How do agents react to dynamic wage increases? An experimental study

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Abstract

We investigate how workers' performance is affected by the timing of wages in a real-effort experiment. In all treatments agents earn the same wage sum but wage increases are distributed differently over time. We find that agents work harder under increasing wage profiles if they do not know these profiles in advance. A profile that continuously increases wages by small amounts raises performance by about 15% relative to a constant wage. The effort reactions can be organized by a model in which agents reciprocally respond to wage impulses, comparing wages to an adaptive reference standard determined by the previous wage.

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1 Introduction

The aim of the present study is to investigate if and how workers' performance is affected by the timing of wage increases. We conduct a laboratory experiment in which an agent repeatedly works on a real-effort task. Before the task starts, the principal has to choose between several wage profiles for the agent that vary the size and frequency of wage increases, while keeping the overall wage budget constant. We find that increasing wage profiles significantly raise overall performance when wage increases occur continuously and agents do not know the full wage profile in advance.

There is abundant evidence from laboratory experiments suggesting that principals can induce extra effort by offering generous wages, even in the absence of performance-contingent incentives. Starting with the seminal study by Fehr, Kirchsteiger and Riedl (1993), a large body of research finds positive correlations between wages and efforts of experimental agents (Fehr, Götte and Zehnder 2009, and Charness and Kuhn 2011, survey important studies in this field). A common explanation for these results rests on the notion that generous wages are perceived as a kind act by the agent that in turn triggers positive reciprocal responses (see Akerlof 1982, Rabin 1993, Levine 1998, Dufwenberg and Kirchsteiger 2004, Falk and Fischbacher 2006, for theoretical approaches to explain this phenomenon).[1]

However, the evidence for the persistence of positively reciprocal reactions by workers in the field is mixed. In two field experiments, Gneezy and List (2006) and Bellemare and Shearer (2009) find positive output responses after workers have received surprise payments. Yet this positive effect vanishes shortly after the experience of the wage

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[1] Fehr and Schmidt (1999) and Bolton and Ockenfels (2000) provide explanations for positive wage-effort correlations based on inequality aversion. Moreover, the findings by Cohn, Fehr and Götte (2015) highlight that fairness perceptions might be key to triggering positive performance effects, as only workers who display social preferences and feel underpaid respond positively to wage increases in this setting. Landry et al. (2011a) find that unconditional rewards increase output, but less so than conditional rewards. Kube, Maréchal and Puppe (2013) and Chemin and Kurmann (2014) provide evidence from the field that negative reciprocal responses to wage cuts are stronger than positive reciprocal responses to wage increases.

increase.[2] Hence, these papers have raised substantial doubts about whether gift exchange based on positive reciprocity can be a persistent motivational device in work settings.

However, in ongoing labor relationships there are additional degrees of freedom for employers to design the distribution of wage increases over time, which might help to foster gift exchange. Initial evidence in line with the idea that it can be beneficial to distribute wage increases over time is provided by Ockenfels, Sliwka and Werner (2015b), who find that the output of temporary workers is higher when wages are increased in two steps rather than with a single large wage increase. The key aim of our paper is to systematically compare effort reactions to different wage schedules that pay out an identical overall wage sum and thus to (i) study whether the persistency of gift exchange can be increased by an appropriate timing of wages, and (ii) gain insights into the different potential underlying behavioral channels explaining the reciprocal reactions.

A few recent studies have indicated that gift exchange between principals and agents can be triggered also by non-monetary factors. Kube, Maréchal and Puppe (2012) show that participants in a field experiment work harder after receiving a gift in kind at the beginning of the task, compared to the case where participants receive an equivalent sum of extra pay. Moreover, structuring wages in a way that presents part of the total payment as a gift can induce higher performance (Gilchrist, Luca and Malhotra forthcoming). Kosfeld and Neckermann (2011) and Bradler et al. (forthcoming) demonstrate that even the assignment of symbolic awards that are not associated with monetary gains can motivate agents to increase effort.

The notion that the specific sequence of payments might have an impact on employee motivation has been indicated in earlier work. Loewenstein and Silcherman (1991) and Grund and Sliwka (2007) suggest that employees can have an inherent preference for

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[2] Likewise, in a field experiment on charitable donations, Landry et al. (2011b) observe that reciprocal responses of solicitees to unconditional gifts are not lasting, as those who initially contribute more in response to a gift are less likely to contribute when they are approached for a second time. Moreover, in a recent field experiment by Esteves-Sorenson and Macera (2015) conducted independently from our study, wage increases are implemented either once or repeatedly across shifts but trigger no output increases of experimental workers. One difference to our main experiment is that workers are informed about future wage increases already at the beginning of the first shift.

increasing payment sequences, and Frank and Hutchens (1993) formalize the idea that utility is not only related to the absolute level of consumption, but also to its growth which, for instance, can explain the empirical observation that wages grow faster than productivity over the work life.[3]

Combining these insights, a natural question is how agents' performance can be affected by dynamic wage increases in an ongoing labor relationship. In particular, it seems important to study in this context how different distributions of wage increases over time affect the timing of agents' efforts. To address these questions, the wage profiles in our setting pay an employee the same amount of money, but vary in the size and frequency of wage increases over time. Principals and agents interact over a total of 8 working periods. At the beginning of each period, an agent learns about the wage payment for this period, and thereafter agents perform a tedious real-effort task that creates revenues for the principal. Prior to the start of the experiment, each principal chooses among specific wage profiles, which then determine the timing of wages across the 8 periods.

Besides its novel focus on a systematic comparison of different wage profiles, our experimental design differs from previous laboratory and field approaches in several other aspects. First, our design is chosen in a way that prevents reputation building and repeated game effects. Importantly, principals cannot react to agents' performance in previous periods, and agents are aware of this, which excludes the use of punishments and rewards as incentive devices. Hence, our design allows us to provide a clean identification of the causal effect of wage increases on reciprocal behavior of the agent.[4] Moreover, previous studies mostly have found positive effort reactions when principals pay higher wages relative to a reference condition without a wage increase. In these cases, positive effort responses were associated with higher costs for the principal. We compare wage profiles with identical total costs and thereby investigate ways to raise performance at no costs for employers.

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[3] Frank (1989) and Loewenstein and Prelec (1993) theoretically and empirically investigate the preference for increasing consumption streams.

[4] See, for example, Brown, Falk and Fehr (2004 and 2012), or Huck, Lünser and Tyran (2012) for related experimental studies with a focus on repeated interaction.

Before analyzing the experimental results in detail, we describe a formal framework to organize the reaction of reciprocal agents to dynamic wage increases. In our model, agents have reciprocal inclinations which can be triggered by their wages. In the spirit of Cox, Friedman and Gjerstad (2007) we assume that agents have social preferences that depend on their "emotional state" towards their principals. In line with Kahneman and Tversky (1979) we allow for the possibility that agents are loss averse and evaluate wages relative to a *reference wage*.[5] Wage increases generate "impulses" affecting an agent's emotional state towards the principal and in turn the efforts exerted. We compare two different processes determining the reciprocal reaction. When agents follow an *absolute* or *fixed reference standard*, they compare each wage level to the same initial reference standard. When they follow an *adaptive reference standard*, wages are compared to the most recent previous wage level.

In both cases, wages above the reference standard create "elation" and thus positive impulses. Wages below the reference standard create "disappointment" and thus negative impulses. We allow for different levels of "memory", which in our model describes the extent to which past wages affect current emotional states.

Importantly, the two reference standards are closely related to the notion of "broad" and "narrow" bracketing (Read, Loewenstein and Rabin 1999, Thaler 1999). When agents apply a fixed reference standard and have a balanced memory (i.e. give all past periods the same weight), they react like "broad bracketers" judging the kindness of wages by the sum of all wages received. If they, however, follow an adaptive reference standard comparing a wage to the wage from the previous period they act like "narrow bracketers", as their kindness judgement strongly depends on the most recent increase. In particular, our notion of an adaptive reference standard combined with a short memory is closely connected to the concept of myopic loss aversion (Benartzi and Thaler, 1995), as a combination of "loss aversion and a short evaluation period". Similarly, Camerer et al. (1997) explain their result that taxi drivers in New York exhibit a negative wage elasticity of labor supply by a

[5] There is abundant evidence that reference standards are important for how employees evaluate their remuneration (see, for example, Mas 2006, Card et al. 2012, and Ockenfels, Sliwka and Werner 2015a, and the references therein).

combination of narrow bracketing (some drivers seem to optimize over a single work day rather than over multiple work days) and the focus on a daily target income.

In our framework, we show that the absolute and the adaptive reference standard predict different effort patterns for a given wage schedule. For instance, if agents follow a fixed reference standard, their efforts should increase when wages stay constant at a level above the initial reference wage. If, however, they follow an adaptive reference standard, efforts decrease in the same case as agents “get used to” generous wages and stable wages provide no further impulses that trigger reciprocal reactions.

Our experimental results show that agents respond positively to wage increases, highlighting the role of positive reciprocity. Moreover, the qualitative patterns observed are well organized by agents following an adaptive reference standard. For instance, wage increases lead to effort increases, but at the same time efforts decrease when wages stay constant even if they exceed the initial reference wage. Moreover, we find evidence in line with decreasing returns to the size of a wage impulse, i.e. it is rather the frequency than the size of wage increases that affects performance positively.

In turn, we find that total output can be affected by varying the timing of wage increases. In particular, a wage profile that regularly increases payments by a small amount induces the strongest output gain relative to a condition with constant wages.

As a further test for the importance of reference standards for the evaluation of wages, we conducted additional treatments where, in contrast to our main experiment, agents were ex-ante informed about the full wage profile before the first working period. If wages then coincide with the respective reference wage in each period, our formal framework would predict that timing effects of wage increases are eliminated. Indeed, we find that in this case increasing wage profiles do not lead to higher performance than stable wages that pay the same overall wage sum. Fully anticipated wage increases thus do not provide impulses that trigger additional reciprocal responses.

Finally, many principals in our setting do not seem to understand that increasing wage profiles may generate higher performance. However, data from an online survey in which we asked human resources managers to evaluate the wage profiles from our setting show that professionals are capable of anticipating the superiority of wage profiles with multiple wage increases.

The remainder of the paper is structured as follows: Section 2 presents our experimental design. In Section 3, we describe a formal model which organizes potential channels through which wage increases affect effort. In Section 4 we report the results from the experiments and the online survey in detail. Section 5 discusses our findings and concludes.

2 Experimental Design

Prior to the start of the experiment, participants were assigned the role of either an agent or a principal, which they kept throughout the experiment. Principals and agents were seated in different rooms to minimize social interaction. Before the experiment started, all subjects were informed about their roles.

One principal and one agent were matched to each other for a total of 8 working periods of the experiment. In each period, the agents had to work on a task for 250 seconds, consisting of counting the digit "7" in blocks of random numbers (see the illustration in the instructions, which can be found in the Appendix). This task has the advantage that no specific previous knowledge is necessary, yet it requires significant concentration to provide correct solutions. Prior to the start of each period, each agent was informed about the wage he would receive for this period. Higher performance by the agents was associated with higher revenues for the respective principals, as each correctly counted block generated a payoff of 20 ECU (our experimental currency unit) on the principal's account.[6] Importantly, during the experiment principals were not informed about agents' performance throughout the periods, and agents were aware of this. Principals therefore could not condition their wage choices in future periods on output in a given period, ruling

[6] The results of the studies by Hennig-Schmidt, Rockenbach and Sadrieh (2010) and Englmaier and Leider (2012a) pointed out that the assessment of the payoffs generated for the principal is an important determinant for positive reciprocity.

out the possibility that wages were used to reward good or punish bad performance.[7] As wages were not performance contingent, there were no material incentives for the agents to invest effort into the task.[8]

This experimental design thus allows us to study the pure effect of experiencing wage increases on agents' behavior without any reputational confounds due to the repeated interaction between principal and agent. Performance of the workers and the final payoff was only revealed to the principals at the end of the 8 periods.[9]

Before the actual experiment started, we implemented an unpaid trial task to familiarize participants with the real-effort exercise. In this trial period of altogether 180 seconds, both principals and agents were presented five blocks in which they had to count the digit "7". We also use the performance in the trial period to control for unobserved ability differences between the subjects.

The treatment variations in our experiment consisted of altogether four wage profiles. Prior to the start of Period 1, each principal had the choice between two of the four wage profiles. We restricted the principal's choice in this way to keep control over the decisive characteristics of each wage scheme with respect to the frequency, the size and the timing of wage increases and to collect a sufficient number of observations for each profile. It is important to note that in our main experiment the agents knew neither the overall wage sum in advance nor the fact that the wage sum was the same for all profiles which is in line with the common policy in many firms to keep wage levels and wage profiles secret (Colella et al. 2007). They only learned the wage relevant for a period directly before the period started and were informed that this wage level was determined by a decision made

[7] In the instructions, it was explicitly stated that "the employer will *not* be informed about the performance of the employee during the 8 periods of the experiment. Only at the end of the experiment, the performance of the employee and the resulting payoff will be displayed to the employer." (translated from German).

[8] Also, workers could take a break during the working task and instead watch cartoons on their screens (time proceeded in these cases).

[9] After each period, agents were informed about the number of the blocks they had counted correctly.

by the principal.[10] The wage profiles are denoted as *Baseline* (our reference condition), *T_Sudden*, *T_Successive* and *T_Continuous*; Table 1 lists the payments of each wage profile over the 8 periods of the experiment. All wage profiles paid the same total wage sum (1000 ECU) but varied the distribution of the payments over the periods. We calibrated the sum of period wages in a way that payments roughly correspond to subjects' typical earnings in the laboratory and therefore to the agents' initial expectation about their remuneration in the experiment.

If the principal chose the wage profile *Baseline*, a worker received 125 ECU in every period. The other wage profiles involved wage increases, but varied their sizes and frequencies. Profile *T_Sudden* paid 100 ECU for the first 4 periods, with a 50% wage increase for the remaining periods 5-8. This profile shares similarities with previous field studies on gift exchange (for example, Gneezy and List 2006, Ockenfels et al. 2015b) that introduced a substantial and unexpected wage increase in the course of the experiment. The remaining two profiles, *T_Successive* and *T_Continuous*, involved more frequent but smaller absolute wage increases. In *T_Successive*, wage increases of 25 ECU were paid 4 times on an irregular and thus not directly predictable basis over the 8 periods, so that in some periods the wage remained constant. However, wages were increased regularly and thus more predictably (by 10 ECU in every period) in *T_Continuous*. Hence, under this wage profile, an agent received altogether 7 wage increases.

[10] Agents were not aware that the principals chose a wage profile in advance. As we stated above, however, agents knew that principals in our setting were not able to condition their wage offers on performance of the agents throughout the rounds, ruling out any extrinsic incentive to exert effort.

Table 1: Wages per Period in Each Wage Profile

Period	T_Constant	T_Sudden	T_Successive	T_Continuous
1	125	100	75	90
2	125	100	75	100
3	125	100	100	110
4	125	100	125	120
5	125	150	125	130
6	125	150	150	140
7	125	150	175	150
8	125	150	175	160
Number of wage increases	0	1	4	7
Wage increase in ECU	0	50	25	10

In sessions 1 to 8 of the experiment, we let principals choose between *Baseline* and a second profile with increasing wages.[11] In sessions 9 to 14, principals could choose between two of the three increasing wage profiles (for each combination of the three profiles, we conducted two experimental sessions). We implemented all possible combinations of wage profiles to ensure that the numbers of observations for each profile do not differ too strongly.[12]

We conducted altogether 14 sessions of the main experiment with 432 participants (216 in the role of principals and 216 in the role of agents) at the Cologne Laboratory for Economic Research (CLER) in July and August 2013. Participants were recruited via the online recruitment system ORSEE (Greiner 2004). The experimental software was programmed with z-Tree (Fischbacher 2007). Upon arrival, participants were randomly seated and received written instructions.[13] Questions were answered privately at each participant's cubicle. After the end of the experiment, subjects privately received their payments and left the laboratory. The conversion rate was 100 ECU = 1 Euro. Average earnings amounted to 12.71 Euro, including a show-up fee of 2.50 Euro (Standard

[11] In these sessions, we also had a second version of *T_Sudden* that paid 50 ECU in periods 1-4 and 200 ECU in periods 5-8 to investigate the effects of a harsh and very salient wage increase. Yet principals in these sessions hardly ever opted for this wage profile (only in 5 out of 32 cases in the corresponding two experimental sessions). Therefore, we do not have enough data to conduct a meaningful analysis of this wage profile and drop these 5 cases from the analysis reported in Section 4.

[12] Since agents do not know the principal's choice alternatives, their actions are independent of the principal's choice alternatives and only depend on the chosen profile.

[13] An English translation of the instructions can be found in the Appendix.

deviation: 2.51 Euros); participants were present in the laboratory for approximately 75 minutes.

In addition to our main experiment, we conducted additional treatments in which each agent learned the complete wage profile (i.e. the wages for all 8 periods) before the start of the first working period. We will explain these additional treatments in detail in Section 4.5.

3 A Conceptual Model

In the following, we develop a theoretical framework to organize potential channels through which wage increases can trigger reciprocal reactions and thus affect performance.

3.1 The Model

An agent interacts with a principal over T periods. In each period t the agent receives a wage w_t and then exerts effort at costs $c(e_t)$ with $c''(e_t) > 0$. The principal receives a return e_t that is equal to the agent's effort. The agent has a preference for reciprocal behavior. In the spirit of Cox et al. (2007) we assume that the agent has social preferences and cares the more for the principal's payoff the higher her "emotional state" towards this principal is. The agent's utility function is given by

$$u_{At} = v_{At} + h(\theta_{At}) \cdot v_{Pt}$$

where $h(\theta)$ defines how the emotional state translates into utility attached to the principal's payoff and has the properties $\frac{\partial h(\theta)}{\partial \theta} > 0$ and $\frac{\partial^2 h(\theta)}{\partial \theta^2} \leq 0$. The variable θ_{it} thus measures agent i's emotional state in period t and v_{At} and v_{Pt} represent the agent's and principal's material payoffs given by

$$v_{At} = w_t - c(e_t)$$
$$v_{Pt} = e_t - w_t.$$

We assume that the emotial state follows a deterministic process where

$$\theta_t = (1 - \alpha_t) \cdot \theta_{t-1} + \alpha_t \cdot f(w_t - w_{rt})$$

with

$$f(\Delta) = \theta_0 + \mathrm{r} \cdot \begin{cases} \Delta & if \quad \Delta \geq 0 \\ \lambda \cdot \Delta & if \quad \Delta < 0 \end{cases}.$$

where $\Delta = w_t - w_{rt}$ and r measures the agent's reciprocal inclinations. The emotional state thus changes over time, as the wage paid in a given period provides an "impulse" leading to changes in the state. As in models of loss aversion (Kahneman and Tversky 1979, Loomes and Sugden 1986, Köszegi and Rabin 2006), the agent evaluates the wage w_t he receives in a period t relative to a reference standard w_{rt}. Wage above the reference level w_{rt} generate "elation", whereas wage below this level generate "disappointment".[14] Moreover, losses relative to the reference standard loom larger than gains such that $\lambda \geq 1$. We further assume that an agent has some initial reference wage w_0 in mind, and the initial emotional state is equal to $\theta_0 = f(0)$.

We consider wage schedules with the property that $\sum_{\tau=1}^{T} w_\tau = T \cdot w_0$ where we define w_0 as the initial reference wage prior to the start of the experiment. Hence, all schemes pay out the same overall wage sum. In our setting the wage sum is chosen in a way that agents roughly receive the typical hourly wage expected from participation in an experiment in our laboratory (see Section 2). This means that the aggregate wages agents receive across all periods roughly correspond to the aggregated reference wage.

The parameters $0 < \alpha_t \leq 1$ measure the degree of "memory" or "inertia" in period t, i.e. when $\alpha_t < 1$ then agents past emotional states carry over to later periods. If, for instance, $\alpha_t = \frac{1}{t}$ then the last impulse has the same weight than all previous impulses: It is straightforward to show that in this case $\theta_0 + \frac{1}{t}\sum_{\tau=1}^{t} f(w_\tau - w_{r\tau})$, i.e. the agent averages all previous impulses. If, however, α_t is equal to a constant then each new impulse has the same weight in a given period irrespective of the number of previous periods. One could

[14] Note we thus model the effect of wages on the emotional state as an automatic or what psychologists sometimes call a "system 1"-type reaction, i.e. a fast, automatic, and emotionally charged reaction requiring minimal cognitive resources (as opposed to a "system 2"-type reaction, which is slower, deliberately controlled, analytical, affect free, and requires cognitive resources (Evans 2008, Kahneman 2011).

interpret $\alpha_t = \frac{1}{t}$ as having an agent with a long memory whereas an agent with $\alpha_t = 1$ only considers the most recent impulse.

We consider two alternative reference standards as potential explanatory mechanisms for an agent's response to wage increases:

- When the agent follows a *fixed reference standard* then $w_{rt} = w_0$ for all periods t and he thus compares the wage in each period to the initial standard.
- When the agent follows an *adaptive reference standard* then $w_{rt} = w_{t-1}$, i.e. the agent compares the wage to that of the previous period. Deviations from the previous wage lead to elation or disappointment.

Note that the notion of an adaptive reference standard in combination with a short memory is closely connected to the concept of myopic loss aversion (Benartzi and Thaler 1995) as a combination of "loss aversion and a short evaluation period".

3.2 Analysis

In each period the agent maximizes

$$\max_{e_t} w_t - c(e_t) + h(\theta_{At}) \cdot (e_t - w_t)$$

such that

$$c'(e_t) = h(\theta_{At}).$$

To simplify notation let $a(\theta) = c'^{-1}\big(h(\theta)\big)$ such that $\frac{\partial a(\theta)}{\partial \theta} > 0$. We obtain:

Proposition 1 *The agent's effort in period t is a monotonically increasing function of his emotional state in t which is strictly increasing in the current wage w_t and decreasing in the reference wage w_{rt}.*

$$e_t = a\big((1 - \alpha_t) \cdot \theta_{t-1} + \alpha_t \cdot f(w_t - w_{rt})\big).$$

Hence, efforts follow the development of the emotional state and wages provide impulses affecting this state. Whenever the wage exceeds the reference wage in a given period, this provides a positive impulse above θ_0; whenever the period wage falls short of the relevant reference wage, a (stronger) negative impulse below θ_0 is created. This has a first simple implication:

Corollary 1 *When the agent's reference standard is met in each period such that* $w_t = w_{rt}$ *for all* $t = 1, .. T$*, then efforts are constant at* $e_t = a(\theta_0) \equiv e_0$.

This directly implies that both, absolute and adaptive reference standards induce the same effort reaction whenever $w_t = w_0$ for $t = 1, .., T$. Moreover, when wages are fully anticipated and, in turn, wages coincide with reference wages in each period the timing of wages should not affect efforts. We now use the constant wage scenario as a benchmark case and call the effort chosen in this benchmark scenario the *reference effort* e_0. Corresponding to our experimental setup, we now compare increasing wage schemes where the wage in the first (last) period is below (above) this constant wage benchmark ($w_1 < w_0$ and $w_T > w_0$).

Before doing so, it is instructive to consider two further specific cases. When $\alpha_t = \frac{1}{t}$ and $\lambda = 1$, i.e. an agent has a long memory and does not value marginal losses relative to the reference standard differently than marginal gains, it is easy to show that an agent who follows an absolute reference standard chooses

$$e_t = a\left(\theta_0 + \mathrm{r} \cdot \left(\frac{1}{t} \sum_{\tau=1}^{t} w_\tau - w_0\right)\right),$$

i.e. efforts at date t are determined by comparing the average wage obtained up to this date with the initial reference standard. Such an agent could be considered as a "broad bracketer" judging the generosity of the principal based on all wages handed out so far.

If, on the other hand $\alpha_t = 1$ (i.e. there is no memory) and the agent follows an adaptive reference standard, his emotional state is

$$\theta_t = a\big(\theta_0 + f(w_t - w_{t-1})\big),$$

such that efforts are purely determined by the most recent change in wages. Here the agent is a myopic "narrow bracketer" judging just the current wage and comparing it to that received in the last period. In the following, we assume that $\alpha_t < 1$, i.e. there is always some memory and the agent recalls recent kindness sensations or disappointments at least to some extent.

We are now interested in patterns of the agent's reaction to wage schedules that deviate from a constant wage and start with lower wages in the beginning. First, note that efforts are increasing in period t relative to period $t-1$ if and only if

$$(1-\alpha_t)\cdot\theta_{t-1}+\alpha_t\cdot f(w_t-w_{rt})>\theta_{t-1}$$
$$\Leftrightarrow f(w_t-w_{rt})>\theta_{t-1},$$

i.e. whenever the most recent impulse is larger than the previous emotional state. If, for instance, the period 1 wage w_1 is smaller than the reference wage w_0 efforts are smaller than efforts under the constant wage scheme, i.e., $e_1 < e_0 = a(\theta_0)$. Moreover, if the agent follows an absolute reference standard, $e_t > e_0$ requires that $f(w_t - w_0) > \theta_0$ which implies the following result:

Proposition 2 *If the agent follows a fixed reference standard, efforts under increasing wage schedules exceed the reference effort e_0 only if $w_t > w_0$.*

Proposition 2 implies that if the agent focuses on an absolute reference standard, he will not exert more effort than the reference level if his wage is still below the reference wage irrespective of the number of wage increases he received so far. Note that Proposition 2 states a necessary, but not a sufficient condition. As long as there is some memory, disappointment from previous lower wages may still carry over to periods where wages exceed the constant reference wage. But we can derive a further property of increasing wage schedules:

Proposition 3 *If the agent follows a fixed reference standard and the wage schedule is non-decreasing, the following property holds: Whenever efforts increase in one period, they must increase in all further periods, i.e. whenever $e_t > e_{t-1}$ for some t, then $e_\tau > e_{\tau-1}$ for all $\tau > t$.*

Proof: See Appendix A2.

The intuition for this result is as follows: Whenever there was a period in which effort increased, the impulse from a higher wage must have led to a higher emotional state in this period. When the wage schedule is non-decreasing, any later wage must lead to an impulse that is at least as strong as the previous impulse – as all wages are compared to the same reference standard – and thus the emotional state must increase over all further periods. It its important to note that this also holds for periods without further wage increases. It follows that if efforts increase in one period, efforts must strictly increase in all further periods even in those where wages remain unchanged.

We can compare these patterns implied by the use of a fixed reference standard to those occuring under an adaptive reference standard, i.e. when $w_{rt} = w_{t-1}$. Here, efforts exceed the reference level in a period t if and only if

$$\theta_t = (1-\alpha_t) \cdot \theta_{t-1} + \alpha_t \cdot f(w_t - w_{t-1}) > \theta_0.$$

which is equivalent to

$$\alpha_t > \frac{\theta_0 - \theta_{t-1}}{f(w_t - w_{t-1}) - \theta_{t-1}}.$$

The right hand side is strictly smaller than 1 if $w_t > w_{t-1}$. Hence, if the agent's memory is sufficiently short (i.e. the current period has a large weight), recent wage increases can lead to efforts above the level associated with constant wages. Note that this leads to an important difference in predictions as compared to the case of a fixed reference standard: Efforts can be higher after a wage increase than the efforts exerted under constant wages even when the absolute wage level is still below the constant wage. The reason is that the impulse comes from the most recent wage increase. If the agent's memory is not too long, a positive impulse may outweigh previous disappointments that led to a lower emotional state in earlier periods. If agents have no memory and only look at the last period ($\alpha_t = 1$), any wage increase would raise the effort level above the reference effort.

Finally, we can derive another property of effort patterns under an adaptive reference standard:

Proposition 4 *When wages remain stable in a period t (i.e. $w_{t+1} = w_t$) and the agent follows an adaptive reference standard, then $e_{t+1} \geq e_t$ if and only if $e_t \leq e_0$.*

Proof: See Appendix A2.

Hence, when the agent applies an adaptive reference standard, stable wages will come along with higher efforts when the previous emotional state is low and lower efforts when the previous emotional state is high. The reason is that stable wages avoid negative impulses from disappointments but at the same time fail to generate positive impulses from elation. When there had been previous disappointments and the emotional state is below the initial level, a stable wage will lead to recuperation towards the initial emotional state as subjects adapt to the lower reference standard and, hence, efforts increase. If, however, the agent received wage increases in previous periods that raised the emotional state above the initial level, a stable wage will lead to a downward pull towards the initial emotional state and thus to decreasing effort levels. Note that the latter property leads to a prediction contrasting the pattern under a fixed reference standard illustrated in Proposition 3: Under a fixed reference standard, a stable wage will increase efforts only if a previous wage increase had already led to increasing efforts. Under an adaptive reference standard, however, there can be exactly the opposite pattern: Whenever previous wage increases have generated an emotional state above the initial state, constant wages lead to decreasing effort levels. Here, previous wage increases "wear off" because agents get used to a higher wage as a result of the upwards shift in their reference standard.

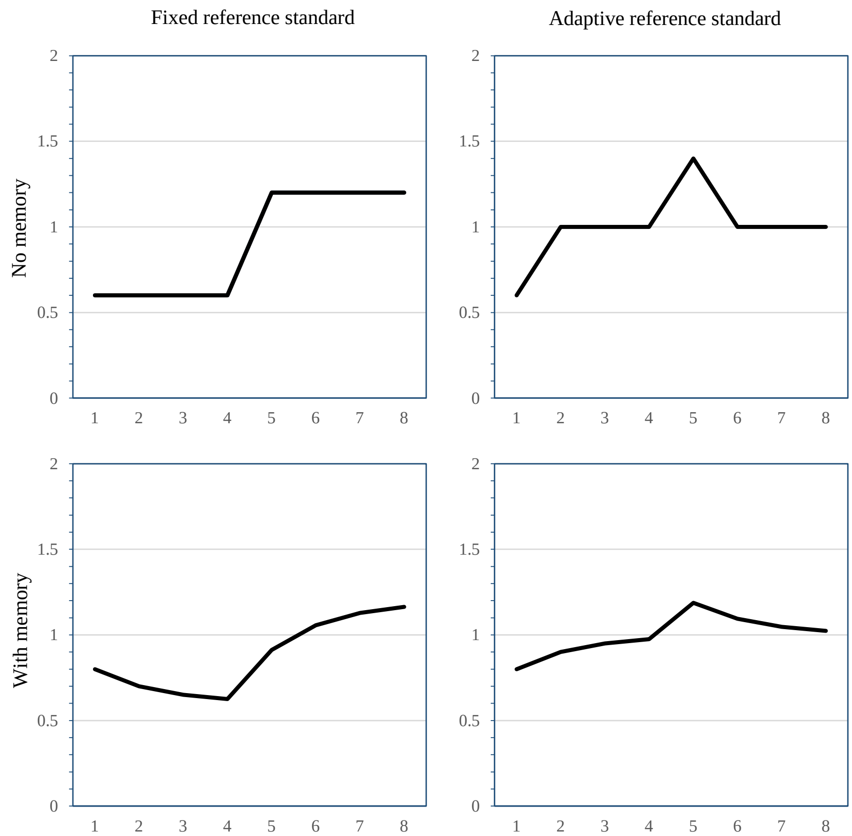
It is instructive to look at the predicted output patterns under a fixed and an adaptive reference standard as well as with and without memory for the example of the *T_Sudden* wage profile. The output patterns for each of the cases are illustrated in Figure 1.[15] The *T_Sudden* profile is characterized by a single wage increase in period 5 such that in the first four periods wages are below the initial reference wage, whereas in the last four periods they exceed this reference wage. The example is computed for $\lambda = 2$, $\mathrm{r} = 1$, $h(x) = x$ and $c(e) = \frac{1}{2}e^2$.[16] Figure 1 plots the development of efforts over time (normalized at e_t/e_0 so that expected performance in the *Baseline* treatment is equal to 1 in every period). The graphs in the first row of Figure 1 show the extreme case where there is no memory or inertia at all so that impulses from previous periods do not carry over to the present period. The second row shows the evolution of efforts when there is some memory (here $\alpha = 0.5$), i.e. the emotional state is a weighted average of the previous state and the new impulse. Moreover, the graphs in the left column of Figure 1 display the development of

[15] An illustration of the predicted output dynamics for the *T_Successive* and the *T_Continuous* wage profiles with the same parametrization can be found in Appendix A4 (Figure A1 and Figure A2, respectively).

[16] Note that in the example the effort is linear in the emotional state; hence, the panels describe the patterns of both emotional state and effort.

performance when agents follow a fixed reference standard whereas the right column shows the patterns for the adaptive reference standard.

Figure 1: Performance Dynamics in *T_Sudden* for a Fixed (Left Panel) and an Adaptive (Right Panel) Reference Standard (Both Relative to the Reference Condition *Baseline*)



Note that for a given degree of inertia, both reference standards imply the same effort in the initial period 1 as the reference wage w_0 is identical here. However, from period 2 on, the predicted performance dynamics associated with each reference standard differ markedly. In the extreme case when there is no memory, efforts follow the most recent impulse. First, under a fixed reference standard, efforts directly "track" the wage development (where negative impulses loom larger than positive impulses as $\lambda > 1$). Thus, predicted performance in the first 4 periods stays below performance under constant wages. After the wage has been increased in period 5, predicted performance is higher than in the reference condition for the remaining periods. On the contrary, when the reference standard is adaptive, agents directly "get used" to both to the initially lower wage, but also to the wage increase in period 5 after one period. It follows that agents who apply an adaptive reference standard deviate from performance under fixed wages only in the first period and in period 5 when they receive the wage increase. Whenever the wage remains stable, agents revert to the reference effort.

In the more realistic case when there is some memory and emotional states from previous periods carry over to the present period, effort reactions are not entirely immediate so that the patterns are smoothed out (see the second row in Figure 1). Again the patterns predicted by both reference standards start at the same effort level in period 1. An agent with an absolute reference standard then reduces efforts further throughout periods 1 to 4 as in each of these periods wages fall short of w_0, leading to a further deterioration of the emotional state. In contrast, the emotional state of an agent with an adaptive reference standard recovers from the initial loss as the reference point adjusts to the wage level in period 1, and the stable wage avoids further negative impulses. Both types of agents increase their efforts substantially with the sharp wage increase in period 5. For an agent with a fixed reference standard, each wage payment afterwards provides the same positive impulse and the emotional state continues to increase. However, agents who follow an adaptive reference standard again "get used to" the higher wage and receive no further positive impulses, as the wage stays constant for the rest of the task. Subsequently, efforts of these agents decline in the remaining periods.

4 Results

4.1 Performance Reactions to Wage Profiles

We start by investigating the timing of the agents' performance as a reaction to the timing of wages. We use the condition *Baseline*, in which wages were constant across all periods, as a control group and compare the effects of each of the other treatments in each period to this setting.[17] In particular, we estimate the causal effect of the exogenously assigned wage profile on each agents' performance in the 8 periods of our experiment. Our key interest lies in estimating the percentage change in performance relative to the baseline

[17] An overview of the average output levels per treatment as well as the number of agents who worked under each treatment can be found in Table A1 in the Appendix.

condition. We contrast this percentage change in performance with the percentage change in the wage level in the relevant period to determine how the timing of wages affects the timing of output.

We ran three separate random effects regressions with the log performance (number of correct answers plus one[18]) as the dependent variable, pooling the data from *Baseline* with one of the other treatments in each regression.[19] We additionally control for performance in the pre-experimental trial period (time needed to complete the trial tasks[20], please see Table A1 in the Appendix for descriptive statistics) as a measure for a subject's ability in the task and estimate robust standard errors clustering on the subject.

The key independent variables are the interaction terms between the specific treatment and dummies for each period. The results are depicted in Figure 2. This figure shows the estimated treatment effects of wage increases (lower row of the figure), i.e. the difference between performance in the respective wage profile relative to the reference condition (measured in % of *Baseline* performance), and contrasts it with the percentage difference in wages between the treatments and the *Baseline* condition (upper row of the figure). The underlying regression results are reported in Table 2 below.

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[18] We use the adjusted value for the performance variable as the number of correct responses is zero for some agents in some periods (altogether 48 out of altogether 1688 observations).

[19] The use of the logarithm of performance allows us to directly assess the percentage changes of effort in response to our treatment variations and thus to evaluate the behavioral responses along the same dimension as the underlying wage change. An economic argument for the use of logs is that if agents differ in their underlying abilities for the experimental task (as it is suggested by the strong heterogeneity in performance in the *Baseline* condition of our experiment, where the average performance of 50.1 blocks is associated with a standard deviation of 18.0 blocks), variations of the wage profiles have heterogeneous effects on agents with different ability levels. A model where the dependent variable is the raw score assumes that an exogenous change in the independent variable raises the raw score by the same absolute amount for all agents irrespective of their ability. A model where the dependent variable is in logs assumes that raw scores of all agents are changed by the same percentage which may be more appropriate when it is easier for a high ability agent to raise performance by the same fixed amount than for a low ability agent.

[20] Subjects vary widely concerning the speed in the trial period: The fastest agent managed to count the 5 trial blocks in 56 seconds. On average, agents required 144 seconds (standard deviation: 29 seconds) for the trial blocks; 47 out of 211 subjects did not manage to count all blocks in the 180 seconds of the trial period. For these censored observations we assign a value of 180 for the trial period time.

Each column in Figure 2 represents one of the treatments with increasing wages. The upper panels illustrate the timing of the exogenously imposed wages, depicted as relative wage differentials compared to the *Baseline* setting: A wage differential of *-0.2* in period 1 of *T_Sudden*, for instance, means that wages had been 20% below the wage in *Baseline* in this period. The lower panels of the figure depict the estimated treatment effect in each period relative to *Baseline*, including a 90% confidence interval. As the dependent variable is in logarithmic form, the coefficients are the estimated approximate percentage changes in performance relative to the respective period performance in the constant wage setting.

Figure 2: Wage Differentials (Upper Panels) and Estimated Treatment Effects (Lower Panels) (Both Relative to the Reference Condition *Baseline*)

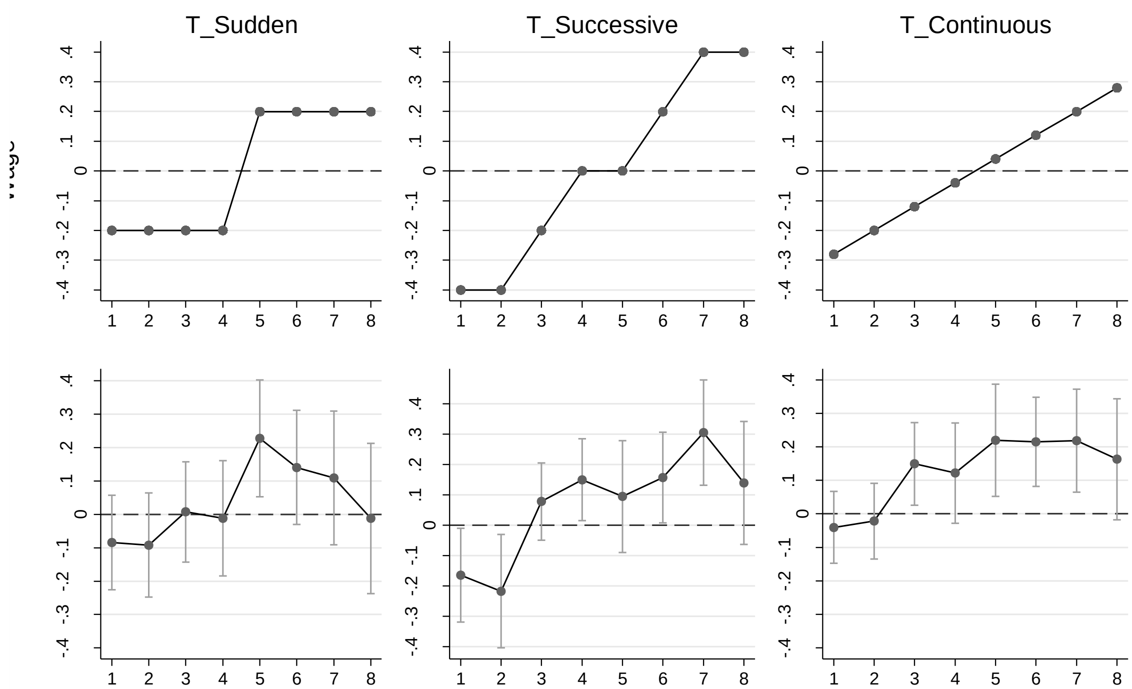


Figure 2 displays wage differentials (upper graphs) and estimated treatment effects on log performance (lower graphs) in the respective period relative to constant wages (*Baseline*), separately for *T_Sudden* (left column), *T_Successive* (middle column) and *T_Continuous* (right column).

First of all, we observe that performance indeed immediately reacts to wage changes, highlighting the role of reciprocity in our setting. In *T_Sudden*, the substantial wage increase in period 5 is associated with a performance increase of some 23% compared to *Baseline* performance in the same period. In *T_Successive*, performance levels are (weakly) significantly higher compared to *Baseline* in three out of the four periods in which a wage increase was implemented (i.e. periods 4, 6, and 7; the exception is period 3). In *T_Continuous*, performance is significantly higher than performance in *Baseline* in four of the eight periods and never significantly lower.

Second, we also observe that the absolute wage level matters for the willingness to work well. In line with the model, we find that in all three treatments with increasing wage schedules, average performance is lower in the first period than in *Baseline*, where agents receive the highest initial wage. In treatment *T_Successive*, where initial wages are the lowest (*40%* below the *Baseline* wage), performance is for instance about 16% lower than in the condition with constant wages.

Third, the observed patterns suggest the importance of an adaptive reference standard for the agents' evaluation of wages: For instance, wage increases seem to "wear off" if the wage stays constant. In case of *T_Sudden*, only one period after agents receive the large wage increase, performance is still somewhat higher but no longer significantly different from performance in *Baseline* in the same period. Subsequently, performance drops to an essentially identical level of performance in *T_Sudden* and *Baseline* in period 8 even though the wage is still larger in the former treatment. This effect is similar to the results reported by Gneezy and List (2006) where a single surprise wage increase leads to an immediate productivity push which, however, is not lasting as productivity slowly converges back to the level of a control group without a wage increase. In *T_Successive*, performance slightly drops in periods when there is no wage increase (i.e. 2, 5, and 8) relative to periods in which wage was increased, as a comparison of the respective interaction terms indicates. Both observations are in line with Proposition 4 of our model: Agents whose emotional state is higher than the initial state will lower their effort in periods where the wages remain stable.[21]

[21] We note, however, that our model would predict a performance increase between period 1 and period 2 of *T_Successive* when agents follow an adaptive reference standard: Whereas the previous emotional state of the agent should still be low because of the initial disappointment in period, the agent would adapt to the low wage to some extent in the second period due to the stability of the wage between period 1 to period 2.

Table 2: Treatment Effects per Period

	(1) T_Sudden	(2) T_Successive	(3) T_Continuous
Treatment × Period 1	-0.084	-0.164*	-0.040
	[0.086]	[0.094]	[0.065]
Treatment × Period 2	-0.092	-0.217*	-0.022
	[0.095]	[0.114]	[0.069]
Treatment × Period 3	0.007	0.079	0.149**
	[0.091]	[0.077]	[0.075]
Treatment × Period 4	-0.012	0.150*	0.122
	[0.105]	[0.082]	[0.091]
Treatment × Period 5	0.227**	0.095	0.220**
	[0.107]	[0.112]	[0.102]
Treatment × Period 6	0.140	0.157*	0.215***
	[0.104]	[0.091]	[0.081]
Treatment × Period 7	0.109	0.306***	0.218**
	[0.122]	[0.106]	[0.093]
Treatment × Period 8	-0.012	0.140	0.163
	[0.137]	[0.123]	[0.110]
Time Trial Period	-0.002	-0.003**	-0.002**
	[0.001]	[0.001]	[0.001]
Observations	928	904	1,024
Number of subjects	116	113	128

Note.– Dependent variable: log(output+1); Random effects regressions with robust standard errors clustered on the subject in brackets; period dummies included; *** p<0.01, ** p<0.05, * p<0.1

Fourth, the small and rather predictable wage increases in *T_Continuous* quickly increase performance to a level above *Baseline*. Moreover, *T_Continuous* already significantly outperforms *Baseline* in period 3 by about 15%, where the wage level is still below the level of *Baseline* and then remains above the reference condition for the rest of the experiment. This again indicates the importance of an adaptive reference standard for agents' effort choices in our setting: If the agents would apply a fixed reference standard instead, we should expect performance in *T_Continuous* to be still below *Baseline* performance for the periods 3 and 4 (see Proposition 2), as wages have not yet reached the level of *Baseline*.[22] Therefore, Proposition 2 is not supported by the data.

Finally, to judge the persistency of agents' responses to wage increases, it is important to consider the performance effects in the final period of the experiment. Estimated performance for *T_Successive* and *T_Continuous* is some 14% and 16% higher than the period performance in *Baseline*, but the respective interaction terms are not significant. Moreover, the estimated performance effects in the last period of these treatments seem to be somewhat smaller than the treatment performance in period 7. Therefore, one potential worry could be that performance effects of repeated wage increases eventually vanish.

However, this seems unlikely in our setting for the following reasons: First, in *T_Successive* wages are stable in the last period, and a performance dip is well in line with our theoretical result that stable period wages which are above initial reference wages lead to a decline in performance when agents use an adaptive reference standard. Moreover, in the period with the last wage increase in *T_Successive* (the penultimate period 7), we observe a significant output increase (some 30% relative to performance in *Baseline*), suggesting that agents still respond to wage increases shortly before the end of the experiment. Second, for the profile *T_Continuous* we observe that performance in the penultimate period is significantly higher as compared to the baseline (+ 22%), although agents have been exposed to the identical (small) wage increases already from periods 2 to 6 suggesting that agents still respond to wage increases shortly before the end of the experiment. Also, the coefficients of the interaction effects Treatment × Period 7 and Treatment × Period 8 are not significantly different from each other ($p = 0.554$, two-sided Wald test) so that we have no significant indication for a performance decline towards the end of the game.

On a more general level our model suggests that under an adaptive reference standard continuous wage increases of the same size indeed raise performance, but eventually

[22] A similar argument can be made for performance in periods 3 and 4 in *T_Successive*, where wages are lower than or equal to the *Baseline* wage.

performance converges to a stable level which exceeds the level of a constant wage schedule (we provide a formal proof of this statement in Proposition 5 reported in Appendix A3). In other words, there is an upper bound to the performance increases that can be achieved with repeated wage increases from the principal's perspective. Therefore, we should expect that, while additional wage increases should keep agents' efforts at a level above the level attained with constant wages, at some point further effort increases are infeasible.

All in all, the evidence so far speaks in favor of the hypothesis that the kindness of wages is judged relative to a reference point determined by the previous wages, as suggested by our notion of an adaptive reference standard. In fact, if we compare the estimated performance effects across the treatments with increasing wage profiles from Figure 2 with our simulations (Figure 1 in Section 3 and Figures A1 and A2 in the Appendix), an adaptive reference standard combined with some "memory" seem to organize the qualitative patterns well. This might suggest that increasing wage profiles are generally preferable from a principal's perspective. Yet, there is clearly a trade-off: Increasing wage schemes induce higher efforts in the end of the experiment, but they tend to come along with lower performance levels in the beginning.[23] Hence, it is important to study the overall effect of the wage profiles on performance, which will be the focus of the next section.

4.2 Which Wage Schedule Maximizes Performance?

An obvious question is whether the (constant sum) re-allocation of wages just reallocates performance across periods or is able to increase overall performance. Therefore, we now estimate the overall treatment effect by regressing the total performance per subject on treatment dummies. The results are shown in column 1 of Table 3. We also report separate regressions for the first half (where wages are higher in *Baseline* than in all

[23] Numerical simulations in our formal model show that the ranking of the investigated schemes depends on the degree of loss aversion and the elasticity of efforts with respect to changes in the emotional state. Hence, we do not have a clear hypothesis which of the profiles yields the largest revenues from the principal's perspective.

other treatments, Model 2) and the second half of the experiment (where the opposite is the case, Model 3).

Table 3: The Overall Treatment Effect

	(1)	(2)	(3)
	Periods 1-8	Periods 1-4	Periods 5-8
T_Sudden	0.035	-0.062	0.146
	[0.100]	[0.091]	[0.125]
T_Successive	0.101	-0.030	0.225**
	[0.072]	[0.074]	[0.094]
T_Continuous	0.148**	0.060	0.256***
	[0.070]	[0.062]	[0.091]
Time Trial Period	-0.003***	-0.003***	-0.003***
	[0.001]	[0.001]	[0.001]
Observations	211	211	211
R-squared	0.058	0.054	0.059

Note.– Dependent variable: log(total output+1); OLS regressions with robust standard errors in brackets; *** p<0.01, ** p<0.05, * p<0.1

Concerning total performance (Model 1), we find no significant overall difference in performance between both *T_Sudden* and *T_Successive* to the reference condition *Baseline*, although the coefficients for the treatment dummies are both positive. But *T_Continuous* significantly outperforms *Baseline* by about 15%.[24] Hence, a simple reallocation of money across periods that implements frequent wage increases leads to a significant increase in overall performance in our setting without any costs to the principal.[25]

We observe no significant difference in the agents' outputs in the first half (Model 2) of the experiment. While the average performance is somewhat smaller in *T_Sudden* and

[24] The coefficient of *T_Continuous* is not significantly different from *T_Sudden* and *T_Successive.*

[25] Our observations on the treatment effects on total performance are confirmed when we use an alternative non-parametric procedure. In order to do so we divide a subject's rank with respect to her total performance across the 8 periods (ranked across all treatments, in descending order from highest to lowest performance) by her performance rank in the trial period so that values smaller than 1 (larger than 1) indicate that the agents performed worse (better) than could be expected from the trial period. If we compare the distributions of these index values between treatments with a two-sided Mann-Whitney U (MWU) test, we again find that *T_Continuous* significantly outperforms *Baseline* ($p = 0.004$, two-sided MWU test) concerning index values but there are no significant differences between *Baseline* and the two other increasing schedules (the *p*-values of the corresponding tests are $p = 0.294$ for *T_Sudden* and $p = 0.824$ for *T_Successive*).

T_Successive, this negative effect of initially lower wages is not significant. Interestingly, even though the wage in *T_Continuous* is smaller in every single period of the first half, productivity in this treatment is not lower than productivity in *Baseline* - in fact, performance in *T_Continuous* is already about 6% higher in the first half (although not significantly so). Again, this observation speaks against a fixed reference standard for the agents' evaluation of payments (which would imply that performance should be smaller in the first half, see Proposition 2) and in favor of an adaptive reference standard.

Performance gains in the second half of the experiment relative to the *Baseline* condition are sizable in the treatments with increasing wage profiles and are statistically significant for *T_Successive* and *T_Continuous*. The highest performance gain is achieved in *T_Continuous* where output exceeds the *Baseline* condition by roughly 25% in periods 5 to 8.

The positive and significant effect in *T_Continuous* has some interesting implications: First of all, we can reject the idea that wage increases have to be irregular in order to trigger positive reciprocity. Second, when agents apply an adaptive reference standard for wages, a larger number of small wage increases may be preferable from a principal's perspective to a smaller number of larger wage increases. We will explore these implications in more detail in Section 4.4.

4.3 The Role of Reciprocity

In the next step, we consider the role of reciprocity. Several studies have shown that individuals differ with respect to the degree of their reciprocal inclinations. In a post-experimental questionnaire, we elicited a measure for the reciprocal inclination by a set of survey questions from a scale developed by Perugini et al. (2003) that have been used, for instance, in the German Socioeconomic Panel (GSOEP) and have been analyzed in detail in Dohmen et al. (2008, 2009). Subjects had to state their agreement to the following statements on a 7-point scale, with the value of 7 indicating the strongest agreement: *"If someone does me a favour, I am prepared to return it", "I go out of my way to help somebody who has been kind to me before"* and *"I am ready to undergo personal costs to help somebody who helped me before"*.

We now investigate whether and to what extent the treatment differences in performance are correlated with the reciprocal inclinations of the experimental subjects. To measure each subject's "preference for reciprocity", we use the standardized mean response to the three survey questions from each subject (i.e. subtracting the overall mean and dividing by the standard deviation in the subject population). We then include this standardized reciprocity measure for each worker as an independent variable in our regression models, with the logarithm of total performance in the experiment as the dependent variable. Also, we control for the gender of a particular agent in these specifications that we also elicited in the questionnaire.

Similar to the models reported in Table 2, we then again compare each of the three treatments with increasing wages separately with *Baseline* and include an interaction term between the treatment and the standardized measure of positive reciprocity. Table 4 reports the respective regression results.[26]

The coefficients for the treatment dummies replicate the result from Table 3. We do not find that the reciprocity measure influences performance in *Baseline.* This suggests that performance in *Baseline* is not predominantly driven by reciprocal inclinations of agents but rather by alternative motivations, such as concerns for efficiency or equality or by intrinsic motivation for the task.[27] However, reciprocity affects the impact of treatment *T_Continuous* on performance (Model 3). Apparently, the treatment effect is driven by the positively reciprocal agents.[28] A rough interpretation from the coefficient sizes of 'Treatment' and 'Treatment x Positive reciprocity (std)' would be that there is no treatment effect for an agent whose reciprocal inclinations is one standard deviation *below* the average type, as the positive effect of 'Treatment' is largely counterbalanced in this case. At the same time, the treatment effect of continuous wage increases is estimated to be

[26] As we include data from post-experimental questionnaire for these models, we have two observations less than in the other analyses (two subjects did not provide answers to all survey questions).

[27] Note that in our formal model, reciprocal inclinations r matter for performance only when there is an impulse, i.e. the wage deviates from the reference wage. When wages are constant, as it is the case in *Baseline*, reciprocal inclinations do not affect performance.

[28] This finding corresponds to the results of Cohn et al. (2015) who observe in a field setting that performance increases in response to wage increases are only triggered among reciprocal workers.

roughly twice as large for an agent whose reciprocal inclinations are one standard deviation *above* the average. The effects of reciprocity are smaller in the other treatments: Model 1 from Table 3 suggests a weakly significant positive impact of the large one-time wage increase among reciprocal agents in treatment *T_Sudden*. Moreover, no significant interaction effect is found for treatment *T_Successive* (Model 2).

Table 4: Heterogeneous Treatment Effects on Total Performance: The Impact of Positive Reciprocity

	(1)	(2)	(3)
	T_Sudden	T_Successive	T_Continuous
Treatment	-0.026	0.107	0.145**
	[0.114]	[0.076]	[0.071]
Treatment x Positive reciprocity (std)	0.335*	0.052	0.130**
	[0.192]	[0.067]	[0.065]
Positive reciprocity (standardized)	-0.005	-0.003	-0.004
	[0.049]	[0.049]	[0.049]
Time Trial Period	-0.003*	-0.004**	-0.003***
	[0.002]	[0.002]	[0.001]
Female	-0.063	0.023	-0.016
	[0.085]	[0.082]	[0.071]
Observations	116	112	127
R-squared	0.140	0.071	0.099

Note.– Dependent variable: log(total output); OLS regressions with robust standard errors in brackets; *** p<0.01, ** p<0.05, * p<0.1

4.4 The Effect of Absolute Wages and Wage Increases

In the next step of our analysis, we try to disentangle the different effects of wage increases on performance in order to shed more light on the reasons for the superiority of the treatment with continuous wage increases. Specifically, our treatments vary both the timing and size of the wage increases, enabling us to disentangle the impact of (i) the absolute wage level, (ii) the mere incidence of a wage increase and (iii) the size of this increase. Note that in this respect our model allows for different elasticities of the agents' effort reactions to a wage increase. In our model, the $h(\theta)$ function captures the effect of the wage increase on the extent to which the agent cares for the principal. If, for instance, this function is linear (as in the example plotted in Figures 1, A1 and A2) we should observe that only the size of the wage increase matters and the effort reaction should be rather linear in the wage change. If, however, the $h(\theta)$ function is strictly concave, then larger wage increases may not lead to substantially larger effort reactions than smaller increases, and it may rather be the incidence that there is wage increase (and thus a positive impulse) than its size that affects the efforts exerted. Our observation that the continuous wage profile with more frequent but smaller wage increases leads to the highest performance points into the latter direction. To test this conjecture, we run random effects regressions, again with the log output as dependent variable. In these models we pool data from all treatments and periods. Results are reported in Table 5.

In Model 1, output is regressed on the absolute wage level. Model 2 adds the (absolute) size of the wage increase in ECU in the period under consideration, relative to the previous period and, Model 3 additionally includes a dummy variable indicating whether or not there was a wage increase. Finally, Model 4 includes also a dummy variable that is equal to one if the period wage is higher than the initial reference wage in *Baseline* (i.e. the wage level that leads to a typical hourly wage in our laboratory, see Section 2).

First, the absolute wage has a highly significant positive impact on performance in all specifications. In addition, Model 2 seems to suggest that the size of a wage increase in a given period increases performance in this period. However, as Model 3 reveals, this effect is driven by the incidence rather than the size of the wage increase – the dummy variable for the incidence is significantly positively associated with performance, whereas the coefficient for the absolute wage increase is insignificant and close to zero. Hence, agents seem to react positively to the fact that there has been a wage increase but not to its size. This suggests that, when controlling for the absolute wage levels, small wage increases are as effective at raising performance as larger wage increases. It follows that the superiority of the continuous wage increase treatment apparently stems from the fact that it provides a continuous stimulus of small wage increases, which repeatedly triggers positive responses among agents and therefore helps to sustain performance at a high level.

Table 5: The Impact of Absolute Wage Level and Wage Increases

	(1)	(2)	(3)	(4)
Wage	0.004***	0.003***	0.003***	0.003**
	[0.001]	[0.001]	[0.001]	[0.001]
Wage Increase in ECU		0.003***	-0.001	-0.001
		[0.001]	[0.002]	[0.002]
Wage Increase (dummy)			0.126**	0.130**
			[0.060]	[0.063]
Wage Higher than Fixed Standard (dummy)				-0.017
				[0.064]
Time Trial Period	-0.002***	-0.002***	-0.002***	-0.002***
	[0.001]	[0.001]	[0.001]	[0.001]
Observations	1,688	1,477	1,477	1,477
Number of subjects	211	211	211	211

Note.– Dependent variable: log(output+1); Random effects regressions with robust standard errors clustered on the subject in brackets; period dummies included; *** p<0.01, ** p<0.05, * p<0.1. Model 1 uses the observations from all 8 periods, whereas Models 2 to 4 use only observations from periods 2 to 8, as the variables 'Wage Increase in ECU' and 'Wage Increase (dummy)' are calculated relative to the previous period and therefore not defined for Period 1.

Finally, Model 4 again provides evidence against a strong importance of a fixed reference standard for agents in our setting: Proposition 2 implies that we should observe an additional positive performance effect as soon as agents are paid more than the wage in the *Baseline* condition. Yet the coefficient of the respective dummy variable is insignificant.[29]

All in all, our previous results indicate that many agents in our experimental setting follow an adaptive reference standard when they judge the kindness of a given period wage

[29] Using the raw output measure as the dependent variable instead of its logarithm for our analyses, thereby implicitly assuming that workers of different abilities show the same absolute performance responses to the different wage profiles (see also footnote 19) leads to similar qualitative conclusions. However, in some of the model specifications, performance effects tend to be statistically less pronounced. Results for the models reported in Tables 2 to 5 that use the raw output measure as the dependent variable can be found in the Appendix (Tables A2 to A5).

paid by the principal. However, efforts seem to be very elastic for small wage increases (i.e. from no increase to a small increase), but rather inelastic for higher wage increases. This helps to explain the superiority of the *T_Continuous* wage profile relative to the other profiles, as agents repeatedly experience a feeling of elation which in turn increases performance.

4.5 What Happens when Wages are Known in Advance?

As an additional test for the importance of wage "impulses" triggered by a comparison of the current wage with a reference standard, we conducted a new experiment. The decision situation and the experimental procedures of our new sessions were identical to our main experiment, with one important difference: Now agents were *ex-ante informed* about the wages they would receive throughout the 8 periods of the experimental working task, and this was common knowledge among principals and agents:[30] After agents had finished the trial period and principals had opted for a wage profile, a table was displayed on the agents' screens that listed the wage for each single period before the actual task began.

In the new experiments, agents thus knew their full wage profiles in advance. One interpretation of this in the light of our model is that a reference standard is set for each period by the wage that has been announced ex-ante for this period. If this is indeed the case, Corollary 1 implies that the timing of wage increases should not matter as actual wages and reference wages coincide in each period. In other words, when an agent knows from the beginning that a wage will be higher (lower) in a specific period, the degree of "elation" ("disappointment") realized in this specific period will be weaker and thus the reciprocal reaction to this impulse. Moreover, since all wage profiles pay the same wage sum, they do not differ in their overall generosity, i.e. the effect of the revelation of the whole profile at the beginning of the experiment on the agent's emotional state should be

[30] In the instructions for the new sessions, we changed the sentence "Prior to each period, the employee is informed about the payment the employer has determined for him in this period" to "Prior to the first period, the employee is informed about the payments the employer has determined for him for all periods". The rest of the instructions were identical to those of the main experiment.

the same for all treatments.[31] Hence, if the revelation of the profiles ex-ante sets the reference standard for each period, then the positive effect of reallocating wages across periods should disappear in our new sessions.

We conducted altogether 9 sessions of the new experiment in which 280 subjects took part (140 in the role of principals and 140 in the role of agents). Experimental procedures were identical to our main experiment. The sessions were conducted in the Cologne Laboratory for Economic Research (CLER) in March 2015. Participants were recruited with the online recruitment system ORSEE (Greiner 2004); the experimental software was programmed with z-Tree (Fischbacher 2007). Participants earned on average 12.56 Euro (standard deviation: 2.79 Euro) including the show-up fee of 2.50 Euro and again were present in the laboratory for about 75 minutes.

In the new sessions we implemented three wage profiles denoted as *Baseline_Info*, *T_Sudden_Info* and *T_Continuous_Info* that paid the same period wage as the profiles from our main experiment.[32] As before, principals had to choose one out of two profiles, and we conducted three experimental sessions for each possible combination of the wage profiles. Altogether, we collected 54, 43 and 43 statistically independent observations for agents' choices under the *Baseline_Info*, *T_Sudden_Info* and *T_Continuous_Info* wage profile, respectively.

An important first observation from the control experiment is that average total performance in *Baseline_Info* is with 50.2 blocks nearly identical to the profile with constant wages (*Baseline*) in our main experiment (50.1).[33] This indicates that neither the ex-ante knowledge of wages throughout periods *per se* nor the agents' knowledge about

[31] We note that increasing wage profiles generally might have an additional positive effect on employee motivation, for example, resulting from preferences for increasing wage profiles (see our discussion in the Introduction).

[32] Originally, we included the *T_Successive* wage profile in our main experiment predominantly to investigate the effect of irregular wage increases in the presence of uncertainty over the full profile. As uncertainty on the part of the agents was resolved in the new sessions, it did not seem necessary to replicate this schedule.

[33] Please see Table A6 in the Appendix for descriptive statistics of performance in the new sessions.

the fact that the full wage profile was determined in advance have a significant effect on the decision of agents how much effort to invest.

Moreover, we find that - in contrast to our main experiment and in line with the conjecture that the timing effect of wage increases is substantially weaker when agents know the full wage profile - neither *T_Sudden_Info* nor *T_Continuous_Info* lead to significant performance impulses in specific periods or to a significant overall performance increase. First, we estimate random effects regressions using the logarithm of period performance as the dependent variable (analogously to Table 2; the results are displayed in detail in Table A7 in the Appendix). Here, the coefficients of the interaction effects between the treatment and the period dummy variables are never significant. Second, in line with the generally weak period responses to wage increases, there is no overall treatment effect on performance in the new experiment, either. In OLS models similar to those reported in Table 3 that use the logarithm of the total performance either in the whole experiment or separately for periods 1-4 and 5-8 as the dependent variables, the dummies for treatments are all insignificant (see Table 6 below).

Table 6: The Overall Treatment Effect (New Experiment)

	(1) Periods 1-8	(2) Periods 1-4	(3) Periods 5-8
T_Sudden_Info	0.023	-0.028	0.038
	[0.116]	[0.112]	[0.119]
T_Continuous_Info	0.037	0.050	-0.027
	[0.134]	[0.109]	[0.162]
Time Trial Period	-0.006***	-0.005***	-0.006***
	[0.002]	[0.002]	[0.002]
Observations	140	140	140
R-squared	0.061	0.062	0.048

Note.– Dependent variable: log(total output+1); OLS regressions with robust standard errors in brackets; *** p<0.01, ** p<0.05, * p<0.1

Hence, the new experiment provides additional evidence for the importance of reference standards for the positive effect of timing in our main experiment: Once agents foresee the payments they will receive throughout the periods, wage increases, and in particular the frequent repetition of small wage increases, do not induce additional efforts.

4.6 The Choice of Wage Profiles

In the final step of our analysis, we explore whether the experimental principals are capable of anticipating that increasing wage profiles, and in particular those with multiple increases, are advantageous in terms of motivating the experimental agents. But in fact, many principals do not seem to understand that increasing wage profiles generate higher performance. When being confronted with the choice between a constant and an increasing wage profile, just about half of the principals (51.6%) opt for increasing wages. When they have the choice between *Baseline* and *T_Continuous*, 59% chose *T_Continuous*, but this is not significantly different from a 50-50 random draw ($p = 0.377$, two-sided Binomial test).[34] In line with the weaker effect of wage increases when the full profiles are *ex-ante* known, fewer principals chose increasing wage profiles in the new experiment (41.9%). However, the difference between the main and the new experiment is not significant ($p = 0.185$, two-sided χ^2-test). Overall, the results suggest that principals are heterogeneous in how they evaluate the impact of the profiles on agents' motivation, and notably, a substantial share of the principals seems to choose incorrectly in terms of maximizing their revenues.

This observation might, however, reflect the lack of experience of the experimental principals. To study the question whether a positive impact of increasing wage profiles can be more easily predicted by human resource management professionals, we conducted a short online survey among German HR managers together with the German Association for People Management (DGFP) that comprises over 2000 companies. The online survey was integrated into a larger survey study on a different topic by Heinz and Schumacher (2015) in April 2015. Altogether 102 managers completed our survey (74% of whom were female) whose average professional experience in the field of HR accounted for 4.6 years.

In the survey, managers learned about the design of our main experiment: They were informed that agents had to work on a tedious task for 8 periods, receiving fixed wages set by a principal prior to the start of the task. Emphasis was put on the fact that there were

[34] This statement refers to 6 out of 14 sessions in which principals were given the choice between *Baseline* and one of the increasing wage profiles. In the remaining 8 sessions principals had to choose one out of two increasing wage profiles (please the description of our experimental procedures in Section 2).

four wage profiles to be chosen, namely our profiles *T_Constant, T_Sudden, T_Successive and T_Continuous* which were denoted as profile A, B, C and D, respectively and the wage payments per period for each profile and were displayed in a table. Survey participants were also informed that workers were ignorant about the full wage profile in advance but only got to know their current wage prior to each working period.

The task of the HR managers was then to estimate which wage profile had led to the highest performance in the experiment by assigning a rank from 1 (highest performance among the four wage profiles) to 4 (lowest performance among the four wage profiles) to each profile. Figure 3 below shows the distributions of rankings for the four different profiles.

Figure 3: Distribution of estimated performance of the wage profiles among HR managers (in % of the respective rank scores assigned to each profile)

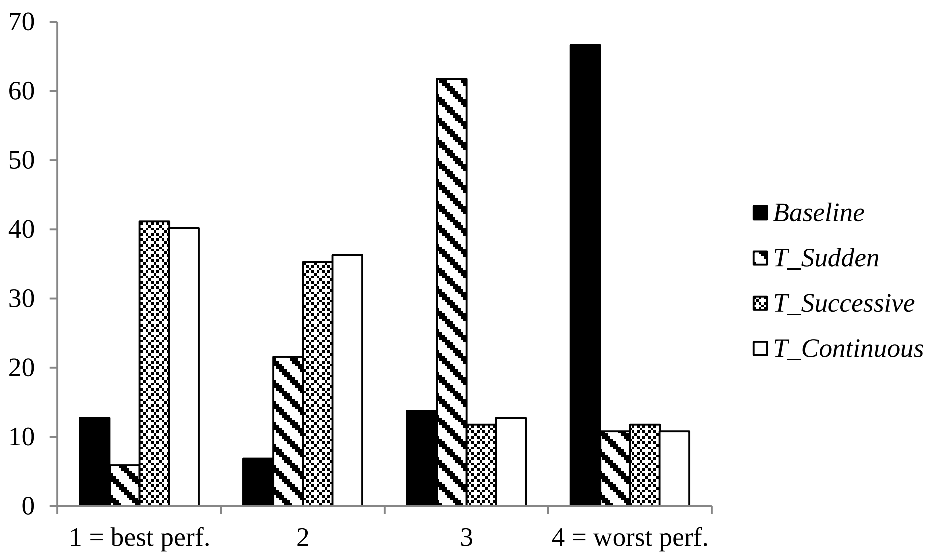


Figure 3 shows that HR managers differ strongly from the experimental principals concerning their assessment of the wage profiles. First, the profile with constant wages (*Baseline*) is ranked lowest, with two thirds of the HR managers assigning the fourth rank for the lowest estimated performance to this profile. The profile *T_Sudden* that implements one large wage increase is ranked next; more than 60% of the HR managers place it above *Baseline* but still below the other two profiles. In contrast, the two profiles that implement multiple wage increases (*T_Successive* and *T_Continuous*) are rated much higher: More than 75% of the HR managers estimate that these wage profiles induce either the highest or the second highest performance.[35] All in all, the findings from the online survey show that HR professionals are indeed capable of anticipating the superiority of wage profiles with multiple wage increases.

5 Discussion and Conclusion

Our experiment provides evidence that the proper timing of wage increases can induce substantial positive performance effects. In our setting, we let principals choose between different wage profiles that vary the number and absolute amounts of wage increases for a constant total wage sum. Overall, experimental agents provide more effort in periods with higher absolute wage levels and also respond positively to wage increases.

With respect to the specific patterns of the dynamic reaction to wage increases, a theoretical framework in which agents reciprocally respond to the perceived kindness of the principals and evaluate their wages relative to a reference wage can organize our findings well. In particular, the observed patterns are in line with the notion that agents apply an adaptive reference standard for wages and judge the current wage relative to the wage received in the previous period. The importance of reference standards for the evaluation of wages is confirmed in a new experiment, where positive responses to wage increases become much weaker if agents know their full wage profile in advance.

Concerning the effect of the frequency of wage increases, we first find that a large one-time pay rise does not create a persistent upward shift in performance in our main experiment. In line with previous field experiments (see, for example, Gneezy and List 2006), we observe an initial productivity push after the wage increase, but in the following

[35] In line with these observations, we find that HR managers evaluate the three profiles with wage increases significantly better than *Baseline* (the respective two-sided sign tests are all significant at $p < 0.001$) and that the wage profiles with multiple increases (*T_Successive* and *T_Continuous*) receive significantly better ratings than *T_Sudden* ($p < 0.001$ in each case). Finally, the ranks assigned to *T_Successive* and *T_Continuous* are not significantly different from each other ($p = 0.921$).

periods performance converges back to the level of workers who receive constant wages throughout the experiment. A wage that is "generous" in one period, seems to be considered "normal" already shortly later, supporting the notion that many agents in our setting apply an adaptive reference standard when judging the kindness of their period wages.

However, persistent performance effects can be achieved in our setting by small but frequently repeated wage increases. Thus, by simply redistributing the total budgets for wage increases over the periods, a principal can induce economically sizable productivity gains at no additional costs. An interpretation of this pattern in the light of our formal framework is that efforts are elastic to small wage increases but become inelastic for larger wage increases.

Our results also yield insights for firms' wage setting decisions and personnel policies in practice. It has recently been argued that, when designing compensation schemes, firms face a choice between using performance pay and tight control mechanisms on the one hand, or paying generous wages and triggering employees' reciprocal reactions on the other (see, for instance, Bartling, Fehr and Schmidt 2012, or Englmaier and Leider 2012b). Our results indicate that even in the presence of reciprocal agents it is important that reciprocity is repeatedly triggered with (potentially smaller) frequent stimuli rather than paying generous wages at the outset. Moreover, our results of the additional experiment show that these stimuli positively and significantly affect efforts only when they are not fully anticipated. This supports the usefulness of the common policy adopted in many firms to keep wage levels and wage profiles secret (Colella et al. 2007).

While nearly half of the principals in our experiment did not anticipate the performance effects of increasing wage schedules, we find clear evidence from an online survey that human resources managers realize the benefits of such patterns: They rate the wage profiles with multiple increases from our experiment as clearly superior concerning their effect on employee motivation.

Finally, our results suggest a novel argument for using deferred compensation as an incentive device. As has been argued by Lazear (1979) and experimentally shown by Huck, Seltzer and Wallace (2011), deferred compensation provides incentives as employees run into the danger of losing higher wages in the future if fired for underperformance. In our experiment, a shift of wage payments to later periods is beneficial even though there is no firing threat and payments are not conditioned on performance, simply as seniority-based pay provides continuous stimuli for positive reciprocity.

References

Akerlof, George. 1982. Labor contracts as a partial gift exchange. *Quarterly Journal of Economics* 97, no. 4:543-69.

Bellemare, Charles, and Bruce Shearer. 2009. Gift giving and worker productivity: Evidence from a firm-level experiment. *Games and Economic Behavior* 67, no. 1:233-44.

Bartling, Björn, Ernst Fehr, and Klaus M. Schmidt. 2012. Screening, competition, and job design: Economic origins of good jobs. *American Economic Review* 102, no. 2:834-64.

Benartzi, Shlomo, and Richard H. Thaler. 1995. Myopic loss aversion and the equity premium puzzle. *Quarterly Journal of Economics* 110, no. 1:73-92.

Bolton, Gary E., and Axel Ockenfels. 2000. ERC:A theory of equity, reciprocity and competition. *American Economic Review* 90, no. 1:166-93.

Bradler, Christiane, Robert Dur, Susanne Neckermann, and Arjan Non. Forthcoming. Employee recognition and performance: A Field Experiment. *Management Science*.

Brown, Martin, Armin Falk, and Ernst Fehr. 2004. Relational contracts and the nature of market interactions. *Econometrica* 72:747-80.

Brown, Martin, Armin Falk, and Ernst Fehr. 2012. Competition and relational contracts: The role of unemployment as a disciplinary device. *Journal of the European Economic Association* 10:887-907.

Camerer, Colin, Linda Babcock, George Loewenstein, and Richard Thaler. 1997. Labor supply of New York City cabdrivers: One day at a time. *Quarterly Journal of Economics* 112, no. 2:407-41.

Card, David, Alexandre Mas, Enrico Moretti, and Emmanuel Saez. 2012. Inequality at work: The effect of peer salaries on job satisfaction. *American Economic Review* 102, no. 6:2981-3003.

Charness, Gary, and Peter J. Kuhn. 2011. Lab labor: What can labor economists learn from the lab? In *Handbook of Labor Economics No. 4 Part A*, ed. Orley Ashenfelter and David Card, 229-330. San Diego and Amsterdam: North-Holland.

Chemin, Matthieu, and André Kurmann. 2014. Do workers feel entitled to high wages? Evidence from a field experiment. Working Paper.

Cohn, Alain, Ernst Fehr, and Lorenz Götte. 2015. Fair wages and effort provision: Combining evidence from a choice experiment and a field experiment. *Management Science* 61, no. 8:1777-94.

Colella, Adrienne, Ramona L. Paetzold, Asghar Zardkoohi, and Michael J. Wesson. 2007. Exposing pay secrecy. *Academy of Management Review* 32, no. 1:55-71.

Cox, James C., Daniel Friedman, and Steven Gjerstad. 2007. A tractable model of reciprocity and fairness. *Games and Economic Behavior* 59:17-45.

Dohmen, Thomas, Armin Falk, David Huffman, and Uwe Sunde. 2008. Representative trust and reciprocity: Prevalence and determinants. *Economic Inquiry* 46, no. 1:84-90.

Dohmen, Thomas, Armin Falk, David Huffman, and Uwe Sunde. 2009. Homo Reciprocans: Survey evidence on behavioral outcomes. *Economic Journal* 119, no. 536:592-612.

Dufwenberg, Martin, and Georg Kirchsteiger. 2004. A theory of sequential reciprocity. *Games and Economic Behavior* 47:268-98.

Englmaier, Florian, and Stephen Leider. 2012a. Managerial payoff and gift exchange in the field. Working Paper No. 3707, CESifo, Munich.

Englmaier, Florian, and Stephen Leider. 2012b. Contractual and organizational structure with reciprocal agents. *American Economic Journal: Microeconomics* 4, no. 2:146-83.

Esteves-Sorenson, Constanca, and Rosario Macera. 2015. Gift exchange in the workplace: Addressing the conflicting evidence with a careful test. Working Paper.

Evans, Jonathan St. B. T. 2008. Dual-processing accounts of reasoning, judgment, and social cognition. *Annual Review of Psychology* 59:255-78.

Falk, Armin, and Urs Fischbacher. 2006. A theory of reciprocity. *Games and Economic Behavior* 54:293-315.

Fehr, Ernst, Lorenz Götte, and Christian Zehnder. 2009. A behavioral account of the labor market: The role of fairness concerns. *Annual Review of Economics* 1:355-84.

Fehr, Ernst, Georg Kirchsteiger, and Arno Riedl. 1993. Does fairness prevent market clearing? An experimental investigation. *Quarterly Journal of Economics* 108:437-60.

Fehr, Ernst, and Klaus Schmidt. 1999. A theory of fairness, competition, and cooperation. *Quarterly Journal of Economics* 114:817-68.

Fischbacher, Urs. 2007. z-Tree: Zurich toolbox for ready-made economic experiments. *Experimental Economics* 10, no. 2:171-78.

Frank, Robert H. 1989. Frames of reference and the quality of life. American Economic Review 79, no. 2:80-85.

Frank, Robert H., and Robert M. Hutchens. 1993. Wages, seniority, and the demand for rising consumption profiles. *Journal of Economic Behavior & Organization* 21:251-76.

Gilchrist, Duncan, Michael Luca, and Deepak Malhotra. Forthcoming. When 3+1 > 4:Gift structure and reciprocity in the field. *Management Science*.

Gneezy, Uri, and John A. List. 2006. Putting behavioral economics to work: Testing for gift exchange in labor markets using field experiments. *Econometrica* 74, no. 5:1365-384.

Greiner, Ben. 2004. An online recruitment system for economic experiments. In *Forschung und wissenschaftliches Rechnen, GWDG Bericht 63*, ed. Kurt Kremer and Noker Macho, 79-93. Göttingen: Ges. für Wiss. Datenverarbeitung.

Grund, Christian, and Dirk Sliwka. 2007. Reference-dependent preferences and the impact of wage increases on job satisfaction: Theory and evidence. *Journal of Institutional and Theoretical Economics* 163, no. 2:313-35.

Heinz, Matthias, and Heiner Schumacher. 2015. Signaling cooperation. Working Paper, University of Cologne.

Hennig-Schmidt, Heike, Bettina Rockenbach, and Abdolkarim Sadrieh. 2010. In search of workers' real effort reciprocity – A field and a laboratory experiment. *Journal of the European Economic Association* 8, no. 4:817-37.

Huck, Steffen, Gabriele Lünser, and Jean-Robert Tyran. 2012. Competition fosters trust. *Games and Economic Behavior* 76:195-209.

Huck, Steffen, Andrew J. Seltzer, and Brian Wallace. 2011. Deferred compensation in multiperiod labor contracts: An experimental test of Lazear's model. *American Economic Review* 101, no. 2:819-43.

Kahneman, D., 2011. *Thinking, fast and slow*. New York: Farrar, Straus & Giroux.

Kahneman, Daniel, and Amos Tversky. 1979. Prospect theory: An analysis of decision under risk. *Econometrica* 47, no. 2:263-91.

Köszegi, Botond, and Matthew Rabin. 2006. A model of reference-dependent preferences. *Quarterly Journal of Economics* 121, no. 4:1133-65.

Kosfeld, Michael, and Susanne Neckermann. 2011. Getting more work for nothing? symbolic awards and working performance. *American Economic Journal: Microeconomics* 3:86-99.

Kube, Sebastian, Michel André Maréchal, and Clemens Puppe. 2012. The currency of reciprocity - gift-exchange in the workplace. *American Economic Review* 102, no. 4:1644-1662.

Kube, Sebastian, Michel André Maréchal, and Clemens Puppe. 2013. Do wage cuts damage work morale? Evidence from a natural field experiment. *Journal of the European Economic Association* 11, no. 4:853-870.

Landry, Craig E., Andreas Lange, John A. List, Michael K. Price, and Nicholas G. Rupp. 2011a. Is there a 'hidden cost of control' in naturally-occurring markets? Evidence from a natural field experiment. Working Paper No. 17472, National Bureau of Economic Research, Cambridge, MA.

Landry, Craig E., Andreas Lange, John A. List, Michael K. Price, and Nicholas G. Rupp. 2011b. The hidden benefits of control: Evidence from a natural field experiment. Working Paper No. 17473, National Bureau of Economic Research, Cambridge, MA.

Lazear, Edward P. 1979. Why is there mandatory retirement? *Journal of Political Economy* 87, no. 6:1261-1284.

Levine, David. 1998. Modeling altruism and spitefulness in experiments. *Review of Economic Dynamics* 1:593-622.

Loewenstein, George, and Dražen Prelec. 1993. Preferences for sequences of outcomes. *Psychological Review* 100, no. 1:91-108.

Loewenstein, George, and Nachum Sicherman. 1991. Do workers prefer increasing wage profiles? *Journal of Labor Economics* 9, no. 1:67-84.

Loomes, Graham, and Robert Sugden. 1986. Disappointment and dynamic consistency in choice under uncertainty. *Review of Economic Studies* 53, no. 2:271-82.

Mas, Alexandre. 2006. Pay, reference points, and police performance. *Quarterly Journal of Economics* 121, no. 3:783-821.

Ockenfels, Axel, Dirk Sliwka, and Peter Werner. 2015a. Bonus payments and reference point violations. *Management Science* 61, no. 7:1496-1513.

Ockenfels, Axel, Dirk Sliwka, and Peter Werner. 2015b. Timing of kindness - Evidence from a field experiment. *Journal of Economic Behavior & Organization* 111:79-87.

Perugini, Marco, Marcello Gallucci, Fabio Presaghi, and Anna Paola Ercolani. 2003. The personal norm of reciprocity. *European Journal of Personality* 17, no. 4:251-283.

Rabin, Matthew. 1993. Incorporating fairness into game theory and economics. *American Economic Review* 83:1281-1302.

Read, Daniel, George Loewenstein, and Matthew Rabin. 1999. Choice bracketing. *Journal of Risk and Uncertainty* 19, no. 1-3:171-197.

Thaler, Richard H. 1999. Mental accounting matters. *Journal of Behavioral Decision Making* 12:183-206.

Appendix

A1. Additional results

Table A1: Average Performance per Treatment[36]

Wage profile	*n*	Performance all periods	Performance periods 1-4	Performance periods 5-8	Time trial period (sec)
Baseline	73	50.1	24.7	25.4	138.3
T_Sudden	43	51.5	23.7	27.8	145.3
T_Successive	40	53.2	24.2	29.0	141.7
T_Continuous	55	53.9	25.2	28.8	151.2

Note.– The table lists the number of agents who worked under a particular wage profile, the average output in number of correctly counted blocks, separately for all periods, for periods 1-4 and for periods 5-8, respectively, and the average number of seconds needed to count the 5 blocks in the trial period. *Baseline* is the reference wage profile for the relative performance measures.

[36] From the 73 agents who received the wage profile *Baseline*, 27 agents participated in our experimental sessions 1 and 2 where the principal could choose between the constant scheme and the extreme version of *T_Sudden* (see also footnote 11). In the sessions where principals could choose between the constant and one of the three increasing wage profiles depicted in Table 1, they picked the constant wage profile in altogether 46 cases.

Table A2: Treatment Effects per Period (Raw Performance Measure)

	(1)	(2)	(3)
	T_Sudden	T_Successive	T_Continuous
Treatment × Period 1	-0.214	-0.544	-0.158
	[0.476]	[0.516]	[0.409]
Treatment × Period 2	-0.384	-0.825	-0.150
	[0.464]	[0.569]	[0.422]
Treatment × Period 3	0.023	0.383	0.906**
	[0.477]	[0.498]	[0.441]
Treatment × Period 4	-0.051	0.756	0.769
	[0.527]	[0.508]	[0.518]
Treatment × Period 5	1.049**	0.170	0.995*
	[0.524]	[0.565]	[0.550]
Treatment × Period 6	0.955*	0.931	1.303**
	[0.541]	[0.572]	[0.520]
Treatment × Period 7	0.662	1.934***	1.111**
	[0.594]	[0.610]	[0.547]
Treatment × Period 8	0.041	0.873	0.846
	[0.655]	[0.692]	[0.584]
Time Trial Period	-0.013*	-0.023***	-0.018***
	[0.007]	[0.008]	[0.006]
Constant	7.877***	9.211***	8.546***
	[0.968]	[1.069]	[0.855]
Observations	928	904	1,024
Number of subjects	116	113	128

Note.– Dependent variable: output in number of blocks; Random effects regressions with robust standard errors clustered on the subject in brackets; period dummies included; *** p<0.01, ** p<0.05, * p<0.1

Table A3: The Overall Treatment Effect (Raw Performance Measure)

	(1)	(2)	(3)
	Periods 1-8	Periods 1-4	Periods 5-8
T_Sudden	2.498	-0.458	2.956
	[3.420]	[1.638]	[1.950]
T_Successive	3.616	-0.280	3.896*
	[3.393]	[1.740]	[2.042]
T_Continuous	5.885*	1.426	4.459**
	[3.123]	[1.466]	[1.839]
Time Trial Period	-0.162***	-0.075***	-0.087***
	[0.039]	[0.019]	[0.023]
Constant	72.553***	35.141***	37.412***
	[5.797]	[2.811]	[3.411]
Observations	211	211	211
R-squared	0.077	0.067	0.080

Note.– Dependent variable: output in number of forms; OLS regressions with robust standard errors in brackets; *** p<0.01, ** p<0.05, * p<0.1

Table A4: Heterogeneous Treatment Effects on Total Performance: The Impact of Positive Reciprocity (Raw Performance Measure)

	(1)	(2)	(3)
	T_Sudden	T_Successive	T_Continuous
Treatment	1.171	3.794	5.525*
	[3.463]	[3.561]	[3.091]
Treatment x Positive reciprocity (std)	7.767*	2.595	6.633**
	[4.099]	[3.223]	[2.808]
Positive reciprocity (standardized)	-0.810	-0.832	-0.882
	[2.005]	[2.001]	[1.996]
Time Trial Period	-0.114**	-0.180***	-0.157***
	[0.057]	[0.063]	[0.049]
Female	-2.052	1.007	-0.892
	[3.274]	[3.423]	[3.010]
Constant	66.944***	74.386***	72.258***
	[8.352]	[9.198]	[7.464]
Observations	116	112	127
R-squared	0.078	0.083	0.117

Note.– Dependent variable: output in number of forms; OLS regressions with robust standard errors in brackets; *** p<0.01, ** p<0.05, * p<0.1

Table A5: The Impact of Absolute Wage Level and Wage Increases (Raw Performance Measure)

	(1)	(2)	(3)	(4)
Wage	0.020***	0.017***	0.017***	0.017**
	[0.004]	[0.005]	[0.005]	[0.008]
Wage Increase in ECU		0.012**	-0.006	-0.006
		[0.005]	[0.011]	[0.011]
Wage Increase (dummy)			0.669*	0.665*
			[0.361]	[0.365]
Wage Higher than Fixed Standard (dummy)				0.016
				[0.332]
Time Trial Period	-0.019***	-0.019***	-0.020***	-0.020***
	[0.005]	[0.005]	[0.005]	[0.005]
Constant	6.468***	6.914***	6.937***	6.963***
	[0.884]	[0.956]	[0.953]	[1.174]
Observations	1,688	1,477	1,477	1,477
Number of subjects	211	211	211	211

Note.– Dependent variable: output in number of forms; Random effects regressions with robust standard errors clustered on the subject in brackets; period dummies included; *** p<0.01, ** p<0.05, * p<0.1. Model 1 uses the observations from all 8 periods, whereas Models 2 to 4 use only observations from periods 2 to 8, as the variables 'Wage Increase in ECU' and 'Wage Increase (dummy)' are calculated relative to the previous period and therefore not defined for Period 1.

Table A6: Average Performance per Treatment (New Experiment)

Wage profile	*n*	Performance all periods	Performance periods 1-4	Performance periods 5-8	Time trial period (sec)
Baseline_Info	54	50.2	24.0	26.2	151.4
T_Sudden_Info	43	50.7	23.9	26.8	142.9
T_Continuous_Info	43	51.0	24.2	26.8	151.8

Note.– The table lists the number of agents who worked under a particular wage profile, the average output in number of correctly counted blocks, separately for all periods, for periods 1-4 and for periods 5-8, respectively, and the average number of seconds needed to count the 5 blocks in the trial period. *Baseline_Info* is the reference wage profile for the relative performance measures.

Table A7: Treatment Effects per Period (New Experiment)

	(1)	(2)
	T_Sudden_Info	T_Continuous_Info
Treatment × Period 1	-0.026	-0.007
	[0.097]	[0.098]
Treatment × Period 2	-0.040	0.020
	[0.110]	[0.089]
Treatment × Period 3	-0.111	0.000
	[0.107]	[0.111]
Treatment × Period 4	-0.090	0.041
	[0.127]	[0.114]
Treatment × Period 5	0.107	0.049
	[0.104]	[0.117]
Treatment × Period 6	0.028	-0.008
	[0.114]	[0.135]
Treatment × Period 7	-0.132	-0.025
	[0.135]	[0.127]
Treatment × Period 8	-0.100	-0.030
	[0.128]	[0.139]
Time Trial Round	-0.005***	-0.005***
	[0.002]	[0.002]
Observations	776	776
Number of Subjects	97	97

Note.– Dependent variable: log(output+1); Random effects regressions with robust standard errors clustered on the subject in brackets; period dummies included; *** p<0.01, ** p<0.05, * p<0.1

A2. Proofs

Proof of Proposition 3:

First, note that $e_t > e_{t-1}$ is equivalent to

$$\theta_t > \theta_{t-1}$$
$$\Leftrightarrow (1-\alpha_t)\cdot\theta_{t-1} + \alpha_t \cdot f(w_t - w_0) > \theta_{t-1}$$
$$\Leftrightarrow f(w_t - w_0) > \theta_{t-1}.$$

This is equivalent to

$$f(w_t - w_0) - \alpha_t \cdot f(w_t - w_0) > (1-\alpha_t)\cdot\theta_{t-1}$$

But as the wage schedule is non-decreasing this implies that

$$f(w_{t+1} - w_0) - \alpha_t \cdot f(w_t - w_0) > (1-\alpha_t)\cdot\theta_{t-1}$$
$$\Leftrightarrow f(w_{t+1} - w_0) > (1-\alpha_t)\cdot\theta_{t-1} + \alpha_t \cdot f(w_t - w_0)$$
$$\Leftrightarrow f(w_{t+1} - w_0) > \theta_t$$
$$\Leftrightarrow \theta_{t+1} = (1-\alpha_{t+1})\cdot\theta_t + \alpha_{t+1}\cdot f(w_{t+1} - w_0) > \theta_t.$$

By the same argument we must then also have that $\theta_{\tau+1} > \theta_\tau$ for all $\tau > t$. ■

Proof of Proposition 4:

When $w_{t+1} = w_t$ the emotional state in period $t+1$ under an adaptive reference standard is equal to

$$\theta_{t+1} = (1-\alpha_{t+1})\cdot\theta_t + \alpha_{t+1}\cdot\theta_0.$$

Hence $\theta_{t+1} \geq \theta_t$ iff

$$(1-\alpha_{t+1})\cdot\theta_t + \alpha_{t+1}\cdot\theta_0 \geq \theta_t$$
$$\Leftrightarrow \theta_0 \geq \theta_t$$
$$\Leftrightarrow e_0 \geq e_t$$ ■

A3. Additional formal analyses

Here we state a formal result that gives a more specific characterization of the performance patterns implied by the wage profile T_Continuous when agents follow an adaptive reference standard. We assume that the memory parameter $\alpha_t = \alpha$ for all periods t.

Proposition 5 *Suppose that the wage profile first pays a wage $w_1 < w_0$ and then wages increase by a constant Δw in each further period. Efforts e_t are then monotonically increasing and strictly concave in t. For $t \to \infty$ efforts are converging towards a constant* $a(\theta_0 + r \cdot \Delta w)$.

Proof:

For each period $t > 1$ we have that

$$\theta_t - \theta_{t-1} = (1-\alpha) \cdot \theta_{t-1} + \alpha \cdot (\theta_0 + r \cdot \Delta w) - \theta_{t-1}$$

$$= \alpha \cdot (\theta_0 + r \cdot \Delta w - \theta_{t-1}). \qquad (1)$$

Hence,

$$\theta_t > \theta_{t-1} \quad \text{if and only if} \quad \theta_0 + r \cdot \Delta w > \theta_{t-1}.$$

This holds for $\mathrm{t} = 2$ as

$$\theta_1 = (1-\alpha) \cdot \theta_0 + \alpha \cdot f(w_1 - w_0) < \theta_0 < \theta_0 + r \cdot \Delta w$$

By induction this holds for any other period as the condition $\theta_{t-1} < \theta_0 + r \cdot \Delta w$ implies that this also holds for θ_t:

$$\theta_t = (1-\alpha) \cdot \theta_{t-1} + \alpha \cdot (\theta_0 + r \cdot \Delta w) < \theta_0 + r \cdot \Delta w.$$

Hence, θ_t is increasing in t. By (1) the increments are decreasing in t. As $e_t = a(\theta_t)$ and a is strictly concave function, the effort profile is increasing and strictly concave in t. Finally note that

$$\lim_{t\to\infty} \theta_t = (1-\alpha) \cdot \lim_{t\to\infty} \theta_{t-1} + \alpha \cdot (\theta_0 + r \cdot \Delta w)$$

which implies that

$$\lim_{t\to\infty} \theta_t = \theta_0 + r \cdot \Delta w.$$

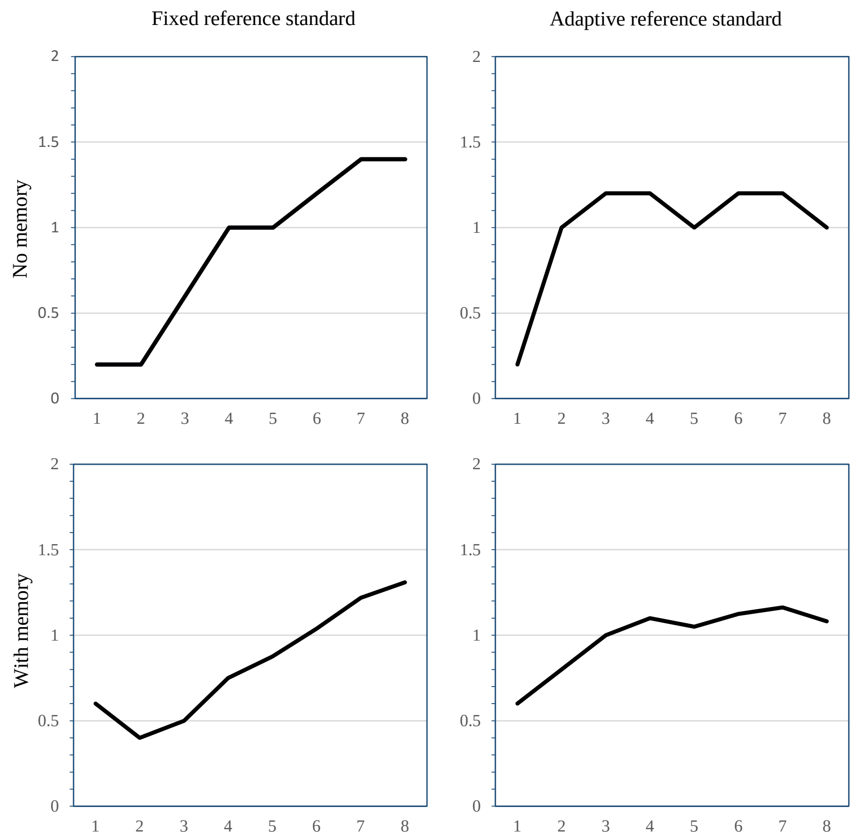
By the continuity of $a()$ we thus also have that

$$\lim_{t \to \infty} a(\theta_t) = a(\theta_0 + r \cdot \Delta w).$$

■

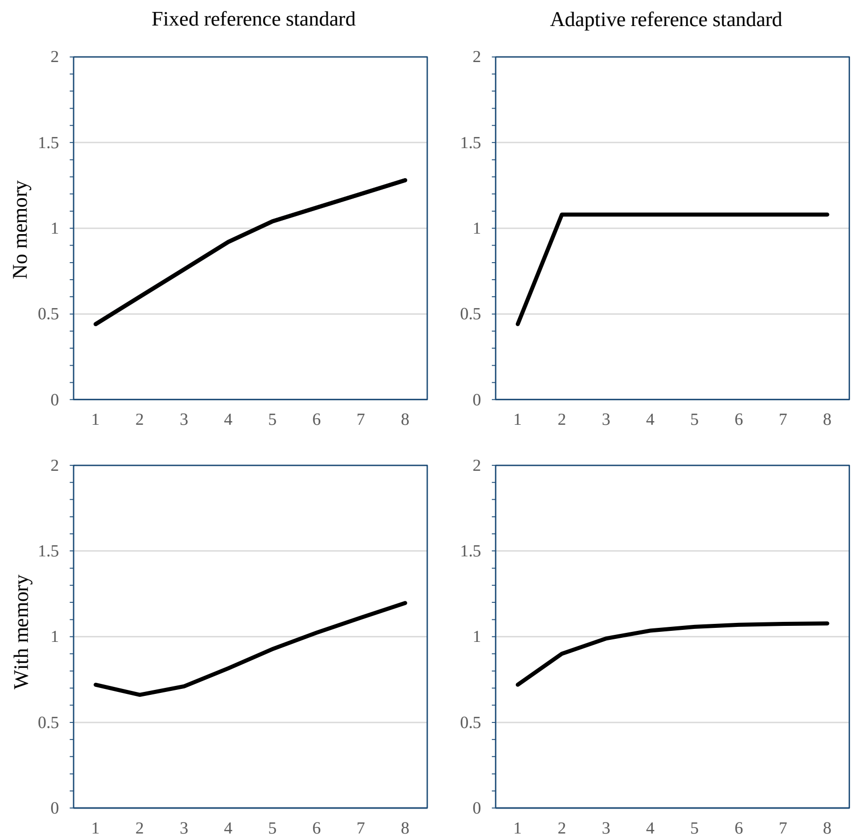
A4. Predicted performance dynamics

Figure A1: Performance Dynamics in *T_Successive* for a Fixed (Left Panel) and an Adaptive (Right Panel) Reference Standard (Both Relative to the Reference Condition *Baseline*)



The example is computed for $\lambda = 2$, $\mathrm{r} = 1$, $h(x) = x$ and $c(e) = \frac{1}{2}e^2$. As in the example an agent's effort is linear in the emotional state, the panels describe the patterns of both emotional state and effort. The figure plots the development of efforts over time (normalized at e_t/e_0 so that expected performance in the *Baseline* treatment is equal to 1 in every period). Simulated performance dynamics in the lower graphs are calculated with a parameter for the agent's memory of $\alpha = 0.5$.

Figure A2: Performance Dynamics in *T_Continuous* for a Fixed (Left Panel) and an Adaptive (Right Panel) Reference Standard (Both Relative to the Reference Condition *Baseline*)



The example is computed for $\lambda = 2$, r $= 1$, $h(x) = x$ and $c(e) = \frac{1}{2}e^2$. As in the example an agent's effort is linear in the emotional state, the panels describe the patterns of both emotional state and effort. The figure plots the development of efforts over time (normalized at e_t/e_0 so that expected performance in the *Baseline* treatment is equal to 1 in every period). Simulated performance dynamics in the lower graphs are calculated with a parameter for the agent's memory of $\alpha = 0.5$.

A5. Experimental Instructions (Translated from German)

Instructions

General Information

Welcome to our experiment. Please read the following instructions carefully. If you have any questions, please raise your hand, and an experimenter will come to you and answer your questions. It is not allowed to communicate with other participants before and during the experiment. If you do not follow these rules, we will have to exclude you from the experiment and all payoffs.

All participants receive 2.50 Euros that is paid out irrespective of the decisions during the experiment. You can earn additional money depending on your decisions and the decisions of other participants. In the following, the experiment is described in detail.

In the experiment, we will use ECU (Experimental Currency Unit) as the currency. At the end of the experiment, final payoffs in ECU of all participants will be converted into Euros and paid out in cash. The exchange rate is 100 ECU = 1 Euro.

None of the participants receives any information about the identity of other participants or about their payoffs during or after the experiment.

Information about the decision situation

In this experiment there are two types of participants: employer and employee. These types are randomly assigned and remain constant during the whole experiment. At the beginning of the experiment, you will be informed about your type.

Before the experiment starts, an employer is randomly matched to an employee. This matching remains constant during the whole experiment.

The experiment consists of 8 periods of 4 minutes each. In each period the task of the employee is to count the number of 7-digits in a block of randomly generated digits (see the illustration below). After counting the 7-digits in one block, the employee enters the number in the blue input box on the screen and confirms his input by clicking on the red button “Input/Continue”. After confirming the input, a new block of randomly generated digits will be displayed on the screen.

The employee has the opportunity to interrupt the task during a period. By clicking on the grey button “Break”, the employee reaches the pause screen on which cartoons are displayed. During a break, time continues in the particular period. As soon as the employee wants to end the break, he can return to the task by clicking on the “End break” button.

During the 8 periods in which the employee works on the task, the employer is not inactive but engaged in answering questionnaires.

Before the experiment starts, employer and employee participate in a short trial period to become familiar with the task.

In each period, the employee receives a fixed amount in ECU as the payment for the task. The employer matched to the employee receives a budget on his account. He chooses between different payments that the employee receives for working on the task during the periods. The payments for each period are subtracted from the employer’s account and paid out to the employee. Prior to each period, the employee is informed about the payment the employer has determined for him in this period.

For each correct input of the employee, the employer receives a payment of 20 ECU. The employer will *not* be informed about the performance of the employee during the 8 periods of the experiment. Only at the end of the experiment, the performance of the employee and the resulting payoff will be displayed to the employer.

The payoffs from the experiment for employer and employee are calculated as follows:

Payoff employee = Sum of payoffs for periods 1 to 8 in ECU

Payoff employer = (Number of correct entries of the employee during periods 1 to 8) * 20 ECU

This is the end of the instructions. If you have any questions, please raise your hand. If there are no more questions, the experiment will start soon.