Intrinsic Information Preferences and Skewness*

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Abstract

We present experimental results from a broad investigation of intrinsic preferences for information. We examine whether people prefer negatively skewed or positively skewed information structures, and how individual preferences over the skewness and the degree of information relate to one another. The results reveal new insights regarding intrinsic preferences for information, including the possibility that positively skewed information structures may ameliorate information avoidance arising from a desire to preserve hope. We discuss our findings through the lens of existing theories.

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1 Introduction

Imagine having 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 on the fate of your paper at 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 your mentors at the conference? If so, to whom would you prefer to talk?

The type of information you seek, and thus whether you talk to Nell or Paul, is likely driven by how you think it would make you feel as you wait to learn about the fate of your paper. Psychologists have long recognized the desire to regulate anticipatory emotions, such as hope, anxiety, and suspense, regarding an uncertain outcome in the future by managing expectations (Norem and Cantor, 1986; Showers, 1986, 1992). For example, Siegel and Scrimshaw (2000) discuss different coping strategies of HIV-positive patients before an emotionally risky event, such as seeing their doctor about their test results or telling family members about their disease. Some patients try to keep their expectations high to remain hopeful, yet others prefer to expect bad news as a way of mentally preparing themselves for the worst. While people may not be able to choose their beliefs directly, they can choose the information sources that shape those beliefs (Akerlof and Dickens, 1982). Thus, the desire to manage expectations can lead to intrinsic preferences for information: a desire for or dislike of certain types of information over and above preferences for the information's instrumentality for the person's future actions.

Until now, the bulk of the theoretical and experimental work in economics considering intrinsic preferences for timing information has focused on preferences over the degree of uncertainty an information source resolves before the outcome is realized, i.e. its informativeness.[1] The desire to regulate anticipatory emotions may lead to a demand for resolving more uncertainty about the outcome earlier than later, even in the absence of an ability to act on that information. For example, voters may park themselves in front of the TV on election night, even though it costs them a good night's sleep. On the other hand, the desire to manage these emotions may also lead to avoiding

[1]Theory work in this domain includes research focusing on a preference for earlier or later resolution of information such as that considered in Kreps and Porteus (1978), Grant, Kajii and Polak (1998) and Caplin and Leahy, 2001, as well as a preference for gradual or one-shot/clumping of information such as Ely, Frankel, Kamenica (2013); Kőzsegi and Rabin (2009) and Dillenberger (2010). Examples of experimental work that focus on timing of information include Chew and Ho (1994), Ahlbrecht and Weber (1997), Arai (1997), Lovallo and Kahneman (2000), Von Gaudecker et al. (2011), Brown and Kim (2014), Falk and Zimmerman (2014), Kocher, Krawczyk and Van Winden (2014), Zimmerman (2014) and Ganguly and Tassoff (2016).

useful information. For example, patients with potential symptoms of a disease may put off taking a diagnostic test, even if it means delaying possible treatments.

However, information sources may also differ in the *type* of information they can provide, regardless of whether these sources differ in their overall informativeness. We term this important, yet less-understood, dimension of intrinsic preference for information as preferences over the *skewness* of information. Certain information sources are negatively skewed: they eliminate more uncertainty about the undesired outcome if they generate a bad signal, but they are unlikely to generate a bad signal. For example, if Nell says that she does not think your article will be well received, it is very likely that your article will be rejected – but she is unlikely to say that. Most of the time, Nell will say something nice, which is not very informative. On the other hand, certain 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. For example, if Paul says that he thinks your article will be well received, it is very likely that your article will be accepted – but he is unlikely to say that. Most of the time, Paul will be somewhat pessimistic. As these examples demonstrate, 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. On the flip side, receiving a good signal from a positively skewed information source carries a higher risk of eventual disappointment, unless it fully reveals the outcome. Therefore, the desire to regulate anticipatory emotions may naturally lead to preferences over skewness of information sources.

Many information sources in the real world are inherently skewed. For example, some companies are known to give systematically low earnings guidance unless they are sure of a positive outcome, while others give more frequent good news that is not as diagnostic. TV news channels covering the same election differ in their tone, which leads to different rates of false positive or false negative predictions in the interim period. Medical tests vary in their ability to rule in or to rule out a disease. It is not possible to achieve a complete understanding of intrinsic information preferences without understanding preferences for skewed signals.

Our experimental investigation aims to uncover a wide range of intrinsic preferences for information, to better understand how individuals search for and acquire information in a world full of skewed signals. We explore (1) whether people prefer negatively or positively skewed information structures when they are equally informative, (2) whether they prefer more informative structures, and (3) how individual preferences for skewness and informativeness are related. By conducting a study inclusive of signals that vary both in skewness and in informativeness, our investigation aims to shed light on the underpinnings of intrinsic preferences for information, with important implications for optimal information design.

Section 2 introduces the preliminaries that inform the design of our investigations. Section 3 details the experiments and presents our results. Our experimental investigations have several important features that address the common challenges in identifying preferences for non-instrumental information. First, the protocol creates an environment in which the information cannot influence actions. Second, the experiment ensures that the observed preferences are for information that influences participants' beliefs about future outcome, and not for information that shapes their self-perceptions, confidence, or ego-utility; important considerations that likely interact with intrinsic preferences for information. Third, the experiment assists subjects in computing probabilities and updating beliefs, to ensure that preferences reflect utility and not cognitive-processing constraints or flaws in Bayesian updating. Fourth, our design allows us to identify preferences for skewness independent of whether an individual prefers more or less informative structures. Finally, the experiment is designed to elicit preferences for information structures directly, rather than studying preferences regarding compound lotteries to make inferences about informational preferences. While there is a theoretical one-to-one mapping between compound lotteries and information structures, an empirical equivalence is not obvious.

Overall, the results reveal a widespread preference for positive over negative skewness. Individuals prefer ruling out more uncertainty about the desired outcome (and tolerating uncertainty about the undesired outcome) than for ruling out more uncertainty about the undesired outcome (and tolerating uncertainty about the desired outcome). In our running example, these preferences suggest that most of our participants would prefer talking to Paul, the advisor whose positive feedback, while rare, is more informative than his negative feedback. In addition, a majority of participants prefer more informative structures (i.e., earlier resolution of information). Furthermore, preferences for positive skewness, as well as preferences for earlier resolution of uncertainty, prevail across a wide range of initial expectations for the desired outcome, but are more commonly held when people have a higher expectation that the desired outcome will occur.

Our design also allows us to evaluate the extent to which preferences for skewness interact with preferences for timing of information. There has been a concern in the literature that some people may resist acquiring fully revealing information. Our results show that this concern is founded, but can be ameliorated with better information design. In particular, there is a sizable proportion (around 30%) of individuals who prefer to avoid full early resolution of information. Interestingly, a large proportion of these individuals are willing to acquire partially revealing information that is positively skewed. These results suggest that policy makers can convince information avoiders to gather (some) information by providing signals that are very informative when delivering good news, and vague enough to preserve hope when delivering bad news.

In Section 4 we discuss our findings through the lens of existing theories in the domain of preferences for intrinsic information. We provide conditions on utility functions over information structures that are consistent, or inconsistent with the observed behaviors. Furthermore, we relate these conditions to particular functional forms used in the literature. We hope that linking theory and data in this way generates new insights that are helpful in developing and extending theoretical models that capture observed behavior.

Finally, our results point to novel policy implications across several economic domains. Economists have recently pointed out the impact of intrinsic information preferences on information demand and the implications for the design of information structures in health (Kőszegi, 2003; Caplin and Eliaz, 2003; Caplin and Leahy, 2004; Oster, Shoulson and Dorsey, 2013; Schweizer and Szech, 2013), media consumption (Mullainathan and Shleifer, 2005), finance (Andries and Haddad, 2014) and collective beliefs (Benabou, 2013). Several models, such as Caplin and Eliaz (2003), Eliaz and Spiegler (2006), Schweizer and Szech (2013) and Dillenberger and Segal (2017) hypothesize that providing positively skewed information may help ameliorate information avoidance. Our results provide concrete evidence for this notion and suggest that skewness should be considered a vital tool in policy design across many economic domains, especially where information avoidance is of policy concern.

2 Preliminaries

In this section, we outline the preliminaries of the experimental setup. We consider a situation where there are three periods $(0, 1, \text{and } 2)$. In Period 0, individuals have a prior probability distribution over the states and the payoffs that will be realized in Period 2. In Period 1 they receive a signal, which might cause them to update their priors. In Period 2 the states are revealed and individuals receive their payoff. There are two possible outcomes, high and low, with utility values $u(H)$, $u(L)$, and the prior probability on the high outcome is denoted as 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 a signal that increases (decreases) the beliefs about the outcome being high compared 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 high outcome is $p = p(G|H)$, and the probability of a bad signal conditional on the low outcome is $q = p(B|L)$. Individuals cannot take any actions conditional on information; thus all preferences for information must come from intrinsic, rather than instrumental, motivations.

In the economics literature, intrinsic information preferences are typically modeled as preferences over two-stage compound lotteries (lotteries over lotteries). There is a natural bijection between prior-information structure pairs and two-stage compound lotteries. Each signal induces a lottery in period 1 regarding the outcomes in period 2. In period 0, the individual faces a lottery over these possible lotteries. Because our focus is on information, we will study preferences, and utility functionals, over the space of prior-information structure pairs.[2] We suppose that individuals have preferences over information structures (p, q) given the prior f, denoted by $\succsim_f$.[3] Among the domain of all possible signal structures represented as points in the (p, q) space (with the horizontal axis being the p-value), we only consider preferences over those that lie above the line $p + q = 1$ along with the point $(.5, .5)$. We denote this set by $\mathbb{S} := \{(p, q)|\ p + q > 1\} \cup (.5, .5)$. All points in $\mathbb{S}$ have a natural interpretation: a good signal is good news (a bad signal is bad news). Also, $\mathbb{S}$ is the minimal set that allows us to capture all possible posterior distributions.[4]

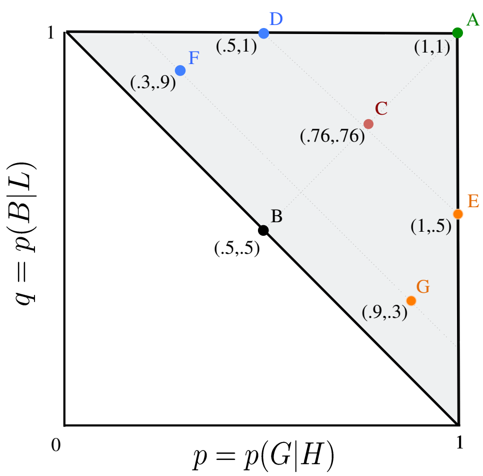


Figure 1: Examples of Information Structures on (p,q) space

Figure 1 provides some examples of information structures in $\mathbb{S}$. The information structure denoted by A resolves all information as early as possible, because a good signal implies that the outcome is H for sure, and a bad signal indicates the outcome is L for sure ($p = q = 1$). On the other hand, B is an information structure that conveys no information at all ($p = q = .5$), since the posterior after either signal is equal to the prior. Information structure C ($p = q = .76$)

[2]Our formal results in Section 4 use the induced preferences in the space of two-stage compound lotteries in order to provide an immediate link with prior theoretical work. Ambuehl and Li (forthcoming) run experiments using the information structure domain as well, albeit in the context of instrumental information demand.

[3]Information preferences in the real world are typically observed for a given prior. For example, a patient decides whether to receive further diagnostic testing, or choosing between different types of tests, conditional on her belief about the chances that she is healthy or sick; she does not get to choose the ex-ante prior chance she is sick. Testing the standard axiomatic approaches to informational preferences, recursive preferences, which were formalized by Segal (1990), requires individuals to compare across priors. But such comparisons are not a natural representation of information preferences.

[4]These statements are formalized in Appendix D.

resolves some interim uncertainty. We refer to signals along the diagonal $p = q$ as *symmetric*. As we formalize below, symmetric information structures resolve more uncertainty as we move from B to A. Much of the literature considering intrinsic preferences for information has focused on understanding whether individuals might prefer more or less information earlier. In our domain, this is equivalent to asking how preferences behave as we move to right and up (or left and down) in (p, q) space.

The main focus of this paper is documenting whether individuals have preferences for skewness — whether in Period 1, individuals prefer to resolve more uncertainty about the high outcome or the low outcome. We define the skewness of an information structure as the standardized third moment of the posterior distribution it induces.[5] Consider the information structures in Figure 1 when $f = .5$. Symmetric information structures have zero skewness, structures to the west of the diagonal are positively skewed, and those to the east of the diagonal are negatively skewed. For example, information structure D provides a 25% chance to resolve all uncertainty in favor of the high outcome (giving a posterior of 1), while delivering worse-than-before news 75% of the time (delivering a posterior of $\frac{1}{3}$). Conversely, E provides a 25% chance to resolve all uncertainty in favor of the low outcome (giving a posterior of 0), while delivering better-than-before news 75% of the time (and giving a posterior of $\frac{2}{3}$). Information structures F and G are also positively and negatively skewed, respectively, but neither of these information structures can fully resolve uncertainty under any signal.

In our experimental investigations of positively skewed and negatively skewed information structures, we are careful to identify individuals' preferences for skewness independently of their preferences for informativeness. In particular, we compare pairs of information structures that are mean- and variance-preserving probability transformations of one another. For example, when $f = .5$, the information structures D and E (and F and G) have the same mean and variance, because they are symmetric across the diagonal. When $f \neq .5$, we need to move away from reflections across the $p = q$ line to find equivariant pairs, as we detail in the context of Experiment 3. Formally, this approach parallels that of Menezes et al. (1980), who consider the effects of downside risk when looking at choices over lotteries. They provide a behavioral characterization of risk preferences over the mean- and variance-preserving transformations that differ in their skewness; and demonstrate that this allows them to identify preference for skewed lotteries independent of risk aversion. Simi-

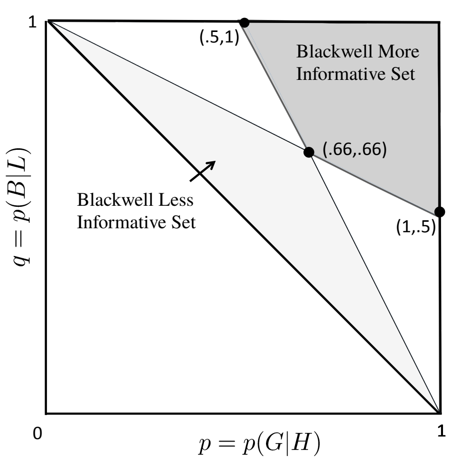
[5] In the theoretical literature, there are other notions related to preferences for skewness, including the central third moment, third-order stochastic dominance, third-degree risk order, and the Dillenberger and Segal (2017) notion of skewness. Given a 50% prior and signal structures that are reflections 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 the ordering imposed by third central moment and our notion coincide.

larly, holding variance constant across structures allows us to hold constant the informativeness of signals and separately identify preferences for skewness.

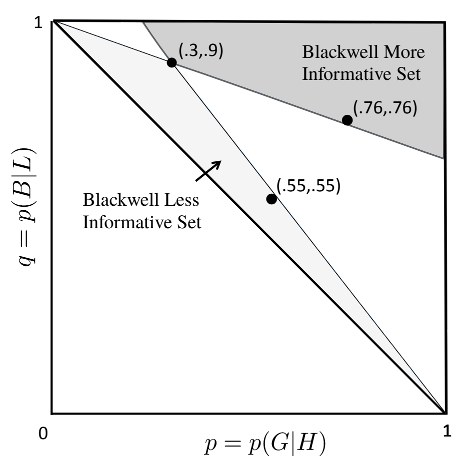
Another objective of this paper is to explore the tradeoff between the informativeness and skewness of two signals. To do so, we need to rank signals in terms of the degree of information they resolve. We achieve this using a well-known ordering of information structures in economics: Blackwell's ordering.[6] Lemma 1 formalizes the conditions that allow us to Blackwell rank signals.

Lemma 1 (p', q') *Blackwell dominates (is Blackwell more informative than)* (p, q) *if and only if* $p' \geq \max\{\frac{p}{1-q}(1-q'), 1-q'\frac{1-p}{q}\}$.

Intuitively, the posteriors under the Blackwell more informative structure are a mean-preserving spread of the posteriors under the Blackwell less informative one. Figure 2 displays Blackwell-ranked signals with respect to a symmetric $(.66, .66)$ and a skewed $(.3, .9)$ structure in panels (a) and (b), respectively. First, consider panel (a). When $p' > p$ and $q' > q$, (p', q') induces a posterior that is a mean-preserving spread of the posterior that (p, q) induces. For symmetric information structures, this is equivalent to a higher variance of the posterior distribution. Thus, moving northeast on the $p = q$ diagonal line, symmetric information structures are increasingly Blackwell more informative. Not only in this example, but more generally, Blackwell information ranking of all symmetric structures is complete.



(a) Blackwell ranked signals with respect to $(.66, .66)$



(b) Blackwell ranked signals with respect to $(.3, .9)$

Figure 2: Examples of Blackwell more and less informative sets

[6] Blackwell's ordering was originally designed to be used in situations where the individual's payoff in Period 2 depends on both the state and an action taken by individuals in Period 1. However, as Kreps and Porteus (1978) and Grant, Kajii and Polak (1998) demonstrate, there is a meaningful mapping between Blackwell's ordering and information preferences even when information is non-instrumental (i.e., individuals cannot take any action based on it).

More generally, Blackwell's ordering provides a partial ordering over the entire (p, q) space. For example, in panel (b), the unshaded areas in the upper triangle denote the collection of signals that are not ranked in terms of their Blackwell informativeness with respect to $(.3, .9)$. These signals not only include information structures that have the same variance as $(.3, .9)$, but also include information structures with lower and higher variance than $(.3, .9)$. When $p \neq q$, for a given f, if (p', q') is more informative than (p, q), then the former has a higher variance, but the converse is not necessarily true.

Blackwell's ranking provides a useful tool to identify information structures that resolve more or less uncertainty than a skewed signal and thus allows us to test the extent to which people trade off informativeness and skewness. As an example, consider the specific information structures in the Blackwell more informative and Blackwell less informative sets that panel (b) Figure 2 highlights. Imagine that we know how an individual chooses between more and less informative symmetric structures. Then, asking an individual who prefers less informative symmetric structures to more informative ones to choose between $(.3, .9)$ and a slightly less Blackwell informative signal (i.e., $(.55, .55)$) would inform us about how s/he trades off skewness and informativeness. Similarly, asking an individual who prefers more informative symmetric structures to less informative ones to choose between $(.3, .9)$ and a slightly more Blackwell informative signal $(.76, .76)$ would reveal his/her tradeoff.

3 Experimental Investigations

This section presents results from three related experiments that test whether people prefer information structures that, given equal priors, are more accurate at predicting the worse outcome than those that are more accurate in predicting the better outcome when information is entirely non-instrumental. The experimental investigation also sheds light on whether preferences for non-instrumental information change over priors, and the relationship between individuals' preferences over skewness and informativeness.

The experiments share certain features that address four important challenges in identifying preferences for non-instrumental information. First, the experiments ensure that information is entirely non-instrumental. In the real world, information typically has some instrumental value, which can confound identification of intrinsic preferences. The experiment keeps the subjects in a controlled environment where they could not engage in any actions based on information about their future earnings to rule out any instrumental use of the information acquired. Eliciting preferences in a setting where instrumental motivations are absent allows us to cleanly identify the non-instrumental preferences. We introduce a considerable delay from the time of information acquisition to the time of uncertainty resolution. Subjects cannot avoid having their beliefs change, however, they can manage the timing between shifts in beliefs, and related anticipatory emotions, by choosing how much and what kind of information they acquire.[7]

Second, the protocol eliminates confounds that may arise from cognitive-processing constraints or flaws in Bayesian updating. The instructions provide the subjects with information regarding the probability they would observe any given signal, and what posteriors they should have after observing said signal. Eliminating confusion regarding objective beliefs allows us to elicit choices that reveal intrinsic information preferences.[8]

Third, the protocol ensures that the observed preferences are for information that impacts subjects' belief-utility regarding a future (exogenous) outcome. The experiment provides information about material outcomes generated by an external process, where the information cannot be interpreted as self-relevant, i.e., being about individuals' actions, ability or traits. Moreover, the experiment offers neither a decision nor an illusion of a decision to the subjects. For these reasons, the information of interest cannot impact subjects' self-perceptions, confidence-utility or ego-utility.[9] Furthermore, the experimental design parallels many of the real-world applications where information is about an outcome that already determined (for example, as in genetic testing, earnings guidance, elections, etc.). This focus eliminates alternative psychological motives, such as illusion of control or superstitious thinking, that might confound our findings if the outcome were determined gradually over time in addition to the information being revealed over time.[10]

Fourth, our design allows us to separate preferences for the skewness from the preferences for timing of information. When eliciting preferences for skewness, we present subjects with a pair of positively and negatively skewed information structures that have the same variance and absolute level of skewness, but vary in the sign of their skewness. In this manner, the design ensures that elicited choices do not conflate preferences for earlier or later resolution with preferences for positive

[7]This feature distinguishes our setting from environments where it is possible for individuals to avoid learning at all, such as in Alaoui (2009).

[8]It is well documented that individuals engage in non-Bayesian updating; recent work in the context of instrumental information demand by Ambuehl and Li (forthcoming) demonstrates that non-Bayesian updating can distort informational choice.

[9]Kőzsegi (2006) provides a model where individuals gain utility from beliefs about their ability. Hoffman (2011), Eil and Rao (2011), and Mobius et al. (2011) provide examples in which information of interest is about the action or characteristics of the participant, and find selective updating with respect to information. Benabou and Tirole, (2011), Benabou (2013), and Gottlieb (2014) develop models where individuals may attempt to manipulate their own future beliefs. In these situations, individuals may commit to information structures in order to prevent strategic self-manipulation.

[10]Such joint resolution occurs in the case of compound lotteries. Experiments examining preferences for the resolution of uncertainty when framed as compound lotteries include Chew, Miao and Zhong (2012), Abdellaoui, Klibanoff and Placido(2013), and Halevy (2007).

or negative skew. Furthermore, keeping the variance and absolute skewness of the information structure pairs constant across priors allows us to make clean comparisons of skewness preferences across different priors. Finally, comparing information avoidance in the case of a fully revealing signal to information avoidance in the cases of partially revealing negatively skewed, symmetric and positively skewed information structures that have the same variance allows us to identify the contribution of skewness preferences (versus preferences for informativeness) to the amelioration of information avoidance.

We discuss the common protocol in further detail in the context of the first experiment.

3.1 Experiment 1: Between-subject evidence for timing and skewness preferences

A total of 700 subjects participated in a real-choice experiment conducted at the University of Michigan Behavioral Lab.[11] When the subjects arrived at the lab, they received raffle tickets, which gave them a chance of winning \$10 in addition to their \$7 show-up compensation. The experimenter gave the tickets to subjects from a ticket roll one by one, making it transparent to all participants that each participant had equal chances in the lottery. The fact that subjects did not pick their own tickets eliminated any perceived choice or control subjects may have had over their chances of winning the lottery.

The experiment was framed as consisting of two different studies. In Study 1, subjects completed a seemingly unrelated set of tasks and gained practice with a protocol that elicited their willingness to switch between two options, which Study 2 also utilized. In particular, subjects first chose between a pen and a postcard, and indicated the strength of their preference for the item they chose versus the item they did not choose, using a scale ranging from 0 (indicating indifference), to 10 (indicating a very strong preference). Figures 4 and 5 in Appendix F display screen shots of these questions. Then, subjects were presented with the option of receiving money for switching their choice. First, they watched an instructional video explaining this protocol.[12] We presented 10 consecutive statements in the following form: "For a compensation of x cents I would change my choice," where x varied from 1 to 50. Figure 6 in Appendix F displays the screen shot of the

[11] The experiment was run in two waves. A total of 223 subjects participated in treatments T1-T5 in the summer semester of 2015, and a total of 477 subjects participated in treatments T1-T10 in the winter and spring semesters of 2017. There were no differences in subject choices across the two waves in treatments T1-T5. Appendix A reports results by wave.

[12] Throughout the study, we relied on video technology to deliver instructions that were either very long or very important, or both. There are three advantages of this technology: 1) visual delivery aids comprehension and increases attention compared to reading long pieces of text, 2) the same amount of information can be conveyed faster, and 3) variation in the delivery of instructions is eliminated across sessions.

willingness-to-switch elicitation page. They indicated 'Yes' or 'No' for each of these statements. On the next screen, a statement was randomly chosen and displayed to the subjects. If the subject marked 'No' for that statement, s/he received the preferred item, but if s/he marked 'Yes', s/he was given the other item and the amount of money indicated in the statement. Study 1 lasted approximately 10 minutes.

In the beginning of Study 2, subjects watched an instructional video that explained that whether a particular ticket wins or loses the lottery is determined by the last digit of the ticket number and the outcome of a 10-sided die throw. They learned that the experimenter would roll the die and cover it with a cup (after seeing the die outcome) to hide the outcome from the subjects. If the die outcome is an odd (even) number and the last digit of the ticket the participant is holding is also odd (even), the subject would win \$10, but otherwise, s/he would not win any money. In this manner, the experiment set prior beliefs about the chances of the high outcome (winning 10 dollars) at $f = .5$, for all subjects. The instructions emphasized that the outcome of the die would not be announced publicly before the experiment was over. Subjects learned that they would enter their ticket number in the program, and the experimenter would supply a code so that the computer would know whether they won or lost, even though the subjects would not. Instructions gave hypothetical examples of this process to explain how the computer would know more than the subjects did, and how it would generate clues if needed.

Subjects learned that they would make a choice between two clue-generating options, observe the clue generated by the option they choose, and sit with that clue as they worked on unrelated hypothetical questions for the rest of the experiment until the die outcome was announced. Instructions also clarified that the information would not change whether they actually won the lottery or not, nor would it help them elsewhere in the experiment. After they listened to these instructions, subjects entered the last digit of the raffle ticket they received and the code supplied by the experimenter. On the next page, the subjects answered several comprehension questions regarding the instructions they received. The program instructed them if they answered any question incorrectly.

Each information structure was presented as containing two boxes, each holding 100 balls of either red or black color. The first box contained $100p$ red balls and $100(1-p)$ black balls. The second box contained $100(1-q)$ red balls and $100q$ red balls. Figure 3 displays an example for $(.3, .9)$ as Option 1 and $(.9, .3)$ as Option 2.

Before making a choice among two information structures, subjects watched another instructional video that detailed the information structures. The instructions clarified that the computer would draw a ball from the first box if the subject won the lottery, and from the second box otherwise, subjects could observe the color of the ball, but not which box it was drawn from; thus, the

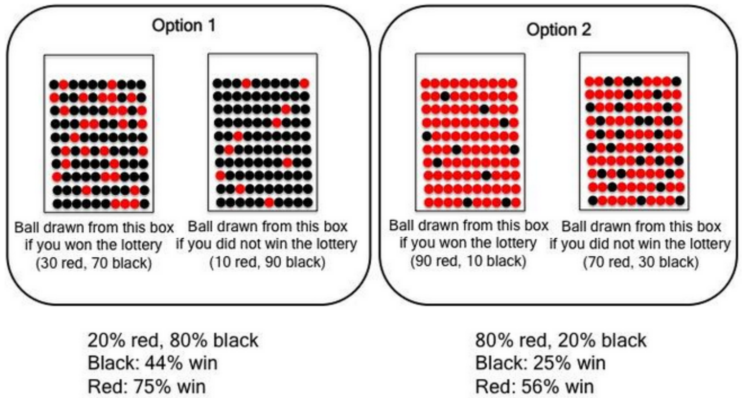


Figure 3: Graphical Presentation of Information Structures

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. After answering questions that checked their comprehension of the instructional video, subjects arrived at a page that displayed the two options graphically and repeated the information regarding the likelihood of observing a ball color and the posterior probability of winning associated with a color for each information structure. Subjects made a choice between two information structures and indicated their preference intensity. The preference intensity was measured 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). Figure 7 and Figure 8 in Appendix F display examples of these questions. Subjects always had to make a choice between information structures, even if one of them was uninformative (i.e., $(p, q) = (.5, .5)$).

The study then asked subjects whether they would agree to see a ball drawn from their unpreferred information structure, instead of seeing a ball drawn from their preferred information structure, in exchange for x cents, where x ranged from 1 to 50.[13] In cases where one information structure is uninformative, this question elicited the willingness to pay to observe a signal for an information structure. In cases where both information structures are informative, it measured the monetary value of the utility difference between the information structures. Based on this elicitation, we defined a minimum compensation required to switch (MCTS) for each individual's choice. We employed the most conservative measure of MCTS. For example, if the subject rejected a compensation of 10 cents, but accepted a compensation of 15 cents, we set his MCTS to be 10.1

[13]In Appendix F, Figure 9 displays the preamble to the willingness to switch elicitation, and Figure 10 shows the set of 10 questions. The program randomly picked one statement and carried it out. Figure 11 displays the page informing the subject of the chosen statement and the implication of his/her answer to the statement.

cents. Similarly, if the subject rejected a compensation of 50 cents, we set his MCTS to be 50.1 cents.

After observing the ball color, as Figure 12 in Appendix F shows, subjects were asked to confirm their posterior beliefs. This marked the end of the main study. The subjects then proceeded to answer several hypothetical questions as they waited for the outcome to be announced. In particular, they explained the reason they preferred the information structure of their initial choice, completed a few demographic questions, 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. These filler tasks took approximately 30 minutes for subjects to complete. At the end of the study, one participant was invited to lift the cup and announce the die outcome. Each participant was paid privately. The average earnings were \$12.46. All instructions and further details of the experiment appear in Appendix A.

DESIGN: The experiment included 10 between-subject treatments, each presenting a choice between two information structures. Treatment T1 asked subjects to choose between $(1, 1)$ and $(.5, .5)$, eliciting preferences for full early resolution of uncertainty versus full late resolution of uncertainty. T2 elicited preferences between $(.5, 1)$ and $(1, .5)$, a positively skewed structure and a negatively skewed structure that may lead to full resolution of uncertainty given some signal realizations. T3 and T4 presented a comparison between two skewed information structures, $[(.3, .9)$ and $(.9, .3)]$ and $[(.6, .9)$ and $(.9, .6)]$, respectively, where information is always resolved gradually. Treatments T2-T4 test whether people prefer information structures that, given equal priors, are more accurate at predicting the worse outcome than those that are more accurate in predicting the better outcome. In all treatments that present two skewed structures (p, q) and (p', q'), we ensure that $mean(p, q) = mean(p', q')$, $var(p, q) = var(p', q')$, and $skew(p, q) = -skew(p', q')$. Because for $f = .5$ the (p, q) space is highly symmetric, these conditions imply that $p = q'$, $p' = q$ where $p > q$, $q' > p'$.

Treatments T5 and T6 asked subjects to choose between an uninformative signal $(.5, .5)$ and the positively skewed structure in T2 and T3, respectively. Similarly, T7 and T8 asked subjects to choose between an uninformative signal $(.5, .5)$ and the negatively skewed structure in T2 and T3, respectively. Finally, T9 and T10 asked subjects to choose between an uninformative signal $(.5, .5)$ and a symmetric structure that resolved the same amount of uncertainty, as measured by the variance of its posterior, as the skewed structures in T2 and T3 respectively. Table 4 in Appendix A reports the order in which information structures were presented in each treatment.

Treatments T5-T10 evaluate two things. First, they allow us to test the extent to which individuals have preferences for (one-shot) late resolution of uncertainty versus gradual resolution of uncertainty. Second, they allow us to assess whether choice patterns indicate any substitution between preferences for information and skew. We examine this question in two ways. First, we evaluate how preferences for information (relative to receiving no information) change across positively skewed, symmetric and negatively skewed structures with equal variance, by comparing T5, T9 and T7, and similarly, by comparing T6, T10 and T8. Second, we evaluate how the proportion of individuals who avoid information in T1 compare to the proportion of individuals who avoid information in T5-T8. Both of these evaluations help demonstrate whether individuals' attitudes towards skewness can ameliorate or exacerbate tendencies to desire or avoid non-instrumental information.

RESULTS: Table 1 summarizes choices across the pairs of information structures presented by T1-T10, and reports p-values from one-sided binomial tests against the null hypothesis of random choice. The results from treatment T1 indicate that while 70% of individuals prefer full early resolution to full late resolution, a substantial proportion of the subjects (30%) prefer to avoid fully revealing information.

Table 1: Treatments and Results from Experiment 1

Treatment	N	Preferences	Percentage	p-value
Early vs. Late				
T1	79	$(1,1) \succ (.5,.5)$	70%	.000
Positively Skewed vs. Negatively Skewed				
T2	78	$(.5,1) \succ (1,.5)$	80%	.000
T3	83	$(.3,.9) \succ (.9,.3)$	67%	.001
T4	78	$(.6,.9) \succ (.9,.6)$	74%	.000
Positively Skewed vs. Late				
T5	75	$(.5,1) \succ (.5,.5)$	87%	.000
T6	68	$(.3,.9) \succ (.5,.5)$	82%	.000
Negatively Skewed vs. Late				
T7	57	$(1,.5) \succ (.5,.5)$	72%	.000
T8	60	$(.9,.3) \succ (.5,.5)$	77%	.000
(Symmetric) Gradual vs. Late				
T9	63	$(.79,.79) \succ (.5,.5)$	81%	.000
T10	59	$(.63,.63) \succ (.5,.5)$	75%	.000

For each treatment, the table reports the total number of subject who participated in each treatment (N), indicates the most prevalent preference ordering, the percentage of subjects who indicated this preference, and the $p-$values from one-sided binomial tests against the null hypothesis of random choice.

The results from T2, T3 and T4 show that the majority of individuals prefer the positively skewed information structure to the negatively skewed information structure. Given that these skewed pairs resolve the same amount of information, this finding suggests that individuals prefer signals that are more accurate at predicting the better outcome than those that are more accurate in predicting the worse outcome.

The results from treatments T5-T10 are instructive in three ways. First, they show that the majority of subjects prefer informative structures that resolve uncertainty gradually over time to late resolution. Therefore, for the majority of the subjects, somewhat informative signals are better than noninformative ones, even if they do not resolve all uncertainty. A second pattern that treatments T5-T7-T9 bring to light is how preferences for the gradual resolution of uncertainty versus late resolution of uncertainty change as skewness declines. Recall that the more informative option in each of these treatments has the same variance, so they are not Blackwell rankable (intuitively they can be thought of as resolving the same amount of uncertainty, but with respect to different outcomes). Results show that the more positively skewed an informative structure becomes, the more willing the subjects are to choose it. In particular, compared to when the alternative signal is negatively skewed the preference for the uninformative signal is lower when the alternative signal is positively skewed (T5 vs. T7: $\chi^2(1) = 6.5$, $p = .011$); and the proportion of subjects who want the informative symmetric signal (in T9) is in between these two extremes, but not statistically different from either T5 or T7.[14] The same ordering, i.e. a growing preference for information as the information structure becomes more positively skewed, is observed across treatments T6-T8-T10, but the contrast between T6 and T8 is not statistically significant.[15] This is not surprising given these difference in the amount of skew of the informative signal between T6 and T8 is smaller than that in T5 and T7.

Relatedly, a third instructive conclusion arises from comparing the proportion of individuals who prefer not to receive any information in treatments T5-T8 with the same proportion in treatment T1. The proportion of individuals who prefer not to receive any information in T1 is comparable to the proportion of information avoiders when the more informative option is negatively skewed, either resolving all (T7) or more (T8) uncertainty about the undesired outcome.[16] On the other hand, the percentage of information-avoiders falls from 30% in T1 to 13% in T5 (two-sided chi-square test, $\chi^2(1) = 6.5$, $p = .011$). Similarly, it falls to 18% in T6 (two-sided chi-square test, $\chi^2(1) = 3.2$, $p = .073$). Importantly, the decline in the proportion of information avoiders in T5

[14] The proportion of individuals making the choice of the informative signal in T9 is indistinguishable from the same proportion in T5 ($\chi^2(1) = .83$, $p = .361$) and in T7 ($\chi^2(1) = 1.36$, $p = .243$).

[15] The proportion of individuals making the choice of the informative signal in T6 is indistinguishable from the same proportion in T8 (82% vs. 77%, $\chi^2(1) = .64$, $p = .425$).

[16] This proportion is 30% in T1, 28% in T7 (two-sided chi-square test, T1 vs. T7, $\chi^2(1) = .085$, $p = .771$), and 23% in T8 (two-sided chi-square test, T1 vs. T8, $\chi^2(1) = .85$, $p = .356$).

and T6 as compared to T1 cannot be explained by a simple preference for gradual resolution of uncertainty. To see this, recall that T5 and T7, as well as T6 and T8, have the same variance and thus resolve the same amount of uncertainty. These results are consistent with the notion that a significant proportion of subjects who avoid information, including full early resolution, are motivated by avoiding information about the undesired outcome.

In summary, Experiment 1 reveals that most subjects prefer positively skewed information and earlier resolution of information. Moreover, the preference for positively skewed information over negatively skewed information is as prevalent in the population as the preference for early resolution over late resolution. However, there is also substantial heterogeneity in terms of attitudes, with up to 30% of responses in any given question indicating a preference for information avoidance.

In order to determine what proportion of the indicated choices reflect a true preference and what proportion can be reconciled with indifference, the experiment also elicits preference intensity and MCTS for the option that each individual chose. Tables 6 and 7 (Appendix A) report the full distributions and average values of preference intensity and MCTS for each treatment, and p-values from one-sided t-tests to evaluate the ordering suggested by the averages.[17] Both the preference intensity and the MCTS data indicate a strong preference behind elicited choices. For example, individuals who chose to receive fully revealing information in T1 indicated a high preference intensity (an average of 8.06 out of 10) and were willing to pay an average of 23.81 cents for their chosen information structure. Similarly, those who chose (.5, .5) had an average preference intensity of 6.71 out of 10 and were willing to pay 29.72 cents on average to avoid learning the outcome of the lottery during the experiment. Overall, the MCTS data showed that 14% of subjects in T1 were indifferent between the option they chose and the alternative, whereas 63% required at least 20 cents to switch their choices, including 22% of subjects who would not switch even for a 50-cent compensation.

The preferences of individuals regarding skewness were also very strong. Across the three conditions that elicited a choice between positively and negatively skewed structures, the average preference intensity among those who preferred the positively skewed structure was 6.6 out of 10, and the average MCTS was 26.95 cents. Among individuals who preferred the negatively skewed structure, the average preference intensity was 6.1 out of 10, and the average MCTS was 24.81 cents. When evaluating T2-T4, only 12-13% of the individuals reported MCTS consistent with

[17] Across subjects and treatments, MCTS and preference intensity measures were highly related, with a point increase in the preference intensity scale corresponding to a 2.4-cent increase in MCTS. In 7 out of 10 treatments, the average preference intensity reported by individuals with majority preferences is larger than the average preference intensity reported by individuals holding the less popular preferences. This result may indicate that the preferences held by the majority of subjects are held more strongly and are harder to move around. However, this pattern is not supported by the MCTS data.

indifference, but 70-81% of individuals required at least 20 cents to switch their choices, including 11-23% of subjects who would not switch even for a 50-cent compensation.

Considering that the subjects had a 50% chance of winning \$10 and the outcome would be revealed at the end of the experiment, the MCTS data reveal substantial utility differences across the choice options for the majority of subjects.

3.2 Experiment 2: Within-subject evidence for the relationship between preferences for skewness and informativeness

In Experiment 1, our results come from a between-subjects design, which leaves us little room for directly testing the consistency of and relationships between our observed preferences within a person. Experiment 2 employs a within-subject design to provide a more direct test of whether individuals trade off positive skew and informativeness of signals.

Protocol and Design: In order to explore the relationship between preferences for skewness and preferences for timing of information in a detailed manner, we recruited 250 subjects for a 60-minute study that presented five pairwise choices between information structures to all subjects. The subjects indicated their choice and their preference strength for each pairwise comparison before the computer randomly picked one question, and displayed the subject's preferred information structure in that question as well as the color of the ball drawn from it. The subjects were informed of this sequence of events before they started indicating their choices. They were specifically instructed to treat each pairwise comparison as independent decisions.[18]

Table 2 presents the order of the five pairwise comparisons Condition 1 and Condition 2 presented to each subject.[19] The first and second questions presented the same options as in T1 and T2 of Experiment 1. The pairwise comparison in T3 of Experiment 1 was presented as the third question to all subjects in Condition 1, but was randomly assigned as one of two possible questions as the fifth question in Condition 2. Similarly, the pairwise comparison in T4 of the main experiment was presented as the third question to all subjects in Condition 2, but was randomly assigned as one of two possible questions as the fifth question in Condition 1. In both conditions, if the subjects were not assigned these pairwise comparisons as the fifth question, they were asked

[18] 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 (2013), 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, the reader may worry about behavioral differences arising from the framing induced by the order of questions. As the result will show, we find highly comparable patterns with the results from Experiment 1, which only presented one pairwise comparison to each subject.

[19] The conditions also varied the order of options presented. Full details are included in Table 8 in Appendix B.

to choose between full late resolution of uncertainty $(.5, .5)$ and another symmetric signal structure that is slightly more informative $(.55, .55)$.

Taking advantage of the within-person design, the fourth question conditioned on subjects' choice in the first question. The subjects 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. The subjects 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. Therefore, the fourth question tested whether the preferences of subjects who exhibit a preference for Blackwell informativeness over symmetric signal structures also respect that same Blackwell ordering when comparing positively skewed structures to symmetric structures. Therefore, the subject responses to Q4 allow us to assess to what extent preferences for skewness may interact with preferences for the amount (or timing) of information. For robustness, Condition 1 and Condition 2 asked different paired comparisons in Q4a and Q4b.

To keep the study manageable in terms of time and logistics, we did not elicit subjects' willingness to pay to see a ball from their preferred information structure, but we did elicit individuals' self-reports of preference intensity. After observing the ball color, subjects worked on filler tasks as they waited for outcome of the lottery to be announced to all subjects. The filler tasks asked hypothetical questions that each presented two options to elicit their risk preferences, ambiguity aversion, ability to reduce compound lotteries and attitude differences towards common ratios. Further details of the experiment are included in Appendix B.

Results: Table 2 summarizes choices across the information structures and reports p-values from one-sided binomial tests against the null hypothesis of random choice.[20] Table 11 in Appendix B reports the summary statistics and distributions of preference strength by treatment. As in the first experiment, preferences are held strongly, with less than 5% of the individuals indicating indifference.

The preference for positively skewed information is very prevalent in the population (Q2, Q3, Q5a), even more so than than the preference for early resolution. In addition, individuals show high consistency in the choice of positively skewed information structures across questions. Among the subjects who prefer the positively skewed option $(.5, 1)$ to the negatively skewed option $(1, .5)$, 83% of those who faced only one additional question over positively and negatively skewed structures also prefer the positively skewed option over the negatively skewed option presented in the future question. Among the set of subjects who answered three questions that presented a choice between

[20] The results are indistinguishable across the two conditions, therefore we collapse the data. Table 9 in Appendix B report choice frequencies by condition and documents the lack of order effects.

positively skewed and negatively skewed information structures, 71% of subjects who prefer the positively skewed option $(.5, 1)$ to the negatively skewed option $(1, .5)$ also prefer the positively skewed option in both of the future questions.

Table 2: Conditions and Results from Experiment 2

Cond. 1	Cond. 2	N	Preferences	Percentage	p-value
Early vs. Late					
Q1	Q1	250	$(1,1) \succ (.5,.5)$	78%	.000
Positively Skewed vs. Negatively Skewed					
Q2	Q2	250	$(.5,1) \succ (1,.5)$	67%	.000
Q3	Q5a	183	$(.3,.9) \succ (.9,.3)$	81%	.000
Q5a	Q3	196	$(.6,.9) \succ (.9,.6)$	74%	.000
(Symmetric) Gradual vs. Positively Skewed					
Q4a		92	$(.76,.76) \succ (.3,.9)$	71%	.000
	Q4a	104	$(.67,.67) \succ (.1,.95)$	64%	.002
Q4b		27	$(.55,.55) \succ (.3,.9)$	33%	.061
	Q4b	27	$(.66,.66) \succ (.5,1)$	56%	.701
(Symmetric) Gradual vs. Late					
Q5b	Q5b	121	$(.55,.55) \succ (.5,.5)$	75%	.000

The table reports the total number of subject who participated in each treatment (N), the percentage of subjects who indicated a preference for the first option in the preference ordering listed, and the $p-$values from one-sided binomial tests against the null hypothesis of random choice.

Again, as in the first experiment, individuals generally prefer fully revealing information to learning nothing at all (Q1). They also prefer learning a little bit earlier rather than learning nothing at all in just as large a proportion (Q5b). In addition, a preference for $(.5, .5)$ over $(.55, .55)$ is significantly correlated with a preference for $(.5, .5)$ over $(1, 1)$ (logistic regression, $p-$value$= .001$).

From the comparisons in Q4a, we see that most of the individuals who exhibit a preference for early resolution also prefer Blackwell more informative signals to positively skewed signals. Thus, we conclude that the choices of subjects who prefer early resolution are mostly consistent with monotonic preferences over information, because more than two-thirds subjects are willing to accept less positive skew in exchange for greater Blackwell informativeness.

On the other hand, even though fewer individuals qualify to answer Q4b, the results suggest that more than half of the individuals who preferred full late to full early resolution of uncertainty in Q1 are willing to accept greater Blackwell informativeness in exchange for more positive skew in Q4b. This finding lends additional support to our earlier finding in Experiment 1 that a certain proportion of individuals who avoid information when it can resolve all uncertainty about the undesired outcome may exhibit information-seeking preferences when the signal is positively skewed.

Comparing subjects who prefer early resolution in Q1 to subjects who prefer late resolution in Q1, those who prefer late resolution in Q1 are less likely to adhere to the ordering induced by Blackwell dominance when evaluating a positively skewed structure (two-sided chi-square test, $\chi^2(1) = 9.47$, $p = .002$). Such a violation of Blackwell dominance is exactly what we would expect to see among subjects who are willing to acquire positively skewed information but prefer to avoid symmetric and negatively skewed information. The within-person design of Experiment 2 allows us to provide direct evidence of this violation.

Relatedly, compared to individuals who choose $(1, 1)$, individuals who choose $(.5, .5)$ in Q1 are more likely to prefer the positively skewed information structure that resolves all uncertainty regarding the good outcome, $(.5, 1)$, to a negatively skewed information structure that resolves all uncertainty regarding the bad outcome, $(1, .5)$, (logistic regression, $p-$value$= .012$). This result supports the notion that individuals who avoid full revelation of information are more likely to be driven by the desire to preserve hope by avoiding to learn about the undesired outcome, a psychological motivation we will present further evidence for in Section 4.

3.3 Experiment 3: Between-subject evidence for preferences across different priors

Experiments 1 and 2 provided results for a symmetric prior ($f = .5$). This prior is common in the real-world. For example, a person with one parent suffering from Huntington's Disease has a 50% chance of inheriting the disease. Therefore, individuals have a symmetric prior when they decide whether to take a diagnostic genetic test. Similarly, when individuals are deciding whether to watch the news coverage of the U.S. presidential election results, the odds of each candidate winning the election are not very far from symmetric. Moreover, from a design perspective, a symmetric prior provides a simpler design, greatly aids in identification, and allows us to derive crisper theoretical predictions. However, to provide a more general set of results that are applicable across a wider array of real-world contexts, and to shed additional light on theoretical concerns, it is important to know whether and how intrinsic information preferences change when priors are more extreme. Therefore, our third experiment explores preferences for the timing and skewness of information when the prior is 10% or 90%.

We recruited 232 subjects for a 60-minute study that presented one pairwise comparison in a between-subject design. The experimental details are included in Appendix C. The protocol and design replicated the Experiment 1, except that 1) sessions were conducted both at the University of Michigan and at the University of Massachusetts, and 2) the probability of winning the lottery was either 10% or 90%, assigned at the session level.[21]

Table 3 lists the three treatments Experiment 3 presents to subjects under each prior. T1 presents a choice between full early and full late resolution of uncertainty. T2 and T3 present a choice between positively and negatively skewed information structures. Note that if a treatment offers a choice between a positively skewed option (x_1, y_1) and a negatively skewed option (x_2, y_2) when $f = .1$, it offers a choice between a negatively skewed option (y_1, x_1) and a positively skewed option (y_2, x_2) when $f = .9$. This design ensures that the variances induced by the structures across priors are equal; therefore, preferences for skewness can be compared across priors without confounds arising from differences in informativeness. In addition, information pairs (p, q) and (p', q') in T2 and T3 are chosen such that, as in Experiments 1 and 2, $p > q$, $q' > p'$, $mean(p, q) = mean(p', q')$, $var(p, q) = var(p', q')$, and $skew(p, q) = -skew(p', q')$.[22]

Table 3 summarizes choice percentages across the three treatments under $f = .1$ and $f = .9$. Tables 14 and 15 in Appendix C summarize distributions of preference intensity and MCTS, respectively. Before we discuss differences across priors, note that overall, the majority of individuals prefer positively skewed signals over negatively skewed signals, and full early resolution to full late resolution of uncertainty, similar to the results obtained from Experiments 1 and 2. As the p-values associated with the choice percentages in Table 2 indicate, all choice percentages for the more commonly held preferences were significantly larger than those predicted by random choice.

Table 3: Treatments and Results from Experiment 3

	Prior 10%						*Prior 90%*			
	N	Preferences	Pct.	p-value	Diff.	p-value	p-value	Pct.	Preferences	N
T1	35	$(1,1) \succ (.5,.5)$	63%	.088	26%	.007	.000	89%	$(.5,.5) \prec (1,1)$	38
T2	40	$(.5,.69) \succ (.84,.35)$	65%	.040	24%	.000	.000	89%	$(.69,.5) \prec (.35,.84)$	36
T3	42	$(.34,.82) \succ (.94,.21)$	69%	.020	16%	.000	.000	85%	$(.82,.34) \prec (.21,.94)$	41

On the leftmost panel, the table reports the total number of subject who participated in each treatment (N) when prior=.1, the percentage of subjects who indicated a preference for the first option in the preference ordering listed, and the $p-$values from one-sided binomial tests against the null hypothesis of random choice. On the rightmost panel, the table reports the same statistics for each treatment when prior= .9. In the middle panel, the table reports the magnitude of the difference in choice percentages and the $p-$values from Pearson χ^2 tests evaluating the significance of this difference.

Experiment 3 uncovers significant differences in the prevalance of different information preferences across the two priors. First, more individuals indicated that they prefer to learn the outcome

[21] A prior of 10% (90%) probability of winning was induced by telling subjects that they would win the lottery if the last digit of their ticket matched (did not match) the die outcome.

[22] Unlike in Experiment 1 and 2, because the prior is not symmetric, pairs with the same absolute degree of skewness are not reflections of one another across the diagonal in the (p, q) space. Also, the fact that we want the structures to be equivariant and have the same absolute skewness constrains the set of potential structure pairs. If structures have p or q values that are too close to 1, we cannot find a matching structure that has the same absolute skewness but the opposite sign.

of the lottery earlier when the ex-ante probability of wining the lottery is 90% than when the prior is 10% (89% vs. 63%, Pearson $\chi^2(1) = 7.23$, $p = .007$).

This result suggests that information avoidance is more severe in contexts where the probability of the undesired outcome looms large. Second, the preference for positive skew is held by more subjects when the ex-ante probability of wining the lottery is 90% (T2, $\chi^2(1) = 23.03$, $p = .000$; T3, $\chi^2(1) = 25.19$, $p = .000$). This result suggests that in most cases, individuals have a stronger preference to preserve hope when hope is initially high.

Our results across the 10% and 90% conditions are comparable because the corresponding information structures have the same variance and absolute skewness. However, the same is not true if we compare choices under 50% priors with choices in Experiment 3. For example, the variance of posterior distributions is much higher when the prior is 50%. Thus, we hesitate to directly compare the results from Experiment 3 to those from our previous experiments. That said, the reader has probably already noted that the preference for full early resolution over full late resolution under the 50% prior falls directly between the preferences found with the 10% and 90% priors. The same is true for preferences for positively over negatively skewed structures.

4 Discussion

4.1 Experimental Findings

This subsection summarizes the data patterns and relates them to prior experimental evidence.

Preferences for Skewness: Looking at choices exhibited by the majority of subjects, we find two patterns regarding preferences for skewness:

Finding 1 *A large proportion of subjects, ranging from 67% to 81% across treatments, prefer positively to negatively skewed information when the prior is 50%.*

Finding 2 *Preferences for positive skew over negative skew are more prevalent when the prior for the good outcome is 90% than when it is 10%.*

There has been very little empirical investigation of intrinsic preferences for skewness. Boiney (1993) asks subjects to make hypothetical choices between one-stage lotteries and two-stage compound lotteries with the same mean. Across three priors (20%, 50% and 80%), he finds a strong preference for positively skewed and a strong aversion to the negatively skewed compound lotteries relative to one-stage lotteries, providing the first evidence that the desire to manage anticipatory emotions may lead to a preference for positively skewed signals.

Boiney's experiment differs from ours in several ways. First, subjects are presented with two-stage lotteries rather than information structures. Second, subjects answer hypothetical choice questions. Third, the design does not fix the variance of the posterior induced by different two-stage lotteries, and therefore may confound preferences for informativeness and skewness. And finally, the design does not control for the possibility that information may have instrumental value to the subjects.

More recently, Eliaz and Schotter (2010, ES) investigate preferences for skewness within a broader investigation of demand for non-instrumental information stemming from confidence-utility. In their experimental setting, subjects were presented with urns that contain balls labeled A or B, and they were told the composition of the two urns (i.e., how many A balls were in each urn) before being asked to choose between letters A and B. The computer randomly chose an urn and drew a ball. If the letter on the ball matched the letter the subject chose, the subject received a payoff. Across different treatments, the composition of balls in the urns varied, and consequently, the priors for receiving the payoff ranged from 50% to 90%. In all treatments, however, each of the urns contained more balls that were labeled A than balls that were labeled B. Therefore, the experimental design presented subjects with a compound lottery with two actions, but where one action (choosing A) dominated the other (choosing B) in all states of the world.

Treatment 4 of their experiment tests preferences over skewness. The ball could be drawn from one of three different urns. The subjects had the opportunity to purchase one of three possible information pieces before choosing between A and B. Each information piece could rule out exactly one of the three urns. This design induced a three-stage compound lottery. Even though information should not have affected the subjects' ultimate choice, many of the subjects demonstrated a positive willingness to pay for this information before they made the (obvious) choice. The authors argue that this demand was driven by a desire to feel more confident about choosing the dominating option. The results showed that subjects preferred a negatively skewed signal over a positively skewed one, but did not indicate a consistent pattern of skewness preferences over priors.[23]

Their setup and the psychological underpinnings generating intrinsic preferences for information greatly differ from the investigation in this paper. ES focus on the desire to increase one's confidence about making an obvious (but risky) choice, and they entirely shut off intrinsic preferences for information that may stem from anticipatory emotions by eliminating delays between the realization of the outcome (by the subject's choice) and its revelation. Congruently, subjects do not have a

[23] Preferences for informativeness and preferences for skewness are difficult to tease apart in this design, because the three-stage lotteries induced by the ES design cannot be reduced to equivariant two-stage lotteries unless individuals are risk-neutral expected utility maximizers with regard to the third stage. In particular, if individuals are risk averse, a preference for earlier resolution is confounded with a preference for negative skewness.

demand for information when it is presented after they make a choice, which lends additional support to the notion that it is the need to make a choice between two uncertain options that evokes the need to bolster confidence and leads to information demand.

In contrast, our experiments focus on the demand for non-instrumental information to manage belief utility induced by the desire to manage anticipatory emotions, and we purposely eliminate any self-relevant utility, such as ego-utility or confidence-utility, by providing a context that is free of choice, agency or other perceptions of control regarding the outcome. Thus, we capture primary drivers of belief utility such as hope, anxiety, disappointment, with implications for whether and how individuals collect information about uncertain future outcomes. Importantly, our study parallels the previous theoretical work trying to model intrinsic preferences for information.

Preferences for Informativeness: Looking at choices exhibited by the majority of subjects, we find two patterns regarding preferences for informativeness:

Finding 3 *A large proportion of subjects, ranging from 70% to 78%, prefer early resolution to late resolution when priors are symmetric.*

Finding 4 *Preference for early resolution is more prevalent when the prior for the good outcome is 90% than when it is 10%.*

Most of the previous experimental work studying informational preferences considers the choice between fully revealing signals and uninformative signals. These studies include Chew and Ho (1994), Arai (1997), Ahlbrecht and Weber (1997), Lovallo and Kahneman (2000), Von Gaudecker et al. (2011), Brown and Kim (2014), Kocher, Krawczyk and Van Winden (2014) and Ganguly and Tassoff (2016). In most of these studies, the preference for full early information is much more prevalent than the preference for information avoidance, and many of them find that priors matter.[24] Focusing on the evidence using monetary gains, Chew and Ho (1994) find that in a monetary gain domain, 57% of subjects choose early resolution for the lowest prior, and this fraction grows as the

[24] These studies often use very different elicitation schemes and designs, which makes it difficult to compare the results across studies. Early studies, such as Chew and Ho (1994), Ahlbrecht and Weber (1997), Arai (1997), and Lovallo and Kahnmean (2000), use hypothetical scenarios. Some studies have subjects directly make a choice between two structures, sometimes with a small payment/discount attached to one to avoid indifference (e.g., Chew and Ho, 1994; Ahlbrecht and Weber, 1997; Brown and Kim, 2014; Kocher, Krawczyk and Van Winden, 2014). Others have subjects provide a number indicating the relative strength of their preference for one information structure over another, either using an abstract scale or a hypothetical willingness to pay (e.g., Arai, 1997; Lovallo and Kahnmean, 2000). Von Gaudecker et al. (2011) have both hypothetical and incentivized choices and attempt to elicit a type of certainty equivalent. Ganguly and Tassoff (2016) elicit a relatively coarse measure of willingness to pay for either early (versus late) resolution, or late (versus early) resolution.

prior increases, to over 80% for their highest prior.[25] Arai (1997) finds that individuals, on average, prefer early resolution, and that the strength of preference for early resolution over late resolution grows with the prior. For subjects providing preferences across three priors in the monetary gain domain, Albrecht and Weber (1997) report that 39% prefer the fully revealing signal, whereas 7% always prefer to avoid information; the rest are indifferent or exhibit preferences that vary by prior. Lovallo and Kahneman (2000) find a strong preference for early resolution (except in lotteries where the prior was skewed — a different phenomenon from skewed information), but their evidence on changing priors is mixed. Using a fixed prior, Brown and Kim (2014) find that 60% of subjects prefer early resolution, only 3% prefer late, and the rest are indifferent. Similarly, Kocher et al. (2014) find that 41% of subjects prefer early resolution, 21% percent prefer late, and the remainder are indifferent. On the other hand, some studies suggest less of a pattern. Von Gaudecker et al. (2011) find no strong preference pattern for early versus late resolution.[26] Ganguly and Tasoff (2016) find that with a 10% prior, only 18-42% (depending on the stake size) of subjects exhibit a preference for early resolution, while 33-45% (again, depending on the stake size) exhibit a preference for late resolution.[27] In a very different domain (electrical shocks), Falk and Zimmerman (2016) report that the proportion of individuals who prefer full early to full late resolution is quite high (over 80%), but they find no effect of priors.[28] These studies differ in their domains and elicitation schemes both from one another and from our investigation, rendering direct comparisons difficult. Still, our evidence is broadly consistent with prior experimental literature.

Skewness and Timing: A unique feature of our experimental design is that it allows us to investigate the relationship between preferences for skewness and preferences for informativeness. We are not aware of prior experimental evidence that speaks to this relationship.[29] Our data uncover two groups of individuals based on their preferences for full early versus full late resolution. Members of the first group, who constitute the majority of subjects, seem to monotonically prefer early to late information, as well as positively skewed information. We observe this pattern of behavior from subjects across all three experiments.

[25] They also find a preference for early resolution in a monetary loss domain, but they find the opposite pattern for priors. A third treatment looks at preferences for receiving grades and finds that for a low expected grade individuals are almost split between preference for early and late resolution, but for a high expected grade over 70% of subjects want early resolution.

[26] Zimmerman (2014) reports preference for early resolution versus gradual resolution and finds that a little over half of subjects prefer early. But it is hard to know how this would translate into a preference for early versus late resolution.

[27] In a different domain, they find that between 15 and 40% of subjects prefer to avoid early resolution when testing for a disease.

[28] They find that when subjects have access to a distraction, the proportion of information seekers falls to 48%.

[29] Although Boiney (1993) looks at preferences for skewed and symmetric structures, he does not attempt to control for informativeness.

Finding 5 *Those who prefer early to late resolution tend to monotonically prefer more informative structures, and tend not to trade off skewness and informativeness.*

Members of the second group, who constitute a sizable minority, have a more nuanced attitude towards information. These subjects sometimes prefer to avoid information, but other times seem to seek out information, depending on the information structure.

Finding 6 *Those who prefer full late resolution to full early resolution may avoid symmetric and negatively skewed information, but sometimes are willing to take positively skewed information.*

4.2 Implications for Theory

In this section, we look at our findings through the lens of existing theories. Our aim is to discuss how particular restrictions on value functions relate to observed behavior. Specifically, we will look at (i) preferences for skewness; (ii) preferences for the timing of information; (iii) the interplay between skewness and timing. For each of these categories, we will discuss some general restrictions on preferences and their implications for particular models used in the literature.

We begin our discussion by noting that traditional expected utility preferences imply that individuals do not have non-instrumental preferences over information. Segal (1990) describes these individuals as satisfying an axiom called Reduction of Compound Lotteries. In our experiment these preferences would imply indifference between all information structures.[30] Thus, we proceed by discussing non-standard models that can accommodate the patterns of behavior we observe in the data.

Most of these non-standard models have been operationalized in the domain of compound lotteries. There is a natural analogy between preferences for information (i.e. compound lotteries) and preferences for monetary lotteries. Specifically, one can think of an information structure as a lottery over different posterior beliefs, so posterior beliefs play the role of monetary payments in standard lotteries. To relate our results to existing theories cast in the domain of compound lotteries, we present theoretical results that show how well-known intuitions in the domain of monetary lotteries can apply in this domain. For our formal analyses, we utilize the concept of local utility functions introduced by Machina (1982) which allow us to extend our standard tool-kit to models of non-expected utility.

Skewness of Information: The following proposition provides necessary and sufficient condi-

[30]Models where beliefs can be altered but only at the cost of distorting future actions, as in Brunnermeier and Parker (2005) do not predict preferences for information in our setting, as there are no actions to take.

tions for attitudes towards skewness of information.[31] All the proofs are in Appendix E.

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 function of V is thrice differentiable then it has a convex (concave) derivative everywhere if and only if $(p,q) \succsim_f (\precsim_f)(p',q')$.*

Proposition 1 elucidates the parallel between preferences for skewed information and preferences over monetary lotteries.[32] Prior research has established that an individual prefers positively skewed monetary lotteries if the derivative of the local utility function is convex. Proposition 1 shows that this intuition naturally maps onto compound lotteries and thus information structures.

In light of Proposition 1, we discuss the implications of Findings 1 and 2. Proposition 1 implies that the large majority of our subjects, who prefer positively skewed information structures (Finding 1), can be modeled as having a utility function with a convex marginal. In Finding 2, we report that some individuals prefer negatively skewed structures at low priors, but positively skewed structures at high priors. Proposition 1 implies that, for these individuals, the local marginal utility function of V is concave for low priors but convex for high priors.

Given Proposition 1, we can also identify whether a specific model can accommodate our results. For example, in the influential models of Kreps and Porteus (1978), the implied restriction of our Finding 1 is equivalent to $u_1 \circ u_2^{-1}$ having a convex derivative, where u_1 is the utility function over early-resolving lotteries, and u_2 is the utility function over late-resolving lotteries, while the restriction of Finding 2 is that the derivative of $u_1 \circ u_2^{-1}$ is concave for low beliefs, and convex for high beliefs. Similarly, in Caplin and Leahy's (2001) model, Findings 1 and 2 would imply that $u_1 \circ \phi$ has convex derivatives, or derivatives that are concave for low beliefs and convex for high beliefs, respectively.

However, there are some models where the utility function cannot have convex marginals. The symmetric prior ($f = .5$) offers a particularly precise test for some of them. When $f = .5$, we always compare information structures in the form of (p,q) and (q,p). We define $\succsim_{.5}$ as exhibiting strong symmetry if $(p,q) \sim_{.5} (q,p)$. The next proposition informs us that the strong symmetry assumption is implied by some important classes of models, notably those of Kőszegi and Rabin (2009) (KR) and Ely, Frankel, and Kamenica (2013) (EFK).[33]

[31] Our requirement on the differentiability of the the local utility functions is stronger than it actually needs to be. Using the techniques of Cerreia-Vioglio, Maccheroni and Marinacci (2014), we can relax the differentiability assumptions.

[32] In our binary-binary domain, comparing skewness (fixing variance) implies an ordering formally analogous to downside risk (Menezes et al., 1980), which allows us to relate preferences for skewness to the third derivative. However, this relationship is not true in general.

[33] Although EFK originally designed their model to explain preferences for gradual resolution of information in

Proposition 2 *Suppose* $\succsim_{.5}$ *represented by a KR or EFK functional form. Then preferences exhibit strong symmetry* (*i.e.,* $(p, q) \sim_{.5} (q, p)$).

Finding 1 shows that very few individuals seem to be indifferent about skewness: only 5% of individuals report indifference based on preference intensity elicitation, and 12% of individuals report indifference based on MCTS elicitation. The fact that most individuals have preferences regarding skewness rules out the strong symmetry assumption. To be able to accommodate our data, one needs to modify these models by relaxing the strong symmetry assumption. This finding serves as a useful illustration of how experimental data can inform theory.

Timing of Information: A large literature, beginning with Kreps and Porteus (1978) has discussed what kinds of utility functions generate preferences for earlier or later resolution of information. Grant, Kajii and Polak (1998) formalized and generalized their model drawing an analogy to risk aversion, and demonstrated 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. The following observation provides necessary and sufficient conditions for attitudes towards the timing of information.

Proposition 3 *Let* $\succsim_f$ *be represented by a Gateaux differentiable value function* V*. Then the local utility function of* V *is everywhere convex (concave) if and only if the decision-maker prefers Blackwell more (less) informative structures.*

Proposition 3 states that a sufficient condition for individuals who always prefer more informative signals (Finding 3 and Finding 5) is that the local utility function of V is everywhere convex. In the framework of Kreps and Porteus (1978), this restriction is equivalent to $u_1 \circ u_2^{-1}$ being convex. In Caplin and Leahy's (2001) model, the restriction amounts to their belief operator $u_1 \circ \phi$ being convex.

Finding 4 indicates that some individuals who prefer late resolution at a low prior prefer early resolution at a high prior. This result is consistent with local utility functions that are concave for low priors and convex for high priors (inverse S-shaped). We can find yet another parallel to conditions on preferences for monetary lotteries. It is well-known that an individual's risk premium

contexts such as sporting events, their functional form is flexible enough to apply to other settings and can generate not only a preference for gradual resolution of information, but also a preference for one-shot resolution of information, depending on the parameterization. Thus, their preferences can generate behavior very similar to that predicted by KR. We believe it is important to discuss the general implications of their functional form, as it represents an easily adaptable alternative to many of the other existing models. EFK present two functional forms. One they describe as capturing surprise, the other as capturing suspense; both have strong symmetry assumptions regarding how beliefs affect utility.

falls as his/her risk aversion falls, or in other words, as the ratio of the second derivative to the first derivative of utility over money shrinks. Similarly, in the domain of information structures the value of earlier resolution (relative to later resolution) grows as the ratio $\frac{V''}{V'}$ (or the equivalent ratio of the local utilities) increases. In the framework of Kreps and Porteus (1978) this restriction is equivalent to $u_1 \circ u_2^{-1}$ being inverse S-shaped, and the same restriction would apply in Caplin and Leahy's (2001) model to $u_1 \circ \phi$.

Note that there is a tight connection between inverse S-shaped local utility functions and Finding 1. The inverse S-shaped local utility functions have a convex derivative. Hence any model with inverse S-shaped local utility functions is consistent with preferences for positive skew (Finding 1).

Skewness and Timing: Although the majority of our subjects seem to have consistent preferences for more informative signals, there is a substantial minority whose attitudes reflect important interactions between skewness and preferences for information. In particular, we find that some individuals may prefer to avoid information that is symmetric or negatively skewed, but still prefer to take information that is positively skewed (Finding 6). The next proposition identifies the theoretical implications of this finding.

Proposition 4 *Let $\succsim_f$ be represented by a Gateaux differentiable value function V. If the local utility functions of V are sufficiently concave for low beliefs and convex for high beliefs, then the individual will prefer no information to either negatively skewed information or symmetric information, but will accept some positively skewed information.*

This condition is reminiscent of that in Dillenberger and Segal (2017). They provide sufficient conditions such that, fixing a prior, if an individual prefers full late resolution over all symmetric but informative structures, s/he must also prefer $(.5, .5)$ over all negatively skewed structures. But these individuals may prefer some positively skewed structures over $(.5, .5)$. We refer the interested reader to their paper for a full description of the conditions. Importantly, they describe their conditions (in the discussion of their Theorem 3) as being sufficient for the first clause of our observation to hold.

According to Proposition 4, Finding 6 is consistent with local utility functions over information structures that are concave below the prior but are convex above. Therefore, any model with an inverse S-shaped local utility function is consistent with Findings 1, 4 and 6. For example, in the framework of Kreps and Porteus (1978), this restriction is equivalent to $u_1 \circ u_2^{-1}$ being inverse S-shaped; while the same restriction would be true of $u_1 \circ \phi$ in Caplin and Leahy's (2001) model. On the other hand, more restrictive models such as that of Epstein and Zin (1989), where information avoidance indicates global convexity, cannot explain the preferences of individuals who trade off skewness and informativeness.

Such an intuition also occurs in Caplin and Eliaz (2003). They provide a model that incorporates intrinsic preferences for information into a game-theoretic framework, and show that individuals may avoid full information but be willing to accept positively skewed information. Their conditions on the utility functions of individuals (this time, the best-response functions) again amount to sufficient conditions for Proposition 4 to hold. Similarly, Schweizer and Szech (2013) consider a utility function that implies that the optimal signal is positively skewed.

SUMMARY: Recall that our results suggest an overall prevalence of preferences for positive skew; albeit with important heterogeneity. There are two groups of individuals: 1) a majority of subjects who seek information and whose preferences are monotonic in the informativeness of a signal, and 2) a substantial minority of subjects who avoid fully revealing signals but whose information aversion decreases with positive skew.

We have shown that the preferences of the first group of subjects can be explained with the relatively straightforward features of a convex utility function over information structures that also features a convex derivative. These restrictions can be consistent with a wide variety of utility functions, for example, Caplin and Leahy's (2001) model where $u_1 \circ \phi$ is convex and has a convex derivative, or the Epstein-Zin framework where the risk aversion parameter is greater than twice the inverse of elasticity of intertemporal substitution.

The behavior of individuals in the second group is consistent with a more complicated structure on utility over information structures, which go from concave to convex as beliefs in the good outcome rise. In fact, Findings 1, 4, and 6 are all consistent with local utility functions over information structures that are concave below the prior but are convex above. Such features are present in several recent models of informational preferences (e.g., Caplin and Eliaz, 2003; Eliaz and Spiegler, 2006; Schweizer and Szech, 2013; Dillenberger and Segal, 2017).

The preference for positive skew (over negative skew) exhibited by both groups of individuals is inconsistent with some well-known behavioral models of preferences, notably those of Kőszegi and Rabin (2009) and Ely, Frankel, and Kamenica (2013). Importantly, our results suggest ways in which these models can be modified to incorporate our findings.

We would like to caution the reader that most of the models we discuss have been formally cast in the domain of compound lotteries. However, they primarily motivate their investigations based on preferences over information structures. While there is a theoretical one-to-one mapping between these domains, whether a behavioral equivalence exists is questionable (Nielsen, 2017).

Hence, the reader should consider the theoretical discussion we provide with this caveat in mind. Ultimately, we hope that our research will inspire future theoretical investigations of informational preferences that are operationalized over the (p, q) domain.

4.3 Psychological Motivations

Our experiments also asked individuals about their reasons for choosing their preferred information structures in an open-ended format. These data provide insights into the psychological reasons underlying individuals' preferences regarding the informativeness and the skewness of information sources. Almost all the subjects cite a desire to manage anticipatory emotions, for example, by coping with anxiety, preserving hope and limiting eventual disappointment.

Managing Anxiety: The overarching regulatory motivation that gives rise to the desire to control anticipatory emotions is that of managing anxiety about the future outcome. For example, when considering whether to choose early or late resolution, many individuals cited the desire to relieve anxiety, although they showed significant heterogeneity in what they believe would be the most effective strategy to achieve this goal. On the one hand, some individuals felt that early resolution would help them manage anxiety better. For example, one subject stated, "I would rather know now rather than dwell over it for the next 20 minutes." On the other hand, some individuals thought that delaying the information would be less stressful. For example, one subject emphasized managing anxiety: "I have a stressful moving day coming up and I would not like to know the result of the lottery until the end of the study because of that; I feel like Option 1 would cause unnecessary stress in the middle of the study for some reason." The anxiety was a concern for some information avoiders especially when the signal could not fully reveal the outcome. A subject explained the perils of changing his beliefs in either direction with the following statement: "I didn't think that Option 1, $(.63, .63)$, had a high enough chance of telling me whether I won or not. It could have falsely led me to believe that I lost even if I had actually won. Or, I would have then been sad for the rest of the experiment. With Option 2, $(.5, .5)$, I won't feel sad with either color ball being drawn because I still have a 50% chance."

While subjects often cite the desire to manage anxiety as the main reason for seeking or avoiding non-instrumental information, it is not clear why some think avoiding information helps reduce anxiety while others think seeking it helps. Psychologists have noted significant heterogeneity regarding what people believe to be the best strategy to regulate anxiety through managing beliefs. They have categorized people who prefer to keep their expectations low as "defensive pessimists" and those who prefer to have high hopes as "strategic optimists" (Norem and Cantor, 1986; Showers

1992).[34] While defensive pessimists are motivated by avoiding disappointment, strategic optimists place more weight on remaining hopeful. Because symmetric information structures are equally likely to provide good and bad signals and these signals are equally informative, we cannot understand whether individuals who avoid information are trying to avoid good signals more than they are trying to avoid bad signals, or vice versa. Similarly, we do not know whether individuals who seek information are trying to receive good signals more than they are trying to receive bad signals, or vice versa. To design appropriate policies, it is important to obtain deeper insights into these psychological motivations. The reasons individuals provide to explain their skewness preferences take us closer to this goal.

Preserving Hope versus Minimizing Potential Disappointment: The most common reason given for choosing the negatively skewed information structure over the positively skewed structure was the desire to avoid potential disappointment, followed by wanting the higher probability of receiving good news. A sample of the statements that allude to the desire to avoid disappointment includes:

- "I wouldn't want to be led on by the hope that I won ten dollars. I would rather have a very strong indication that I didn't win by getting a black ball so that I wouldn't have uncertainty or false excitement."
- "I'd rather know more surely that I lost if I got a black ball, than deceive myself into keeping false hope that my black ball actually will yield a positive result."
- "I would rather be more sure that I lost than be confident that I won because I don't want to get my hopes up."

Therefore, it seems that a preference for negatively skewed information structures aligns more with the defensive pessimism strategy to manage anticipatory emotions. In contrast, the most common reason for preferring positively skewed information structure was the desire to preserve hope.[35] A sample of subjects' explanations about why they prefer positively skewed structures to negatively skewed structures includes:

[34]These coping strategies are different from dispositional optimism and dispositional pessimism (Scheier and Carver, 1985).

[35]While the motivation for preserving hope was by far the most common reason cited for preferring positive skew, in the case of the choice between $(.5, 1)$ and $(1, 5)$, a handful of subjects mentioned the desire to avoid disappointment to explain their preference for $(.5, 1)$. These individuals perceived $(.5, 1)$ to prevent disappointment more than $(1, .5)$, because it resolved all uncertainty about winning if the news was good. For example, one subject stated: "I would rather be sure of the good news if/when I receive it."

- "I would rather either know I won or have the knowledge that I could still win, rather than have the knowledge that I lost."
- "While info is essentially the same to me, slightly prefer to keep hope alive, i.e., prefer less certainty about losing."
- "I would rather receive positive, or at least optimistic news. Option 1 would be saddening if I learned that I had definitely lost."

Importantly, the theme of preserving hope also emerged as a mechanism for reducing anxiety by avoiding information. For example, one subject explained: "I would like to be surprised, perhaps happily at the end of the study. It stretches out my perceived participation in the game on my end, even though the play technically stopped with the die roll."

Given the prevalence of preferences for positively skewed signals, it seems possible that preserving hope, or strategic optimism, is an important driver of preferences for non-instrumental information. In this regard, we find the interactions between preferences for skewness and informativeness to be interesting and important. Recall that our data revealed that there is a substantial fraction of subjects whose attitude towards the timing of resolution of information is linked to the skewness of the information: individuals who may avoid information when it is likely that such information will resolve much of the uncertainty regarding the undesired outcome (relative to the desired outcome) may seek it when the information is likely to resolve more uncertainty about the desired outcome. The subjects' statements suggest that this finding could be driven by the fact that positively skewed information structures are unlikely to eliminate "hope"; i.e., they are unlikely to significantly reduce beliefs about the chance of the good outcome. Therefore, the data suggest that policies aiming to reduce information avoidance need to provide information sources that are more likely to preserve hope.

SUMMARY: These qualitative data provide supporting evidence for the role of anticipatory feelings discussed by the previous literature as the foundation for intrinsic preferences for information. Studying preferences of skewness provides deeper insights into why the prospect of receiving information can be anxiety provoking and why subjects may be inclined to avoid it. The desire to preserve hope emerges as the main motivating factor for choosing positively skewed signals, and suggests that the ability to preserve hope may be the reason that individuals who otherwise avoid information otherwise may seek out positively skewed information.

5 Conclusion

We present results from a broad investigation of intrinsic preferences for information. Our results provide some important insights. Individuals overwhelmingly prefer positively skewed information structures. Such information structures have the potential to resolve more uncertainty regarding the desired outcome than the undesired outcome, in exchange for generating bad signals more frequently. The experimental results also reveal how preferences for skewed information relate to preferences for the timing of non-instrumental information, and how preferences for skewness and informativeness change with initial beliefs about the likelihood of the uncertain outcome. We believe that these results are relevant for the design of information provision in domains where intrinsic preferences for information lead to large welfare effects, such as in medical testing and financial disclosures.

Moreover, understanding preferences for skewness can also lead to insights into closely related topics. For example, as discussed previously, understanding skewness can lead to insights about preferences for timing, as a preference for positive skew is consistent with individuals being information avoiders at low priors, but information seekers at high priors. Understanding skewness can also lead to a better understanding of other, linked, behavioral parameters. For example, in the Epstein-Zin preferences often used in macro-economic modeling a preference for positive skew implies that the risk aversion parameter is greater than twice the inverse of elasticity of intertemporal substitution. Recent evidence in macroeconomics examining the relationship between risk aversion and the elasticity of intertemporal substitution generate estimates that are consistent with a preference for positive skew (Van Binsbergen et al., 2012). Finally, preferences for skewed information can generate a preference for ordering of information — a preference for positive skewness is consistent with a preference to see “good” information early, and delay bad information.

Our results also point to new avenues for exploration. We highlight four empirical questions that future research should address to aid in the design of context-sensitive policies. First, how do preferences for skewness and informativeness vary if the future outcome is perceived as a loss relative to the status quo? Early work on monetary losses experimentally investigate the impact of this framing difference on preferences for informativeness using hypothetical payoffs (Chew and Ho, 1994; Ahlbrecht and Weber, 1997; Arai, 1997; and Lovallo and Kahneman, 2000). More recently, using incentivized choices, Ganguly and Tassoff (2016) and Falk and Zimmerman (2016) investigate domains that also could be considered losses. However, there is no consensus on the impact of the loss framing on intrinsic preferences for information. A broader investigation, especially in the context of the relationship between preferences for skewness and informativeness, is needed.

Second, it may be important to know whether intrinsic preferences for information change if the outcome is perceived to unfold over time, rather than be predetermined, as in our experiments. For example, in cancer treatments, both the outcome and the information gradually unfold over time. Experiments that feature a compound lottery framing, such as Halevy (2007) , Chew, Miao and Zhong (2012), and Abdellaoui, Klibanoff and Placido(2013) may be more suited to capture such an environment. Nielsen (2017 presents preliminary evidence that preferences over compound lotteries and mathematically equivalent information structures are not the same. Third, little is known about the interplay between intrinsic preferences for information and non-Bayesian or costly updating of information. In our experiment, we control for updating errors in order to separately identify underlying informational preferences. Recent work in the context of instrumental information demand by Ambuehl and Li (forthcoming) demonstrates that non-Bayesian updating can distort informational choice. It would be useful to know how updating errors influence information acquisition when a large component of informational demand is due to intrinsic preferences. This is likely to be particularly important when information is relevant to self-conception; see Hoffman (2011), Eil and Rao (2011), and Mobius et al. (2011) for empirical work and Benabou and Tirole (2011), Benabou (2013), and Gottlieb (2014) for theoretical work. Fourth, in some cases, information may be about outcomes which individuals possess subjective beliefs about. Our experiment focuses on information about objective risk. Li (2015) and Strzalecki (2013) develop models that describe informational preferences with subjective beliefs. Empirical research should investigate whether intrinsic preferences for information differ if beliefs are subjective.

We conclude that intrinsic preference for information is a fertile area of inquiry with many potential applications to important economic problems. This paper takes an important initial step towards a more comprehensive understanding of preferences for non-instrumental information in a world where information signals vary not only in their informativeness, but also in their skew. We hope that our work inspires future research on this issue.

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