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Concentration Bias in Intertemporal Choice

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Many intertemporal trade-offs are unbalanced: while the advantages of options are concentrated in a few periods, the disadvantages are dispersed over numerous periods. We provide novel experimental evidence for “concentration bias”, the tendency to overweight advantages that are concentrated in time. Subjects commit to too much overtime work that is dispersed over multiple days in exchange for a bonus that is concentrated in time: concentration bias increases subjects’ willingness to work by 22.4% beyond what standard discounting models could account for. In additional conditions and a complementary experiment involving monetary payments, we study the mechanisms behind concentration bias and demonstrate the robustness of our findings.

Key words: Attention, Focusing, Bounded rationality, Future bias, Present bias, Framing.

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1. INTRODUCTION

Trade-offs in multiattribute choice are often unbalanced: the advantage of an option relative to alternatives is concentrated in fewer attributes, while its disadvantage is dispersed over numerous other attributes. In such unbalanced choices, the “focusing model” by Kőszegi and Szeidl (2013) posits that a decision maker focuses disproportionately on, and hence overweights, the advantages of options that are concentrated in fewer attributes. Consequently, the decision maker is too prone to choose options with concentrated advantages: she exhibits “concentration bias”. While direct

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empirical evidence on concentration bias is lacking, potentially important theoretical implications of concentration bias have been identified in, for instance, industrial organization (Dertwinkel-Kalt *et al.*, 2019; Apffelstaedt and Mechtenberg, 2021), political economy (Gallice and Grillo, 2020; Nunnari and Zápal, 2020), bargaining (Canidio and Karle, 2021), and intertemporal choice (Kőszegi and Szeidl, 2013). In intertemporal choice, concentration bias implies systematic distortions between a decision maker's time preferences and her choices. Depending on the temporal position of a concentrated advantage, the decision maker may act either too patiently or too impatiently. For instance, the decision maker may overcommit to working overtime each day of the year in order to receive a large concentrated bonus at the end of the year. At the same time, she may be too prone to avoiding the concentrated hassle of going to the gym on one day at the cost of marginally poorer health on future days.

In this paper, we identify and quantify the causal effect of concentration bias on intertemporal choice based on two laboratory experiments. Our main experiment is preregistered and involves dated consumption events. We demonstrate that concentration bias can cause subjects to be too patient: subjects overcommit to dispersed effort provision in exchange for redeeming a concentrated restaurant voucher at a later point in time. In additional conditions of this experiment, we study the mechanisms behind concentration bias and demonstrate the robustness of our results. In our second experiment—which involves monetary payments—we corroborate these findings and add evidence that concentration bias can cause subjects to be too impatient as well.

In Section 2, we present our main contribution: the design of the MAIN-TREATMENT condition of the consumption experiment and the evidence it provides for concentration bias. In MAIN-TREATMENT, we provide a non-parametric measure of concentration bias on the individual level which allows us to account for heterogeneity in subjects' time preferences and their per-period utility functions. In a set of unbalanced choices, we elicit subjects' willingness to complete real-effort tasks on *multiple* workdays in exchange for a restaurant voucher. The voucher is valid on a *single* day, the "restaurant day", after the last workday. This trade-off is unbalanced because the real-effort tasks involve a utility cost that is dispersed over multiple workdays, while the restaurant voucher involves a subsequent utility benefit that is concentrated on the restaurant day. The focusing model predicts that subjects overweight the concentrated restaurant voucher and, thus, commit to completing more tasks than their preferences can account for. To identify this effect of concentration bias, we contrast subjects' unbalanced choices with balanced choices. The balanced choices consist of balanced trade-offs between real-effort tasks concentrated on a *single* workday and a restaurant voucher concentrated on the restaurant day. In these balanced trade-offs, the predictions of focusing and standard discounting coincide: subjects' preferences entirely determine their intertemporal choices. The balanced trade-offs thus provide a *within-subjects* benchmark of subjects' preferences. We find a statistically significant ($p < 0.001$) and large concentration bias in the unbalanced choices. Concentration bias causes subjects to be too patient: they are willing to complete 22.4% more tasks per workday than their preferences, as measured via the balanced choices, can account for.

In Section 3, we investigate the mechanisms behind concentration bias. Concentration bias could be caused by concentration in time—as the focusing model posits—or by a concentrated versus dispersed *framing* of utility outcomes. In MAIN-TREATMENT, the degree of temporal concentration and the corresponding type of framing coincide: additional work is not only dispersed over all workdays but it is also displayed in a dispersed framing, that is, per workday; the restaurant voucher is concentrated in time and also displayed in a concentrated framing, that is, its value is depicted in its entirety. If overweighting is at least partially caused by a concentrated framing, both temporal concentration and framing may cause the observed concentration bias. To disentangle these mechanisms, we designed the MECHANISM-TREATMENT condition. In comparison to MAIN-TREATMENT, we only change the framing of the restaurant voucher in MECHANISM-TREATMENT.

If concentration bias were exclusively caused by concentration in time, the same degree of concentration bias would hence be predicted in both conditions. In MECHANISM-TREATMENT, we frame the restaurant voucher in a dispersed way. Instead of depicting the value in its entirety, we depict the value as the sum of multiple parts. If framing contributes to concentration bias, there should be a less pronounced concentration bias in MECHANISM-TREATMENT than in MAIN-TREATMENT. We find that both concentration in time and framing contribute to concentration bias. MECHANISM-TREATMENT yields a statistically significant concentration bias that is significantly smaller than the degree of concentration bias estimated in MAIN-TREATMENT. This provides evidence for both the assumption of the focusing model that generates the prediction of concentration bias and the un-modelled intuition of Kőszegi and Szeidl (2013, p. 68–69) that framing may additionally affect concentration bias.

In Section 4, we provide robustness checks. We show that noise in subjects' choices cannot explain our findings, and we replicate the evidence for concentration bias by using a charitable donation instead of the restaurant voucher. In addition, we discuss the main assumptions behind our TREATMENT conditions. We assume that subjects' preferences are stable over the course of the experiment (since our measurement of concentration bias is within-subjects) and that subjects anticipate that their per-workday disutility is additively separable over time. We discuss violations of these assumptions that would confound our identification of concentration bias and show that these violations are implausible.

In Section 5, we report further evidence for concentration bias. In our money experiment, we test concentration bias over monetary payments. We find that subjects overweight payments concentrated in time relative to payments dispersed over time. Again, both concentration in time and framing contribute to concentration bias. Depending on the temporal position of the concentrated payment, concentration bias causes subjects to be either too patient or too impatient. Finally, concentration bias is more pronounced for a greater degree of dispersion over time.

We conclude in Section 6 with a discussion of related models of attention-based decision making (Rubinstein, 2003; Bordalo *et al.*, 2012; Bushong *et al.*, 2021) and of potential policy implications of our findings.

We make the following additional contributions: (i) Recent lab studies find little evidence for present bias (*e.g.* Andreoni and Sprenger, 2012), while field studies typically find substantial present bias (*e.g.* DellaVigna and Malmendier, 2006; Paserman, 2008; Laibson *et al.*, 2018). The use of monetary payments in the lab and real consumption in the field may partially explain this disparity (Augenblick *et al.*, 2015). Concentration bias, however, may also contribute: choices have been exclusively balanced in the lab and often unbalanced in the field, with costs of present-biased behaviour being dispersed over many periods. For instance, not searching for a job prolongs unemployment for many more days. (ii) Our findings inform the literature on debt repayment. Kettle *et al.* (2016) find that the repayment of debt that is accumulated on multiple accounts is greater if repayment is framed to be account-wise than if it is framed as a uniform reduction across all accounts. While this finding is consistent with a motivation to break even, it also relates to our effects of a concentrated versus a dispersed framing. (iii) Goals often draw attention to productive actions. This may come at the cost of intangible adverse consequences, such as unethical behaviours (Ordóñez *et al.*, 2009). Our results suggest that such adverse consequences could be made more tangible by increasing their degree of concentration (in time or framing). (iv) Concentration bias may contribute to the annuity puzzle. This puzzle refers to people's tendency to prefer a concentrated lump-sum payment over an annuity—a dispersed payment stream—even when the annuity has a substantially greater expected present value (*e.g.* Yaari, 1965; Davidoff *et al.*, 2005). (v) More broadly, we contribute to the recent experimental literature on the bounded rationality of behavioural biases (*e.g.* Enke and Zimmermann, 2019; Esponda and Vespa, 2019; Enke and Graeber, 2021; Frydman and Jin, 2021).

2. EXPERIMENTAL EVIDENCE FOR CONCENTRATION BIAS

In *unbalanced* intertemporal trade-offs, the focusing model (Kőszegi and Szeidl, 2013) predicts concentration bias: distortions between a decision maker's preferences and her choices. In *balanced* trade-offs, by contrast, the predictions of focusing and standard discounting coincide: the decision maker's preference determine her choices entirely. We derive these predictions in Section 2.1 and explain how balanced and unbalanced trade-offs allow us to identify concentration bias in Section 2.2. In the Main-Treatment condition of our consumption experiment, we implement these trade-offs and find evidence for concentration bias (see sections 2.3 and 2.4).

2.1. *The focusing model*

2.1.1. Unbalanced trade-off. Consider a choice between two work plans. Each work plan $\mathbf{c}$ consists of consequences, c_t, on nine fixed future days, $t \in \{1,\ldots,9\}$, that affect utility negatively (work) or positively (compensation). The baseline work plan $\mathbf{c}^{\mathrm{b}}$ consists of strictly positive numbers of real-effort tasks, $(e_1,\ldots,e_8)$, on eight workdays, $t \in \{1,\ldots,8\}$, and a compensation. The compensation is a non-cashable and personalised restaurant voucher of value $v>0$. The voucher is valid on the restaurant day at $t=9$. The overtime work plan $\mathbf{c}^{\mathrm{o}}$ consists of a raise $R>0$ in the value of the restaurant voucher in exchange for additional tasks on all eight workdays, $\tilde{\mathbf{x}} = (\tilde{x}_1,\ldots,\tilde{x}_8)$, with all $\tilde{x}_t > 0$. Let C be the choice set of this choice which includes only

$$\begin{aligned}\mathbf{c}^{\mathrm{b}} &= (-e_1, \quad -e_2, \quad -e_3, \quad \ldots,-e_8, \quad v) \qquad \text{and}\\ \mathbf{c}^{\mathrm{o}} &= (-e_1-\tilde{x}_1,-e_2-\tilde{x}_2,-e_3-\tilde{x}_3,\ldots,-e_8-\tilde{x}_8,v+R).\end{aligned}$$

This choice implies an *unbalanced* trade-off: choosing either work plan amounts to an *unequal* number of periods with utility costs and utility benefits, relative to the rejected work plan. The overtime work plan $\mathbf{c}^{\mathrm{o}}$, for instance, involves the utility cost of completing additional tasks on all *eight* workdays and the utility benefit of a more valuable voucher on the restaurant day. In short, while the utility cost is *dispersed over time*, the utility benefit is *concentrated in time*.

Consider a decision maker whose time preferences and per-period utility functions make her indifferent between the two work plans in the absence of focusing. Her discounted utility benefit of the raise R is equal to her discounted utility cost of the additional tasks $\tilde{\mathbf{x}}$:

$$D(9)\,(u(v+R)-u(v)) = \sum_{t=1}^{8} D(t)\,(u(-e_t)-u(-e_t-\tilde{x}_t)), \tag{2.1}$$

with discount factor $D(t)$ allowing for any (including exponential and hyperbolic) discounting. This assumes that aggregate utility $U(\mathbf{c})$ is additively separable in per-period utility $u(c_t)$.

According to the focusing model (Kőszegi and Szeidl, 2013), the decision maker does not choose by considering the discounted utility of the available work plans, but by comparing the *focus-weighted* discounted utility. Focusing augments discounted utility with period-t focus weights $g_t(C)$ that scale discounted per-period utility $D(t)u(c_t)$:

$$\tilde{U}(\mathbf{c},C) := \sum_{t=1}^{9} g_t(C)\,D(t)\,u(c_t). \tag{2.2}$$

The central assumption of focusing is that per-period utility differences attract attention: the greater the utility difference between alternatives is at a certain point in time, the greater is the decision weight that is assigned to the utility consequences at this point in time. Formally, focus weights g_t are generated by a function g that strictly increases in the difference between the maximum and the minimum utility in period t across all elements of the choice set C:

$$g_t(C) := g[\Delta_t(C)] \quad \text{with} \quad \Delta_t(C) := \max_{\mathbf{c}\in C} D(t)u(c_t) - \min_{\mathbf{c}\in C} D(t)u(c_t) \quad \text{and} \quad g'[\cdot] > 0. \tag{2.3}$$

In unbalanced trade-offs, alternatives with a concentrated utility benefit and a dispersed utility cost tend to "profit" from focus weighting relative to alternatives with a dispersed utility benefit and a concentrated utility cost. In the choice between the baseline work plan $\mathbf{c}^{\mathrm{b}}$ and the overtime work plan $\mathbf{c}^{\mathrm{o}}$, the latter profits from focus weighting because of its concentrated utility benefit (the raise on the restaurant day) and its dispersed utility cost (the additional tasks on eight workdays).

To illustrate this formally, note that the argument of g is the per-period utility difference between the two work plans. From the perspective of the overtime work plan $\mathbf{c}^{\mathrm{o}}$, the utility difference is the *per-workday* utility cost of additional work, $D(t)(u(-e_t)-u(-e_t-\tilde{x}_t))$, on each workday t and the utility benefit of the raise, $D(9)(u(v+R)-u(v))$, on the restaurant day. Since the decision maker's preferences satisfy indifference between $\mathbf{c}^{\mathrm{b}}$ and $\mathbf{c}^{\mathrm{o}}$, see equation (2.1), the utility difference on the restaurant day exceeds the utility difference on any individual workday. And, since g is strictly increasing, the focus weight assigned to the restaurant day is larger than for any workday:

$$g[D(9)(u(v+R)-u(v))] > g[D(t)(u(-e_t)-u(-e_t-\tilde{x}_t))], \quad t\in\{1,\ldots,8\}. \tag{2.4}$$

Focus weighting hence leads to an overweighting of the utility benefit of choosing the overtime work plan $\mathbf{c}^{\mathrm{o}}$ relative to its utility cost:

$$D(9)(u(v+R)-u(v)) > \sum_{t=1}^{8}\left(\underbrace{\frac{g[D(t)(u(-e_t)-u(-e_t-\tilde{x}_t))]}{g[D(9)(u(v+R)-u(v))]}}_{<1} D(t)(u(-e_t)-u(-e_t-\tilde{x}_t))\right). \tag{2.5}$$

Consequently, focusing causes *concentration bias* in the unbalanced choice between the two work plans: in order to obtain the concentrated raise in the value of the voucher, the decision maker is willing to complete *more* tasks on the workdays than her preferences—which are captured in $\tilde{\mathbf{x}}$—can account for. Concentration bias causes the decision maker to be too patient in her choice: she overweights the delayed raise in the value of the voucher at the cost of additional work earlier.[1]

2.1.2. Balanced trade-off. In binary choices with *balanced* trade-offs, both focusing and standard discounting predict that the decision maker's preferences determine her choices entirely. Consider a choice between the following two work plans:

$$\begin{aligned} \mathbf{c}^{\mathrm{b},j} &= (-e_1,\ldots,-e_{j-1},-e_j, \quad -e_{j+1},\ldots,-e_8,v^j) && \text{and} \\ \mathbf{c}^{\mathrm{o},j} &= (-e_1,\ldots,-e_{j-1},-e_j-\tilde{x}_j,-e_{j+1},\ldots,-e_8,v^j+r^j) && \text{with} \quad j\in\{1,\ldots,8\}. \end{aligned}$$

This choice implies a balanced trade-off: the utility benefit and utility cost of accepting either work plan are *both* concentrated in time. Overtime work plan $\mathbf{c}^{\mathrm{o},j}$, for instance, involves the utility

1. When the concentrated utility benefit of an action precedes its dispersed utility cost, concentration bias may cause too impatient choices. We study such unbalanced choices in our money experiment, see Section 5.

cost of additional tasks only on one workday, $t=j$, and the utility benefit of the raise r^j on the restaurant day.

Assume that the time preferences and per-period utility functions of the decision maker make her indifferent between $\mathbf{c}^{b,j}$ and $\mathbf{c}^{o,j}$ in the absence of focusing, that is,

$$D(9)\left(u(v^j+r^j)-u(v^j)\right)=D(t)\left(u(-e_j)-u(-e_j-\tilde{x}_j)\right). \tag{2.6}$$

Because of equation (2.6), the focus weights of the utility benefit of the overtime work plan and its utility cost are identical. Thus, focusing also predicts indifference between $\mathbf{c}^{b,j}$ and $\mathbf{c}^{o,j}$:

$$D(9)\left(u(v^j+r^j)-u(v^j)\right)=\underbrace{\frac{g[D(j)(u(-e_j)-u_j(-e_j-\tilde{x}_j))]}{g[D(9)(u(v^j+r^j)-u_9(v^j))]}}_{=1}D(j)\left(u(-e_j)-u_j(-e_j-\tilde{x}_j)\right). \tag{2.7}$$

In binary choices with balanced trade-offs, the predictions of the focusing model and discounted utility coincide: the decision maker's preferences determine her choices entirely.

2.2. *Identifying concentration bias*

We identify concentration bias via the unbalanced and balanced trade-offs summarised in Table 1. In the unbalanced trade-off, focusing predicts concentration bias: a decision maker is willing to complete *more* tasks on the workdays than her preferences can account for (see Section 2.1.1). To identify concentration bias, we hence need to know what the decision maker's willingness to work would be if it were exclusively based on her preferences. When looking at an unbalanced trade-off in isolation, this information is not observable and hence amounts to the main identification challenge of concentration bias. To overcome this challenge, we employ the following approach. First, since focusing predicts no concentration bias in balanced trade-offs (see Section 2.1.2), we design our balanced trade-offs to reveal sufficient information about the decision maker's preferences. Second, the design of our balanced and unbalanced trade-offs is interconnected in order to allow us to provide a non-parametric measure of concentration bias. This means that our measure does not rely on any assumptions regarding the decision maker's time preferences and per-period utility functions. In the following, we first discuss the balanced and unbalanced trade-offs separately and then discuss their interconnected design.

At first, the decision maker faces all eight balanced trade-offs of Table 1. In each balanced trade-off $j\in\{1,\ldots,8\}$, the decision maker states the number of additional tasks $\tilde{x}_j$ that make her indifferent between the baseline work plan $\mathbf{c}^{b,j}$ and overtime work plan $\mathbf{c}^{o,j}$. Each $\tilde{x}_j$ quantifies the maximal number of additional tasks on workday $t=j$ that the decision maker is willing to work in exchange for the raise r^j. Importantly, since focusing predicts no distortions in these balanced trade-offs (see Section 2.1.2), the decision maker's eight indifference points, $(\tilde{x}_1,\ldots,\tilde{x}_8)=\tilde{\mathbf{x}}$, are determined entirely by her time preferences and per-period utility functions.

Thereafter, the decision maker faces the unbalanced trade-off of Table 1. The decision maker states the value of extra tasks $\tilde{d}$ that make her indifferent between the baseline work plan $\mathbf{c}^b$ and overtime work plan $\mathbf{c}^o$. Since $\mathbf{c}^o$ requires the decision maker to complete $(\tilde{x}_1+d,\tilde{x}_2+d,\ldots,\tilde{x}_7+d,$ $\tilde{x}_8+d)$ additional tasks on the eight workdays, $\tilde{d}$ quantifies how many tasks per workday she is willing to work beyond the number of additional tasks $\tilde{\mathbf{x}}$. Consequently, the decision maker is willing to complete *no* more than $\tilde{\mathbf{x}}$ additional tasks when stating $\tilde{d}=0$, $\tilde{d}$ *fewer* tasks per workday than $\tilde{\mathbf{x}}$ when stating $\tilde{d}<0$, and $\tilde{d}$ *more* tasks per workday than $\tilde{\mathbf{x}}$ when stating $\tilde{d}>0$.

The decision maker's value of $\tilde{d}$ identifies the effect of concentration bias on her willingness to work in the unbalanced trade-off. This follows from the interconnected design of the trade-offs:

TABLE 1

The balanced and unbalanced trade-offs of Main-Treatment

Options	Baseline, **e**, and additional, **x** and d, real-effort tasks								Value of the voucher
	$t=1$	$t=2$	$t=3$	$t=4$	$t=5$	$t=6$	$t=7$	$t=8$	$t=9$
Balanced trade-offs									
$\mathbf{c}^{b,1}$	$-e_1$	$-e_2$	$-e_3$	$-e_4$	$-e_5$	$-e_6$	$-e_7$	$-e_8$	$v^1=v$
$\mathbf{c}^{o,1}$	$-e_1-x_1$	$-e_2$	$-e_3$	$-e_4$	$-e_5$	$-e_6$	$-e_7$	$-e_8$	$v^1+r^1=v^2$
$\mathbf{c}^{b,2}$	$-e_1$	$-e_2$	$-e_3$	$-e_4$	$-e_5$	$-e_6$	$-e_7$	$-e_8$	v^2
$\mathbf{c}^{o,2}$	$-e_1$	$-e_2-x_2$	$-e_3$	$-e_4$	$-e_5$	$-e_6$	$-e_7$	$-e_8$	$v^2+r^2=v^3$
$\mathbf{c}^{b,3}$	$-e_1$	$-e_2$	$-e_3$	$-e_4$	$-e_5$	$-e_6$	$-e_7$	$-e_8$	v^3
$\mathbf{c}^{o,3}$	$-e_1$	$-e_2$	$-e_3-x_3$	$-e_4$	$-e_5$	$-e_6$	$-e_7$	$-e_8$	$v^3+r^3=v^4$
$\mathbf{c}^{b,4}$	$-e_1$	$-e_2$	$-e_3$	$-e_4$	$-e_5$	$-e_6$	$-e_7$	$-e_8$	v^4
$\mathbf{c}^{o,4}$	$-e_1$	$-e_2$	$-e_3$	$-e_4-x_4$	$-e_5$	$-e_6$	$-e_7$	$-e_8$	$v^4+r^4=v^5$
$\mathbf{c}^{b,5}$	$-e_1$	$-e_2$	$-e_3$	$-e_4$	$-e_5$	$-e_6$	$-e_7$	$-e_8$	v^5
$\mathbf{c}^{o,5}$	$-e_1$	$-e_2$	$-e_3$	$-e_4$	$-e_5-x_5$	$-e_6$	$-e_7$	$-e_8$	$v^5+r^5=v^6$
$\mathbf{c}^{b,6}$	$-e_1$	$-e_2$	$-e_3$	$-e_4$	$-e_5$	$-e_6$	$-e_7$	$-e_8$	v^6
$\mathbf{c}^{o,6}$	$-e_1$	$-e_2$	$-e_3$	$-e_4$	$-e_5$	$-e_6-x_6$	$-e_7$	$-e_8$	$v^6+r^6=v^7$
$\mathbf{c}^{b,7}$	$-e_1$	$-e_2$	$-e_3$	$-e_4$	$-e_5$	$-e_6$	$-e_7$	$-e_8$	v^7
$\mathbf{c}^{o,7}$	$-e_1$	$-e_2$	$-e_3$	$-e_4$	$-e_5$	$-e_6$	$-e_7-x_7$	$-e_8$	$v^7+r^7=v^8$
$\mathbf{c}^{b,8}$	$-e_1$	$-e_2$	$-e_3$	$-e_4$	$-e_5$	$-e_6$	$-e_7$	$-e_8$	v^8
$\mathbf{c}^{o,8}$	$-e_1$	$-e_2$	$-e_3$	$-e_4$	$-e_5$	$-e_6$	$-e_7$	$-e_8-x_8$	$v^8+r^8=v^1+r^1+\cdots+r^8$
Unbalanced trade-off									
$\mathbf{c}^{b}$	$-e_1$	$-e_2$	$-e_3$	$-e_4$	$-e_5$	$-e_6$	$-e_7$	$-e_8$	$v=v^1$
$\mathbf{c}^{o}$	$-e_1-\tilde{x}_1-d$	$-e_2-\tilde{x}_2-d$	$-e_3-\tilde{x}_3-d$	$-e_4-\tilde{x}_4-d$	$-e_5-\tilde{x}_5-d$	$-e_6-\tilde{x}_6-d$	$-e_7-\tilde{x}_7-d$	$-e_8-\tilde{x}_8-d$	$v+R=v^1+r^1+\cdots+r^8$

Notes: In each balanced trade-off j, the decision maker states her willingness to work $\tilde{x}_j$. In the unbalanced trade-off, the decision maker states her willingness to work more ($\tilde{d}>0$) or fewer ($\tilde{d}<0$) additional tasks than $\tilde{\mathbf{x}}=(\tilde{x}_1,\ldots,\tilde{x}_8)$, or equally many ($\tilde{d}=0$). While discounted utility predicts $\tilde{d}=0$, the focusing model predicts $\tilde{d}>0$.

(i) The overtime work plan $\mathbf{c}^{\mathrm{o}}$ in the unbalanced trade-off includes the decision maker's own indifference points from the balanced trade-offs, $\tilde{\mathbf{x}}$. (ii) The structure of the voucher values (see Table 1) implies that the utility benefit in the unbalanced trade-off and the sum of utility benefits of the balanced trade-offs coincide:

$$D(9)\,(u(v+R)-u(v)) = D(9)\sum_{j=1}^{8}(u(v^j+r^j)-u(v^j)). \tag{2.8}$$

Design features (i) and (ii) individualize the unbalanced trade-off with respect to the decision maker's preferences. This individualization has an important consequence in the absence of focusing. At $\tilde{\mathbf{x}}$, the discounted utility cost of choosing the overtime work plan in the unbalanced trade-off is equal to the sum of discounted utility costs of choosing the overtime work plans of the balanced trade-offs:

$$\sum_{t=1}^{8}D(t)\,(u(-e_t)-u(-e_t-\tilde{x}_t-\tilde{d})) = \sum_{t=1}^{8}D(t)\,(u(-e_t)-u(-e_t-\tilde{x}_t)). \tag{2.9}$$

Equation (2.9) can only hold for $\tilde{d}=0$. This implies that the preferences of the decision maker require her to be willing to complete the same number of additional tasks in the unbalanced trade-off as in all balanced trade-offs. Consequently, she states a value of $\tilde{d}=0$. A value of $\tilde{d}\neq 0$, by contrast, would imply that her unbalanced choices are not entirely determined by her preferences.

Focusing predicts a particular distortion between the decision maker's preferences and her choices: she should be willing to complete more tasks than her preferences can account for. Thus, she states a value of $\tilde{d}>0$ (see Section 2.1.1). Moreover, her value of $\tilde{d}$ is the larger, the larger the effect of concentration bias is (that is, the steeper g is). We henceforth refer to $\tilde{d}$ as the absolute effect of concentration bias, it measures the decision maker's deviation from discounted utility.

2.3. *Experimental implementation*

2.3.1. General set-up. We identify concentration bias in Main-Treatment by applying the procedure outlined in Section 2.2. Each subject first completes the eight balanced trade-offs of Table 1 in random order and thereafter completes the unbalanced trade-off of Table 1. In the balanced trade-offs, we elicit from each subject their indifference points $(\tilde{x}_1,\ldots,\tilde{x}_8)$ which we then include in their respective unbalanced trade-off. In the unbalanced trade-off, we elicit from each subject their indifference point $\tilde{d}$, which identifies concentration bias on the subject level.

2.3.2. Protocol. Before subjects face the intertemporal trade-offs, they receive information about the real-effort task and the restaurant for which the voucher is valid. The real-effort task require subjects to transcribe a sequence of six numbers into a sequence of six letters, see Figure A2 in Supplementary Appendix A. The mapping of numbers to letters is randomly determined for each individual task, making each task equally challenging. Subjects complete 10 real-effort tasks to gain experience before they face the trade-offs. Subjects learn that they will complete the workload on each future workday online. Thereafter, subjects choose their eight workdays from a set of 20 dates and the restaurant day, $t=9$, from a set of seven dates.[2]

2. The available workdays comprised all business days during the four weeks following the date of the experiment. The average first workday was 6.65 days after the experiment. The average distance between workdays, including weekends, was 1.84 days. The average restaurant day was 15.73 days after the last workday.

This allows subjects to accommodate their individual schedules and allows us to emphasize the intertemporal dimension of the trade-offs.

We implement the following parametrization of the trade-offs. The mandatory number of real-effort tasks **e** require subjects to complete between 115 and 143 real-effort tasks per workday (which took them 28 minutes on average).[3] We employ a substantial number of mandatory tasks to keep transaction costs between workdays fairly constant and to reproduce an overtime work setting. The smallest attainable value of the voucher $v = v^1$ is €7.50 and ensures that subjects can consume a main course at the restaurant. Each raise in the value of the voucher r^j is between €2.70 and €3.20 and ensures a greater range of items on the menu that they can choose from.[4] We introduce the slight variation in r^j and e_t with the objective that the intertemporal trade-offs vary enough to induce subjects to cognitively engage with each choice.

Following the procedure outlined in Section 2.2, we elicit indifference point $\tilde{x}_j$ in each balanced trade-off $j \in \{1,\dots,8\}$. Thereafter, we elicit $\tilde{d}$ in the unbalanced trade-off. We explain our elicitation procedure in Section 2.3.3.

After subjects complete the intertemporal trade-offs, we elicit proxies for their cognitive abilities—Raven Matrices (Raven, 1941), Cognitive Reflection Test (Frederick, 2005), and an incentivised arithmetic test—to investigate potential heterogeneity in concentration bias, as well as demographic information that we use as control variables in our regression analyses.

All subjects receive €10 in cash, plus their earnings from the arithmetic task (on average, €0.94). Following Attema *et al.* (2016), three subjects are randomly selected at the end of each session (27–32 participants) to implement the work plan associated with their payoff-relevant choice. After completion of their entire work plan, these subjects receive their respective restaurant voucher as well as an additional lump-sum compensation of €100. All selected subjects completed their work plans.

Experimental sessions lasted up to 75 minutes. Subjects were invited using ORSEE (Greiner, 2015), and the experiment was programmed in oTree (Chen *et al.*, 2016).

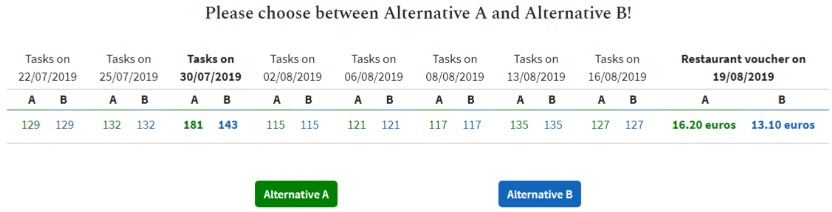
2.3.3. Elicitation of indifference points. All indifference points are elicited from subjects via a series of binary choices. In each balanced trade-off j, subjects repeatedly choose between the baseline work plan $\mathbf{c}^{b,j}$ and overtime work plan $\mathbf{c}^{o,j}$. Figure 1 depicts an exemplary balanced choice of trade-off $j = 3$. Between individual choices within each balanced trade-off j, we vary the number of additional tasks $x_t \in \{0,1,2,\dots,125\}$, with $t = j$, while keeping all remaining parameters ($\mathbf{e}$, v^j, r^j) constant. Likewise in the unbalanced trade-off, subjects repeatedly choose between the baseline work plan $\mathbf{c}^b$ and overtime work plan $\mathbf{c}^o$. Figure 2 depicts an exemplary unbalanced choice. Between unbalanced choices, we only vary the number of extra tasks $d \in \{-63,-62,\dots,0,\dots,61,62\}$, while keeping the remaining parameters ($\mathbf{e}$, v, R, $\tilde{\mathbf{x}}$) constant.

Each trade-off hence consists of 126 pairwise choices. In each trade-off, however, subjects make only up to nine choices *directly*. The remaining choices are made *indirectly* according to a procedure that is logically equivalent to making choices in a choice list. In contrast to a choice list, however, our procedure avoids a potential tendency to switch close to the middle of the list. We explain the procedure in the following paragraph and provide an example in Supplementary Appendix B.

The procedure works as follows: The first choice in each trade-off is made directly. To that end, the computer randomly chooses a number of additional tasks from all 126 possible values,

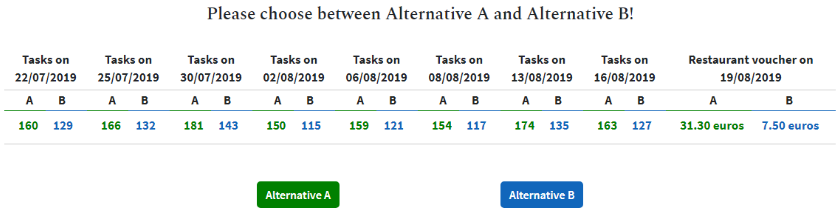
3. $\mathbf{e} = (e_1,\dots,e_8) = (129,132,143,115,121,117,135,127)$.

4. $\mathbf{r} = (r^1,\dots,r^8) = (€2.90,€2.70,€3.10,€2.70,€3.20,€2.90,€3.10,€3.20)$.



Tasks on 22/07/2019		Tasks on 25/07/2019		Tasks on 30/07/2019		Tasks on 02/08/2019		Tasks on 06/08/2019		Tasks on 08/08/2019		Tasks on 13/08/2019		Tasks on 16/08/2019		Restaurant voucher on 19/08/2019	
A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
129	129	132	132	**181**	**143**	115	115	121	121	117	117	135	135	127	127	**16.20 euros**	**13.10 euros**

Figure 1
Screenshot of a balanced choice in Main-Treatment



Tasks on 22/07/2019		Tasks on 25/07/2019		Tasks on 30/07/2019		Tasks on 02/08/2019		Tasks on 06/08/2019		Tasks on 08/08/2019		Tasks on 13/08/2019		Tasks on 16/08/2019		Restaurant voucher on 19/08/2019	
A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
160	129	166	132	181	143	150	115	159	121	154	117	174	135	163	127	31.30 euros	7.50 euros

Figure 2
Screenshot of an unbalanced choice in Main-Treatment

that is, x_t from $\{0,1,\ldots,125\}$ in balanced trade-off $j=t$ or d from $\{-63,\ldots,62\}$ in the unbalanced trade-off. If a subject agrees to complete this particular number of additional tasks for the given raise, then she *indirectly* also agrees to complete any lower number of tasks. Conversely, if a subject chooses not to complete this particular number of additional tasks and thereby forgoes the given raise, she then *indirectly* also chooses not to complete any larger number of additional tasks. Each next direct choice is then determined dynamically so that the expected number of direct choices that a subject has to make until she reaches her indifference point is minimised. This is achieved by selecting as the next direct choice the midpoint of the implied interval of additional tasks that has not been covered by direct and indirect choices yet. The procedure stops when all choices have been made (directly or indirectly). We then conservatively define a subject's indifference point as the largest number of additional tasks that she agrees to complete in exchange for the respective raise. Subjects' comprehension of this procedure was ensured by computerised instructions, control questions, and practice choices.

The procedure has the following implications: we elicit indifference points with a low number of direct choices—which prevents subjects from getting bored and tired—despite being able to cover a wide range of additional tasks;[5] and the method ensures single switching so that indifference is unambiguously determined for subjects without corner choices. A subject makes a corner choice whenever she always chooses the same option in a trade-off.

The procedure incentivizes subjects to report their indifference points truthfully: (i) Each direct and indirect choice has the same probability of being randomly selected to be payoff-relevant in the end. (ii) As in Halevy *et al.* (2018), subjects are not made aware that balanced and unbalanced trade-offs are interconnected.

2.3.4. Corner choices in balanced trade-offs.

By construction, our measurement of concentration bias in the unbalanced trade-off relies on subjects stating indifference points in the

5. Our subjects make between 53 and 70 binary decisions. In comparison, subjects make 45 decisions in Andreoni and Sprenger (2012), 100 in Andersen *et al.* (2008), and 523 in Attema *et al.* (2016).

TABLE 2
Absolute and relative measure of concentration bias ($\tilde{d}$ and $\tilde{d}^{\text{rel}}$, respectively) in MAIN-TREATMENT

	OLS			Tobit
	Lower bound (1)	Midpoint (2)	Upper bound (3)	(4)
$\tilde{d}$ in MAIN-TREATMENT	31.640*** (2.685)	37.610*** (3.575)	43.580*** (4.683)	37.094*** (3.658)
$\tilde{d}^{\text{rel}}$ in MAIN-TREATMENT	0.190*** (0.016)	0.224*** (0.021)	0.259*** (0.027)	
Observations	100	100	100	100

Notes: This table presents estimates of the average absolute and relative measure of concentration bias, $\tilde{d}$ and $\tilde{d}^{\text{rel}}$, respectively. Robust standard errors are in parentheses. The sample includes all observations from MAIN-TREATMENT. * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

balanced trade-offs. We hence preregistered to exclude all subjects with at least one corner choice in the set of balanced trade-offs from our main analyses. In Supplementary Appendix A.4, we show that this exclusion restriction does not affect our results.

2.3.5. Corner choice in the unbalanced trade-off. Our measure of concentration bias is subjects' indifference point $\tilde{d}$ in the unbalanced trade-off. Subjects with upper corner choices—always choosing the overtime work plan—only reveal a lower bound of their indifference point: the upper bound of the interval from which d is chosen (that is, 62). In an un-incentivised way, we ask these subjects to state their indifference point $\tilde{d}$ manually (see Figure A4 in Supplementary Appendix A.2 for a screenshot). We henceforth use the following three values to proxy their $\tilde{d}$: (i) the lower bound ($\tilde{d}=62$); (ii) the upper bound (their manually stated indifference point); (iii) the midpoint between (i) and (ii).

2.3.6. Preregistration. After presenting the results of MAIN-TREATMENT, we discuss further conditions of our consumption experiment in sections 3 and 4. All conditions were preregistered, including their design, sample size, exclusion restrictions, and a preanalysis plan.[6]

2.4. *Results*

Our measure of concentration bias is $\tilde{d}$: the number of per-workday tasks that subjects are willing to complete in the unbalanced trade-off beyond what their preferences could account for, that is, beyond $\tilde{\mathbf{x}}$. We elicit $\tilde{\mathbf{x}}$ from each subject in the balanced trade-offs and find, on average, that subjects' preferences allow them to complete between 33 and 43 additional tasks per workday:[7]

$$\tilde{\mathbf{x}} = (39.2, 34.9, 33.6, 41.5, 41.8, 42.2, 35.9, 38.3). \tag{2.10}$$

Via the unbalanced trade-off, we can reject that subjects' choices are entirely determined by their preferences. In particular, we find evidence for concentration bias: subjects are willing to

6. See https://doi.org/10.1257/rct.4446 for MAIN-TREATMENT, MECHANISM-TREATMENT, MAIN-CONTROL, and MECHANISM-CONTROL and https://doi.org/10.1257/rct.4341 for DONATION-TREATMENT and DONATION-CONTROL.

7. Between-workdays differences in $\tilde{\mathbf{x}}$ may reflect, for instance, non-linear costs from effort and between-workdays differences in the number of mandatory real-effort tasks, the temporal distance of the date on which the tasks have to be completed, and the possibility that subjects have more time to work on some dates than on others.

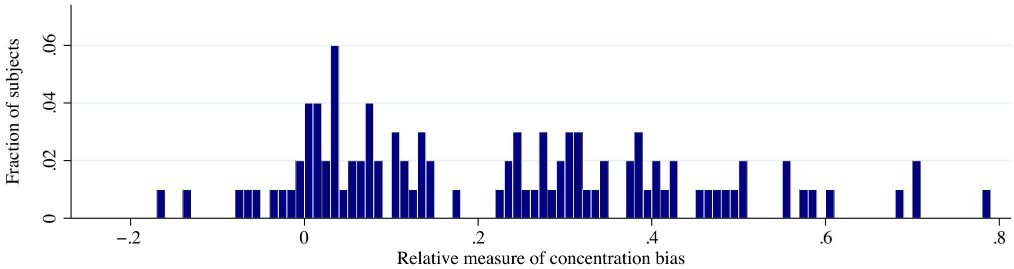


FIGURE 3
Distribution of the relative measure of concentration bias ($\tilde{d}^{\text{rel}}$) in MAIN-TREATMENT

complete more overtime work than is implied by $\tilde{\mathbf{x}}$. While we directly measure $\tilde{d}$ from subjects with an interior indifference point (73% of all subjects in MAIN-TREATMENT), subjects with an upper corner choice (see Section 2.3.5) yield a lower bound, midpoint, and upper bound estimate of $\tilde{d}$. These estimates yield three across-subjects averages of $\tilde{d}$ that are between 31.6 and 43.6 tasks, see columns 1, 2, and 3 of Table 2. A Tobit regression based on the lower bound yields an estimate of concentration bias in similar magnitude, see column 4 of Table 2. All estimates of $\tilde{d}$ are statistically significantly greater than zero ($p<0.001$). Taking the midpoint estimate, subjects' willingness to work in the unbalanced trade-off is, on average,

$$\tilde{\mathbf{x}}+\tilde{d}\cdot\mathbf{1}=\tilde{\mathbf{x}}+37.6\cdot\mathbf{1}=(76.8,72.5,71.2,79.1,79.4,79.8,73.5,75.9), \tag{2.11}$$

and hence exceeds $\tilde{\mathbf{x}}$ substantially. In relative terms, concentration bias causes subjects, on average, to increase their per-period willingness to work by $\tilde{d}^{\text{rel}}=22.4\%$ ($p<0.001$), where

$$\tilde{d}^{\text{rel}} := \frac{1}{8}\sum_{t=1}^{8}\frac{\tilde{d}}{e_t+\tilde{x}_t}. \tag{2.12}$$

Figure 3 depicts the distribution of $\tilde{d}^{\text{rel}}$ and shows that a large fraction of subjects (88%) exhibit concentration bias ($\tilde{d}^{\text{rel}}>0$).[8] Row 2 of Table 2 reports $\tilde{d}^{\text{rel}}$ also based on the two other estimates of $\tilde{d}$; both values are significantly greater than zero. In the following, we refer to $\tilde{d}^{\text{rel}}$, based on the midpoint estimate for subjects with corner choices, as our measure of concentration bias.[9]

Result 1. *Concentration bias causes subjects to increase their willingness to work by 22.4%.*

3. MECHANISM

Having identified concentration bias in intertemporal choice, we now investigate its mechanisms. According to the focusing model, the observed concentration bias in MAIN-TREATMENT is the

8. Figure 3 reveals substantial heterogeneity in the degree of concentration bias. In Supplementary Appendix A.3, we investigate preregistered correlates of this heterogeneity. While cognitive skills are not correlated with concentration bias, response times in unbalanced choices are significantly and negatively correlated with concentration bias.

9. All results based on our relative measure of concentration bias are robust to using a different specification of the relative measure (see Supplementary Appendix A.5) and to using the absolute measure (see Supplementary Appendix A.6).

result of differential concentration in time. Alternatively, concentration bias may be driven by the *framing* of utility consequences. A utility consequence is framed in a concentrated way when the entirety of the consequence is directly observable and, hence, tangible. A utility consequence, by contrast, is framed in a dispersed way when the entirety of the consequence is not directly observable and rather difficult to grasp. Framing could contribute to concentration bias if a greater degree of tangibility increases how much attention is paid to a utility consequence. In the domain of belief updating, Enke (2020) provides evidence for such a link between tangibility, attention, and overweighting: subjects overweight signals that are directly observable and underweight signals that are merely (yet easily) inferable.

To illustrate how framing could explain our observed concentration bias, we consider the utility benefit and utility cost of choosing the overtime work plan in Main-Treatment. The raise in the value of the voucher is not only concentrated in time, it is also displayed in a concentrated framing: the raised value of the restaurant voucher is depicted in its entirety and hence framed in a tangible way. The additional tasks, in contrast, are dispersed over time and are also framed in a dispersed way: they are depicted for each workday separately. The aggregated utility cost of additional tasks on all workdays is hence not tangible. An effortful mental aggregation is required before a cognitive representation is available (Kahneman, 2003). If subjects' decision weights of utility consequences are affected by how tangible they are, the concentrated utility benefit of the overtime work plan may be overweighted relative to the dispersed utility cost of additional tasks on all workdays. Consequently, the concentrated framing of the utility benefit and the dispersed framing of the utility cost may contribute to (if not entirely explain) our evidence for concentration bias.

Based on these deliberations, we designed the Mechanism-Treatment condition to make the following contributions. First, we test whether temporal concentration drives concentration bias, as predicted by the focusing model. Second, we investigate the role of framing in concentration bias. Third, we discuss how our findings in Mechanism-Treatment relate to the focusing model. (In Section 6, we briefly discuss potential policy implications.)

Mechanism-Treatment consists of the same balanced and unbalanced choices as Main-Treatment. In the unbalanced trade-off of both conditions, the raise in the value of the voucher is equally concentrated on the restaurant day, and the additional tasks equally arise on all eight workdays. If concentration in time causes concentration bias, subjects also exhibit concentration bias in Mechanism-Treatment. If framing also contributes to concentration bias, we predict, however, a smaller degree of concentration bias in Mechanism-Treatment than in Main-Treatment. This follows from employing a dispersed framing of the raise in the restaurant voucher in Mechanism-Treatment: instead of depicting the raise in its entirety as in Main-Treatment,

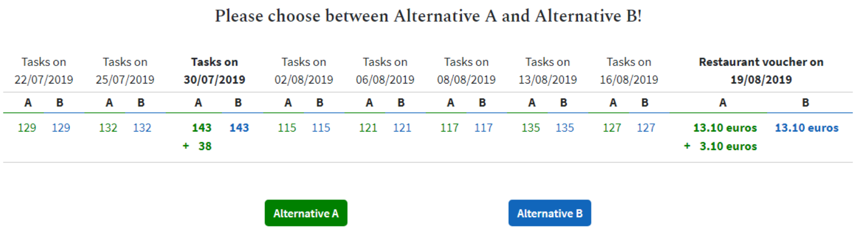
€31.30 (see Figure 2),

we depict the raise as the sum of multiple parts in Mechanism-Treatment,

€7.50+€2.90+€2.70+€3.10+€2.70+€3.20+€2.90+€3.10+€3.20 (see Figure 5).

Consequently, the utility benefit of completing additional tasks is no longer tangible in Mechanism-Treatment. At the same time, we maintain a dispersed framing of the dispersed-over-time additional tasks in Mechanism-Treatment.[10] Thus, concentration bias should be less pronounced in Mechanism-Treatment if framing plays a role.

10. The dispersed framing of the raise in the restaurant voucher in Mechanism-Treatment involves “+” signs to ensure that subjects understand that they would receive the sum. In order to maintain the same display of differences in the available choice options between utility benefits and costs, the display of per-workday additional tasks was also



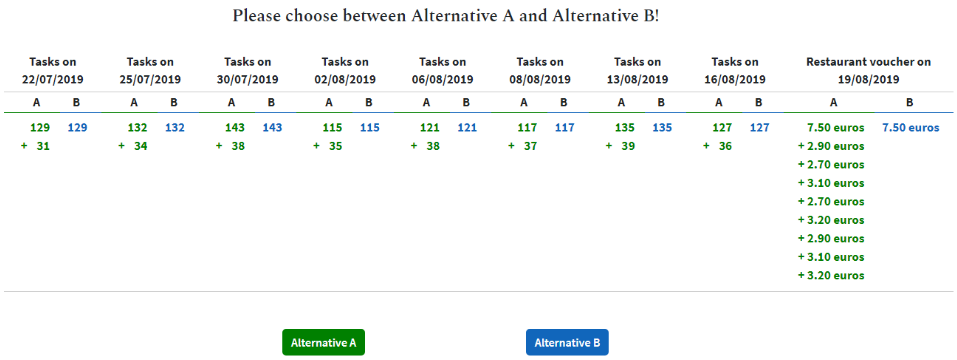
Please choose between Alternative A and Alternative B!

Tasks on 22/07/2019		Tasks on 25/07/2019		Tasks on 30/07/2019		Tasks on 02/08/2019		Tasks on 06/08/2019		Tasks on 08/08/2019		Tasks on 13/08/2019		Tasks on 16/08/2019		Restaurant voucher on 19/08/2019	
A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
129	129	132	132	143	143	115	115	121	121	117	117	135	135	127	127	13.10 euros	13.10 euros
				+ 38												+ 3.10 euros	

Alternative A | Alternative B

FIGURE 4

Screenshot of a decision screen for a balanced choice in the MECHANISM-TREATMENT condition



Please choose between Alternative A and Alternative B!

Tasks on 22/07/2019		Tasks on 25/07/2019		Tasks on 30/07/2019		Tasks on 02/08/2019		Tasks on 06/08/2019		Tasks on 08/08/2019		Tasks on 13/08/2019		Tasks on 16/08/2019		Restaurant voucher on 19/08/2019	
A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
129	129	132	132	143	143	115	115	121	121	117	117	135	135	127	127	7.50 euros	7.50 euros
+ 31		+ 34		+ 38		+ 35		+ 38		+ 37		+ 39		+ 36		+ 2.90 euros	
																+ 2.70 euros	
																+ 3.10 euros	
																+ 2.70 euros	
																+ 3.20 euros	
																+ 2.90 euros	
																+ 3.10 euros	
																+ 3.20 euros	

Alternative A | Alternative B

FIGURE 5

Screenshot of a decision screen for an unbalanced choice in the MECHANISM-TREATMENT condition

Conditions MECHANISM-TREATMENT and MAIN-TREATMENT were conducted (i) at the same laboratory, (ii) based on the same subject pool, and (iii) on the same dates (in alternating sessions). In fact, subjects' average balanced choices do not differ significantly between MECHANISM-TREATMENT and MAIN-TREATMENT, as would be expected given that the balanced choices should be determined entirely by subjects' preferences.

Turning to the results of the unbalanced trade-off in MECHANISM-TREATMENT, we find that concentration bias causes subjects to be willing to complete 7.5% more tasks than their preferences could account for. This relative measure of concentration bias is significantly greater than zero ($p < 0.001$), yet significantly smaller than in MAIN-TREATMENT ($p < 0.001$), see column 1 of Table 3. In particular, significantly fewer subjects display concentration bias in MECHANISM-TREATMENT than in MAIN-TREATMENT (70% versus 88%, $p = 0.002$), and the magnitude of concentration bias conditional on concentration bias being present is significantly smaller in MECHANISM-TREATMENT than in MAIN-TREATMENT (16% versus 26%, $p < 0.001$). We conclude:

Result 2. *Both concentration in time as well as framing contribute to concentration bias.*

According to the focusing model, focusing weights are applied to the exogenous attributes of choice options. In intertemporal choice, Kőszegi and Szeidl (2013) assume that attributes

adapted to include "+" signs (see Figures 4 and 5). While this minor display change allows us to maintain a dispersed framing of the dispersed-over-time additional tasks, we can rule out that it affects intertemporal choices in isolation: all balanced choices in MECHANISM-TREATMENT also employ this minor display change and subjects' average choices in the balanced trade-offs do not differ between MECHANISM-TREATMENT and MAIN-TREATMENT.

TABLE 3
Relative measure of concentration bias ($\tilde{d}^{\text{rel}}$) across conditions

	OLS			
	(1)	(2)	(3)	(4)
$\tilde{d}^{\text{rel}}$ in MECHANISM-TREATMENT	0.075***			
	(0.019)			
Difference: MAIN-TREATMENT − MECHANISM-TREATMENT	0.149***			
	(0.028)			
$\tilde{d}^{\text{rel}}$ in DONATION-TREATMENT		0.135***		
		(0.021)		
Difference: DONATION-TREATMENT − DONATION-CONTROL		0.158***		
		(0.022)		
$\tilde{d}^{\text{rel}}$ in MAIN-CONTROL			−0.023***	
			(0.008)	
Difference: MAIN-TREATMENT − MAIN-CONTROL			0.247***	
			(0.023)	
$\tilde{d}^{\text{rel}}$ in MECHANISM-CONTROL				−0.014
				(0.010)
Difference: MECHANISM-TREATMENT − MECHANISM-CONTROL				0.090***
				(0.021)
Observations	200	200	200	200

Notes: This table presents estimates of the average relative measure of concentration bias, $\tilde{d}^{\text{rel}}$, across the different conditions of the consumption experiment. Robust standard errors are in parentheses. The sample includes all observations from the mentioned (between-subjects) conditions. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

are time periods. Consequently, *per-period* differences in utility consequences attract attention according to the focusing model. Result 2 supports this view of time period-based attributes: subjects disproportionately focus on the large utility difference on the restaurant day (even when the utility benefit is framed in a dispersed way). Result 2 indicates that the framing of utility consequences matters as well: concentration bias is more pronounced when the utility benefit that is concentrated in time is also framed in a concentrated manner.

While framing is not part of the focusing model, Kőszegi and Szeidl (2013) discuss how framing relates to the focusing model: Framing may affect what constitutes attributes in a given choice. To illustrate this, consider a consumer who contemplates buying a consumption product via a financing option that disperses the overall cost into monthly payments of $39 over two years. Since the payments are dispersed over time, the focusing model predicts that the financing option makes purchasing relatively attractive. The seller may even advertise the product by framing the payments in terms of $1.28 a day; a friend, by contrast, may frame her advice in terms of the total payment of $936. Kőszegi and Szeidl (2013, p. 68–69) argue that

> the first type of framing can make the consumer think about the daily costs as attributes, so that she finds the financing option even more attractive [. . .], whereas the second type of framing can make her think about the total cost as an attribute, so that she finds the financing option less attractive [. . .].

Result 2 provides support for this. By employing a dispersed framing of the utility benefit in MECHANISM-TREATMENT, subjects may tend to treat the individual parts of the benefit as separate attributes, focusing less on the utility benefit, and hence exhibiting less concentration bias.

4. ROBUSTNESS

Noise in subjects' choices. Our measure of concentration bias is robust to potential noise in subjects' choices. Since we vary d in the unbalanced trade-off between −63 and +62, we symmetrically allow positive and negative values of $\tilde{d}$. This ensures that noise cannot simply produce our finding of an average value of $\tilde{d} > 0$. In addition, 88% of subjects in MAIN-TREATMENT stated values of $\tilde{d} > 0$, which is significantly greater than 50% ($p < 0.001$).

DONATION-TREATMENT. In the DONATION-TREATMENT condition of our consumption experiment, we test concentration bias in another utility domain: utility from charitable giving. DONATION-TREATMENT replicates MAIN-TREATMENT, apart from one difference: the utility benefit of working is a donation to a good cause[11] instead of a restaurant voucher. In DONATION-TREATMENT, we find a concentration bias of 13.5% ($p < 0.001$), see column 2 in Table 3. Campaigns that promote charitable giving could hence benefit from dispersing the costs of contributions.[12]

Result 3. *Concentration bias is also present when the utility benefit is a donation.*

Main assumptions. Our design of the consumption experiment is based on two assumptions. In the following, we discuss which violations of these assumptions would confound our identification of concentration bias. We provide specific evidence against each type of violation below.

Preference stability. We assume that a decision maker's preferences are stable across the balanced choices and the subsequent unbalanced choices of our TREATMENT conditions. If the decision maker's preferences change and suddenly allowed her to tolerate more additional real-effort tasks in the final choices, our measurement of concentration bias could be confounded.[13] We designed the CONTROL conditions (MAIN-CONTROL, MECHANISM-CONTROL, and DONATION-CONTROL) to test this and conducted them alongside their respective TREATMENT conditions.[14] In all CONTROL conditions, subjects first complete the balanced trade-offs in random order like in their respective TREATMENT conditions. Instead of completing the unbalanced trade-off thereafter, however, subjects complete balanced trade-off $j = 1$, $j = 4$, or $j = 8$ for a second time. In this repetition, we vary the number of additional real-effort tasks in the same way as in the unbalanced trade-off of the TREATMENT conditions: subjects can deviate from their indifference point $\tilde{x}_t$ (that was elicited in balanced trade-off $j = t$) in both directions, by integers in $[-63, +62]$. In contrast to the TREATMENT conditions, the final trade-off hence consists of balanced choices in the CONTROL conditions. This implies that now the focusing model does not predict that subjects will deviate from their earlier choices. In particular, $\tilde{d}^{\text{rel}}$ should not be greater than zero. If, however, subjects' preferences suddenly tolerated more work in the final choices, $\tilde{d}^{\text{rel}}$

11. The donation was made to LichtBlick Seniorenhilfe (https://seniorenhilfe-lichtblick.de), a German non-profit organization that provides financial and administrative assistance to old-age citizens in financial distress.

12. We use greater values for the restaurant vouchers in MAIN-TREATMENT than the donation values in DONATION-TREATMENT to ensure that subjects can purchase dishes solely based on the voucher. Consequently, our preregistration does not include a comparison between MAIN-TREATMENT and DONATION-TREATMENT.

13. Since the unbalanced trade-off is preceded by eight balanced trade-offs, fatigue might be a factor.

14. Assignment to a condition within the three pairs of conditions MAIN, MECHANISM, and DONATION was randomised within-session under the following restriction: We stratify the assignment based on the average number of tasks chosen in the balanced choice blocks. All participants who fulfil the inclusion criterion, see Section 2.3.4, are ranked according to the average number of tasks chosen in the balanced trade-offs, and pairs of neighbouring ranks are formed for whom conditions are randomly and mutually exclusively assigned. This is done to make subjects as comparable as possible between the conditions of each condition pair.

should also be greater than zero in the CONTROL conditions. We do not find such evidence—see columns 3 and 4 of Table 3: subjects do not tolerate more work in the final trade-off in the CONTROL conditions.[15] In addition, all estimates of concentration bias from the TREATMENT conditions are significantly ($p < 0.001$) larger than the "placebo" deviations in the respective CONTROL conditions. Our evidence for concentration bias is hence not confounded by preference instability.

Additive separability. We assume that a decision maker expects that her disutility from completing real-effort tasks is additively separable over time. If instead the decision maker expects her disutility from work to decrease strongly in the number of previously completed real-effort tasks, she could, in principle, be more willing to work in an unbalanced trade-off than in balanced trade-offs. In light of our experimental design and subjects' observed intertemporal choices, such a violation of time separability is implausible. First, the real-effort task was designed to be dull and repetitive, and to prevent learning beyond mere familiarity effects. The latter follows from two features of the task: each trial was equally demanding (due to a novel letter–number mapping in each trial), and the general structure of the task was not complex enough to give subjects room to figure out more efficient executions after sufficient exposure. Since subjects practised the real-effort tasks prior to facing the intertemporal choices, they experienced how dull and repetitive the task is, and that little if any learning is possible. In light of these design features, we think that it is not plausible that subjects anticipate a violation of additive separability.[16] Second, an anticipation of such a violation would affect subjects' willingness to work not only in the unbalanced trade-off, but also in the balanced trade-offs. We show in a calibration exercise in Supplementary Appendix C that a violation that is extreme enough to explain the observed willingness to work in the unbalanced trade-off would imply one of the following: a pattern of indifference points in the balanced trade-offs should be observed that is at odds with subjects' actual behaviour; or an absurd level of anti-discounting is required.[17]

Result 4. *Unstable preferences and a violation of additive separability cannot explain our evidence for concentration bias.*

5. MONEY EXPERIMENT

In our money experiment, we corroborate and extend our experimental evidence for concentration bias. First, we test for concentration bias over dated money transfers to subjects' bank accounts. Second, we test the prediction of the focusing model that concentration bias can cause both too patient and too impatient choices. Third, we test whether a greater degree of dispersion leads to stronger concentration bias. To perform these tests, we again exploit comparisons between balanced and unbalanced intertemporal choices. This time, however, we use a slightly different design. This has two implications: First, the design relies on the assumption of non-convex

15. If anything, we find that subjects tolerate slightly fewer tasks in the last trade-off. While this effect is small in magnitude, it is statistically significant only in MAIN-CONTROL and DONATION-CONTROL when considering subjects' average values of $\tilde{d}$ and $\tilde{d}^{\text{rel}}$. Turning to medians instead yields no significant differences from zero.

16. If anything, we anticipated that our real-effort task might be tiring over time (which could not confound our estimation of concentration bias). To circumvent such potential exhaustion/fatigue effects, we limited the within-workdays scope of the tasks and allowed subjects to choose their own workdays in advance to accommodate their own personal schedules as well as their potential need to rest between workdays.

17. A daily discount factor of 1.24 would be required. Recent studies estimate daily discount factors very close to unity. For instance, Augenblick *et al.* (2015) estimate a weekly (daily) discount factor of 0.999 (0.9999) and Augenblick and Rabin (2019) a daily discount factor between 1.003 and 1.005.

per-period utility.[18] Second, since we did not individualize the unbalanced choices, the money experiment provides only a conservative estimate of concentration bias. We summarize the design and its results in the following and provide a detailed description in Supplementary Appendix D.

The money experiment consists of two conditions: MONEY-MAIN tests for concentration bias that is potentially generated by both framing and concentration in time; MONEY-MECHANISM focuses on the framing channel only.

MONEY-MAIN. In MONEY-MAIN, each subject repeatedly allocates a monetary budget to an earlier and a later payoff (Andreoni and Sprenger, 2012). Our variable of interest is subjects' "savings rate", that is, the share of the budget that they allocate to the later payoff. We implement an intertemporal budget constraint with a strictly positive nominal interest rate. Thus, the sum total of the payoffs is the greater, the more subjects save. To identify concentration bias, we compare subjects' savings rate between balanced and unbalanced decisions. In balanced decisions, both payoffs are concentrated on a single payment date. In unbalanced decisions, either the *earlier* or the *later* payoff is dispersed over two, four, or eight payment dates.[19] Importantly, the discounted utility of each dispersed payoff is weakly greater than that of its concentrated counterpart: all payments of the dispersed payoffs occur no later than the corresponding concentrated payment, and they sum up to the concentrated payoff. In the absence of concentration bias, subjects hence should save more when the *later* payoff is dispersed and should save less when the *earlier* payoff is dispersed. The focusing model, by contrast, predicts that subjects overweight concentrated payoffs relative to dispersed payoffs: compared to the balanced choices, a sufficiently strong concentration bias leads subjects to save less when the later payoff is dispersed and to save more when the earlier payoff is dispersed.[20]

The results of MONEY-MAIN provide evidence for concentration bias. Subjects allocate, on average, 5.7 percentage points (p.p.) less money to later payment dates when the later payoff is dispersed rather than concentrated. They also allocate, on average, 6.8 p.p. more money to the later payment dates when the earlier payoff is dispersed rather than concentrated. Both differences are significantly different from zero ($p < 0.001$). This demonstrates that concentration bias can cause subjects to be too impatient as well as too patient, consistent with the central prediction of the focusing model.

In addition, we find that the size of concentration bias depends on the degree to which the dispersed payoff is spread over time. Our measure of concentration bias is 8.1 p.p. for a dispersion over eight payment dates, 6.6 p.p. for four payment dates, and 3.7 p.p. for two payment dates. While all three measures are significantly different from zero ($p < 0.001$ for eight and four dates, $p = 0.004$ for two dates), concentration bias is significantly greater when payoffs are dispersed over four or eight payment dates than when they are dispersed over two payment dates ($p = 0.007$ and $p = 0.014$, respectively).

MONEY-MECHANISM. Like in Section 3, we investigate whether framing contributes to the concentration bias observed in our money experiment. To that end, we compare MONEY-MAIN

18. Previous findings in experiments using monetary payments, for instance, Andreoni and Sprenger (2012) and Augenblick *et al.* (2015), estimate that utility is close to linear but concave.

19. To equalize transaction costs between balanced and unbalanced decisions, we hold the number of transfers constant across conditions. To this end, subjects receive an additional fixed amount of €1 on each of 9 payment dates. That is, each budget set gives rise to 9 money transfers to subjects' bank accounts at given dates in the future.

20. Since the discounted utility of each dispersed payoff is weakly greater than its concentrated counterpart, our measure of concentration bias is conservative. For some subjects, the greater discounted utility of the dispersed payoff may dominate the overvaluation of the concentrated payoff due to concentration bias and for others it may just reduce the effect of concentration bias.

with the between-subjects condition Money-Mechanism. Relative to Money-Main, subjects face exactly the same balanced decisions as in Money-Mechanism, but slightly different unbalanced decisions. The dispersed payoffs in these decisions are not dispersed over time, but are "dispersed within a day": they are presented to subjects in a dispersed framing although occurring on a single day. More precisely, in the dispersed-within-a-day decisions either the earlier or the later payoff is displayed as the sum of two, four, or eight smaller payments that all occur on a single day. This implies that in all decisions of Money-Mechanism the payoffs are concentrated in time and subjects face only balanced trade-offs.[21]

If both framing and concentration in time contribute to concentration bias, we should also observe concentration bias in Money-Mechanism but in a smaller size than in Money-Main. This is what we find: On average, subjects allocate 2.6 p.p. more of their budget to concentrated than to "dispersed-within-a-day" payoffs ($p < 0.001$). A difference-in-differences analysis reveals that our measure of concentration bias from Money-Main is significantly greater than the effect in Money-Mechanism ($p = 0.004$). Like in our consumption experiment (see Result 2), both framing and concentration in time contribute to concentration bias in our money experiment.

Result 5. *In summary, the results of the money experiment are:*

1. *Concentration bias is also present in monetary trade-offs.*
2. *Also in this setting, framing and concentration in time contribute to concentration bias.*
3. *As predicted by focusing, concentration bias can cause subjects to be too patient or too impatient.*
4. *Dispersion over more periods increases concentration bias.*

6. CONCLUSION

By providing clean and robust evidence for concentration bias, our findings relate to other recent theories of attention-based decision making. Relative thinking (Bushong *et al.*, 2021) is built on the opposite assumption of focusing (Kőszegi and Szeidl, 2013) and hence predicts a reversed concentration bias effect in our unbalanced trade-off, which is inconsistent with our evidence. Since similarity-based decision making (Rubinstein, 2003) and salience theory (Bordalo *et al.*, 2012) assume, like focusing, that differences in an attribute attract attention, these models are broadly consistent with our findings. They differ from focusing, however, in several aspects. Consequently, they do not unambiguously predict concentration bias: (i) According to similarity-based decision making, the more often a utility difference is repeated over time, the more attention it attracts (see Experiment II in Rubinstein, 2003). In unbalanced trade-offs, a dispersed disadvantage could hence be overweighted, and concentration bias may not be predicted. (ii) Salience theory also assumes diminishing sensitivity, which counteracts the behavioural forces implied by the focusing assumption. The relative importance of these assumptions for behaviour is not fully determined. If diminishing sensitivity dominates, concentration bias is not predicted by salience theory.

Our findings have implications for policy interventions that try to mitigate the adverse consequences of too impatient (present-biased) intertemporal choice. First, the attention-grabbing advantages of undesirable behaviours which are typically concentrated in the present could be reduced through substantially higher purchasing prices. Second, the dispersed-over-time costs of undesirable behaviours which are typically easy-to-neglect could be made more tangible. For

21. Importantly, subjects see exactly the same numbers in their unbalanced decisions in Money-Main and Money-Mechanism. The only difference is that the dispersed payoffs are dispersed over time and in display in Money-Main, while they are merely dispersed in display in Money-Mechanism.

instance, pension savings may be increased if the total value of the retirement savings at the time of entering retirement is reported as a lump sum instead of being reported as an annuity. Similarly, public health campaigns that promote healthy life styles could focus on quantifying the consequences of unhealthy behaviours in terms of the total treatment costs over one's entire life. For instance, a campaign aimed at reducing excessive consumption of sugar could highlight the total cost of treating chronic diseases such as diabetes. Alternative approaches may involve presenting adverse health consequences in a concentrated framing. For instance, mandating pictures on cigarette packs that illustrate the severe health consequences of smoking may make the costs of smoking more tangible and thereby reduce smoking.

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Supplementary Data

Supplementary data are available at *Review of Economic Studies* online. And the replication package is available at https://doi.org/10.5281/zenodo.5005989.

Data Availability Statement

The data and the code underlying this article are available in Zenodo, at https://doi.org/10.5281/zenodo.5005989.

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