More Effort with Less Pay: On Information Avoidance, Belief Design and Performance

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Abstract

In a tedious real effort task, agents can choose to receive information about their piece rate that is either low or ten times higher. One third of subjects deliberately decide to forego this instrumental information, revealing a preference for information avoidance. Strikingly, agents who face uncertainty about their wage outperform all others, including those who know that their wage is high. This also holds for enforced uncertainty. We demonstrate that all our findings can be captured by a model of optimally distorted expectations following Brunnermeier and Parker (2005).

Keywords: Optimal Expectations, Belief Design, Performance, Real Effort Task

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1 Introduction

Orthodox economic theory posits that agents have a non-negative willingness to pay for instrumental information, that is, information that may affect their subsequent choices. They have no reason to refuse information that comes for free. In the workplace, for example, agents would want to know their precise wage. Knowing the piece rate they earn for their work allows agents to adjust their effort optimally, balancing costs and expected rewards.

Recently, this view has been challenged. When anticipations matter, agents may have an incentive to avoid information (see, e.g., Caplin and Leahy, 2001, 2004; Bénabou and Tirole, 2002; Koszegi, 2003; Brunnermeier and Parker, 2005; Schweizer and Szech, 2014). Optimal expectations will balance the psychological benefits of distorted expectations about the future with the material costs of making suboptimal choices. This recent literature studies how agents actively design their beliefs. Optimal beliefs often turn out to be coarse. That is, if an agent decides just for him- or herself, anticipation often gives a reason to avoid information structures that are too precise.

Oster et al. (2013) demonstrate the power of information avoidance and belief design in the context of medical testing for the hereditary Huntington's Disease. They show that a large fraction of people who are at risk shy away from medical testing despite costs of testing being small and behavioral adjustments to test results being large. They conclude that a model of belief design in the spirit of Brunnermeier and Parker (2005) captures observed behavior much more accurately than orthodox neoclassical approaches. In the latter, the only reason for information avoidance can be found in prohibitive costs of obtaining information.

We explore whether similar information avoidance can be found in a less extreme but familiar economic setting: the workplace. We conduct a real-effort experiment (with a strenuous task) where the piece rate that is paid can either be small or large. We first establish that information about this piece rate is instrumental. Our data show substantially greater effort and output for the high piece rate compared to the low piece rate in treatments in which subjects are informed about their piece rate at the outset. Nevertheless, we observe a sizable fraction of subjects (robustly around one third of all subjects) who prefer not to receive precise and costless information about their piece rate when given the choice. We will refer to these subjects as information avoiders. When asked in a post-experimental questionnaire why these subjects decided to stay uninformed, two main reasons emerge. Some information avoiders state that they did not want to be demotivated by a potentially low wage. Others mention their aversion to too much pressure caused by a potentially high wage. To the best of our knowledge, this presents the first laboratory evidence for the prevalence of information avoidance in an economic context in which information is instrumental.

Our data further reveal that subjects who avoid information perform even better than those who learn that their piece rate is high. A treatment in which all subjects remain uninformed about their personal piece rate and simply know the (fifty-fifty) probability distribution about the low and the high piece rate shows that this effect is not due to selection. The treatment with forced uncertainty generates outputs that are indistinguishable from the high performance results achieved by self-selected information avoiders, and consistently higher than outputs under the certain high wage. Consequently, the much cheaper treatment with forced uncertainty generates better performance outcomes than the treatment that guarantees the high piece rate to subjects.

As a theoretical explanation, we propose a simple variation of the Brunnermeier and Parker (2005) framework, allowing for heterogeneous agents. This variation captures potential differences in the way agents react to performance schemes. Whereas for some agents higher rewards unambiguously increase motivation and effort, for others such high rewards can have potential adverse effects. Specifically, when the high piece rate is high, some agents may choke under pressure, a phenomenon that has received considerable attention in the psychology literature since Baumeister's seminal paper (Baumeister, 1984) and that has more recently also been documented in a number of economic studies (see, for example, Dohmen, 2008; Ariely et al., 2009; Apesteguia and Palacios-Huerta, 2010).

In a population with such heterogeneous agents, uncertain incentives may prove superior to any fixed reward system. Coarse information structures may allow different types of agents to adjust their expectations in different ways, according to their personal preferences, and to bias beliefs according to their individual needs. Those who value the motivation-enhancing effect of high wages may bias their beliefs towards more optimism, which increases their output. Those who dread choking may bias their beliefs downwards, thereby enhancing their performance. Optimal incentive design might, thus, make deliberate use of uncertainty. Indeed, tournament incentives which are widely used in the workplace might exploit this very mechanism.

Our paper is organized as follows. Section 2 describes the design and procedures of our experiment. Section 3 presents our results and sets them into the context of the related literature. Section 4 proposes a variation of the Brunnermeier and Parker (2005) model allowing for heterogeneous agents, and Section 5 concludes.

2 Experimental Design

We conduct three main treatments, Full Info, No Info, and Info Choice. These treatments are identical except that information about piece rates varies—exogenously or endogenously.

In all treatments, subjects know that they have to work on a tedious task. Subjects have 60 minutes to enter lines of strings, containing numbers, upper case and lower case letters, *backwards* into the computer interface. Each string consists of 60 characters. For example, one of the strings used in the experiment looks as follows.

NXgCX7JHxYZj2cfBSd8JtkYp3LPcyDX8y8NNQhrzJfg22S2ACjC85EQ43B7L

Each task consists of one of these randomly generated strings and all tasks are identical for all subjects. After each string that subjects enter, they learn whether they entered it correctly and they can then move to the next stage by clicking the corresponding button. Subjects are informed about the time that remains. Subjects are not allowed to use any electronic devices, but are each given a copy of a well-known German weekly, called DER SPIEGEL. This magazine has a weekly circulation of more than one million. It contains all sorts of articles, from investigative journalism over reports on German and international politics to articles about scientific discoveries and information on cultural events. Subjects are explicitly told that they can make use of the magazine "...whenever, during the experiment, [they] would like to take a break or pass time". Thus, no subject has to feel obliged to work on the task if he or she prefers to spend their time otherwise.

Subjects know that piece rates per task are either high (1 EUR) or low (0.1 EUR).[1] We vary across treatments how much information subjects have about their piece-rate when working on the task.

The structure of our main treatments is as follows. When entering the lab, each participant is randomly allocated a red or a black chip by one of the experimenters. Half of the

[1] At the time of the experiment, 1 EUR $\approx$ 1.37 USD

chips are black, the other half red. Each participant is then told to take a seat at a computer terminal where the screen shows a square with the color corresponding to the color of his/her chip. Subjects know that depending on the color (red or black), they can either earn 0.1 EUR or 1 EUR for each correctly entered string.

To determine which color corresponds to a high piece rate and which to a low one, we use the following procedure. We prepared two pieces of cardboard which look identical from the outside when folded, but inside either show a red or a black square. After showing the cardboard pieces (from outside and inside) to all participants, they are folded, secured with paper clips, placed into a small bag and shuffled. Another experimenter then draws one of the two folded cardboard pieces. The color of the drawn piece determines which color is associated with the high wage for this session.

In treatment Full Info, the cardboard is unfolded and the color is revealed to all subjects immediately. Thus subjects know whether they are going to receive the high piece rate, or the low one.

In treatment No Info, the folded cardboard is placed onto a white board at the front of the room where it remains for the whole duration of the experiment and is revealed to all participants once the allowed time for the effort task (60 minutes) is up. Hence subjects do not know whether they earn the high or the low piece rate when working on the task.

In treatment Info Choice, subjects are asked on their computer screen whether they would like to receive the information about the color now, or wait until the end of the experiment. After clicking the button corresponding to their choice, another screen appears which states the subject's decision. After all subjects have made their choice, the experimenter walks through the lab and privately reveals the color inside the cardboard to those subjects who decided to see it. As in the No Info treatment, the folded cardboard is then placed onto a white board and revealed afterwards. Thus, in this treatment, subjects choose whether they want to know their piece rate beforehand or not. Then the real effort task starts.

We would like to add that we first ran a couple of sessions without the weekly magazine. Then we realized that it would be helpful to integrate an explicit alternative to working on the task. Otherwise, it may still be fine for subjects to work on the tedious task if they find no other interesting occupation in the lab. We report the findings from these sessions as well. Overall, results are pretty similar to those in our main treatments, though effects are slightly less pronounced. This confirms that information on the piece rate transports instrumental value, specifically when subjects have an alternative to spend their time on.

Finally, we implement another treatment, Medium Wage, where every subject earns a piece rate of 0.55 EUR. In this treatment, there is no need for any randomization in the beginning and subjects immediately start working on the task after reading the instructions. They are, however, given some context as we inform them that other participants could earn either 0.1 EUR or 1 EUR for the same task in previous experiments. We decided to run this treatment in order to understand whether a piece rate of 0.55 EUR leads to the same results as the uncertain piece rate with expected value of 0.55 EUR in the No Info treatment. As we will see, these two treatments lead to different results, with subjects performing better in the No Info treatment. While average piece rates in No Info exactly correspond to those in the 0.55 EUR treatment, No Info leads to significantly better performance results.

At the end of the experiment, we ask subjects to provide us with some basic demographic information about themselves. In treatment Info Choice we also ask them to state their reasons for choosing (not) to obtain information about their piece rate. In total, our sample consists of 238 subjects. All treatments were run at the WZB-TU Laboratory in Berlin between November 2013 and April 2014. There were no restrictions imposed on the invited participants regarding gender, subject of study, or previous experience with experiments. We used z-tree (Fischbacher, 2007) as the experimental software and ORSEE (Greiner, 2004) to recruit subjects.

3 Results

In Info Choice, acquiring information allows subjects to learn whether they receive a high or a low piece rate, where the high piece rate is 10 times higher than the low one. We find that about one third of our participants decide to avoid this important information. In the four sessions that we conducted for treatment Info Choice, 30 out of 95 subjects (31.6%) individually and independently choose not to know their piece rate while working on the task. These subjects thus preferred to work on a tedious task without knowing whether they received 1 EUR or 0.1 EUR per correctly solved task.

As a robustness check, we can look at the two sessions we ran that where identical to Info Choice except that subjects did not have access to the magazine. There, 15 out of 44

piece rate	Full Info		Info Choice		No Info		Medium Wage	
	mean (s.d.)	median	mean (s.d.)	median	mean (s.d.)	median	mean (s.d)	median
0.1	20.67 (10.49)	22	17.69 (11.37)	17				
0.55							24.66 (9.58)	24
1	26.21 (8.75)	26	25.53 (9.86)	23				
unknown			30 (9.35)	29	28.02 (8.41)	28		

Table 1: Mean and median performance across treatments

subjects (34.1%) decided not to acquire information, an effect of almost identical magnitude.

The difference in piece rates is sizable and information about piece rates is instrumental as can be seen from the performance results of participants in the treatment Full Info. Subjects in this treatment did not have the option to avoid information and were fully informed about their piece rate from the outset.[2] Using the number of correctly solved tasks as our measure of performance[3], we find that subjects working for the low piece rate of 0.1 EUR solve 20.67 tasks on average with a median of 22, whereas for subjects working for the high piece rate of 1 EUR, the average is 26.21 and the median is 26. This difference is significant (p=0.043) and tells us that subjects in treatment Full Info received instrumental information.[4] Subjects' performances reacts to their wage. On average, the high piece rate leads to significantly better performance results. Of course, there may be individual differences, and perhaps some subjects might perform better under a low piece rate than due to choking under pressure. Yet also in this case, it would be instrumental to learn which piece rate is paid out while working on the task. In Table 1 we present the full performance results for all treatments.

It is interesting to examine subjects' explanation in our post-experimental questionnaire for why they avoided information. There are basically two types of answers with many subjects explaining that they wanted to avoid being demotivated in case of having a low

[2]Indeed, on the screen where they enter the strings, subjects always see their wage. It would thus be very hard for them to try to forget about their wage and create an environment for themselves that would allow them to recreate a situation with uncertainty about the wage.

[3]The other possible measure of effort would be the number of attempted tasks. Arguably, our task is prone to errors and for some subjects this measure might more correctly reflect the actual effort put in. Others might choose a more risky strategy and tolerate more errors. The two measures are highly correlated ($\rho = 0.8533$, p-value=0.0000) and the results are very similar.

[4]Unless indicated otherwise, all p-values are calculated using a Wilcoxon Rank Sum test.

piece rate	Pooled		Pairwise test with (p-value)			
	mean (s.d.)	median	$w = 0.1$	$w = 0.55$	$w = 1$	w unknown
0.1	18.90 (11.03)	19				
0.55	24.66 (9.58)	24	0.0091			
1	25.83 (8.56)	25	0.0003	0.2073		
unknown	28.78 (8.78)	28	0.0000	0.0015	0.0645	

Table 2: Pairwise comparisons of performance results across treatments

piece rate while others stressed that they were afraid of the pressure in case of having a high piece rate. More on this at the end of this section.

Remarkably, subjects who avoid information in Info Choice perform significantly better than subjects who decide to receive information on the piece rate. This suggests that information avoiders on average worked under beliefs that motivated their performance in better ways than those subjects who received information. Information avoiders solved 30 tasks correctly on average, while information receivers solved only 21.31 tasks correctly (p=0.0002). Strikingly, information avoiders even outperformed the subgroup of subjects who received the information that their piece rate was high (30 versus 25.53, p=0.0573).

As performance results of information avoiders were that high, we wanted to understand whether self-selection played a role for these results. In order to understand the role of selection, we ran treatment No Info with forced uncertainty. Subjects knew that piece rates were either 1 EUR or 0.1 EUR with equal probability. Thus, subjects' knowledge in No Info was exactly as the knowledge that information avoiders had in Info Choice. Performance results between these two groups of subjects are remarkably similar and statistically indistinguishable (30 versus 28.02, p=0.3710). Not receiving information about the piece rate enhances performances, even if subjects do not freely opt for this lack of information, as revealed by the comparison of No Info with Full Info (23.44 versus 28.02, p=0.0274).

Table 2 shows pooled data for our sample for different information about wages—ignoring whether the precise information is exogenously given or endogenously chosen. Such pooling is interesting as we show above that there are no selection effects. We find that the result from above regarding the effort level for the known wages 0.1 EUR and 1 EUR carries over: Subjects perform significantly better at the higher wage (18.90 vs. 25.83 correct tasks on

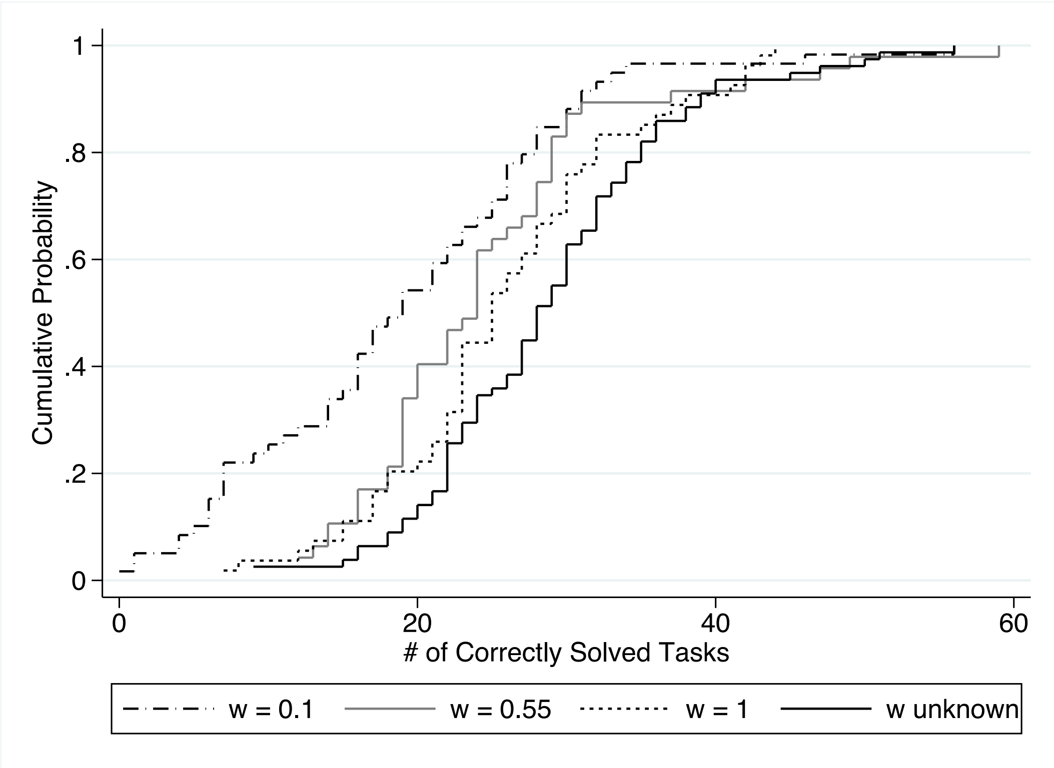

Figure 1: CDFs of effort choices, by wage.

average, p=0.0003). Subjects in treatment MEDIUM WAGE, who work for a wage of 0.55 EUR, solve on average 24.66 tasks correctly. This is significantly more than the performance of subjects at 0.1 EUR. It is furthermore lower, yet not significantly different from the performance of subjects who receive 1 EUR (p=0.2073).

Pooling our data on performance of subjects who did not know whether their piece rate is 0.1 EUR or 1 EUR, we obtain an average performance of 28.78 correctly solved tasks. In other words, a participant who does not know his wage solves about 3 more tasks than a subject who knows that he or she receives the high wage of 1 EUR per solved task (p=0.0645).[5] Figure 1 plots the empirical distribution functions for the four cases. Visually, the distribution for the case in which the piece rate is unknown almost first-order stochastically dominates the distributions for all other treatments, in which piece rates were deterministic.

Our results on performance and information are inconsistent with classical models of expected utility. Consider a utility function that is separable in monetary payoffs and effort costs, and make the natural assumption that the cost of effort is increasing. Then, irrespective

[5] Using attempted tasks as the effort measure we find a similar statistically significant effect: when the wage is unknown subjects attempt on average 40.51 tasks as compared to 35.46 at the certain wage of 1 EUR (p=0.0052).

of the agents' risk attitudes, the optimal level of effort is predicted to be higher in the case where the agent works for a fixed piece rate compared to the case where he faces a lottery over this piece rate and any lower piece rate.

At the end of the experiment, after subjects finished working on the task, we asked them to state the reasons for obtaining (avoiding) information about their wage. Among those who decided to obtain the information, the vast majority of people (49 out of 65) state that they wanted to know their wage as to adjust their effort according to the wage, thereby acknowledging the instrumental role of information for them.[6] A minority of people (13 out of 65) explicitly state preferences for information, e.g. "curiosity", as their reason for obtaining information. Looking at subjects who avoided information, a more diverse picture emerges. On the one hand subjects state that by not knowing their wage they wanted to ensure that they would be sufficiently motivated in light of the risk of receiving a low wage (7 out of 30), and on the other hand subjects reveal that they are afraid of being under too much pressure when knowing for certain that their wage is high (8 out of 30).[7] Interestingly, another group of subjects (9 out of 30) explicitly state that both potential demotivation as well as pressure of a high wage influenced their decision, or that they felt they could work best without being influenced too much by a certain wage. All these answers point towards an important role for belief design in our setting. Subjects consciously reflect on they way their performance will be affected by the wage and deliberately choose wage uncertainty in order to optimize their effort choice.

Related findings in the literature. Our finding that roughly a third of participants choose to avoid instrumental information does not have a precedent in the literature in so far as settings as the workplace are concerned. Oster et al. (2013) document evidence for information avoidance in the domain of health outcomes. The authors find that only 7 percent of individuals that can be classified as being at-risk of contracting the hereditary Huntington Disease decide to undergo testing that provides them with certainty about their health status. This effect of information avoidance is significantly larger than ours, although unlike in our setting obtaining information is not costless.

[6] A typical statement was, for example, "I wanted to know whether putting in effort would be worthwhile, if the wage would have been low, I would not have bothered".

[7] For the first group, a typical statement reads "with the hope of the higher payment, I wanted to keep up my motivation", whereas those potentially choking under the pressure of a high wage gave answers like "I chose not to learn the color in order to take the pressure off myself. I would have been even more error-prone".

In a laboratory study Ganguly and Tasoff (2014) give subjects the option to avoid being tested for herpes at a cost of 10 USD. Depending on the type of virus they are tested for, 5.2% to 15.6% of individuals are willing to give up 10 USD in order not to be tested, an effect substantially smaller than ours. While in this setting information about the health status is instrumental, Ganguly and Tasoff (2014) also look at demand for non-instrumental information. Giving subjects the option to learn (or avoid) information about potential monetary payments at some cost, they find that some subjects are willing to pay money to avoid learning about the outcome of a lottery whereas others are willing to pay for early resolution of uncertainty (each of the two groups roughly comprises between 30% and 40% of the sample).

Eil and Rao (2011) find evidence for information avoidance when they elicit subjects' willingness-to-pay of learning their relative rank in terms of IQ and attractiveness. The authors show that subjects who believe themselves to be below average in a category are willing to pay for not learning their true rank in the ability distribution. However, in their setting when subjects were given the option to learn their rank, this information did not have an impact on their earnings in the experiment, and is thus non-instrumental.

Likewise, Eliaz and Schotter (2010) and Falk and Zimmermann (2014) analyze the demand for non-instrumental information. Both studies find evidence that subjects have a preference for obtaining non-instrumental information. In Eliaz and Schotter (2010), a majority of subjects choose to pay a fee to obtain information that will only alter their confidence about their decision, but not their decision itself. In Falk and Zimmermann (2014), subjects can choose the timing when to find out about whether they are to receive small electrical shocks and a large majority chooses to find out immediately, and can thus be classified as "curious", i.e. having a strict preference for information. Compared to our setting, these results indicate that we might be underestimating the magnitude of the effect of anticipatory utility and the desire for belief design. For subjects in our sample with a high degree of curiosity (we can identify some of them via their answers in the post-experimental questionnaire, see above) or desire for confidence, these motives might outweigh the benefits from being able to optimally design their beliefs when the wage is unknown.

In relation to our findings in the domain of effort choices, Ariely et al. (2009) find in experiments conducted in the U.S. and in India for a variety of different tasks that high incentives might backfire and reduce performance. For the majority of the tasks administered in their study, performance varies non-monotonically with the compensation offered; moderate incentives typically deliver the highest performance level. Dohmen (2008) and Apesteguia and Palacios-Huerta (2010) document a similar effect for professional athletes. Building on Baumeister (1984), all these studies identify the phenomenon that individuals may choke under too much pressure induced by high rewards. However, note that our Medium Wage treatment reveals that this effect cannot explain our results on its won as subjects at the known wage of 1 EUR do not solve fewer tasks than individuals working for 0.55 EUR (if anything, they solve more tasks correctly). Furthermore, in our experiment, a wage schedule that pays either 0.1 EUR or 1 EUR induces significantly higher effort levels compared to when subjects are simply paid the expected wage of 0.55 EUR with certainty. These analyzes reveal that that the effects of pressure cannot be the sole behavioral issue in our data. Nevertheless, it appears that some of our subjects were afraid of choking under pressure.

The paper that documents an effect closest to ours is Shen et al. (2015). There, the authors document that in certain real-effort situations a small reward that is uncertain and either higher or lower (e.g. 1 USD or 2 USD with equal probability, or a smaller versus a larger amount of candy) may generate a better performance than the fixed higher reward (e.g. 2 USD). In all the settings studied by Shen et al. (2015), overall rewards are pretty small. The authors suggest that the uncertainty about these rewards may increase subjects' excitement, and subsequently, their motivation with which they engage in the task. While this may be true when stakes are low anyway, it is unlikely that excitement alone drives our results, in which overall stakes can be rather high (e.g. about 30 EUR if the piece rate is 1 EUR). Various papers show that most agents are risk-averse in economic settings, and try to avoid overly risky lotteries (e.g. Holt and Laury, 2002). As discussed above, in our ex-post questionnaire, many subjects argue that they decided to avoid information in order to prevent demotivation from a low piece rate, while others stated that they wanted to avoid feelings of pressure . Excitement from the lottery does not seem to play a major role in the explanations subjects gave. In the next section, we adapt the model of Brunnermeier and Parker (2005) on belief design in order to account for these heterogeneous design goals across agents.

4 Theory

In the model by Brunnermeier and Parker (2005) (BP henceforth), agents optimally choose their beliefs as to balance benefits from anticipatory emotions and costs in decision making due to biased beliefs. In our experimental setting, subjects either know the wage they are working for (in treatments Full Info, Medium Wage, and if they opted for information to be revealed in Info Choice) or they face uncertainty about whether it is the high or the low wage (No Info and Info Choice, if they decided to stay uninformed). Whereas the former case leaves no room for manipulation of beliefs, in the latter subjects might hold subjective beliefs that that do not treat the high and the low wage as being equally likely (which would be the natural objective belief).

In our setting, the agent derives utility from the payment he receives for solving tasks but has to bear the cost of effort. We model effort directly as the number of correctly solved tasks, e, and assume risk neutrality throughout. The (expected) payment is we, where w is the (expected) wage. As described in the previous section, we aim to develop a model that can capture the notion of "choking under pressure", that is, the phenomenon that an agent's performance might be adversely affected if the (expected) wage for the task is high. We therefore allow the cost of effort to not only depend on e, but also (negatively) on w for these agents. In the specific case we look at below, such a cost function delivers an optimal effort level that is "hump-shaped" in the wage, i.e. effort is maximized at an intermediate wage. In cases where there is uncertainty about the wage, we interpret w as the expected wage, potentially distorted by optimal belief design by the agent. Assuming additive separability of monetary payments and effort costs the agents' consumption utility is then given by $u(e, w) = we - c(e, w)$.

At time 0, subjects in treatment Info Choice decide whether to learn their wage or not. Subjects in all other treatments either know their wage by default or do not. At time 1, subjects decide how much effort to exert when working on the task and they experience *anticipatory utility* based on their expected consumption utility which materializes at time 2. Following BP, we assume that agents who do not know their wage can can optimally choose their beliefs $\pi \in [0, 1]$, where π denotes the belief that the wage is high, w_H, rather than low, w_L (where $w_H > w_L > 0$). The chosen belief affects anticipatory utility but has not direct effect on consumption utility. Indirectly, however, it does affect consumption utility through the agent's effort choice which will be based on the subjective wage $w(\pi) = \pi w_H + (1-\pi)w_L$.

Agents' overall well-being is given by the sum of anticipatory utility and consumption utility where the relative weight of anticipatory utility is denoted by $\delta \geq 0$. Given a belief π and the corresponding expected wage $w(\pi)$, the agent chooses effort e to maximize $w(\pi)e - c(e, w(\pi))$, i.e. the anticipated consumption utility. Expecting this effort choice $e^*(w(\pi))$, the agent maximizes overall well-being by choosing the belief π that balances anticipatory feelings and final consumption utility. Due to the risk-neutrality, the belief choice directly corresponds to a choice of the subjective wage. We can therefore suppress the dependence on π and allow the agent to choose $w \in [w_L, w_H]$ directly. Defining $\bar{w} = \frac{1}{2}(w_H + w_L)$, the agent then maximizes

$$U(w|\bar{w}) = \delta \left[we^*(w) - c(e^*(w), w)\right] + \bar{w}e^*(w) - c(e^*(w), \bar{w}) \tag{1}$$

The optimal choice of beliefs has to consider the following trade off: an agent may distort beliefs away from $\bar{w}$ in order to increase his anticipatory utility. By being more optimistic about his odds to be paid the high wage, he manipulates himself into exerting more effort since effort is determined by his subjective expected wage. However, choosing a belief different from $\pi = 0.5$ may come at a cost because the agent will exert more effort than what is optimal given $\bar{w}$. In general, choking and non-choking agents differ in their choice of how much to distort their beliefs: under our assumptions on the cost function, by being more optimistic, non-choking agents unambiguously increase their anticipatory utility and the more they care about it the more optimistic they will be. Agents who choke at high wages, however, will prefer to distort their beliefs less in order to work at a (subjective) expected wage that is lower than w_H and closer to the wage that maximizes their effort.

It is worth noting that the wage that enters the cost function differs between the anticipatory utility term and the consumption utility term. When the agent experiences "true" consumption utility, his cost of effort is given by the undistorted expected wage $\bar{w}$. Nevertheless, when anticipating these costs we assume that they are based on the subjective wage w.

To demonstrate how this variation of BP can account for our experimental findings, we formalize the above intuition using the family of cost of effort functions given by

$$c(e,w) = \frac{1}{2}\alpha e^2 + \gamma e f(w)$$

with $\alpha > 0$, $\gamma \geq 0$, and $f(w) > 0, f'(w) > 0, f''(w) > 0$.

It is straightforward to see that for a given w, optimal effort is given by

$$e^*(w) = \frac{1}{\alpha}\left(w - \gamma f(w)\right).$$

Optimal effort e^* is strictly concave in the (expected) wage and if γ is sufficiently large, e^* is decreasing for sufficiently large w. We add two more assumptions which essentially impose that γ is not too high. We assume that $w_L > \gamma f(w_L)$ and $w_H > \gamma f(w_H)$ so that optimal efforts e^* are positive over $[w_L, w_H]$. Moreover, we assume $\gamma f'(w_L) < 1$ so that optimal efforts are increasing in wage for small wage levels, though not necessarily for high wages.

As desired, our model delivers an optimal effort level that can be hump-shaped in the wage. Specifically, we define $\hat{w}$ as the unique wage that maximizes effort. If an interior solution $\hat{w} < w_H$ exists, it solves $\gamma f'(\hat{w}) = 1$. This means that for any agent with $w_H > \hat{w}$ effort is maximal at a wage level lower than w_H and we think of these agents as "choking" under the pressure of a high wage. To simplify the exposition below, we also assume that $\hat{w} > \bar{w}$. If there is no $\hat{w}$ solving $\gamma f'(\hat{w}) = 1$, we know that e^* is increasing and $\hat{w} = w_H$. Define $\hat{\gamma}$ as $\hat{\gamma} = 1/f'(w_H)$. Then, the agents who do not choke under pressure, that is, those with $\hat{w} = w_H$, can be characterized as the agents with $\gamma \leq \hat{\gamma}$. These agents always exert more effort as the wage increases.

Before presenting the solution for the full problem, consider an agent who only cares about anticipatory utility. This agent will choose w to maximize $we^*(w) - c(e^*(w), w)$. By the envelope theorem, the first order condition for this problem is given by

$$e^*(w)\frac{de^*(w)}{dw} = 0. \tag{2}$$

Since e^* is positive, the unique maximizer of anticipatory utility is the wage $\hat{w}$ which maximizes effort. This holds both for the interior solution of the choking agents and for the corner solution $w = \hat{w}$ of the non-choking agents. [8]

[8] It is straightforward to check that this equation has more than one solution, but that only $w = \hat{w}$ is indeed a maximum, provided that $\hat{w} < w_H$. Hence, for choking agents, the wage that maximizes anticipatory

Next, consider the other extreme, an agent who does not care about anticipatory utility at all, $\delta = 0$. He chooses the wage w to maximize $\bar{w}e^*(w) - c(e^*(w), \bar{w})$, which yields the following first order condition:

$$\frac{de^*(w)}{dw}\left(e^*(\bar{w}) - e^*(w)\right) = 0$$

It is straightforward to check via the second derivative that $w = \bar{w}$ maximizes the objective function. However, for choking agents there might be a second maximizer due to the hump-shaped nature of effort in wage, namely the effort level that induces the same effort level as $\bar{w}$, if it exists. For our purposes it is immaterial which one of the two the agent chooses: A "standard" agent who is not affected by anticipatory emotions chooses the same effort level as an agent that faces a sure wage of $\bar{w}$, like in our MEDIUM WAGE treatment. Thus, for $\delta = 0$ our model nests the neoclassical model, since under risk neutrality effort choices should only depend on the average wage.

Putting these two effects together for intermediate values of δ, we obtain the FOC of the full objective function in (1) as:

$$\frac{de^*(w)}{dw}\left(e^*(\bar{w}) - (1-\delta)e^*(w)\right) = 0.$$

Analyzing this expression allows us to derive the solution w^* to the maximization problem:

Proposition 1. *Define $\delta^* = 1 - \frac{e^*(\bar{w})}{e^*(\hat{w})} \in (0, 1]$. (a) For all $\delta < \delta^*$, the optimal wages w^* are implicitly defined through the equation*

$$e^*(\bar{w}) = (1-\delta)e^*(w^*)$$

All solutions induce the same effort and satisfy $w^* > \bar{w}$. (b) For $\delta \geq \delta^*$, $w^* = \hat{w}$.

Proof. See Appendix. □

The proposition tells us that in the case where $\gamma < \hat{\gamma}$ (i.e. where the agent does not choke and therefore $\hat{w} = w_H$) a sufficiently large δ implies that the agent will choose $\pi = 1$, that is, he chooses effort and receives anticipatory utility under the (distorted) belief that he will be paid w_H per correctly solved task with probability 1. These non-choking agents then

utility is interior and equal to the effort-maximizing wage, whereas for non-choking agents the optimal wage is w_H since for $\gamma < \hat{\gamma}$ sufficiently low the LHS in (2) is positive everywhere on $[w_L, w_H]$.

exert the same effort in the case where they do not know their wage and in the case where they have found out that their wage is w_H. Non-choking agents with a lower value of δ, will adopt interior $\pi \in [0.5, 1)$ because they care relatively more about the upward distortion of consumption utility induced by over-exerting effort.

Agents that choke under pressure, as represented by a positive value of γ do not distort beliefs in such an extreme way. Since their optimal level of effort is strictly below $e^*(w_H)$, they will, provided they care enough about anticipatory utility (δ is large enough) distort beliefs only up to the point where they exert the maximum level of effort, $e^*(\hat{w})$. Hence, the model delivers the result that these choking agents exert a strictly higher effort in the case where they do not know their wage, compared to where they know for sure that they will be paid according to w_H.

Corollary 1. *Consider a group of agents consisting of two types of agents with different parameters $\gamma_2 > \hat{\gamma} > \gamma_1$. If $\delta \geq \delta^*$ then average effort (= average number of correctly solved tasks) of the group will be higher when the agents do not know whether their wage is w_L or w_H than in the case when they all know that that their wage will be w_H.*

Proof. Under the assumptions on γ_1 and γ_2 (which ensures that the effect of choking is sufficiently large as to guarantee that agents of type 2 ("choking agents") put in maximal effort at a wage lower than w_H) and δ (that anticipatory utility is large enough) it is then the case that when the wage is unknown, $w_1^* = w_H$ and $w_2^* = \hat{w}$. Furthermore, agents of type 1 exert effort of $e_1^*(w_H)$ whereas agents of type 2 exert effort of $e_2^*(\hat{w})$. Under a known wage of w_H, the respective effort levels are given by $e_1^*(w_H)$ and $e_2^*(w_H) < e_2^*(\hat{w})$. Choking agents thus exert higher effort when the wage is unknown whereas standard agents exert the same effort level as for a known high wage, proving the statement. □

Our variant of BP can also explain that in treatment Info Choice some agents choose not to obtain information about their wage. An agent who decides whether to learn the wage faces a tradeoff between optimally choosing his effort after having eliminated uncertainty about the wage, but also forgoes the opportunity to benefit from being able optimally to choose his belief and benefit from distorting anticipatory utility upwards. Formally, an agent decides not to learn the wage if

$$\begin{aligned}&\delta \left[w^* e^*(w^*) - c(e^*(w^*), w^*)\right] + \bar{w} e^*(w^*) - c(e^*(w^*), \bar{w}) \geq \\ &\frac{1}{2}(1+\delta)\left[w_H e^*(w_H) - c(e^*(w_H), w_H) + w_L e^*(w_L) - c(e^*(w_L), w_H)\right] \qquad (3)\end{aligned}$$

Proposition 2. *There exists a $\hat{\delta} \geq 0$ such that all agents with $\delta > \hat{\delta}$ prefer not to know whether their wage is w_H or w_L.*

Proof. Dividing both sides by $(1 + \delta)$ ensures that the RHS of the condition in (3) stays constant once we increase δ. The LHS is then simply a weighted average between anticipatory utility and consumption utility. Using a standard envelope theorem argument, we then see that increasing δ strictly increases the LHS because $w^*e^*(w^*) - c(e^*(w^*), w^*) \geq \bar{w}e^*(w^*) - c(e^*(w^*), \bar{w})$. Hence, for large enough δ, inequality (3) is satisfied. □

To conclude this section, consider again the experimental results described in the previous section. An orthodox model of effort choice without anticipatory utility or choking ($\delta = \gamma = 0$), would predict that for all treatments where the wage is known, average effort is increasing in the wage, $e^*(w_L) < e^*(\bar{w}) < e^*(w_H)$ and that under risk neutrality agents who do not know their wage choose $e^*(\bar{w})$. Also, we should not see anybody rejecting the information about the wage. Our results do not conform to this. Introducing anticipatory utility can remedy this: agents who do not know their wage, optimally choose more optimistic beliefs, inducing themselves to exert more effort. If they value anticipatory utility sufficiently much, they will actively choose to stay uninformed. Observe, however, that such a model predicts that the highest effort level chosen by the uninformed subjects is at most $e^*(w_H)$. It cannot explain our finding that in the aggregate subjects with an unknown wage perform better than $e^*(w_H)$. Hence, in order to fully explain our results, we must incorporate the concept of "choking" into the BP model. We posit that some agents' productivity may be highest at a wage strictly below w_H. For a known wage these agents' performance may still be as in the standard model, but their effort will be highest at a subjective wage $\bar{w} < w < w_H$. Not knowing the wage might therefore induce them to be most productive. Moreover, if they care enough about anticipatory utility, they will also choose not to learn the wage before they start working.

5 Conclusion

We considered a real-effort task in which agents can choose to receive instrumental information about their piece rate before exerting effort. Our data show that one third of subjects deliberately choose not to receive information, revealing a preference for information avoidance. Furthermore, agents avoiding information achieve considerably better performance than agents receiving the information.

For comparison, we run a treatment in which subjects are forced to stay uninformed on the piece rate. Performance again turns out to be high. Uncertainty, even if enforced instead of chosen, significantly enhances performance. This is a striking finding very much at odds with predictions from orthodox economic theory and indeed with deep-rooted economic intuition.

Looking into reasons why subjects choose to avoid information reveals that there are two types of subjects: some avoid information in order to avoid potential demotivation if the piece rate turns out to be low; others say that learning about a high piece rate could make them feel stressed and lead to choking under pressure. Both effects have been documented in the (psychological) literature.

In an otherwise standard Brunnermeier and Parker (2005) model, we incorporate heterogeneity of agents and the possibility of choking under pressure. This extended version of BP can easily capture all key patterns of our data. A substantial part of agents may thus have biased their beliefs about the piece rate considerably upwards in order to stay motivated in the task. Other agents may have adjusted beliefs more cautiously in order to avoid feeling of pressure.

By and large, our study documents that giving agents room to design their beliefs may not only be beneficial in contexts such as health (as has been documented by Oster et al., 2013 and Ganguly and Tasoff, 2014), but also in economic settings of paid effort exertion and performance in the workplace. While randomization over piece rates may be unpopular with workers and unions, there are other more subtle and perfectly accepted ways of introducing uncertainty about effective pay in a firm. Any type of incentive scheme that introduces interdependencies between workers' payments generates scope for beneficial belief distortion and rampant overprovision of effort in contests may have one of its root causes in anticipatory utility.[9]

The possibility of inducing more effort with less pay is tantalizing and offers much scope for further research.

[9]For a detailed survey of the experimental literature on contests, see Dechenaux et al. (2014) who document evidence for overprovision of effort in a large number of different settings.

6 Appendix

6.1 Proof of Proposition 1

Using the specific functional form, the first order condition for maximizing (1) can be written via equation (4) as:

$$\frac{de^*(w)}{dw}\left(e^*(\bar{w}) - (1-\delta)e^*(w)\right) = 0$$

Solutions of this condition are either $\hat{w}$, since $\frac{de^*(w)}{dw}\mid_{w=\hat{w}} = 0$, provided it exists, or the w that solve the term in brackets. In order to solve the term in brackets, $e^*(w)$ must be larger than $e^*(\bar{w})$ and δ must not be too large. The boundary value δ^* is derived from $e^*(\bar{w}) = (1-\delta^*)e^*(\hat{w})$. A solution w^* which sets $e^*(\bar{w}) - (1-\delta)e^*(w)$ to zero exists whenever $\delta \leq \delta^*$. Since e^* is continuous and increasing over $[0, \hat{w}]$, there is always a solution $w^* \in [\bar{w}, \hat{w}]$. There may be further solutions $w^* \in [\hat{w}, w_H]$ which induce the same wage.

Consider the second derivative, given by

$$-(1-\delta)\left[\frac{de^*(w)}{dw}\right]^2 + \frac{d^2e^*(w)}{dw^2}\left(e^*(\bar{w}) - (1-\delta)e^*(w)\right)$$

If the solution to the problem is given by a solution of $e^*(\bar{w}) = (1-\delta)e^*(w^*)$, this is a maximum because such a solution can only exist for $\delta < \delta^* < 1$, so that the second derivative is negative.

Given the definition of $\hat{w}$, $e^*(w)$ is maximized at $\hat{w}$ if $\hat{w} < w_H$. $\hat{w}$ sets the first term in the second derivative to zero. Furthermore, for any $\delta > \delta^*$, $\frac{d^2e^*(w)}{dw^2}\mid_{w=\hat{w}} < 0$ and the term in brackets then is positive and we thus have a maximum here as well. Note that for $\delta < \delta^*$, $\hat{w}$ will be a minimum because in this case $e^*(\bar{w}) - (1-\delta)e^*(\hat{w})$ will be negative. For $\delta = \delta^*$, the second derivative is zero, but for $\varepsilon > 0$, the first derivative at $\hat{w} - \varepsilon$ is positive and at $\hat{w} + \varepsilon$ it is negative. In the case where $\hat{w} = w_H$, and there is no w to satisfy $e^*(\bar{w}) = (1-\delta)e^*(w^*)$, the first derivative in (4) will be strictly positive and thus $w^* = w_H$.

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