Beliefs and Utility: Experimental Evidence on Preferences for Information

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Abstract

Beliefs are a central determinant of behavior. Recent models have assumed that beliefs about or the anticipation of future consumption can have direct utility-consequences. This gives rise to informational preferences, i.e., preferences over the timing and structure of information. Using a novel and purposefully simple set-up, we experimentally test key predictions about preferences for information along four natural dimensions. We find evidence that the majority of subjects prefers receiving information sooner. This preference, however, is not uniform, but depends on the context. When the environment allows subjects to not focus attention on (negative) consumption events, later information becomes more attractive. We also identify an aversion towards piecemeal information. Variations in prior distributions do not seem to affect information preferences.

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1 Introduction

Beliefs are a key determinant of economic behavior. Individuals facing choice problems, e.g., investing in education, choosing a health insurance plan, buying a house or deciding how much to save for the future, need to hold beliefs about prospective outcomes in order to be able to make an informed decision. Intuitively, however, the role of beliefs goes beyond being instrumental. Imagine a person learning that in the near future she will have to go through some painful surgery. Quite likely, a substantial portion of total disutility from this event will not come from the surgery itself, but from the belief or anticipation that the surgery is soon to occur. Likewise, an employee holding a belief that she imminently faces a promotion will experience utility long before the actual act of promotion, via positive anticipation. In other words, beliefs about future consumption or life outcomes are likely to be directly relevant for utility. Such a direct link between beliefs and utility implies that beliefs about future consumption play a distinct role in determining human well-being and welfare in general. It may also create incentives for holding biased, for instance overly optimistic beliefs. Relatedly, belief-based or anticipatory utility gives rise to information preferences, i.e., preferences towards the timing, and structure of information.[1]

Starting with Loewenstein (1987), recent theoretical approaches have modeled the notion that beliefs about or the anticipation of future consumption can have direct utility-consequences and have analyzed implications for behavior (see, e.g., Palacios-Huerta (1999), Caplin and Leahy (2001, 2004), Kőszegi (2006b), Epstein (2008), Kőszegi and Rabin (2009), Dillenberger (2010), Schweizer and Szech (2013), Golman and Loewenstein (2014)). Empirically, however, little is known about anticipatory utility. In this paper we use a novel and simple set-up that allows us to experimentally test central assumptions and implications of these models for informational preferences.

An investigation of information preferences presents several challenges, calling for a tightly controlled environment. First, the provision and timing of information needs to be precisely controlled. Second, information ideally should be purely non-instrumental, to shut down instrumental motives for a demand for early information. In addition, information needs to be meaningful to participants, in the sense that it plausibly triggers anticipatory utility. In our experiment, subjects can choose how they want to be informed about the outcome of a lottery. The lottery determines whether subjects

[1]Throughout the paper, we use the terms belief-based utility and anticipatory utility interchangeably. In principle, belief-based utility is the broader concept, as it also captures models of self-image and ego utility (see for example Bénabou and Tirole (2002), Kőszegi (2006a), Möbius et al. (2013)). In this paper we focus on utility coming from beliefs about future consumption or life outcomes.

will experience real (negative) consumption, a series of electric shocks. In this set-up, information is of no instrumental value and the consumption event is likely to cause (negative) anticipatory feelings. We analyze preferences for information along four natural dimensions, suggested in the models cited above. First, we let subjects choose between receiving information sooner or later. Second, we investigate the intuition that information affects the level of attention on future consumption such that, given anticipatory utility, subjects might use the timing of information to steer attention on or away from future consumption. Third, subjects can select between clumped or piecemeal information. Finally, we systematically vary the prior probability of the consumption event, both for decisions between sooner or later and for decisions between clumped or piecemeal information. In all conditions, we have full control over the timing of information provision. This design allows us to obtain a comprehensive picture on information preferences and to test different models of belief-based utility in a unified framework.

Concerning choices between sooner or later information provision in our experiment, several theories predict a preference for early information revelation (e.g., Kőszegi and Rabin (2009)). Other models, (e.g., Schweizer and Szech (2013)) formalize a motive for a preference for delayed information. Observed choices from our experiment can directly inform and test these models. In addition, our findings will be useful for models that use preferences for early or delayed information as a primitive and study implications depending on the nature of these preferences (see, e.g., Caplin and Leahy (2001, 2004)).[2]

In contrast, Golman and Loewenstein (2014) do not predict a uniform preference for sooner (or later) information, but rather that such preferences can depend on specific features of the environment. Here, information can change attention on future outcomes and individuals, due to (negative) anticipatory emotions, might not want to focus attention on bad outcomes. They model two conflicting motives that impact the demand for information, curiosity and managing attention on future outcomes. While curiosity implies demanding sooner information, later information helps reduce attention on (potentially) bad outcomes. In the baseline choice between sooner and later information in our experiment, subjects by design strongly focus their attention on the consumption event, regardless of the timing of information. This implies that there are little opportunities for subjects to manage and reduce attention on the electric shocks via delayed information, and therefore the curiosity motive should dominate.

[2] See also Kreps and Porteus (1978) for an earlier axiomatic approach that analyzes dynamic choice behavior if individuals are allowed to distinguish between different timings of the resolution of uncertainty.

In additional treatments we exogenously manipulate the experimental environment by offering subjects an entertaining and distracting activity during the experiment. In other words, we create a situation where attention is not always focused on the consumption event, such that information can potentially affect the level of attention on the consumption outcome. In that environment, Golman and Loewenstein (2014) predict that people might prefer later information, as this allows them to manage their level of attention, away from the unpleasant consumption event towards distracting activities.

For treatments where subjects can select between information in one piece and piecemeal information, Kőszegi and Rabin (2009) predict an aversion to information piece by piece. Palacios-Huerta (1999) also develops an argument why people might prefer clumped information based on the model of disappointment aversion by Gul (1991). Relatedly, Dillenberger (2010) studies a general class of recursive, non-expected preferences over compound lotteries and shows equivalence between a preference for clumped information and the so-called "certainty effect" (Kahneman and Tversky (1979)).

Both, for choices between sooner or later and for choices between clumped or piecemeal information, we vary the prior probability of the event. The preferred timing of information might depend on the ex-ante likelihood of the consumption event. Epstein (2008) models anticipatory feelings such as anxiety or hope and shows that preferences for sooner or later revelation of uncertainty can depend on priors. More specifically, his model formalizes the intuition that individuals prefer early information if the good outcome is very likely ex-ante while preferring delayed information in case the bad outcome is very likely. Other models, e.g., Kőszegi and Rabin (2009) predict that the qualitative pattern of information preferences does not depend on prior probabilities.

Our findings can be summarized as follows. The large majority of subjects prefers sooner to later information. Importantly, however, this preference is not uniform. In the presence of an exogenously implemented distracting activity, the preference relation between sooner and later information changes, and a much larger fraction of subjects now prefers delayed information. When choosing between clumped and piecemeal information, subjects display an aversion towards the latter.[3] Finally, neither choices between early and late resolution of uncertainty, nor choices between piecemeal

[3]Note that variations in whether information is provided in one piece or piece by piece necessarily imply variations in whether information is provided sooner or later. In our condition, for example, piecemeal information also implies a delay in information. Therefore, theoretical predictions in this context also require a theory of whether information is provided sooner or later. Kőszegi and Rabin (2009) for instance only predict a preference for clumped information, if no information is delayed through clumping. Interestingly, our findings point to a distinct aversion to piecewise information, on top of an aversion to delayed information (see section 3).

information and information in one piece seem to depend on the ex-ante likelihood of the consumption event.

Our results are in particular supportive of two key insights developed in Kőszegi and Rabin (2009) and Golman and Loewenstein (2014) respectively. Golman and Loewenstein (2014) formalize different motives for information demand in a unified theoretical framework. In particular, they model the role of attention for anticipatory utility. In their model, information can generate attention, and consequently, individuals can use their demand for information to manage their attention. Their model permits interesting predictions for instance in the context of ambiguity. Our findings lend support to a central insight provided by their model, that people might use information to manage their attention. In Kőszegi and Rabin (2009), utility generates from anticipated belief changes about future consumption and anticipation is based on rational expectations. At the core of their model is the assumption that decision-makers are loss averse with respect to anticipated belief changes. Direct consequence of this is an aversion to piecewise information. Information piece by piece exposes people to fluctuations in their beliefs and these expected belief fluctuations do not cancel in utility terms, because bad news weigh stronger than good news. Their theory offers an explanation for important phenomena such as precautionary savings or overconsumption and has been applied in different contexts, such as for example life-cycle consumption (Pagel (2013a)), portfolio choice (Pagel (2013b)) or moral hazard (Macera (2013)). Our finding that subjects are averse to piecemeal information provides empirical support for central assumptions and implications of their model.[4]

Apart from testing existing models, our findings contribute to a better understanding of belief-based utility and information preferences more generally. Our pattern of results might proof useful in predicting how information preferences shape behavior. For instance, the observation that subjects are averse to piecewise information suggests, that when choosing between different economic activities, people shy away from activities that imply piecemeal information revelation. This could provide an explanation for myopic loss aversion (see Benartzi and Thaler (1995) and Gneezy and Potters (1997)) as we argue in more detail in section 4. Our results also contribute to a better under-

[4]In that sense our findings relate to a vibrant recent literature on expectations-based reference-dependent preferences. In this literature, individuals are assumed to be loss averse with regard to *actual* consumption, and the reference point is generated from (rational) expectations (see, e.g., Bell (1985), Loomes and Sugden (1986), Gul (1991), Kőszegi and Rabin (2006, 2007). Several empirical studies provide support for expectation-based reference points in actual consumption. See for example Abeler et al. (2011), Crawford and Meng (2011), Gill and Prowse (2012) and Ericson and Fuster (2012). More recent experimental work has identified limitations of expectation-based reference dependence (see for example Heffetz and List (forthcoming)).

standing of individuals' demand for information. Markets where information is traded are ubiquitous, but empirically little is known about the factors that influence the demand for information. Our findings suggest that preferences towards the timing of information are important determinants. Relatedly, Ambuehl and Li (2014) study demand for information and its relation to belief updating. They find that non-standard belief-updating is associated with non-standard valuations of information.

Results from our attention treatments also highlight the role of context for information preferences. We demonstrate that preferences for sooner or later information are not uniform. In environments that cause high attention on future consumption events, individuals seem to prefer to be informed right away. Instead, if the context allows subjects to not constantly think about future outcomes (and when the nature of the future event is such that individuals prefer not to think about it), more individuals prefer receiving information later. This seems particularly likely when attention can be focused on alternative activities (as is the case in our AttMain treatment) or when the consumption event lies in the distant future. This provides a potential explanation why many people prefer to not be informed about possible negative events such as diseases, and therefore avoid being tested. For example, there is evidence that many people at risk for developing Huntington disease in the future prefer not to be tested (see for example Oster et al. (2013) and the discussion in Schweizer and Szech (2013)). Not being tested might allow individuals to not think about and anticipate the negative potential future outcomes.

More generally, our results contribute to a small but growing literature that is incorporating attention and focus into economic decision-making. Bordalo et al. (2013) and Kőszegi and Szeidl (2013) present models of consumption choice where a decision-maker's attention or focus is drawn particular attributes of the alternatives in the choice set. Gennaioli and Shleifer (2010) and Bordalo et al. (2014) model updating and inference when individuals only attend to or recall a subset of the overall available information. In all these models, attention is shaped by the environment, for instance the set of available alternatives. Our findings underscore the importance of attention for belief-based utility and support the idea that individuals can actively manage attention in a self-serving way. Intuitively, utility from anticipating future outcomes requires high levels of attention on these future outcomes. This makes attention a central determinant of anticipatory utility and opens a channel through which individuals can influence and manipulate their anticipation.

There exists a small experimental literature studying preferences for information. Eliaz and Schotter (2010) show evidence for a demand for non-instrumental (ex-post) information about the likelihood that a past risky choice was optimal. Van Winden et al. (2011) examine how investment decisions are affected by a delay in the resolution of risk. They find a significant impact of the delay of non-instrumental information on investment, modulated by emotions. Kocher et al. (forthcoming) find evidence that some subjects have a preference for delayed resolution of risk in the context of lottery tickets. Zimmermann (forthcoming) analyzes the theoretical prediction that people are averse to piecewise information. Using information about winning or loosing in a monetary lottery, he finds no evidence for such an aversion. Our study differs from these studies in several important ways. First, in our study information is on an actual consumption event, while in previous studies information has always been about monetary earnings. This is important for testing existing theories, as in most of these theories beliefs and information are about future consumption events. Second and relatedly, most existing theories are meant to capture situations where beliefs and information are meaningful to subjects, thus plausibly creating anticipatory utility. Examples are results from medical tests or career information for employees. In a lab environment situations of such meaning are potentially difficult to create. We argue that the consumption event we implement (an aversive stimulus) is ideally suited to trigger anticipatory utility in a lab context. Finally, while previous studies have focused on specific aspects of individuals' preferences for information, we explore a large range of variations in the information structure, permitting a comprehensive picture on information preferences.

The next section introduces our experimental design. Section 3 contains our results, and section 4 concludes.

2 Design and Predictions

An environment allowing to study information preferences in a clean and unambiguous way ideally requires the following features: (i) Non-instrumentality of information: information needs to be on a predetermined event that can not be affected by subjects. (ii) Full control over the timing of information. In particular, one needs to make sure that subjects realize the information at the moment they receive it. (iii) A consumption event where the act and timing of consumption can be controlled and that plausibly triggers anticipatory utility.

2.1 Experimental Design

Our design accommodates all these features. In the experiment subjects obtained information about whether or not they would receive an aversive stimulus. This stimulus consisted of a series of 30 electric shocks, which were administered using a standard electronic device frequently used in pain stimulation studies in medicine. In case a subject received the stimulus, two electrodes were attached to the subject's wrist and the series of 30 shocks was delivered in random time intervals within a time span of four minutes (see section 2.2 and Appendix A for details). These shocks are medically harmless, but painful. The electric shocks are ideal for our purposes as they are likely to trigger (negative) anticipatory utility and permit the implementation of real consumption in a tightly controlled way.[5]

Table 1 summarizes the eight main treatments and three additional control treatments we conducted. In the eight main treatments, a lottery determined whether subjects received the aversive stimulus or not. Lotteries were implemented as follows: at the beginning of the experiment, the experimenter placed ten sealed envelopes in front of the subject. In all conditions, five envelopes contained a red card and five envelopes contained a blue card. Subjects were asked to pick five of the ten envelopes and hand them over to the experimenter. The outcome of the lottery was determined by the number of red cards contained in the five envelopes the subject selected. In four conditions (SLmedium, CPmedium, AttMain and AttControl), subjects received the shocks if at least three of the five selected envelopes contained a red card. The likelihood for this event is exactly 50%. In conditions SLhigh and CPhigh, subjects received the stimulus if at least one envelope contained a red card, implying an ex-ante probability of getting shocked of more than 99%. In conditions SLlow and CPlow, subjects received the series of shocks if all five envelopes contained red cards, leading to a likelihood below 1% of getting shocked.

Subjects could choose how they wanted to be informed about the lottery outcome. The timing of information and subsequent (potential) consumption followed a fixed and precise protocol. The timeline (in minutes) was as follows: subjects decided in t=0 how to be informed about whether they would receive a series of shocks that would start at t=15.[6] They could always select between two alternatives. In the SL-treatments, the choice was between sooner or later information. If a subject opted for sooner information, at t=0 the experimenter would directly (and secretly) open the

[5]In fact, evidence on both neural and physiological responses to the prospect of receiving an electric stimulus in the future suggests that the electric shocks indeed trigger negative anticipatory feelings (see, e.g., Berns et al. (2006) and Schmitz and Grillon (2012)).

[6]Appendix A provides graphs capturing the timelines for the different treatments.

Table 1: Experimental Treatments

Treatment	Decision	Prior Probability of Consumption Event	# Observations
SLmedium	Sooner or Later	50%	30
SLhigh	Sooner or Later	>99%	30
SLlow	Sooner or Later	<1%	32
AttMain	Sooner or Later	50%	30
AttControl	Sooner or Later	50%	30
CPmedium	Clumped or Piecewise	50%	32
CPhigh	Clumped or Piecewise	>99%	30
CPlow	Clumped or Piecewise	<1%	31
ControlWTA	Willingness to Accept Stimulus	NA	25
ControlPerception	Perception of Stimulus	NA	24
ControlCalibration	Highest Tolerable Shock Level	NA	24

five selected envelopes, and reveal the five contained cards in one piece to the subject.[7] In case of later information, the experimenter would open the five selected envelopes at t=12, and show the cards to the subject. In the CP-treatments, the two alternatives were information in one piece or piecemeal information. A subject deciding for clumped information would obtain information exactly as in the sooner information condition. At t=0 the experimenter would secretly open the five selected envelopes, and then reveal the five cards in one piece to the subject. If information was transmitted piece by piece, every three minutes the content of one envelope was revealed to subjects. More specifically, at t=0, the experimenter would open the first envelope and show the respective card to the subject. At t=3, the second card would be revealed, and so on, until at t=12 the fifth and last card would be shown.[8]

In order to test the intuition that information affects the level of attention on future consumption events and that subjects therefore, due to anticipatory utility, might use sooner or later information to manage attention, we conducted treatments

[7]By letting the experimenter directly transmit information to subjects face-to-face, we ensured that subjects would realize the information by the time it was revealed.

[8]Thus, as discussed already in footnote 2, piecewise information in our set-up also implies a delay in information. We chose this implementation because theories predicting an aversion towards piecewise information require that no information is delayed through clumping (see Kőszegi and Rabin (2009)). Thus, an aversion to delayed information could potentially explain why subjects choose clumped information in the CP-treatments. Note, however, that our findings point to a distinct aversion towards piecemeal information (see section 3).

AttMain and AttControl. In the baseline SL-treatments (SLmedium, SLhigh, SLlow), by design attention was likely to be focused on the consumption event (regardless of the timing of information) since subjects were not provided any means to distract attention from the electric stimulus (see also discussion in section 2.3). This implies that there were little opportunities for subjects to manage (reduce) attention on the electric shocks via the timing of information. In AttMain we changed this feature of the experimental environment by offering subjects an entertaining activity between t=0 and t=12. In other words, we created an environment where attention was not always high on the consumption event, such that information could potentially affect the level of attention on the consumption outcome. Specifically, the treatment was building on treatment SLmedium except for one key difference. In AttMain subjects had to perform a multiple choice quiz task. Subjects were asked general knowledge questions from various fields such as sports, geography, history, arts, music etc. We wanted the quiz to be entertaining for subjects and to allow them to not focus on the electric stimulus while performing the quiz. For that purpose, the quiz was administered at a different computer next to the main computer device, such that subjects could not see the shocking device or the electrodes while answering the quiz questions (see Appendix A for a picture). In addition we paid subjects for quiz performance such that subjects had incentives to focus on the quiz.[9] The timeline in AttMain was as follows. Before choosing how to be informed about the outcome of the lottery, the quiz was running for four minutes. This was done to familiarize subjects with the quiz and to make them realize that the quiz could potentially distract them from the consumption event. Then the quiz was interrupted (t=0) and subjects could choose if they wanted to be informed now or at t=12. After the interruption the quiz continued for 12 minutes. In other words, subjects could choose if they wanted to be informed at t=0 (during the interruption of the quiz) or at t=12 (after the quiz was finished).[10]

For being able to cleanly identify potential attention management via information choice, we implemented a control condition that was as similar as possible to AttMain, with the exception that between the information choice (t=0) and t=12 there would be no means for subjects to distract from the electric stimulus. Accordingly, in AttControl subjects went through four minutes of the same quiz as in AttMain. Then the quiz was interrupted (t=0) and subjects could decide whether they wanted information

[9] The quiz had a total of six levels and earnings increased convex in level. Level 1 = 0 euros, level 2 = 1 euro, level 3 = 2 euros, level 4 = 4 euros, level 5 = 8 euros, level 6 = 16 euros.

[10] Note that the length of the interruption was fixed and calibrated such that there was sufficient time for subjects to make their choice and to potentially receive the information. Thus, subjects could not affect the length of the interruption with their information choice.

now or in 12 minutes. However, in contrast to AttMain, in treatment AttControl the quiz did not continue after the interruption. Between t=0 and t=12, subjects (like in the baseline SL-treatments) had to sit in front of the main computer with the shocking device, electrodes etc., with no means to distract attention from the electric stimulus. Subjects knew that the quiz was only resumed at the very end of the experiment, after subjects (potentially) had received the electric stimulus. Comparison of choices between AttMain and AttControl allows for clean identification of attention management via information choices.

The experiment was administered in two separate office rooms of the BonnEconLab. In each room there were two desks with a computer, a set of instructions and the electronic pain stimulation device (see Appendix A for pictures).[11] Subjects were invited to the lab such that only two subjects would participate at the same time (one per room). In some cases, it happened that consecutive experimental sessions overlapped, due to subjects arriving too early or too late. In case this happened, there were two subjects present in one room for some time. To avoid potential spillover effects should this occur, the two desks in each room were separated with partition walls. Moreover, in all treatments subjects were asked to wear noise-canceling headphones while reading instructions and taking their decisions.

There was always one experimenter assigned to one subject. The experimenter welcomed the subject and asked him or her to read and sign a consent form. Afterwards, subjects were randomly assigned to treatments. Experimental instructions were provided to subjects on computer screens. Subjects were instructed in detail about the structure and timing of the respective information conditions they could select from and were given the opportunity to ask questions. Then subjects made their choice on the computer screen. The order in which the two choice alternatives were presented to subjects on the computer screen (left or right) was randomized between sessions. After subjects had made their choice, the experimenter started an electronic time clock that was running down 15 minutes (the time after which subjects potentially would receive the shock series). We wanted to keep the number of times the experimenter interacted with the subject fixed between information conditions, in particular between clumped and piecemeal information. Therefore, every three minutes, the experimenter informed subjects about the time elapsed so far. In case a subject opted for piecewise information, the pieces of information were transmitted during these interactions. This was also done in treatments SLmedium, SLhigh and SLlow, to maximize comparability

[11]In treatments AttMain and AttControl there were two computers per desk. The additional computer was used to administer the quiz, and was placed sufficiently distant from the other computer, such that while doing the quiz, subjects could not see the other computer and the shocking device.

with choices in the CP-treatments. Note that this was not done in treatments AttMain and AttControl. Remember that the purpose of these treatments was to investigate attention management of subjects. Therefore, in these two treatments, we refrained from having the experimenter interrupt subjects every three minutes. In all treatments all this was known to subjects ex-ante.

In case the lottery determined that a subject received the series of electric shocks, the experimenter attached the two electrodes and a calibration phase began. Calibrating the shock intensity was demanded by the ethics comittee and is standard and necessary for using electronical pain stimulation, because individual pain perception and tolerance is very heterogenous and depends on various factors such as body weight or the exact position of the electrodes. During the calibration phase, the shock level was increased in consecutive steps (starting from a very low level), and subjects could indicate the shock level that was just tolerable for them. This level then determined the intensity of the series of shocks.[12]

In addition to Control Calibration, we conducted two further control treatments, ControlWTA and ControlPerception. In these experiments we investigate how subjects experience and evaluate the consumption event we implemented. In ControlWTA, we used a price list format to elicit the amount of money we would have to pay subjects to be willing to experience the series of 30 shocks. After experiencing the calibration, subjects faced 20 decisions, where they could choose between receiving the series of 30 shocks plus a fixed amount of money (that was increased in 1 euro increments from 1 euro to 20 euros) and receiving no stimulus but also no additional money. In ControlPerception, subjects experienced the series of shocks and were subsequently asked to rate how unpleasant they perceived the stimulus on a scale from 1 (not at all unpleasant) to 7 (very unpleasant).

[12]This entire calibration procedure was known to subjects ex-ante. Therefore one could argue that subjects might misreport their own tolerance level in order to receive very low, i.e., less painful shocks. First note that, if this were true, it would only reduce the intensity and therefore likely the anticipation of the negative consumption event, making it less likely for information preferences to manifest themselves. Second, there is strong evidence that people have a preference for truth-telling (see, e.g., Gneezy (2005), Fischbacher and Heusi (forthcoming), Abeler et al. (forthcoming)) which creates incentives to report pain perception truthfully. Such preferences are likely to be particularly strong in the face-to-face interaction we are implementing. To further investigate the issue of a potential downward bias in reported tolerance levels, we conducted treatment ControlCalibration. In this treatment, subjects only went through the calibration phase, but without receiving any further shocks. Therefore, there were no strategic incentives to misreport tolerance levels. As we show in more detail in section 3, reported elicited tolerance levels did not differ significantly between that treatment and calibrations in the main treatments.

2.2 Procedural Details

A total of 318 subjects participated in our study. Participants were recruited from the regular subject pool of the BonnEconLab (University of Bonn) using the online recruitment system by Greiner (2003) and received a show-up fee of 20 euros.[13] The experiment was computerized using the software Presentation. The electric shocks were administered using "Pain Stimulation Shockers" (SHK1), developed and produced by the company Psychlab. These devices are specialized for scientific use in laboratory environments. Appendix A provides further details and pictures of these devices.[14]

2.3 Predictions

Our experimental treatments allow us to discriminate between different theories of belief-based utility and can inform theories that use information preferences as primitives for their analysis. In the following we briefly summarize theoretical predictions for our treatment variations, focusing on key intuitions. In Appendix B we derive formal predictions.

Sooner Versus Later Information

Several theories predict that subjects should prefer sooner information in treatments SLmedium, SLhigh and SLlow. In Kőszegi and Rabin (2009), people obtain utility from anticipated changes in beliefs about future consumption. Beliefs correspond to rational expectations and people are assumed to be loss averse with regard to changes in their beliefs. In addition the model assumes that people care at least weakly less about changes in beliefs, the further away the time of belief change lies from the actual point of consumption. This implies that people (weakly) prefer to receive information sooner rather than later. Golman and Loewenstein (2014) model two conflicting motives that impact the demand for information, curiosity and managing attention on future outcomes. In the situation we are implementing in the SL-treatments, several exogenous factors, e.g., the abstract lab environment as such, the constant presence and visibility of the electronic device, the relatively short time interval and the lack of opportunities to distract attention, are likely to cause high levels of attention on the consumption event and make it difficult to manage and reduce attention. Thus, in our set-up the curiosity motive should dominate, implying the prediction that subjects

[13] In treatments AttMain and AttControl subjects could earn additional money during the quiz, which is why we reduced the show-up fee to 15 euros.

[14] A complete set of instructions including the consent from and instructions for the calibration phase are available from the authors upon request.

should prefer early information.

Schweizer and Szech (2013) study the optimal information revelation for severe outcomes such as diseases. For that purpose a standard demand for instrumental information is contrasted with a desire to avoid information due to anticipatory utility. Information avoidance is formalized by assuming risk aversion over anticipated outcomes. Applying their utility function to our experiment where information is purely non-instrumental, this implies that subjects should prefer delayed information.

Attention Management

In treatments AttMain and AttControl we systematically manipulate the environment, varying the extent to which subjects can manage their attention. Golman and Loewenstein (2014) formalize the intuition that information can influence attention on consumption outcomes. Given anticipatory utility, individuals do not want to focus attention on bad outcomes and can use the choice of later information to reduce the level of attention on the bad outcome. In addition, however, individuals are assumed to be curious. Thus, in treatment AttMain, they predict that both curiosity and managing attention on future outcomes impact information choices, with the two motives operating in different directions. While curiosity implies demanding sooner information, later information helps reduce attention on the bad consumption outcome. In contrast, in treatment AttControl, we took away the possibility to manage attention, such that the curiosity motive should dominate. Accordingly, Golman and Loewenstein (2014) predict that more subjects choose sooner information in treatment AttControl, compared to AttMain. We are not aware of other models that share this prediction.

Clumped Versus Piecemeal Information

Kőszegi and Rabin (2009) predict an aversion to information piece by piece in the CP-treatments. This aversion is caused by loss aversion in belief changes. This type of loss aversion implies an aversion towards the gradual resolution of uncertainty, since piecewise information exposes people to fluctuations in their beliefs. These expected fluctuations in beliefs do not cancel in utility terms, because bad news weigh stronger than good news. In combination with a preference for early information, the prediction of Kőszegi and Rabin (2009) is that people should prefer clumped information as long as no information is delayed through clumping. Thus, in our set-up the model predicts that people select information in one piece rather than piecemeal information. Relatedly, Palacios-Huerta (1999) develops an argument why people might prefer clumped information based on the model of disappointment aversion by Gul (1991).

On the other hand, obtaining information piece by piece could be perceived as more entertaining and exciting. Ely et al. (forthcoming) theoretically analyze information demand if individuals like the feeling of suspense. In their model, suspense is indeed higher for piecemeal than for clumped information.[15]

Variations in Prior Probabilities

Most models we are aware of predict that the qualitative pattern of information preferences does not depend on prior probabilities. Epstein (2008) is an exception. He models anticipatory feelings such as anxiety or hope, and shows that preferences for sooner or later revelation of uncertainty may depend on priors. More specifically, he shows that individuals prefer early information if the good outcome is very likely ex-ante and prefer delayed information if the bad outcome is very likely ex-ante. Applied to our set-up, this implies that the fraction of subjects preferring early information should be higher in treatment SLlow compared to treatment SLhigh.

3 Results

Figure 1 summarizes the key findings from our eight main treatments. We start by analyzing choices in the SL-treatments and ask if these choices depend on prior probabilities, followed by choices between sooner or later information in treatments AttMain and AttControl. Then we investigate choices between clumped and piecemeal information and potential dependencies on priors. We also analyze whether there exists a specific aversion to information piece by piece, independent of preferences for receiving information sooner or later. Finally, we summarize findings from the three additional control treatments.

Pooling observations from the three SL-treatments, we find that 76% of subjects prefer to receive information early. Using a binomial test we reject the null hypothesis that choices of sooner and later information are equally likely, pointing towards a distinct preference for early information ($p < 0.01$). Looking at each of the SL-treatments separately, Figure 1 (left panel) reveals that the fraction of subjects preferring sooner over later information is above 73% in all three treatments. Performing binomial tests (again testing the null hypothesis that choices of sooner and later information are equally likely) separately for each SL-treatment confirms the result from the pooled

[15]In their paper they model demand for non-instrumental information such as international news and sports events. They formalize the idea that such information creates entertainment value, and analyze how information should be provided if individuals want to maximize suspense or surprise.

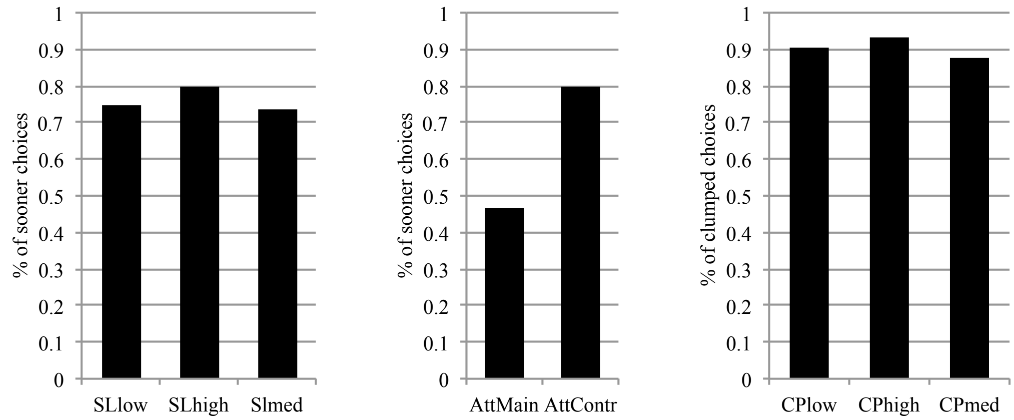

Figure 1: Left Panel: Fractions of subjects choosing sooner information in the SL treatments. Middle Panel: Fractions of subjects choosing sooner information in the Attention treatments. Right Panel: Fractions of subjects choosing clumped information in the CP treatments.

data (SLmedium, $p = 0.016$; SLhigh, $p < 0.01$; SLlow, $p < 0.01$). Columns 1, 2 and 3 in table 2 analyze if choices in the SL-treatments are affected by treatment variations in prior probabilities. Information choices in the SL-treatments are regressed on a set of dummy variables capturing variations in the prior. In columns 2 and 3, additional controls are added. We find that information choices when choosing between sooner or later information are not affected by manipulations of the prior probability of the consumption event. None of the treatment coefficients is significantly different from zero. Joint Wald-tests cannot reject the null hypothesis of zero treatment differences (column (1): $chi2(2) = 0.40$, $p = 0.820$; column (2): $chi2(2) = 0.10$, $p = 0.952$; column (3): $chi2(2) = 0.09$, $p = 0.958$).

Turning to the attention treatments, figure 1 (middle panel) shows that 80% of subjects prefer sooner information in treatment AttControl, similar to the respective fractions of subjects in the SL-treatments. In treatment AttMain, however, about 48% of subjects prefer sooner information. Regression analysis in table 2 reveals that this drop in choices of sooner information is significant. In columns 4, 5 and 6, information choice is regressed on a treatment dummy being equal to 1 for observations from treatment AttMain. In columns 5 and 6, additional controls are included. In all specifications, the proportion of subjects choosing later information is significantly higher in AttMain.

Taking findings from the SL-treatments and treatments AttMain and AttControl together, overall subjects seem to prefer sooner information. However, this preference is not uniform, but rather depends on specific contextual features. In contexts where the nature of the environment does not induce constant focus on the (negative) consumption event, later information becomes relatively more attractive. This is consistent with the idea that later information allows subjects to reduce attention on the bad outcome.

Turning to choices between clumped and piecemeal information, pooling data from all three treatments, we find that about 90% of subjects prefer clumped information. A binomial tests rejects the null hypothesis that subjects randomized with equal probability between clumped and piecemeal information. Figure 1 (right panel) also reveals a pronounced preference for information in one piece. In all CP-treatments, more than 87% of subjects choose clumped information. Performing binomial tests separately for the three CP-treatments confirms the result from the pooled data (CPmedium, $p < 0.01$; CPhigh, $p < 0.01$; CPlow, $p < 0.01$). Columns 7, 8 and 9 in table 2 analyze whether choices in the CP-treatments are affected by variations in prior probabilities. Choices in the CP-treatments are regressed on a set of dummy variables capturing variations in the prior and additional controls (columns 8 and 9). The respective coefficients reveal that, similar to the SL-treatments, behavior in the CP-treatments does not depend on priors. Furthermore, joint Wald-tests cannot reject the null hypothesis of zero treatment differences (column (7): $chi2(2) = 0.60$, $p = 0.743$; column (8): $chi2(2) = 1.12$, $p = 0.570$; column (9): $chi2(2) = 1.44$, $p = 0.487$).

We implemented the lotteries using envelopes, in order to make the ex-ante probabilities rather salient and easy to comprehend for subjects. For the treatments where the ex-ante likelihood was high (low) we also directly told subjects in the instructions that receiving the shocks was rather (un)likely. Still, one might wonder if our finding that information choices are not significantly affected by variations in prior probabilities might potentially be due to possible misperceptions of these probabilities on the side of the subjects. To further address this, for some subjects we elicited perceived probabilities at the end of the experiment. In Appendix C we demonstrate that our variations in priors were effective in the sense that they strongly influence subjects' perceived priors. We also show that information choices are not significantly affected by perceived priors (confirming our finding that choices are not affected by objective priors).

Note again that variations in whether information is provided in one piece or piece by piece necessarily imply variations in whether information is provided sooner or later. In other words, preferences for sooner or later information inevitably affect choices between clumped or piecemeal information. In the CP-treatments we have implemented, piecemeal information implied a delay in information. Thus, an aversion to delayed

Table 2: Probit Estimates of Information Choices

	SL-treatments			Attention treatments			CP-treatments			SL- and CP-treatments		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
SLmed	-.219	-.114	-.107									
	(0.360)	(0.366)	(0.367)									
SLlow	-.167	-.071	-.069									
	(0.357)	(0.361)	(0.365)									
AttMain				-0.952***	-0.966***	-0.965***						
				(0.350)	(0.354)	(0.353)						
CPmed							-.351	-.307	-.334			
							(0.455)	(0.488)	(0.476)			
CPlow							-.201	-.512	-.552			
							(0.472)	(0.483)	(0.462)			
SL										-.591**	-.617***	-.619***
										(0.230)	(0.221)	(0.220)
Additional Controls	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Implementation left/right			.254			-0.137			-.569			-.054
			(0.295)			(0.378			(0.370)			(0.220))
Constant	.842***	2.086	1.873	0.842***	0.229	0.155	1.501***	.255	-.182	1.300***	1.775	1.805
	(.262)	(1.374)	(1.435)	(0.263)	(1.503)	(1.527)	(.354)	(2.760)	(2.947)	(.179)	(1.161)	(1.188)
Observations	92	92	92	60	60	60	93	93	93	185	185	185
(Pseudo R^2)	0.004	0.029	0.037	0.094	0.107	0.109	0.010	0.172	0.201	0.041	0.054	0.054

Probit estimates, robust standard errors in parentheses. In regressions (1), (2) and (3), choice between sooner or later information is regressed on a set of dummy variables capturing variations in priors in the SL-treatments (where SL-high is the omitted category). In columns (4), (5) and (6) respectively, we regress information choice from treatments AttMain and AttControl on a treatment dummy taking the value 1 for treatment AttMain. In regressions (7), (8) and (9), choice between clumped or piecemeal information is regressed on a set of dummy variables capturing variations in priors in the CP-treatments (where CPhigh is the omitted category). In columns (10), (11) and (12), we regress information choices from the whole sample (where choices of clumped or sooner information respectively are categorized as 1, and choices of piecemeal or delayed information are categorized as 0) on a dummy variable being equal to 1 for observations from the SL-treatments and equal to 0 for observations from the CP-treatments. Additional controls include age and gender. In regressions (10), (11), (12), controls also include a set of dummy variables capturing variations in priors. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

information could contribute to our finding that most subjects choose clumped over piecemeal information. Interestingly, however, our findings point towards a distinct aversion to piecemeal information, independent of preferences over sooner or later information. If an aversion against delayed information would be the sole driver of behavior in the CP-treatments, then the fractions of subjects choosing clumped information in the CP-treatments should be similar to the fractions of subjects choosing early information in the SL-treatments. In fact, the delay from piecemeal information in the CP-treatments in expectations was less severe than the delay caused by later information in the SL-treatments.[16] Thus, a pure aversion to delayed information would predict that the fractions of subjects choosing clumped information in the

[16] If information was provided later, subjects learned after 12 minutes whether they would receive the aversive stimulus or not. Instead, if information was provided piece by piece, (depending on the treatment) it could happen that subjects already knew after the first pieces of information whether they receive the aversive stimulus and under no circumstances was the delay in information larger than 12 minutes. More specifically, in treatments CPhigh and CPlow, if information was transmitted piece by piece, it could happen that subjects knew already after the first piece of information (delay of zero minutes) whether they get shocked or not. In CPmed, subjects could sometimes have certainty after three pieces of information (delay of six minutes).

CP-treatments should potentially be even lower than the fractions of subjects choosing sooner information in the SL-treatments. Figure 1 reveals, however, that the fraction of subjects choosing clumped information in the CP-treatments is higher compared to the fraction preferring sooner information in the SL-treatments.

This is formally confirmed by our regression analysis in table 2. We demonstrate that the clumped information option in the CP-treatments is chosen more frequently than the sooner information option in the SL-treatments. To identify this effect, in columns 10, 11 and 12 of table 2 we pool observations from the SL- and the CP-treatments. We categorize information choices such that choices of clumped and sooner information respectively are categorized as 1, and choices of piecemeal and delayed information are categorized as 0. Information choices are regressed on a treatment dummy being equal to 1 for observations from the SL-treatments and equal to 0 for observations from the CP-treatments. In columns 11 and 12, additional controls are included. The negative coefficient of the treatment dummy reveals that the fraction of subjects preferring clumped information is significantly higher than the fraction of subjects preferring sooner information, providing evidence for a distinct aversion towards piecemeal information.

Recall that in all main treatments we randomized which choice alternative appeared on which side of the decision screen. Given that information preferences are potentially easily malleable by framing or ordering effects, it could be that the mere order of choice alternatives affected choice behavior. In columns 3, 6, 9 and 12 of table 2 we introduce the order of the choice alternatives on the screen as an additional control variable in our regression analysis. We do not find evidence that the ordering of the way the alternatives were presented to subjects mattered for their choices.

In two additional treatments, ControlWTA and ControlPerception, we wanted to investigate how subjects perceived the consumption event we implemented. In ControlWTA we elicited the amount of money subjects needed to receive to be willing to experience the series of 30 shocks. We find that the average amount was 8.3 euros (median = 8, std. dev. = 5.4). In ControlPerception subjects experienced the series of shocks and were subsequently asked to rate how unpleasant they perceived the stimulus on a scale from 1 (not at all unpleasant) to 7 (very unpleasant). The average rating was 5.6 (median = 5, std. dev. = 1.2). In sum, the perception of the consumption event was (as expected) quite negative and the amount of money subjects demanded to experience the event was substantial. Finally, we conducted treatment ControlCalibration to examine potential misreporting by subjects in the calibration phase. The average tolerance level elicited in ControlCalibration was 10.46 compared to 9.61 in the eight main treatments.[17] Testing for differences between elicited tolerance levels from the main treatments and tolerance levels from ControlCalibration yields no significant effects (t-test, $t = -0.85$, $p = 0.40$; Ranksum-test, $z = -0.77$, $p = 0.44$).

4 Concluding Remarks

In this paper we investigate individuals' preferences for information. We implement a real (negative) consumption event in a lab environment and vary information structures along four key dimensions. Our experimental design allows precise control over the timing of information and the consumption event and ensures non-instrumentality of information. Findings from our experiment permit a comprehensive view on information preferences and are informative for existing theories that assume a direct link between beliefs about future consumption and utility.

Our results reveal an aversion to delayed information as well as an aversion to piecemeal information. We also find find evidence that subjects use the timing of information (sooner or later) to manage attention on the consumption event. Variations in prior probabilities of the consumption event do not affect choices. Thus, our findings lend support to models predicting a preference for sooner information and disutility from piecewise information, as well as models capturing the use of information to steer attention.

Our pattern of observations might improve our understanding of how the connection between beliefs and utility and resulting preferences for information shape behavior. For instance, our results suggest that when choosing between different economic activities, people shy away from activities that imply piecemeal information revelation, relating to the literature on myopic loss aversion (see Benartzi and Thaler (1995) and Gneezy and Potters (1997)). Gneezy and Potters (1997) let subjects go through a series of risky investment choices and manipulate the frequency with which they received feedback regarding the outcome and with which they could make their choices in a between-subjects design. They find that investments in the risky asset are higher when the frequency of feedback and choices is low. Our results suggest that an aversion to piecemeal resolution of risk might contribute to myopic loss aversion.[18]

[17] A total of 116 subjects from the eight main treatments received the aversive stimulus and thus went through the calibration phase.

[18] Bellemare et al. (2005) provide evidence in this direction. They build on the design by Gneezy and Potters (1997), with the additional twist that it allows to disentangle effects of frequency of feedback from frequency of choices. They find that manipulating feedback is sufficient to generate myopic loss aversion. This finding is compatible with a preference for clumped information. Langer and Weber (2008), however, document the opposite. They identify frequency of choices as the relevant factor that

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Appendix A

Pictures of Lab Environment

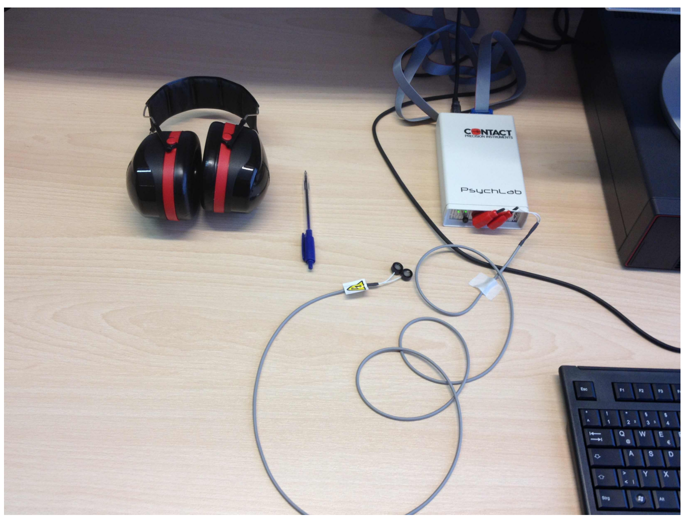
Picture of desk for the SL and CP treatments.

Picture of desk for treatments AttMain and AttControl, including the two computers. The right computer administered the quiz. Note that the two computers in AttMain and AttControl were placed such that while performing the quiz, subjects could not see the other computer.

The Electric Stimulus

The electric stimulus was administered with devices (SHK 1) manufactured by the company Psychlab. The devices are specifically tailored for scientific purposes. Electric stimulation is frequently used to induce pain or fear (see, e.g., Brooks et al. 2010 and Cohn et al. 2013) and neural as well as physiological evidence suggests that the expectation of receiving an electric stimulus indeed triggers negative anticipatory feelings (see, e.g., Berns et al. (2006) and Schmitz and Grillon (2012)).

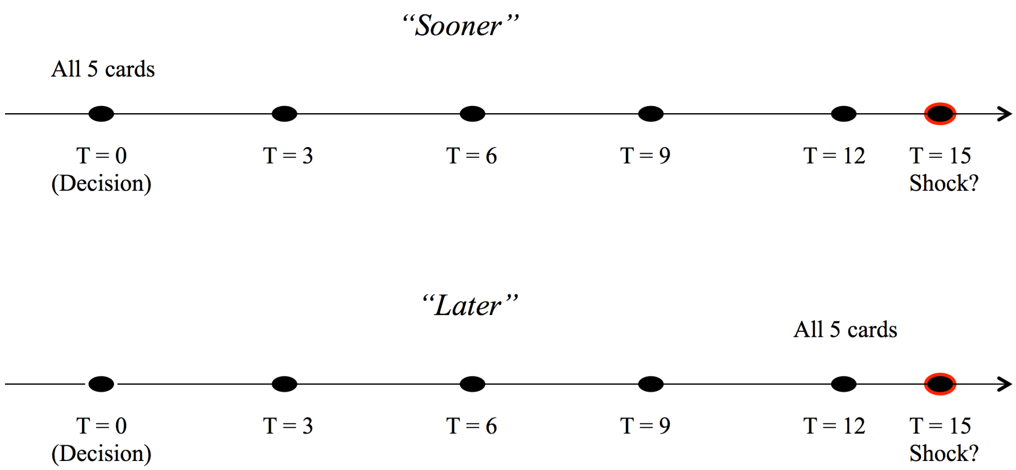
If a subject received the electric stimulus, two electrodes were attached to the subject's wrist (see below for a picture of an electronic device including electrodes). The electrodes delivered focused and centered electric shocks. After the calibration phase, subjects received a series of 30 shocks which were delivered in random time intervals within a total time span of four minutes, and each individual stimulus had a length of 0.1 seconds.



Picture of electronic device, electrodes, noise-cancelling headphones.

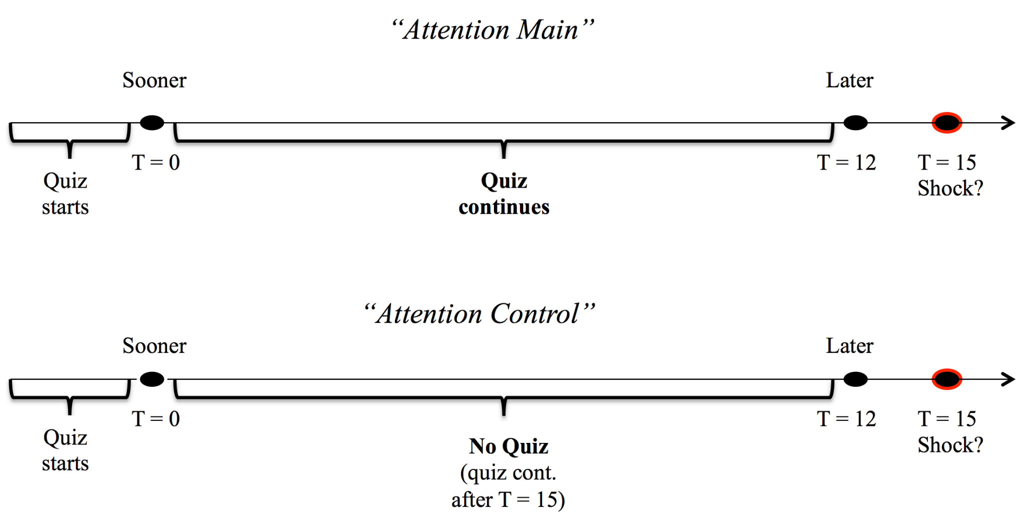
Timeline of Different Treatments

SL-Treatments



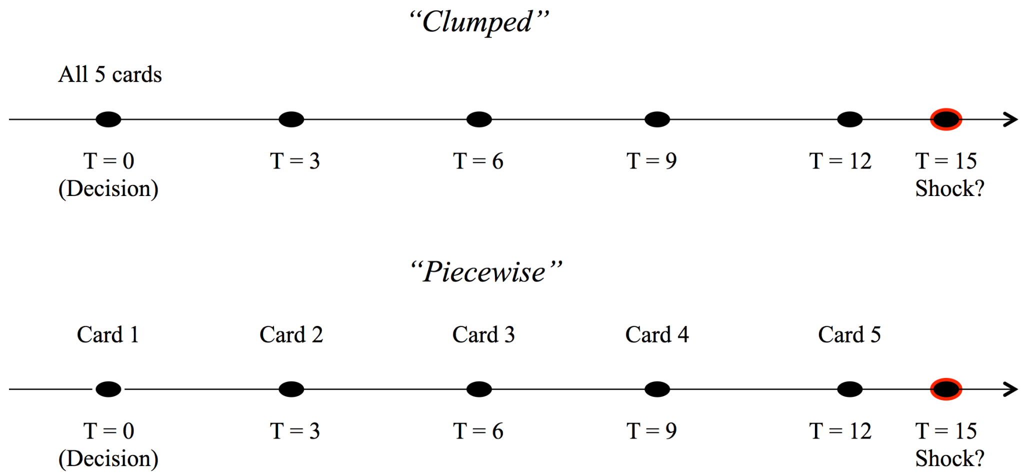
Timeline in the SL-treatments (in minutes). Subjects decide at $t = 0$. The upper panel shows the timeline if the option "Sooner" is chosen. The lower panel displays the timeline if "Later" is chosen.

Attention Treatments



Timeline Attention treatments (in minutes). The figure depicts both attention treatments. Subjects decided in $t = 0$ if they want to be informed sooner or later. The consequences of the information choice are shown in the figure depicting the timeline of the SL-treatments. The upper panel shows treatment Attention Main. The lower panel depicts treatment Attention Control.

CP-Treatments



Timeline in the CP-treatments (in minutes). Subjects decide at $t = 0$. The upper panel shows the timeline if the option "Clumped" is chosen. The lower panel displays the timeline if "Piecewise" is chosen.

Appendix B

Here we formally derive predictions for our experimental treatments, focusing on the theories by Kőszegi and Rabin (2009) and Golman and Loewenstein (2014). We also provide formal predictions for additional models for the specific dimensions where we discussed these models.

Our experimental set-up can be captured by 6 periods, $t = 0$ through 5.[19] There is one consumption good (the aversive stimulus) which is consumed in $t = 5$. Consumption c is binary, i.e., subjects either receive the series of shocks or not (for simplicity say $c \in \{0, 1\}$ where $c = 0$ reflects receiving the aversive stimulus and $c = 1$ reflects not receiving it). At the beginning of period t, the decision-maker holds beliefs F_{t-1} about consumption in $t = 5$, where π_{t-1} denotes the probability that $c = 1$. Then, (in periods 0 through 4) some signals may arrive and the decision-maker accordingly forms new beliefs F_t.

Kőszegi and Rabin (2009)

Applying Kőszegi and Rabin (2009) to our set-up, instantaneous period-t utility for periods $t = 0$ through 4 depends on belief changes in t regarding future consumption:

$$u_t = \gamma_t N(F_t \,|F_{t-1})$$

In period $t = 5$, consumption is realized, and instantaneous utility in that period is given by:

$$u_t = m(c_t)$$

$m(c_t)$ denotes reference-independent consumption utility and we assume for simplicity that $m(c_t) = c_t$. The terms $N(F_t \,|F_{t-1})$ represent "gain-loss utility" from belief changes. $0 < \gamma_0 \leq \gamma_1 \leq ... \leq \gamma_4$ are the weights on gain-loss utilities. The weights γ represent the importance of new information depending on how far in advance of actual consumption the news are received. Importance decreases, the earlier new information is realized.

Gain-loss utilities are specified such that decision-makers compare current and previous beliefs about consumption. Then we have that:

[19]We define periods based on the CP-treatments. In periods 0 through 4, subjects (potentially) receive pieces of information, in period 5, consumption is realized.

$$N(F_t \,|F_{t-1}) = \mu(\pi_t - \pi_{t-1})$$

$\mu()$ is a "standard" gain-loss utility function. We assume linearity such that $\mu(x) = \eta x$ if $x \geq 0$ and $\mu(x) = \eta\lambda x$ if $x < 0$.

The decision-maker wants to maximize the expected sum of instantaneous utilities. Thus, when choosing between different information conditions, he maximizes

$$U_0 = \sum_{\tau=0}^{5} u_\tau.$$

We now have all the ingredients necessary to make predictions for our different treatment variations.

Sooner Versus Later Information

In all our SL-treatments, subjects start with some prior belief (which is varied in treatments SLhigh, SLmedium and SLlow) and can choose between being fully informed in $t = 0$ or $t = 4$. Due to loss aversion in belief changes, information from an ex-ante perspective always decreases utility. Because by assumption, decision-makers care (weakly) less about belief-changes the further away they are from actual consumption (recall that $0 < \gamma_0 \leq \gamma_1 \leq ... \leq \gamma_4$), it is easy to see that subjects should (weakly) prefer information sooner rather than later, as this maximizes the distance between information and consumption realization. Note that this prediction is independent of priors, such that in treatments SLhigh, SLmedium and SLlow, subjects should prefer information sooner rather than later.

Attention Management

Kőszegi and Rabin (2009) do not try to model attention and potential effects of information on attention. Accordingly, due to a preference for early information, their model predicts that subjects should prefer early information in treatments AttMain and AttControl.

Clumped Versus Piecemeal Information

In all CP-treatments, subjects could choose between being fully informed (clumped) at $t = 0$, or receiving one piece of information per period, from $t = 0$ through $t = 4$ (piecemeal). As an intermediate step, first consider another sequence of information, identical to the piecewise sequence, but the last two signals are clumped together in period 3. When comparing this intermediate sequence with the piecemeal sequence, we can focus on these last two signals. Denote by π_2 a subject's belief before receiving the last two signals and denote by $\pi_{3,4}$ the belief after receiving the last two signals. First note that (trivially) in cases where $\pi_2 = 0$ or $\pi_2 = 1$, or where the fourth signal necessarily leads to $\pi_3 = 0$ or $\pi_3 = 1$, the expected utility of the two sequences is identical. For all other cases we can write that expected utility at the beginning of $t = 3$ for the intermediate sequence is given by,[20]

$$\gamma_3\mu(\pi_{3,4} - \pi_2) = \gamma_3\mu(\pi_{3,4} - \pi_3 + \pi_3 - \pi_2) > \gamma_3\mu(\pi_{3,4} - \pi_3) + \gamma_3\mu(\pi_3 - \pi_2),$$

where the last inequality is driven by loss aversion. Because decision-makers prefer sooner to later information, it also holds that:

$$\gamma_3\mu(\pi_{3,4} - \pi_3 + \pi_3 - \pi_2) > \gamma_4\mu(\pi_{3,4} - \pi_3) + \gamma_3\mu(\pi_3 - \pi_2).$$

Thus, subjects should prefer the intermediate sequence to the piecemeal sequence (this is stated in more general form in Proposition 1 in Kőszegi and Rabin (2009)). One can easily see that by the same logic, decision-makers should prefer the clumped sequence to the piecemeal sequence. Note that (as for the SL-treatments) this prediction is independent of priors, such that in treatments CPhigh, CPmedium and CPlow, subjects should prefer information clumped rather than piecewise.

Golman and Loewenstein (2014)

Applying the model by Golman and Loewenstein (2014) to our set-up leads to the following utility function:

$$U(\pi_t, w_t) = \pi_t m(1) + (1 - \pi_t)m(0) + w_t\big(\pi_t v(1) + (1 - \pi_t)v(0) - H(\pi_t)\big)$$

The first part captures standard expected utility over consumption, where we again assume for simplicity that $m(c) = c$. The second part captures belief-based utility. Individuals are assumed to get utility from their beliefs about answers to "questions". In our set-up, the question subjects ask themselves is: "Do I get shocked, or not?". w_t captures the degree to which subjects focus attention on that question. $v(c)$ reflects the degree to which subjects like or dislike thinking about the different answers to the ques-

[20] Note that we abstract here from consumption utility which is identical in all information sequences.

tion, in our case “I get shocked” or “I do not get shocked”. It seems plausible to assume that subjects dislike thinking about the possibility of getting shocked. Accordingly, we say that $v(0) < 0$ and $v(1) = 0$. Finally, individuals in general dislike uncertainty about the answers to questions, implying curiosity. Uncertainty is captured by the entropy of the belief distribution $H(\pi_t) = -(\pi_t log(\pi_t) + (1 - \pi_t)log(1 - \pi_t))$.

Notice that, differently from Kőszegi and Rabin (2009), Golman and Loewenstein (2014) do not explicitly model the timing structure of future periods where utility is realized in each period. Instead, the individual utility components in their model should be thought of as aggregates over all future time periods, i.e., sums of (expected) future standard utilities from consumption as well as (expected) future anticipations.

Sooner Versus Later Information

An important factor in the model of Golman and Loewenstein (2014) is the effect of information on attention. Receiving information about a question can potentially raise the attention weight w_t. In treatments SLhigh, SLmedium and SLlow, an effect of information on attention is made unlikely or limited by design. Several exogenous factors, e.g., the constant presence and visibility of the electronic device, the relatively short time interval and the lack of opportunities to distract attention, are likely to cause very high levels of attention on the consumption event, regardless of information. As a consequence, the predominant effect of information on utility from an ex-ante perspective is that it reduces uncertainty. Subjects that choose information sooner can reduce uncertainty from $H > 0$ to $H = 0$.

Thus, from an ex-ante perspective (i.e. before actually receiving the information), subjects that (at the beginning of $t = 0$) choose information sooner have expected utility:

$$U('sooner') = \pi_t m(1) + (1 - \pi_t)m(0) + w_t\big(\pi_t v(1) + (1 - \pi_t)v(0) - 0\big).$$

Instead, subjects that choose later information remain uncertain, having expected utility:

$$U('later') = \pi_t m(1) + (1 - \pi_t)m(0) + w_t\big(\pi_t v(1) + (1 - \pi_t)v(0) - H(\pi_t)\big)$$

Accordingly, due to curiosity, Golman and Loewenstein (2014) predict that subjects should prefer sooner information in the SL-treatments.

Attention Management

The prediction for treatment AttControl is identical to the SL-treatments. Curiosity should dominate, implying that subjects should prefer sooner to later information. In AttMain, we now exogenously change the environment. Attention is now not necessarily high on the consumption, giving rise to a potential effect of information on attention. In other words, attention weight w is likely to increase due to information. Denote by w_{info} the attention weight if subjects obtained information and say that w_{noinfo} and say that $w_{info} > w_{noinfo}$.

Then, again from an ex-ante perspective, subjects that at the beginning of $t = 0$ choose information sooner have expected utility:

$$U('sooner') = \pi_t m(1) + (1 - \pi_t)m(0) + w_{info}\big(\pi_t v(1) + (1 - \pi_t)v(0) - 0\big).$$

Instead, subjects that choose later information remain uncertain but focus attention less on the aversive stimulus, having expected utility:

$$U('later') = \pi_t m(1) + (1 - \pi_t)m(0) + w_{noinfo}\big(\pi_t v(1) + (1 - \pi_t)v(0) - H(\pi_t)\big)$$

Thus, one can see that curiosity motive remains present, implying a choice of sooner information. However, now a countervailing motive exists. Sooner information causes attention to rise. Since subjects do not like thinking about the aversive stimulus (recall that $v(0) < 0$ and $v(1) = 0$), higher attention decreases utility. Which motive dominates is likely to be individual-specific. However, if the attention motive is sufficiently strong, subjects should prefer later to sooner information. It could also be that that the two motives basically cancel each other leaving subjects more or less indifferent between sooner or later information. In any case, it should if the attention is strong enough, more subjects should choose later information in AttMain compared to AttControl.

Clumped Versus Piecemeal Information

Concerning choices between clumped and piecemeal information, there is no specific utility-consequence of obtaining information piecewise, except that piecewise information in the CP-treatments also implies a delay of information. Accordingly, Golman and Loewenstein (2014) predict that subjects should prefer clumped information. The model, however, does not predict a distinct aversion to piecemeal information.

Schweizer and Szech (2013)

Applying the model by Schweizer and Szech (2013) to our set-up leads to the following utility function:

$$U(\pi_t) = \pi_t U_c(1) + (1 - \pi_t) U_c(0) + \theta U(\pi)$$

The first two parts capture standard expected utility where U_c is assumed to be an increasing function. The last part reflects anticipatory utility over expected consumption, where U is assumed to be increasing and concave. θ specifies the importance of anticipatory utility.[21]

Similar to Golman and Loewenstein (2014), Schweizer and Szech (2013) do not explicitly model the timing structure of future periods. Instead, the individual utility components in their model can be thought of as summaries over all future time periods, i.e., sums of future standard utilities from consumption as well as future anticipations.

We stated that Schweizer and Szech (2013) predict that subjects should prefer later information in our SL-treatments. It is easy to see that this is driven by the assumption of concavity of U. The curvature of U implies that the lottery over beliefs about future consumption that people enter if they obtain information earlier (either knowing for sure to receive the aversive stimulus or knowing for sure not to receive it) makes them worse off relative to remaining uncertain. More formally, if subjects choose sooner information, utility (before actually receiving the information) at $t = 0$ can be captured by

$$U(\pi_t) = \pi_t U_c(1) + (1 - \pi_t) U_c(0) + \theta(\pi U(1) + (1 - \pi) U(0)).$$

Utility (at $t = 0$) from choosing later information can be captured by

$$U(\pi_t) = \pi_t U_c(1) + (1 - \pi_t) U_c(0) + \theta U(\pi).$$

Thus, due to the concavity of U, objects are better of choosing later information, regardless of the prior belief π.

[21] In Schweizer and Szech (2013), there is an additional utility component capturing instrumental benefits from holding precise beliefs. Since in our context there are no such benefits, we abstract from this.

Ely et al. (forthcoming)

Here we show that, if subjects have a preference for suspense as formalized in Ely et al. (forthcoming), the they should prefer piecemeal information in the CP-treatments. In Ely et al. (forthcoming), information creates more suspense, the higher the variance of the belief that is induced by that information. In other words, suspense in a given period t is given by

$$U(E_t(\tilde{\pi}_{t+1} - \pi_t)^2),$$

where $\tilde{\pi}_{t+1}$ is a random variable capturing possible beliefs in $t+1$ induced by the information received in t. U is increasing, reflecting a preference for suspense and assumed to be concave.

Note that $E_t(\tilde{\pi}_{t+1} - \pi_t)^2$ is simply the variance of the belief in $t+1$ given information t, thus we can write.

$$E_t(\tilde{\pi}_{t+1} - \pi_t)^2 = \sigma_t^2.$$

Now, utility from suspense in the clumped information condition is:

$$E(U(\sigma_C^2)),$$

where σ_C^2 is the variance of the final belief induced by receiving the whole information in one piece.

Instead, in the piecemeal condition, utility from suspense is given by:

$$E\big(\sum_{t=0}^{4} U(\sigma_t^2)\big),$$

where σ_t^2 now reflects the belief variance induced by the piece of information in t respectively. By noting that the sum of variances in the piecewise condition equals the variance in the clumped condition, i..e,

$$E\big(\sum_{t=0}^{4} \sigma_t^2\big) = \sigma_C^2,$$

and by recalling that U is concave, one can easily see that suspense is higher in the piecemeal condition.

Appendix C

Here we analyze findings from the measure of perceived ex-ante likelihood of getting shocked we elicited for a subset of subjects from the SL- and CP-treatments (133 out of 185). We first demonstrate that our manipulation of prior probabilities was effective in the sense that it had a strong impact on perceived priors. Then we show that (similar to objective priors) subjective priors did not affect information choices.

Table 3: Linear Regression of Perceived Priors

	Perceived ex-ante likelihood	
	(1)	(2)
Prior high	33.101***	33.108***
	(2.084)	(2.060)
Prior low	-40.097***	-40.212***
	(1.583)	(1.491)
Additional Controls	No	Yes
Constant	49.688***	40.767***
	(0.311)	(12.394)
Observations	133	133
(R^2)	0.889	0.889

OLS estimates, robust standard errors in parentheses.
Perceived ex-ante likelihood for receiving a shock is regressed on a set of dummy variables capturing variations in objective priors.
Additional controls include age and gender.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

We find that in the two treatments with a low ex-ante likelihood of getting shocked (SLlow and CPlow) all subjecs stated perceived priors that reflected the fact that getting shocked was less likely than not getting shocked. More specifically, perceived priors of receiving the shocks were always less than (or equal) to 30%. 83% of subjects stated perceived priors of 10% (or lower). For treatments SLmedium and CPmedium 95% of subjects stated priors of exactly 50% (note that in these treatments we also directly told subjects in the instructions that getting shocked and not getting shocked was equally likely). For treatments with a high ex-ante probability of getting shocked (SLhigh and CPhigh) all subjecs stated perceived priors that reflected the fact that getting shocked was more likely than not getting shocked. Perceived priors of receiving the shocks for all subjects were more than (or equal) to 70%. 67% of subjects stated perceived priors of 90% (or higher). These findings are also reflected by regression analysis. In table 3 we regress perceived likelihood of getting shocked on a set of dummy variables capturing variations in objective priors. The coefficients of the dummy variables are highly significant, indicating that the exogenous variations in priors were effective in manipulating the perceived likelihood of getting shocked.

Next we analyze if subjects' perceived priors affected choices of information conditions. In table 4 we regress information choices on perceived priors and additional controls. Similar to results from table 2 where objective probabilities are used, we find no effect of perceived priors on information choices.

Table 4: Probit Estimates of Information Choices

	Dependent variable:					
	Sooner vs. later			Clumped vs. piecemeal		
	(1)	(2)	(3)	(4)	(5)	(6)
Perceived Prior	-.001 (0.005)	-.002 (0.005)	-.002 (0.005)	0.004 (0.007)	0.010 (0.008)	0.110 (0.008)
Additional Controls	No	Yes	Yes	No	Yes	Yes
Implementation left/right			.101 (0.335)			-.629 (0.507)
Constant	0.676** (0.273)	3.709** (1.639)	3.642** (1.666)	1.041*** (0.358)	1.301 (2.886)	1.265 (3.188)
Observations	70	70	70	63	63	63
(Pseudo R^2)	0.058	0.058	0.0659	0.010	0.250	0.278

Probit estimates, robust standard errors in parentheses. In regressions (1), (2) and (3), choice between sooner or later information is regressed on the perceived ex-ante likelihood of getting shocked. In regressions (4), (5) and (6), choice between clumped or piecemeal information is regressed on the perceived ex-ante likelihood of getting shocked. Additional controls include age and gender.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$