vs. T7: $p = 0.243$). Proportions of information takers in T6–T10–T8 are ordered in the same way but are not statistically different.

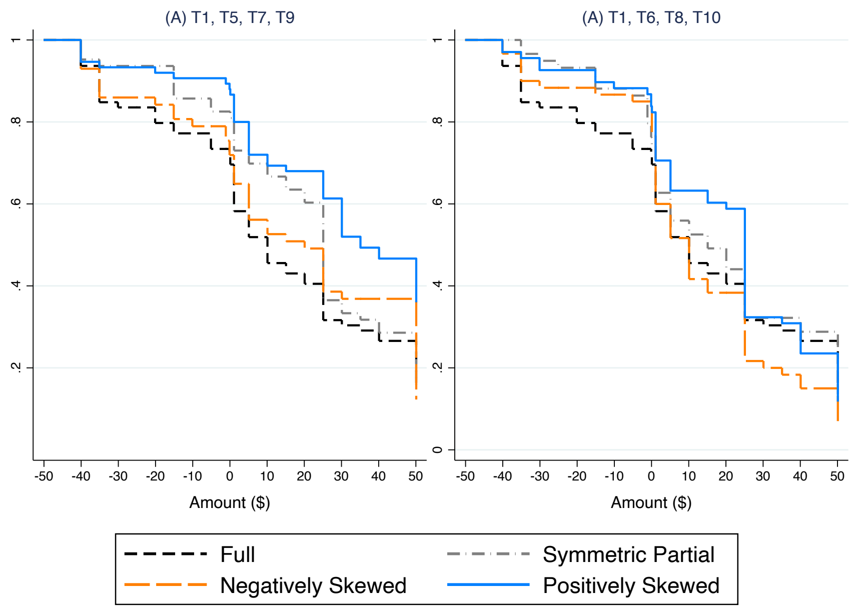


Figure 3. : Inverse Demand Curves for Information Structures in Experiment 1

Note: This figure plots the information premia for information structures $(p > 0.5, q > 0.5)$ compared to $(0.5, 0.5)$. Panel (A) depicts the inverse demand curves for informative structures $(1, 1)$ and for the structures in the equivariant set $[(0.5, 1), (1, 0.5), (0.79, 0.79)]$. Panel (B) depicts the inverse demand curves for a set of less informative equivariant structures $[(0.3, 0.9), (0.9, 0.3), (0.63, 0.63)]$ and for $(1, 1)$.

sided χ^2 test, $p = 0.011$) and to 18% in T6 ($p = 0.073$). Figure 3 shows that the demand for information is higher for the positively skewed signals than for the fully informative signal at almost every point in the demand curve (two-sample Wilcoxon rank-sum tests, T1 vs. T5: $p < 0.001$; T1 vs. T6: $p = 0.154$). In contrast, comparing T1 to T7 and T8 shows that information avoidance is not lower with the negatively skewed signals (two-sided χ^2 tests, T1 vs. T7: $p = 0.771$; T1 vs. T8, $p = 0.356$), and information premia are also indistinguishable (two-sample Wilcoxon rank-sum tests, T1 vs. T7: $p = 0.506$; T1 vs. T8, $p = 0.864$). Therefore, the decline in the proportion of information avoiders in T5 compared with T1 cannot be explained by a simple preference for gradual resolution of uncertainty. These results are consistent with the notion that a proportion of participants who avoid information, including full early resolution, are in fact willing to acquire positively skewed information but not necessarily other kinds of partially informative signals.

In summary, Experiment 1 reveals a strong preference for positively skewed information. The skewness preferences are also consistent across treatments.[13]

[13] Treatments T5-T2-T7 and T6-T3-T8 also allow us to check whether our data satisfies any notions of stochastic transitivity (the appropriate weakening of transitivity to environments where we observe

Whether we reflect on choice proportions, information premia, the fraction of consumers willing to acquire information at a price, or the price we can charge given a target demand level, we can see that individuals are most interested in positively skewed information relative to other structures with the same variance but lower skewness. Experiment 1 is conducted in an environment where the priors are fixed and uniform across outcomes. We also conducted an experiment where we let the prior vary. In Appendix C we discuss this experiment in detail and show that our results regarding a preference for positive skew are robust to changing the prior.

Results of Experiment 1 also point to a non-monotonicity in preferences for informativeness and, in particular, a compromise between preferences for informativeness and skewness, suggesting that individuals who may otherwise avoid information may be willing to acquire information with positive skew. Experiment 2 employs a within-subject design to provide a more direct test of whether individuals trade off the positive skew and informativeness of signals.

C. Experiment 2: Within-Subject Evidence for the Relationship Between Preferences for Skewness and Informativeness

A total of 250 participants took part in a 75-minute long real-choice experiment conducted at the University of Michigan Behavioral Lab. The experiment followed the general protocol of Experiment 1 but presented five pairs of information structures to each participant. Participants were told to treat each decision independently, and one decision was chosen to be implemented.[14] To keep the study manageable in terms of time and logistics, we did not elicit MCTS. The experiment is reproduced in Appendix B.

The first three questions presented information structures included in T1, T2, and T3 of Experiment 1: Q1 presented $(1, 1)$ and $(0.5, 0.5)$; Q2 presented $(0.5, 1)$ and $(1, 0.5)$; and Q3 presented $(0.3, 0.9)$ and $(0.9, 0.3)$. Taking advantage of the within-subject nature of this study, Q4 conditioned on the participants' choice in Q1. Those who preferred early resolution in Q1 were asked Q4a, which presented a choice between a positively skewed signal and a symmetric signal that was Blackwell more informative than it. Participants who preferred late resolution in Q1 were asked Q4b, which presented a choice between a positively skewed signal and a symmetric signal that was Blackwell less informative than it. Appendix B.B3 explains how information structures are ranked in the (p, q)

choice distributions as described in Fishburn (1973)). In both cases, our data satisfy strong stochastic transitivity.

[14]If preferences satisfy recursivity, then eliciting multiple choices and implementing one of them does not influence preferences (Segal (1990)). Dillenberger and Raymond (2017) show that if preferences feature additive separability, as in Caplin and Leahy (2001); Kőszegi and Rabin (2009), and Ely, Frankel and Kamenica (2015), then so long as all choices have the same reduced form chance of winning (as is in our setting because the prior is fixed), then our elicitation procedure again does not affect preferences. Nevertheless, one may worry about behavioral differences arising from the framing induced by the order of questions. As the result will show, Experiment 2 generates highly comparable patterns with the results from Experiment 1, which only presented one pairwise comparison to each participant.

space in terms of their Blackwell informativeness. Q4a randomly presented either $(0.3, 0.9)$ and $(0.76, 0.76)$ or $(0.1, 0.95)$ and $(0.67, 0.67)$; Q4b randomly presented either $(0.3, 0.9)$ and $(0.55, 0.55)$ or $(0.5, 1)$ and $(0.66, 0.66)$. Unconditional on prior choices, Q5 randomly presented either $(0.6, 0.9)$ and $(0.9, 0.6)$ or $(0.55, 0.55)$ and $(0.5, 0.5)$.[15] We randomized the options presented in Q4 and Q5 to limit the number of questions asked to each subject, while still being able to explore preferences over a larger area in the (p, q) space.

Results

Table 2 summarizes choice proportions in each binary comparison individuals make across the four unconditional questions (Q1 – Q3, and Q5). The results echo the main findings of Experiment 1. First, a majority of individuals (78%) prefer early resolution to late resolution of uncertainty (Q1) and 75% of individuals also prefer partial resolution to late resolution of uncertainty (Q5b), suggesting that the typical participant prefers informative structures. Second, a majority of individuals exhibit a preference for positively skewed versus negatively skewed information structures (67% in Q2, 81% in Q3, and 74% in Q5a). Table B3 in Appendix B reports distributions of preference strength for each question in Experiment 2. Overall, the preferences are meaningful, with less than 5% of the participants indicating indifference.

Table 2—: Preferences for Informativeness and for Skewness in Experiment 2

Question	N	Preferences	Percentage	p-value
Early vs. Late				
Q1	250	$(1, 1) \succ (0.5, 0.5)$	78%	0.000
Q5b	121	$(0.55, 0.55) \succ (0.5, 0.5)$	75%	0.000
Positively Skewed vs. Negatively Skewed				
Q2	250	$(0.5, 1) \succ (1, 0.5)$	67%	0.000
Q3	183	$(0.3, 0.9) \succ (0.9, 0.3)$	81%	0.000
Q5a	196	$(0.6, 0.9) \succ (0.9, 0.6)$	73%	0.000

The table reports the number of participants who took a decision in each binary comparison presented by Q1, Q2, Q3, and Q5 of Experiment 2, the percentage of participants who indicated a preference for the first option in the preference ordering listed, and the $p-$values from two-sided binomial tests of the null hypothesis that the aggregate choice proportions are 50%.

Because participants answered at least two questions that presented a choice between a negatively and a positively skewed signal, we can extend our analysis

[15]To test for robustness to sequence effects, the experiment also featured two between-subject conditions, which Table B1 in Appendix B details. For approximately half the subjects, the pair $(0.6, 0.9)$ and $(0.9, 0.6)$ was presented as Q3 and $(0.3, 0.9)$ and $(0.9, 0.3)$ could be presented as Q5. Table B2 in Appendix B reports choice frequencies by condition and documents a lack of sequence effects, therefore we collapse the data.

and test whether individuals exhibit consistent preferences for positively skewed information. Table B4 in Appendix B reports frequencies of participants' choices in the questions that present positively and negatively skewed information structures. The proportions of choices that are consistent across the three pairs of questions range from 65% to 79%. We find that these consistency proportions are significantly larger than predicted by random choice (one-sided binomial test, all $p < 0.001$), which we interpret as evidence of preferences in one question being positively related to preferences in the other. Congruently, an individual's choice in any question significantly predicts their choice in another (p's ≤ 0.016 across logistic regressions).[16]

We can also ask whether the fraction of individuals who prefer positive to negative skew differs between avoiders and takers. For two out of the three comparisons, we do not find significant differences between the fraction of individuals preferring positive over negative skew when comparing takers to avoiders. However, avoiders are more likely than takers to prefer the positively skewed information structure that resolves all uncertainty regarding the good outcome, $(0.5, 1)$, to a negatively skewed information structure that resolves all uncertainty regarding the bad outcome, $(1, 0.5)$ (81% vs. 63%, McNemar test, $p-$value$= 0.009$). This result lends partial support to the notion that individuals who avoid full revelation of information likely want to avoid learning about the undesired outcome.

Table 3—: Preferences for Skewness versus Informativeness

Question	N	Preferences	Percentage	p-value
Among subjects who chose $(1,1) \succ (0.5,0.5)$*:*				
More Information vs. Positive Skewness				
Q4a	92	$(0.76, 0.76) \succ (0.3, 0.9)$	71%	0.000
Q4a	104	$(0.67, 0.67) \succ (0.1, 0.95)$	64%	0.002
Among subjects who chose $(0.5,0.5) \succ (1,1)$*:*				
Less Information vs. Positive Skewness				
Q4b	27	$(0.55, 0.55) \succ (0.3, 0.9)$	33%	0.974
Q4b	27	$(0.66, 0.66) \succ (0.5, 1)$	56%	0.351

The table lists the total number of participants who answered each version of Q4 in Experiment 2, the preference ordering that would reflect a consistent preference for informativeness as elicited by Q1, the proportion of participants who made choices in line with this ordering, and the $p-$values from one-sided binomial tests of the null hypothesis that the consistency proportions are not greater than 50%.

We last turn to examining whether positively skewed signals may be a remedy

[16]We can conduct a similar exercise for preferences for earlier resolution: 75% of those who saw Q1 and Q5b made consistent choices ($p < 0.001$) and the choice in Q1 was predictive of the choice in Q5b (logistic regression $\beta = 1.57$, $p = 0.001$).

for information avoidance, testing the conjecture that individuals (particularly information avoiders) exhibit a trade-off between preferences for skewness and informativeness. Leveraging our within-person design, Q4 asks individuals to choose between a positively skewed signal and a symmetric signal that is either less informative (targeted to information avoiders in Q1) or more informative (targeted to information takers in Q1). Table 3 lists the preferences expected from those who have monotonic preferences over information, i.e. those who do not trade off skewness and informativeness. It reports the proportion of individuals who make choices consistent with these preferences: i.e., preferring the more informative option for those asked Q4a, and preferring the less informative option for those asked Q4b (in both cases over a positively skewed option). We find that 67% of the information takers (Q4a collapsed across questions) made choices consistent with their informational preferences as elicited by Q1, preferring the more informative signal over the positively skewed alternative (one-sided binomial test, $p < 0.001$). However, less than half (44%) of the information avoiders (Q4b collapsed across questions) chose the less informative signal. We fail to reject the null hypothesis that consistency in terms of preferences for informativeness among avoiders is not greater than what we could obtain by chance (one-sided binomial test, $p = 0.83$). Contrasting the results in Q4a and Q4b, we show that avoiders are significantly less likely to adhere to the ordering induced by Blackwell dominance when evaluating a positively skewed structure than takers (two-sided chi-square test, $\chi^2(1) = 9.47$, $p = 0.002$). These results suggest that (1) a trade-off between preferences for skewness and informativeness is more likely among information avoiders, and (2) that a significant proportion of individuals who otherwise reject symmetric and negatively skewed information, may be willing to acquire positively skewed information.

II. Field Evidence

Our lab experiments show strong preferences for positively skewed signals among all individuals and suggest a willingness to acquire positively skewed signals among those who otherwise reject negatively skewed or more informative signals. These experiments address four important challenges in identifying preferences for non-instrumental information. First, they ensure that information is entirely non-instrumental. Second, they eliminate confounds that may arise from cognitive-processing constraints or flaws in Bayesian updating by explicitly providing the probability of observing a good or a bad signal and objective posteriors conditional on observing each signal for each information structure. Eliminating confusion about beliefs allows us to elicit choices that reveal intrinsic information preferences.[17] Third, our design allows us to separate preferences for the skewness from the preferences for the timing of information. Fourth, the experiment exogenously sets common priors, which allows us to construct signals with

[17]Recent work in the context of instrumental information demand by Ambuehl and Li (2018) demonstrates that non-Bayesian updating can distort informational choice.

known posterior distributions—a necessary feature for assessing their informativeness and skewness—and to generate exogenous variation in priors to assess how informational preferences change with initial expectations.

In this section, we examine information preferences in field contexts to test whether the preference for skewness and informativeness that we have documented in the lab translates to richer contexts in which information potentially has instrumental value but has been rejected by a substantial proportion of individuals. We examine preferences for genetic tests that can provide information about one's likelihood of developing Alzheimer's disease later in life and preferences for feedback about one's (relative) performance on an IQ test. We choose these settings for three reasons. First, it is not only possible but also natural to offer positively skewed and negatively skewed signals as well as a more informative signal in these contexts. Second, these contexts allow us to construct designs that minimize confounds arising in field contexts due to the lack of control over individuals' priors and the exact properties of information structures.[18] Third, information avoidance has been highlighted as a concern in both contexts (see Oster, Shoulson and Dorsey (2013*a*); Golman, Hagmann and Loewenstein (2017), and Ganguly and Tasoff (2017) for the avoidance of medical information and Bénabou and Tirole (2016) for the avoidance of information regarding ego-relevant traits).

A. *Alzheimer's Disease*

Alzheimer's Disease (AD) is known by many adults in the United States as a feared degenerative condition. Apolipoprotein E (APOE) gene variants are associated with varying risks of developing AD later in life. Each person carries two variants: carrying an APOE2 allele decreases and an APOE4 allele increases the risk of developing AD, whereas carrying an APOE3 allele is considered neutral. People with two copies of the APOE2 (APOE4) have the lowest (highest) risk for AD, with other combinations falling somewhere in between. Seventy percent of the population carries at least one neutral allele, 5%–10% carry at least one protective allele, and 10%–15% carry at least one risky allele. Individuals do not know the combination they carry without a genetic test. As many adults start experiencing memory issues in their 40s and 50s, feedback about the possibility of succumbing to AD later in life becomes personally relevant.

In a survey that first provides the aforementioned information about alleles, we elicit *stated* preferences for information regarding the possibility of developing AD later in life among adults who are 40 years of age or older. This domain presents a realistic and natural context to examine preference for skewed information structures in the medical domain for two reasons: (i) the lack of

[18]Given a particular utility function, the relative informativeness of different signals can depend on the priors. Similarly, the relative benefit of a particular information structure will vary with the assignment of payoffs across states. We specifically controlled for the non-instrumentality of information, the prior, and the variance of the signals in the lab. In field studies, preferences elicited may confound preferences for skewness and preferences for informativeness.

discernible symptoms and the common information about the population prevalence of variants provides more control over priors than what would be possible in other health domains, and (ii) the having two alleles as genetic determinants of the disease presents the opportunity to provide skewed signals without unnatural manipulations.

We ask each participant whether they would take a saliva-based genetic test that detects whether they carry a copy of the protective allele (positively skewed), a test that detects whether they carry a copy of the risky allele (negatively skewed) and a maximally informative test that determines the exact allele combination they carry. For each test, we also elicit participants' willingness to pay $X to learn its result, where X ranged from –50 to 50. The study does not offer an actual genetic test, so these questions capture stated, rather than revealed, preferences. A total of 626 participants from Amazon MTurk (average age of 53 years) completed the survey, which is reproduced in Appendix D.

Departing from our experimental results capturing (only) the intrinsic value of information, in this context, information may be instrumental. Therefore, we may expect preferences for the most informative option to be stronger than partially revealing signals, and the negatively skewed test to be more useful than the positively skewed test in this context, going against finding support for intrinsic preferences for positively skewed signals.

Results

In line with prior studies that have reported information avoidance for medical information, 28% of individuals avoid learning about the exact combination of APOE alleles. However, information avoidance decreases to 24% for the positively skewed test. In contrast, avoidance of the negatively skewed test is about the same as the avoidance of learning about both alleles, at 29%. In summary, the results show that people are more likely to take up information that is positively skewed compared with (i) information that is strictly more informative but relatively more negatively skewed (McNemar $\chi^2 = 16.1$, $p < 0.001$) and (ii) information that is negatively skewed (McNemar $\chi^2 = 23.17$, $p < 0.001$). We find no difference between the demand for negatively skewed and more informative information structures (McNemar $\chi^2 = 2.33$, $p = 0.19$).

The deviation from standard preferences for informativeness is driven mainly by people who avoid the most informative test. We examine two groups: participants who did not want to learn the exact combination of their APOE alleles (avoiders) and those who wanted to learn this information (takers). Takers generally want information: 98% of them also take the positively skewed test and 97% also take the negatively skewed test. Figure 4 shows the inverse demand curves. Among takers (Panel (A)), the willingness to pay for information (relative to no information) is generally positive. Moreover, the average willingness to pay for the most informative test ($26.3) is larger than that for negative skew ($22.3), which is in turn higher than for positive skew ($20.4) (paired t-tests, $p < 0.001$).

This ranking is congruent with monotonic preferences for informativeness that we expect from this group.

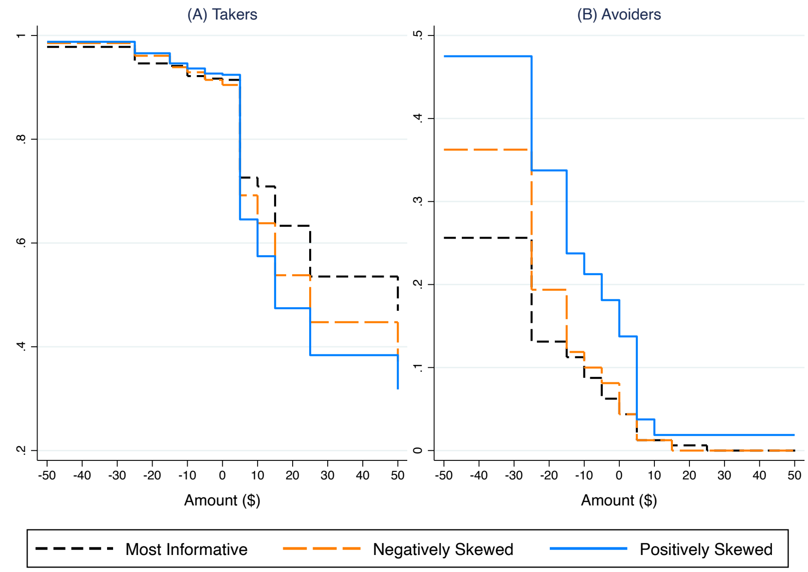


Figure 4. : Inverse Demand Curves for Genetic Testing Results of Alzheimer's Disease

Note: This figure plots the willingness to pay for each information structure in the Alzheimer's disease study among participants who wanted to acquire the most informative signal (Takers, Panel (A)) and those who did not (Avoiders, Panel (B)). In depicting these inverse demand curves, we exclude 9% of the sample who had more than a single crossing in the price list used to elicit willingness to pay.

Avoiders, on the other hand, have very different preferences across the two skewed tests. Although all of them reject the most informative structure and only 4% would take the negatively skewed test, 19% were willing to take the positively skewed test (negative vs. positive, McNemar $\chi^2 = 23.52$, $p < 0.001$). Avoiders' willingness to pay also reflects this ranking: the average subsidy they required for the positively skewed test is \$29.4, which is significantly lower than the average subsidy required to learn about the risky allele (\$37.1, paired t-test $p = 0.001$) or both alleles (\$40.2, paired t-test $p < 0.001$). As apparent from Panel (B) in Figure 4, the inverse demand curves reveal an even stronger result: the demand for positively skewed tests dominates the demand for other tests at each price point (Wilcoxon signed-rank tests, both $p < 0.001$). The results indicate that providing positively skewed information may indeed reduce information avoidance: 23.4% of those who avoid the most informative test, and even when paid \$5 to do so, would demand to take the positively skewed test if it were free. A total of 9.25% of them would pay a positive amount to take it.

Overall, this study shows that individuals who are willing to learn about both allele types always prefer learning more versus less, and therefore positively skewed information does not improve information uptake for these individuals. In contrast, individuals who avoid learning about both types of alleles seem to be primarily worried about learning of the presence of risk-enhancing alleles, and providing a positively skewed structure makes them more favorable toward acquiring information on both the extensive margin (how many people are willing to acquire information) and the intensive margin (how much they value information). These results show that for avoiders, whose intrinsic preferences are strong enough to overcome instrumental preferences for information, providing positive skew can help induce more information acquisition.

B. IQ Test

The IQ study asked participants to complete two sets of fluid intelligence tests that lasted two minutes each. Since we need to compare preferences for information structures in a real-world context where priors are heterogeneous, the study asked participants to submit a guess μ on where they ranked within a set of 100 randomly chosen participants ($\mu = 1$ meant they expected to rank at the very top). They were offered four information options: (1) no information; (2) most informative: learn whether you ranked A or better, ranked between A and B, or ranked B or worse; (3) positively skewed: learn whether you ranked A or better; and (4) negatively skewed: learn whether you ranked B or worse.

The cutoff values A and B were personalized based on μ in a way that created similar degree of informativeness, positive skew, and negative skew across participants with different priors.[19] Participants were asked to preference rank these informational structures, knowing that the option they rank as first would have a 60% chance of being chosen, the option ranked second would have a 30% chance of being chosen, the option ranked third would have a 10% chance of being chosen, and the option ranked as fourth would never be chosen. They were also given the chance to learn the number of questions they got right in each test, which is an absolute (vs. relative) performance metric. The study then executed these preferences and displayed information as appropriate. Six hundred Amazon MTurk participants completed the study, which is reproduced in Appendix E. Compared with our prior experiments and with extant literature on information preferences, the ranking data allow us to make richer within-person comparisons.

[19]We picked $A = \mu - \delta_\mu$ and $B = \mu + \delta_\mu$, where $\delta_\mu = \frac{1}{4} min\{\mu, 100 - \mu\}$. For example, a person who expected to rank 40th out of 100 people was asked whether they wanted to learn if their score ranked them better than 30 or worse than 50; and a person who expected to rank 20th out of 100 people was asked whether they wanted to learn if their score ranked better than 15 or worse than 25. We chose δ_μ as a proportion to create a transparent approach that does not suffer from truncation. In addition, under some conditions (e.g., if the prior distribution is symmetric around the mean belief), our skewed signal structures induce equivariant posterior beliefs under this approach.

Results

A majority of the individuals (58.2%) ranked the most informative option as their top-ranked information structure. The positively skewed structure was ranked as the most preferred option by 21.5% of individuals, followed by the non-informative option (by 12%) and the negatively skewed option (by 8.3%).[20] In terms of information uptake, 82.2% preferred the most informative option over no information. We refer to this group as information takers and the remaining 17.8% as information avoiders. Uptake of other information structures was 80.5% for the positively skewed option over no information, and 75.3% for the negatively skewed option over no information.[21] While similar proportions of individuals are willing to acquire positively skewed information (which is strictly less informative) and the most informative signal (McNemar $\chi^2 = 1.39$, $p = 0.24$), the proportion of individuals willing to take the negatively skewed option was significantly lower (McNemar $\chi^2 = 16.32$, $p < 0.001$).

Table 4 summarizes the top choices in the top panel and binary comparisons of interest in the bottom panel, for information takers and avoiders separately. By construction, 0% of avoiders rank the most informative option as the best, and 0% of takers rank the no-information option as their most preferred option. The top panel shows that the positively skewed option is more likely to be ranked first than the negatively skewed option, both by avoiders (24.3% vs. 8.4%, Wilcoxon signed-rank test $p = 0.004$) and by takers (20.9% vs. 8.3%, Wilcoxon signed-rank test $p < 0.001$).

The binary comparisons in the bottom panel aggregate all possible rankings for each group. The preference for positively skewed information again dominates: 67.3% of avoiders and 68.6% of takers rank the positively skewed over the negatively skewed option. Also, 71% of avoiders prefer the positively skewed information to the most informative option. In contrast, only 56.1% of those individuals prefer negatively skewed information to the most informative option. Among the avoiders, the difference in the propensity to rank the most informative signal below a skewed signal is statistically significant ($p < 0.005$, McNemar's $\chi^2 = 8$) and suggests that offering positively skewed information not only offers a net benefit in increasing a preference for information among avoiders but is also significantly better at doing so compared to offering negatively skewed information. Even among those who prefer the most informative option to no information (takers), a non-trivial fraction, 23.9%, ranks positively skewed information even higher, while only 12.6% of individuals do the same for the negatively skewed option (difference is significant at $p < 0.001$, McNemar's $\chi^2 = 29.04$). Overall, these results suggest a strong preference for positively skewed information in the context of intelligence-ranking feedback and a potential avenue for decreasing

[20]Figure E1 in the Appendix displays the histogram of rankings across the four information structures.

[21]Information avoidance for the raw test score was the lowest: 86% of individuals requested to learn their absolute scores. The instructions clarified that these scores are difficult to interpret in the absolute.

Table 4—: Preference Patterns for Feedback about Relative Performance on IQ Test

	Avoiders (No Info. $\succ$ Most Info.)	Takers (Most Info. $\succ$ No Info.)
Most Info. Ranked Best	0%	70.8%
Pos. Skew Ranked Best	24.3%	20.9%
Neg. Skew Ranked Best	8.4%	8.3%
No Info. Ranked Best	67.3%	0%
Pos. Skew $\succ$ Neg. Skew	67.3%	68.6%
Pos. Skew $\succ$ Most Info	71.0%	23.9%
Neg. Skew $\succ$ Most Info	56.1%	12.6%

The table shows a summary of information structure preferences among participants in the IQ test study based on elicited ranks of the following four options: most informative, positively skewed, negatively skewed, and no information. Avoiders (N=107) refer to the group of people who rank no information better than the most informative option. Takers (N=493) refer to the group of people who rank the most informative option better than no information.

information aversion.[22]

The ranking data allow us to examine the potential preferences for positively skewed information among avoiders in more detail. We focus attention on those individuals who would, for some information structures, be willing to acquire information, i.e., 32.7% of avoiders who do not rank the no-information option as their top choice. As the top panel of Table 4 shows, among avoiders who do not rank the no-information option as their top choice, the vast majority of them prefer positively skewed information best versus preferring negatively skewed information best (74% vs. 26% $p = 0.004$). As a result, providing the positively skewed information structure in addition to the most informative one would increase information updating from 82.2% to 86.5% of the individuals. In sum, the data show that adding positively skewed information would increase information uptake among those who might otherwise avoid full information.

III. Discussion

A. *Summary of Findings and Main Contributions*

The bulk of the prior experimental work on informational preferences considers the choice between fully revealing signals and uninformative signals. In most of these studies, the preference for fully revealing information is much more prevalent than the preference for information avoidance. Our results confirm

[22]Out of 107 avoiders, 35 people (33%) are willing to take skewed information that partially resolves uncertainty. Among these people who are open to some type of information, 28 (80%) rank positive skewed information above negatively skewed information even though an equal number (31 out of 35) would take positively skewed or negatively over no information.

these previous findings — across the two experiments, a majority (70% to 82%) of individuals preferred more informative signals to less informative signals; however, the proportion of individuals refusing to acquire such signals (often at a considerable monetary cost) was substantial and comparable to the proportions documented in prior work.[23]

The novel contributions of our paper revolve around preferences for skewness and how these preferences interact with preferences for informativeness. We believe there are two major takeaways from the paper. The first is documenting a consistent pattern of preferences for positively over negatively skewed signals across several economic environments.

FINDING 1: *The majority of individuals, ranging from 67% to 81%, prefer positively to negatively skewed information.*

Although there is little empirical evidence in the literature regarding intrinsic preferences for skewness, we know of three papers that investigated similar topics prior to our work. Boiney (1993) considers hypothetical choices between one-stage lotteries and two-stage compound lotteries with the same mean, but his work differs from ours in several ways: his framing uses two-stage lotteries with hypothetical choices, the design does not fix the variance of the posterior induced by different two-stage lotteries (thus confounding skewness and informativeness), and he does not control for the possibility that information may have instrumental value. Abdellaoui, Klibanoff and Placido (2013) also find a preference for positive skew in pure compound lottery domains, although the design changes the prior in conjunction with the skewness. Note that these two papers examine preferences over compound lotteries. Despite the mathematical equivalence between information structures and compound lotteries, preferences may differ across the two domains – a point we will return to discussing in the next section. Moreover, two recent papers have recently replicated our results regarding preferences for positive skew, albeit with slightly different setups. Nielsen (2020) focuses on information structure choices from budget sets, unlike the binary choice framework we use. Like us, Diecidue et al. (2022), focuses on choices between two options but considers situations where the reduced form probabilities have trinary support.

We know of two papers in which subjects seemingly prefer negative skew. In the domain of information structures, Eliaz and Schotter (2010) test preferences for skewness within a broader investigation of demand for non-instrumental information stemming from a desire to increase confidence about making an obvious (but risky) choice. Their design shuts down anticipatory emotions by eliminating

[23]Existing studies use a variety of elicitation methods. Many earlier studies (e.g., Chew and Ho (1994); Ahlbrecht and Weber (1997); Arai (1997); Lovallo and Kahneman (2000)), use hypothetical scenarios in conjunction with a non-incentivized measure of the strength of preference. More recent studies involve incentivized pairwise choice (e.g., Brown and Kim (2014); Kocher, Krawczyk and van Winden (2014)), willingness to pay (e.g., Ganguly and Tasoff (2017)) or certainty equivalents (e.g., Von Gaudecker, Van Soest and Wengström (2011)). Despite this, almost all the papers come to similar conclusions about a preference for earlier resolution, although some find, again like us, a significant fraction preferring full late resolution.

delays between the realization of the outcome and the resolution of information. As a result, compared with other studies, they find substantially weaker preferences for early resolution after the decision has been made. Second, the three-stage lotteries induced by their experimental design cannot be reduced to equivariant two-stage lotteries unless individuals are risk-neutral expected utility maximizers with regard to the third stage. This implies that if individuals are risk averse, a preference for earlier resolution is confounded with a preference for negative skewness. Recent work by Gul et al. (2022) finds that subjects, preferring relative to full early resolution, prefer negative over positive skew. However, their environment changes priors simultaneously with the skewness of the information structure, again making it difficult to draw a conclusion. In particular, they find at a lower prior ($\frac{1}{3}$ chance of winning a prize) the average subject prefers negative skew over early information. In comparison, at a higher prior ($\frac{2}{3}$ chance of winning a prize) the majority of subjects prefer early resolution over negative skew.

Our second finding relates the preferences for skewness and the preferences for informativeness.

FINDING 2: *Those who prefer early to late resolution tend to monotonically prefer more informative structures, and tend not to trade off skewness and informativeness. However, those who prefer full late resolution to full early resolution may avoid symmetric and negatively skewed information, though sometimes they are willing to take positively skewed information.*

We are not aware of any prior experimental evidence that speaks to this relationship. At large, our data highlight two groups of individuals based on their preferences for informativeness. Members of the first group (information takers) constitute the majority of participants, and of them, a majority of them monotonically prefer more informative signals. Members of the second group (information avoiders), who constitute a sizable minority, have a more nuanced attitude toward information. This second group sometimes prefers to avoid information, but they seek information out when it is positively skewed.

B. *Implications for Theory*

Findings 1 and 2 are useful not only for information design policies as we discuss in the next section but also because they shed light on existing theories. Because standard expected utility preferences satisfy the "Reduction of Compound Lotteries" axiom (Samuelson (1952); Segal (1990)), and so are indifferent between all information structures, we turn to examine models which relax that assumption. To keep in line with existing models that have made predictions for informational preferences, we formally model preferences for information structure using their equivalence to compound lotteries (we discuss to what extent this is reasonable in Section IV.), and denote the utility function over compound lotteries as V, an arbitrary compound lottery as P, with prior $f(P)$. Because we focus on only two outcomes, one-stage lotteries are isomorphic to the unit interval. V may not be the expected utility, but we restrict our attention to Gateaux differentiable functions, which, following Machina (1982), allows us to analyze the local utility functions, which we denote as $v(f, P)$. Local utility functions map from combinations of one-stage and compound lotteries to $\mathbb{R}$. We denote the variance of the posterior distribution induced by an information structure (p, q) as $var(p, q)$ and the third normalized moment of the posterior distribution as $skew(p, q)$.

Recall that our results suggest an overall prevalence of preferences for informativeness and for positive skew. It is well known, beginning with Kreps and Porteus (1978), and further developed by Grant, Kajii and Polak (1998), that a preference for more (less) Blackwell informative signals is equivalent to the local utility function of V being convex (concave) if mild smoothness assumptions on preferences hold (see Proposition 5 in Appendix H for a formal statement.) The following new proposition provides necessary and sufficient conditions for attitudes toward skewed information. All proofs appear in Appendix H.

PROPOSITION 1: *Let $\succsim_f$ be represented by a Gateaux differentiable value function V. Suppose i) $var(p, q) = var(p', q')$, ii) $skew(p, q) = -skew(p', q')$, and iii) $skew(p, q) > 0$ given f. If the local utility functions of V are thrice differentiable then it has a convex (concave) derivative everywhere if and only if $(p, q) \succsim_f (\precsim_f)(p', q')$.*

This result parallels known results about monetary lotteries. In our setting, skewness (fixing variance) of information structures implies an ordering formally analogous to downside risk (Menezes, Geiss and Tressler, 1980), which allows us to relate preferences for skewness over monetary lotteries to the third derivative. As our proof highlights, we must control for variance in order to identify preferences for skewness.

Combining Proposition 1 with the results of Grant, Kajii and Polak (1998) allows us to understand the first group of individuals discussed in Finding 2—that is, those who prefer earlier resolution and positively skewed information. These individuals have a utility function where the local utility functions are convex everywhere and their first derivatives are also convex everywhere. These restrictions are consistent with a wide variety of widely used utility functions. To relate the result to known function forms, we need some additional notation. We denote an information structure as ν, the set of posteriors as $\mathbb{M}$, a posterior as μ (with associated distribution over monetary outcomes $x \in X$ $\mu(x)$), and abusing notation somewhat, the distribution over posteriors that ν induces as $\nu(\mu)$. Recall that in Kreps and Porteus (1978), the utility function over compound lotteries is $V = \int_{\mathbb{M}} u_1 \circ u_2^{-1}(\int_X u_2(x)\mu(x))d(\nu(\mu))$. To match both a preference for early resolution as well as a preference for positively skewed information $u_1 \circ u_2^{-1}$ needs to be both convex and have a convex derivative. The most widely used parameterization of Kreps and Porteus (1978) is the Epstein and Zin (1989) and

Weil (1990) framework, where $u_1(x) = x^\rho$ and $u_2(x) = x^\alpha$. Our restrictions imply that $\rho > 2\alpha$, or in other words $1 - 2\alpha > 1 - \rho$ (since the first three derivatives of $u_1 \circ u_2^{-1}$ are $\frac{\rho}{\alpha}$, $(\frac{\rho}{\alpha} - 1)\frac{\rho}{\alpha}$ and $(\frac{\rho}{\alpha} - 2)(\frac{\rho}{\alpha} - 1)\frac{\rho}{\alpha}$). Recall that $1 - \alpha$ measures the relative risk aversion, while $1 - \rho$ is the inverse of the elasticity of intertemporal substitution. Our restriction accords with parameter values typically estimated in the macroeconomics and finance literature.[24]

Although Proposition 1 allows us to capture behavior demonstrated by many of the participants there is also a second group that forms an important minority. These individuals avoid many kinds of information but are willing to acquire information with a positive skew. To capture this second group we turn to our next proposition.[25] This proposition highlights the importance of the third derivative in driving behavior.

PROPOSITION 2: *Let $\succsim_f$ be represented by a Gateaux differentiable value function V. If the local utility functions $v(\cdot; P)$ of V are (i) monotone and thrice differentiable (ii) convex (concave respectively) for all $v(\cdot; P) \geq$ ($\leq$ respectively) $v(f(P); P)$ and (iii) loss averse: $|v(f(P)-\epsilon; P) - v(f(P); P)| > |v(f(P)+\epsilon; P) - v(f(P); P)|$ for all $\epsilon > 0$, then the individual will prefer no information to either negatively skewed information or symmetric information but will accept some positively skewed information.*

The behavior of individuals in the second group of Finding 2 is consistent with a more complicated structure of utility over information structures. In particular, choices are consistent with a utility function where the local utilities go from concave below the prior to convex above the prior. We call these inverse S-shaped local utility functions. Such a utility function can also explain why some individuals prefer no information at low priors but prefer information at high priors (as we find in Experiment 3, reported in Appendix C). The fact that individuals may avoid full information but be willing to accept positively skewed information is present in several recent models of informational preferences including Caplin and Eliaz (2003); Eliaz and Spiegler (2006*a*); Schweizer and Szech (2018), and Dillenberger and Segal (2017).

In addition to providing constructive results about the structure of utility functions required to match our data, we can also use our data to analyze specific models. As our next result shows, several important classes of models, notably those of Kőszegi and Rabin (2009)(KR) and Ely, Frankel and Kamenica

[24]Van Binsbergen et al. (2012) estimate $1 - \alpha$ as around 46, and $1 - \rho$ as around 1, and so $1 - 2\alpha$ is around 91. The estimates of $1 - \alpha$ and $1 - \rho$ from Bansal, Gallant and Tauchen (2007) (99 and 0.5 respectively) and Chen, Favilukis and Ludvigson (2013) (17-60 and 0.5-1 respectively) are also consistent with our results, although Epstein and Zin (1991) find estimates inconsistent with our restrictions.

[25]This proposition resembles the results in Dillenberger and Segal (2017), but this proposition is distinct. Their results require recursivity and Frechet differentiability, while ours use the weaker condition of Gateaux differentiable (and need not satisfy recursivity). Moreover, they focus on conditions regarding the quasi-concavity of utility and the "fanning out" of indifference curves over single-stage lotteries, while we provide conditions directly on the local utility functions over two-stage lotteries.

(2015)(EFK), do not satisfy this condition. Rather they predict that for equal priors a decision-maker must be indifferent between (p, q) and (q, p).[26]

PROPOSITION 3: *Suppose* $\succsim_{.5}$ *is represented by a KR or EFK functional form. Then* $(p, q) \sim_{.5} (q, p)$.

Proposition 3 is in contrast to our findings where few individuals seem to be indifferent about skewness. This result suggests that such models may need to be modified to allow for preferences that are tilted toward positively skewed signals.

In a recent series of papers, Gul, Natenzon and Pesendorfer (2021) and Gul et al. (2022) characterize and explore peak-trough utility. In addition to having a utility function u_1 and an aggregator u_2 (similar to Kreps-Porteus), their innovation is that individuals place a weight θ_H on utility from the best belief from a sequence of experienced beliefs, and a weight θ_L on the utility from the worst belief from the sequence of experienced beliefs. This introduces a novel mechanism to generate a preference for skewness — individuals are concerned about the best and worst beliefs they may experience. Our next result shows that even in the absence of curvature from u_1 and u_2 (necessary in Kreps-Porteus type models for a preference for skewness) peak-trough utility can generate a preference for skewness.

PROPOSITION 4: *Suppose* $\succsim_{.5}$ *is represented by peak-trough utility with* u_1 *and* u_2 *the identity mapping, and i)* $var(p, q) = var(p', q')$*, ii)* $skew(p, q) = -skew(p', q')$*, and iii)* $skew(p, q) > 0$*. Then* $(p, q) \succsim_{.5} (q, p)$ *if and only if* $\theta_H + \theta_L \leq 0$.

C. Policy Implications of a Preference for Positive Skew

In many situations, accuracy of information is achieved at a cost. For example, more accurately predicting the occurrence of a disease requires running additional tests, which requires time, money, and effort. Thus, a social planner may want to maximize the uptake of information, subject to a cost constraint. Our results suggest that positively skewed signals have the highest demand among equivariant signals, in terms of both uptake and monetary premia. Thus, our first policy recommendation is to maximize the skewness of signals subject to any constraint on the informativeness that can be achieved.

Now, consider situations in which improving informativeness is free, but where the social planner is trying to decide what set of signals to offer. What signals should be in the choice set? The answer is clear under neo-classical thinking: the social planner can achieve first best by providing perfectly revealing information. However, our results (in line with many other papers) suggest that providing a perfectly revealing information structure will lead to information avoidance on

[26] EFK present two functional forms: one that they describe as capturing surprise and the other they describe as capturing suspense; both have strong symmetry assumptions regarding how beliefs affect utility, and both are covered by our result.

the part of a non-negligible subgroup of the target population. Offering an additional positively skewed, but not fully informative structure will attract the most additional uptake among those who reject more informative signals. For example, only 72% of individuals demanded the most informative test in our AD study, yet adding a positively skewed test would increase total test uptake to 77%. Similarly, while only 82% of individuals wanted to get feedback after taking the IQ test, adding positively skewed feedback would increase the total uptake to 86.5%. Although the aggregate increase may be modest, these gains can be important because they represent information acquisitions by otherwise information-resistant individuals.

Of course, whether offering a positively skewed signal in addition to the most informative signal is optimal will depend on substitution patterns between these options. To the extent that the positively skewed signal induces information-resistant individuals to learn, then offering both is strictly beneficial. However, there may be individuals who would choose the fully revealing information when it alone is offered but would deviate to acquiring the positively skewed signal when both are offered. This can reduce overall information acquisition.[27] Such crowding out can be observed in our IQ test study: among individuals who prefer the most informative option to no information, 20.9% rank positively skewed partial information as their most preferred option, and 23.9% rank it better than the most informative option. Similar results are found in Experiment 2. When crowding out is a concern, it may be feasible to minimize it through pricing full and positively skewed information structures differently. Alternatively, if individuals are not fully aware of the available information options, and if there is an intermediary who can sequentially present them, the optimal policy would be to offer positively skewed information structures only to those who had already refused the most informative option. Such a solution would be possible and sensible in a medical context, for example, with the physician offering the more positively skewed test only if the most informative test is rejected.

IV. Conclusion

Intrinsic preference for information is a fertile area of inquiry with many potential applications to important economic problems. This paper takes an initial step toward a more comprehensive understanding of intrinsic preferences for information in a world in which information signals vary not only in their informativeness but also in their skew. The preferences for positive skew we document in this paper can impact optimal information design by policymakers who want to improve information uptake (both with respect to the number of individuals acquiring information, and the amount of information they acquire).

While we document a persistent preference for positive skew across a wide

[27] Whether crowding out is a concern not only depends on choice substitution, but also on the instrumental value differences between the most informative signal and the positively skewed signal compared with the value of acquiring no information.

variety of environments, a pattern which is supported both by suggestive evidence from earlier studies (such as Boiney (1993) and Abdellaoui, l'Haridon and Nebout (2015)) and other recent papers (like Nielsen (2020) and Diecidue et al. (2022)), we believe that much work remains to be done in order to better understand how to leverage skewed structures in information design problems. Papers such as Diecidue et al. (2022), Gul et al. (2022) and Eliaz and Schotter (2010) indicate that different features of the economic environment may impact how individuals view skewed signals. We turn now to a brief discussion of avenues for future research that may help improve our understanding of these issues.

First, our subjects know that uncertainty about whether or not they won the prize has already been resolved. Their choice governs the process by which they learn about the information, i.e. the information structure. In contrast, it could be that the outcome itself has not been predetermined and that the random signals themselves determine the outcome, as in a compound lottery. It is plausible that individuals may treat learning about an already realized outcome, as in information structures, differently than learning about an as-of-yet unrealized outcome, as in compound lotteries. Recent evidence presented by Nielsen (2020) and Diecidue et al. (2022) relates preferences for information structures and compound lotteries. As mentioned previously, although they replicate our findings in the domain of information structures, they find that this preference disappears when considering compound lotteries. Given that many settings have both aspects of information structures and compound lotteries (e.g., the movement of stock prices), understanding to what extent our lessons extend to contexts where future outcomes are yet to be determined is an important avenue for future work.

Second, in our experiments, there is a delay between receiving the signal and the final resolution of uncertainty, a feature shared by many papers which consider information structures and compound lotteries (e.g., Nielsen, 2020 and Diecidue et al., 2022). However, some papers which look at compound lotteries (e.g., Halevy, 2007, Abdellaoui, Klibanoff and Placido, 2013, and Chew, Miao and Zhong, 2017), impose no time delay between the interim signal (i.e. the drawn ball) and the full resolution of uncertainty (learning for sure about winning or not). We know of no work detailing the effect of the length of time between the intermediate signal and final resolution on preferences for information structures (nor work in the compound lottery setting directly manipulating the length of time between obtaining signals and final resolution).[28] If we observe preferences getting weaker as we reduce the temporal distance between the intermediate signal and the final resolution, it would be indicative that the passage of time itself is important. Such a pattern would be consistent with the preferences we documented being generated, at least in part, by flow utility from emotions that are

[28]Eliaz and Schotter (2010) report suggestive evidence that increasing the length of time increases the strength of preference but given their design choices, it is hard to directly compare this to a standard compound lottery setting. Moreover, their increase is significant at the 13% level. Studying a distinct phenomenon, Drobner (2022) finds that individuals motivate their beliefs less when they have less time prior to the resolution of uncertainty.

themselves experienced over time (e.g., anxiety or hope). On the other hand, some kinds of emotional reactions, such as disappointment and elation, may exist so long as there is an adjustment of reference points between the intermediate signal and final resolution, regardless of the time individuals have to savor their beliefs. Understanding the relationship between the passage of time and preferences for information structures would help refine our understanding of the underpinnings of intrinsic preferences for information.

Third, additional research is needed to also understand how informational premia may changes as time delays grow longer and stakes grow larger. We observe relatively large informational premia in our setting (e.g., the average subject is willing to 4.7% of the expected value of the lottery to move from full late to full early resolution) despite short periods of delay. As Epstein, Farhi and Strzalecki (2014) note, estimates of the Epstein-Zin-Weil model imply relatively large premia for the timing of information. Although our results are not directly comparable to their exercise, we believe they are broadly supportive of their predictions.[29] Understanding how the premia may scale as the delay in resolution grows longer is important when attempting to use models in many applied settings.

Fourth, our lab experiments use a binary state and binary signal realization structure. This is the simplest, but still sufficiently rich, environment to study preferences for skewed information. With more than two outcomes, the space of posteriors has dimensionality greater than two, making the definition of positive skew more involved. Although many applications of information preferences similarly focus on a two-outcome space, richer spaces, e.g., with trinary outcomes, can help us understand the degree to which a preference for skewness depends on how probability mass changes across different subsets of the support of a lottery. Moreover, it is well known that binary settings are not able to carefully distinguish between many popular models of non-expected utility (e.g., disappointment aversion is a special case of rank-dependent expected utility in this domain). Thus, extending the domain can allow for more insightful tests. Ahlbrecht and Weber (1997) is an early demonstration of this, where they test the Kreps-Porteus model in a novel way that leverages a trinary domain. We are certain similar tools could be brought to bear on skewness preferences. For a recent effort in this direction, see Diecidue et al. (2022).

Finally, our results indicate that the interplay between instrumental and intrinsic informational preferences is an important area for future research. Given the importance of context in the optimal information provision, fieldwork is necessary to provide more guidance for policymakers when seeking to improve uptake in particular environments. We hope that our work inspires additional research on this issue.

[29]They work with an infinite horizon process with intermediate consumption, while we have a two-stage compound lottery with no intermediate consumption. In addition, they use utility values in their comparison, while we use monetary stakes. Within their framework they calculate the utility of an early resolving infinite-horizon compound lottery with intermediate consumption to be 20% to 30% higher than that of a lottery where the resolution of uncertainty is as late as possible.

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