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Abstract

The effectiveness of health recommendations and treatment plans depends on the extent to which individuals follow them. For the individual, medical adherence involves an inter-temporal trade-off between expected future health benefits and immediate effort costs. Therefore examining time preferences may help us to understand why some people fail to follow health recommendations and treatment plans. In this paper, we use a simple, real-effort task implemented via text message to elicit the time preferences of pregnant women in South Africa. We find evidence that high discounters are significantly less likely to report to adhere to the recommendation of taking daily iron supplements daily during pregnancy. There is some weak indication that time inconsistency also negatively affects adherence. Together our results suggest that measuring time preferences could help predict medication adherence and thus be used to improve preventive health care measures.

JEL-Codes: C930, D910, I120.

Keywords: time preferences, medication adherence, experiment.

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1 Introduction

Failing to correctly adhere to prescribed medication schedules can be extremely harmful to an individual's health and well-being. However, the rate of adherence to medication plans is estimated to only around 50% (Haynes et al. 2002, WHO 2003). Non-adherence is even a substantial problem in settings where information and medication is free and accessible, and the costs of failing to adhere are extremely high.[1] Several behavioral approaches have been suggested to address adherence, but the evidence of their effectiveness has shown mixed results (Guinart & Kane 2019, Anderson et al. 2020, Shih & Cohen 2020). Two of the primary approaches have been the use of *incentives* (see, e.g., DeFulio & Silverman 2012, Petry et al. 2012, Bassett et al. 2015) and *text-message reminders* (see, e.g., Lester et al. 2010, Pop-Eleches et al. 2011, Thirumurthy & Lester 2012, Mbuagbaw et al. 2013). These studies typically use a "one size fits all" approach, applying the intervention uniformly across the target population. However, it is likely that there is substantial heterogeneity in the demand for, and effectiveness of, medication adherence interventions. In addition, if different underlying mechanisms are generating poor adherence for different individuals, this will imply that different interventions will be effective for different sub-populations. Being able to better tailor interventions based on the preferences or characteristics of individuals could improve the effectiveness of the interventions while also reducing costs.

This paper investigates whether measured time preferences can predict an individual's propensity to adhere to their prescribed medication. Time preferences are typically heterogeneous across individuals (see, e.g., Falk et al. 2018). If a relationship between time preferences and adherence exists, it would provide one possible avenue for the screening of individuals to identify those at risk of low adherence.[2] Improved screening could be especially policy-relevant for preventive measures and chronic diseases, where the benefits of medication are not immediate and non-adherence is not directly observable. While the current paper focuses on medical adherence, our experimental design, model and insights can be easily transferred to other situations that require consistent effort and delayed benefits, such as studying, going to the gym or eating healthy.

In order to investigate the relationship between individual time preferences and medi-

[1] In the case of HIV treatment, researchers find problems with medication adherence even though the costs of failing to adhere (even temporarily) is extremely high. A meta-analysis of 84 studies find that only an average of 64% of patients reported medication adherence of $\geq 90\%$, with lower estimates in countries with lower scores on the Human Development Index (Ortego et al. 2011).

[2] The current literature on the relation between time preference and medical adherence is scarce. Studies apply different hypothetical time preference measures or incentivised time preferences in the monetary domain, and the results are mixed (Chapman et al. 2001; Sloan et al. 2009; Brandt & Dickinson 2013; Mørkbak et al. 2017; Van Der Pol et al. 2017.)

cation adherence, we conduct a low cost, text-message-based study in which we contact a total of 694 pregnant women in South Africa to elicit their time preferences and collect information about medication adherence to recommendations to take daily iron supplements intended to prevent anaemia during pregnancy.[3] This allows us to analyze whether heterogeneity in time preferences measured with a simple and scalable task is predictive of heterogeneity in medication adherence. This low-cost approach could be used to identify those who would benefit most from interventions that target attention or procrastination and thus, reduce overall costs of interventions. In addition, early identification of and targeting of interventions to individuals who are unlikely to comply with treatment regimes can improve their health outcomes. In comparison, waiting to intervene until the individual has failed to take the prescribed medication can involve large health costs. For example, during pregnancy, but also for e.g. HIV or tuberculosis patients, early consistent compliance is important to avoid irreversible health outcomes later on.

Medication adherence can be modeled as a situation in which one has to exert immediate effort in order to obtain some benefit (or to reduce some cost) in the future. Since we are interested in an inter-temporal trade-off that involves effort in the earlier period, it is important to measure time preferences in the effort domain. To do so, we create a simple text-message task. Our task is loosely based on the work by Augenblick et al. (2015), who develop a real-effort task to measure time preferences in the lab. The main difference between their method and ours is that our version is simpler and can be implemented in a wider range of settings (e.g. via a basic phone), which makes it suitable for resource-limited settings.[4] In our task, we ask participants to complete a short, incentivized word task within a specified number of days. If the participant completes the task, she is rewarded with a fixed payment of credit for her phone. The magnitude and date of this payment is always held constant, however, the difficulty of the task depends on *when* the participant completes it, with the task requiring more effort as time passes. In addition, prior to the start of the task, we elicit the participant's plan regarding when she will complete the task. This allows us to measure: (i) how patient the participant is and hence whether she anticipates that she will complete the task early or with a delay, and (ii) whether she behaves time-consistently or not.

In order to place structure on our empirical analysis, in Section 3 we develop a simple

[3] These iron supplements are available at no cost at their local health clinic.

[4] Haushofer et al. (2018) also adjusted the incentivized task by Augenblick et al. (2015) for measuring time preferences to a mobile phone design. The employ a multiple price list design to determine how many rows of numbers the women need to text to a phone number of the research center on specific days. While the technological constraints are lower than in the original task, the task still requires detailed in-person instructions and a significant amount of time.

theoretical framework that examines how time preferences might influence medication adherence. In Section 4, we then provide a detailed description of our experimental design and discuss how we we classify women, based on their inter-temporal choices in our real-effort task, into the following groups: *On-timers* (who have largely time-consistent preferences), *Late-or-Never-Doers* (who have present-biased preferences) or *Early-Doers* (who are either future biased or sophisticated about their present bias). In addition, we classify participants based on their exponential daily discount factor δ as being either High- or Low-Discounters. Section 5 explains the experimental timeline and sample selection.

In Section 6, we report our results which are based on a final sample of 480 women for which we have data on both time preferences and medication adherence. We find that the level of stated adherence in our sample is high, with the majority of women reporting that they take their iron pills every day. Despite the low variation in the outcome variable, we find a significant correlation between our measure of the discount rate, δ, and missing days in taking iron supplements. Surprisingly, we find that a large share of the women (ca. 25%) are *Early-Doers*, who do the task earlier than planned. Only 9% do the task later than planned or not at all (*Late-or-Never-Doers*). The remaining 66% do the task as planned (*On-timers*).[5] Given the high share of women, who do the task on the first day, we do not have enough power to detect a significant correlation between time inconsistency and adherence when controlling for the discount rate. Our measured time preferences are significantly associated with self-reported difficulty in remembering to take one's pills. In Section 7, we discuss the robustness of our results to demographics, general busyness, and cognitive ability of the women, and we present evidence for several self-reported health outcomes.

A related paper to ours is Haushofer et al. (2018) who among other behavioral measures implement a time preference elicitation task to predict adherence to chlorination. In contrast to our paper, they employ a time-preference treatment consisting of interactive lectures, case stories, exercises and drawings to affect patience in their sample and show that their treatment decreased diarrhea episodes in children, a proxy for more chlorinated water. Their time-preference elicitation task was part of a large battery of surveys and interventions run with household enumerators, while our approach is more light touch and could in the future easily be implemented by our project partner or transferred to other mobile health settings. Our paper focuses on the possibility to predict adherence using time preferences whereas Haushofer et al. (2018) aims to change preferences and thus change behavior. Brandt & Dickinson (2013) also studies the effect of time-preferences on med-

[5] These individuals did the task when they said they would, e.g. due to having time-consistent preferences in the sense of $\beta = 1$ (Laibson 1997, O'Donoghue & Rabin 2015).

ication adherence in an incentivized way. Investigating 47 asthmatic patients, they find a positive correlation between individual time preferences and adherence levels in taking asthma medication. In another small, but non-incentivized study (n=79) of chronic diabetes patients, Mørkbak et al. (2017) document evidence that indicates a link between present-bias and both: (i) the age of onset of the disease, and (ii) the prognosis after diagnosis. However, in general, the literature in this area is scarce and the results are mixed. Larger surveys focusing on hypertension, diabetes, or chronically ill patients have generated mixed results regarding the association between medical adherence and hypothetical time-preference measures (Chapman et al. 2001, N=195 and N=124; Sloan et al. 2009, N=1530; Van Der Pol et al. 2017, N=1849). We document evidence that is consistent with Brandt & Dickinson (2013), namely that individual time preferences are predictive of patterns of adherence. Interestingly, our results suggest that only measuring the discount factor δ, rather than δ and β has significant predictive power to identify individuals that struggle with medication adherence. Given that the elicitation of time-inconsistent preferences is more difficult than only eliciting the discount rate, our findings could be good news for health care providers aiming to identify at-risk individuals.

More generally, our study contributes to the literature designing and evaluating behavioral interventions to address medication non-adherence (see, e.g., Lester et al. 2010, Pop-Eleches et al. 2011, Thirumurthy & Lester 2012, Bassett et al. 2015) as well as the literature developing tools for measuring time preferences with real-effort tasks, particularly in low-resource settings (see, e.g., Augenblick et al. 2015, Andreoni et al. 2015, Augenblick 2018, Augenblick & Rabin 2018, DellaVigna & Pope 2018, Haushofer et al. 2018, Cohen et al. 2020).

2 Context

In this study, we focus on the effect of time preferences on the medication adherence of expectant mothers in South Africa. In 2014, the South African National Department of Health (NDoH) developed a text message based information and reminder system called MomConnect. This platform aims to assist expectant mothers through their pregnancy, and in the early period after birth. It does this by, for example, reminding them to schedule pregnancy check-ups, providing them with a description of how babies develop, informing them about the health benefits of breastfeeding and informing them about symptoms that would indicate that they should seek medical help. When we ran this study, nearly 2 million women had joined MomConnect, making it one of the largest mHealth programs of its kind. Similar programs have been developed in other places, for example in India.

One of the aims of the program is to improve medication adherence among expectant mothers in South Africa, since pregnancy and early infancy are critical periods for the development of a child. In this paper, we focus on studying adherence to the specific recommendation that pregnant women should take daily iron supplements to prevent anaemia. Anaemia during pregnancy has negative health effects for both mothers and babies. During the last two trimesters of pregnancy, iron is essential for the mother as her body needs to produce more blood and grow both the placenta and the fetus. Anemia is associated with an elevated risk of maternal mortality, problems with lymphocyte stimulation (related to the immune systems), risk of pre-term delivery, and risk of low birth weight (see, e.g., Allen 2000, Lozoff et al. 2006, Kalaivani et al. 2009, Abu-Saad & Fraser 2010, Balarajan et al. 2011). The World Health Organization estimates that in 2016 the rate of anaemia amongst women of reproductive age was around 25% in South Africa and 33% globally (World Health Organization 2020). This is in spite of the fact that in South Africa the government runs a program to supply free iron supplements to all pregnant women. Health workers are instructed to provide pregnant woman with a supply of the supplements at the first antenatal visit and to follow-up by checking for signs of anaemia during the second visit (for further evidence documenting the status of anaemia and iron supplement intake in the South African context, see, e.g. Nojilana et al. 2007, Phatlhane et al. 2016, Tunkyi & Moodley 2016, Mbhenyane & Cherane 2017, Harika et al. 2017, Symington et al. 2019).

In summary, all women we sample from are recommended to take iron supplements and all should have access to free supplements[6]. This makes the context ideal for testing our research question because it enables us to abstract from budget and availability constraints. At the same time, the South African setting is one in which WHO numbers suggest that there is scope for reducing anaemia and where a suitable platform for scalable interventions is well-established.

3 Theoretical Framework and Hypotheses

In this section, we provide a simple theoretical framework to illustrate the effect of time preferences on the decision to take iron supplements. The theoretical framework informs our experimental design and the interpretation of our results.

A pregnant woman's decision of whether to follow the recommendation to take iron supplements daily during pregnancy has similar characteristics to an investment decision: It requires an immediate cost and involves a future benefit. The immediate cost c includes

[6]We control for whether they actually have access by asking them.

the effort cost of getting and taking supplements, the cognitive cost of remembering to take the supplements, and costs of short term side effects such as an upset stomach. In general, the cost would also involve costs of buying the supplements but in our setting pills are typically available for free at the health centers. The future benefits b_t capture all health benefits to the mother and her baby, e.g. the reduced risk of maternal mortality, the reduced risk of pre-term delivery, and the reduced risk of low birth weight. If the expectant mothers do not take iron supplements, they receive the best alternative payoff which, without loss of generality, we normalize to 0.

As with other investment decisions, the decision to take daily supplements is an intertemporal decision problem. Allowing for the present-biased time preferences (Phelps & Pollak 1968, Laibson 1997, O'Donoghue & Rabin 1999) as captured by the $\beta-\delta$model (O'Donoghue & Rabin 1999), the net benefit of taking the supplements in period t are:

$$-c+\beta\sum_{s=t+1}^{\infty}\delta^{s-t}b_s. \tag{1}$$

where β is an additional discount factor between present and future periods, applied on top of the usual exponential discount factor δ. The expectant mother has time-consistent preferences if $\beta=1$ and she has present-biased preferences whenever $\beta<1$. As suggested by O'Donoghue & Rabin (1999) individuals may or may not correctly anticipate future present bias. Let $\hat{\beta}\in[\beta;1]$ denote the prediction of β in future periods. The standard time-consistent *exponential* discounter then has $\beta=\hat{\beta}=1$, the *sophisticated* present-biased individual has $\hat{\beta}=\beta<1$, and the *fully naive* present-biased individual has $\beta<\hat{\beta}=1$. With this notation the expectant mother anticipates that the future net benefit of doing the task in a future period is $-c+\hat{\beta}\sum_{s=t+1}^{\infty}\delta^{s-t}b_s$. Hence, naive present-biased individuals mispredict their future net benefit. The distinction between naivety and sophistication may be of importance, when individuals have opportunities to delay doing a task (e.g. to later in the day)[7], as sophisticates will anticipate that they may not do the task if they delay. As shown by (O'Donoghue & Rabin 1999), sophisticates may then do the task sooner than a time-consistent individual would have done and they may use commitment devices to ensure that they take supplements. This gives the following two hypotheses:

Hypothesis 1. *Adherence is increasing in the exponential discount factor δ, i.e. women who discount the future more are less likely to take supplements.*

Hypothesis 2. *For naives, adherence is increasing in the present-bias parameter β, i.e. women who display time-inconsistent delay are less likely to take supplements.*

[7]Note that there is no option to delay from day to day in our setting, as iron pills have to be taken daily.

4 Measuring Time Preferences in the Effort Domain

In order to test our hypotheses, it is necessary to elicit the time preferences of pregnant women. Traditionally, time preferences have been elicited in the monetary domain, where participants choose between either more money now or more money later. However, recent papers have emphasized the importance of measuring time preferences within the specific domain of interest (see, e.g., Ubfal 2016, Augenblick et al. 2015, Cohen et al. 2020). Since adhering to medication can be viewed as a type of (cognitive) effort task, we investigate time preferences in the effort domain. For this purpose, we design a simplified version of the experiment used by Augenblick et al. (2015)[8] which is suitable for a text-message based implementation.

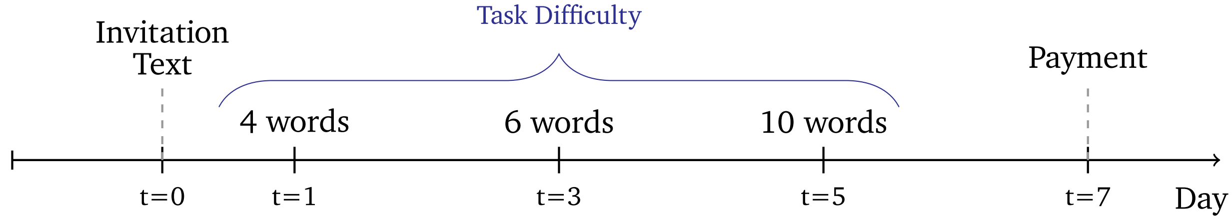
4.1 Experimental Design

The experiment begins on day $t = 0$ when participants are informed that they can earn phone credits worth 20 South African Rand (equivalent to 1.4 USD) if they complete a word task. The task involves writing a list of words backwards. Participants are given two examples and are told that they will receive text messages containing the relevant word lists in the coming days. Importantly, the longer participants wait to do the task the more words they will need to write to earn the 20 Rand phone credits. The reason for this increasing effort cost is to make procrastination expensive. The participants can choose between writing four words on day $t = 1$, six words on day $t = 3$, or ten words on day $t = 5$. Irrespective of *when* they complete the task they will receive the phone credits on day $t = 7$. At time $t = 0$, participants are fully informed about this procedure and are asked *whether* and *when* they expect to do the task. We provide a fixed payment of 5 Rand for their answer to this question on day $t = 0$ and we do not incentivize how accurately their choice on day $t = 0$ matches subsequent choices.

On day $t = 1$, participants receive a new message with a list of four words: "baby, parent, bottle, mom". A participant who replies with these words written backwards, has completed the task. If the participant does not complete the task, she gets two additional chances to do the task: on day $t = 3$ and on day $t = 5$ when new lists of words are sent. The time-line of the text-message task can be seen in Figure 1 and the full set of messages for the task can be found in the Supplementary supplementary appendix.

[8] Augenblick et al. (2015) use a real-effort task to measure the time preferences of university students during a six-week period. The students decide when they want to do tedious tasks and are paid a varying piece-rate. The tedious task is either to transcribe Greek letters or to play a modified and not very enjoyable, Tetris-style game. The experiment is implemented both in a computer lab and in an online setting where participants use their own computers.

Figure 1: Timeline of the Text-Message-Based Real-Effort Task



We developed this specific word task for several reasons. First, the task had to be suitable for the text-message implementation. The majority of the effort tasks commonly used in the economics literature are either too long, or infeasible for a limited contact context such as this (e.g. implemented over text-message).[9] Second, in our setting, it is important that participants can complete the task at any time throughout a day. This way the task might mimic the underlying effort and cognitive constraints that drive time preferences and medication adherence. In pilot tests, we found that although the word task was considered tedious and frustrating, it did not take long to do.

4.2 Interpreting Choices in the Time-Preference Elicitation

We follow the approach in Augenblick (2018) and Augenblick & Rabin (2018) to identify time preferences from a comparison of future and immediate effort choices. The initial plan of *whether* and *when* to do the task is a future effort choice. Behavior in the subsequent periods, implicitly give us an immediate effort choice. However, the simplicity of our task implies that we cannot identify precise estimates of the time-preference parameters in the $\beta - \delta$model, instead we classify the women based on their behavior as either *On-timers* (who largely have time-consistent preferences), *Late-or-Never-Doers* (who have present-biased preferences) or *Early-Doers* (who are either future biased or sophisticated about their present bias)[10] and additionally we classify participants based on their exponential daily discount factor δ as either *High* or *Low Discounters*. We discuss the details of the classifications in this subsection.

To illustrate the elicitation mechanism, let k denote the time period when an effort

[9] See, e.g., Charness et al. 2018 for a review of experimental real effort tasks. The task closest to ours is the one used by Gerhards & Gravert (2020), which asks participants to solve five letter anagrams within a certain time period.

[10] Note that we classify people based on their *observed behavior* and not based on *preferences* which are inherently unobserved. For example, an individual with time-consistent preferences will do as she plans while a person with present-biased preferences may either do as planned, do it later, or not do it after all. Hence, we cannot distinguish whether an individual who acts as planned has time-consistent preferences or present-biased preferences.

decision is made, let t denote the time period when the task is performed, and let e_t denote the effort level, i.e. number of written words where $e_1 = 4$, $e_3 = 6$ and $e_5 = 10$. The wage level, w, is the amount of money paid out at time $T = 7$. In our experiment, $w = 20$ if the participant completes the task at any point in time, and $w = 0$ otherwise. For tractability we assume that the disutility of effort is captured by a function $C(e_t) = \frac{1}{\phi} e_t$ where ϕ can be interpreted as the "exchange rate" between effort and money as in Augenblick (2018).[11] We assume that both effort and monetary payments are discounted by a quasi-hyperbolic discounting function that discounts costs by the discount factor 1 when $t = k$ and $\beta\delta^{t-k}$ when $t > k$.

In this setting, where the payment for the task does not depend on when the task is completed, utility maximization is equivalent to effort-cost minimization subject to a participation constraint. The participation constraint ensures that the discounted effort cost of doing the task at the chosen time t^* does not exceed the discounted payment from doing the task. That is at time $k \geq 0$ the participant should expect to do the task at time

$$t^\star = \underset{t \in \{1,3,5\}, t \geq k}{\operatorname{argmin}} \{\beta^{1(k<t)} \delta^{t-k} \cdot \frac{1}{\phi} e_t\} \tag{2}$$

subject to the participation constraint $\beta\delta^{T-k} \cdot 20 \geq \beta^{1(k<t^\star)} \delta^{t^\star - k} \cdot \frac{1}{\phi} e_{t^\star}$ where $1(k < t)$ is an indicator function for whether the effort allocation is in the future relative to the point in time when the decision is made. In both Equation 2 and in the participation constraint, β is replaced by $\hat{\beta}$ when the participant makes a prediction about future present bias. This allows us to capture sophistication ($\hat{\beta} = \beta < 1$) and naivete ($\beta < \hat{\beta} = 1$) about future present bias.

4.2.1 Future Effort Choices: Eliciting the Exponential Discount Factor

At time $k = 0$ the participant states whether and when she plans to do the task and therefore implicitly states anticipated future effort at time $t = 1$, $t = 3$ and $t = 5$. As mentioned above we do not incentivize the accuracy with which the future effort choice matches effort choices made at later points in time (i.e. for $k > 0$). This is to reduce the extent to which (sophisticated) participants use their answer at time $k = 0$ as a commitment device to discipline future behavior and it is important because our categorization of individuals is

[11] Augenblick (2018) assume the more general $C(e_t) = \frac{1}{\phi\gamma}(e)^\gamma$, where γ determines the function curvature and assume convexity. In our experiment, convexity of the effort function would imply that each word is increasingly annoying to write. However, it is also plausible that reversing the order of letters in a word gets easier with practice and that the effort function is therefore concave. For simplicity we therefore assume that the cost function is linear, i.e. $\gamma = 1$.

based on a comparison between future and immediate effort choices, and hence to get variation in behavior, we do not specifically want to encourage (or discourage) time-consistent behavior.

In our main analysis, we focus on the case were individuals are naive about future present bias at time $k = 0$ when they make their future effort plan.[12] This naivete assumption leaves room for discrepancies between planned future effort from the perspective of time $k = 0$ and actual behavior at time $k > 0$. In contrast, full sophistication at time $k = 0$ implies fully time-consistent behavior.[13]

Solving the problem in Equation (2) for $k = 0$ (when assuming naivete at time $k = 0$) involves doing a number of pairwise comparisons of the discounted cost of exerting effort at $t \in \{1, 3, 5\}$. Since subjects are making the plan at time $k = 0$, all effort costs and payments are in the future and hence β is irrelevant. Table 1 summarizes the conditions generated by the pairwise comparisons:

Table 1: Planned Future Effort

	Timing optimal		Participation constraint
$t = 1$ if	$\delta^2 > \frac{2}{3}$	and	$\delta^6 \geq \frac{1}{5\phi}$
$t = 3$ if	$\delta^2 \in \left[\frac{3}{5}; \frac{2}{3}\right]$	and	$\delta^4 \geq \frac{3}{10\phi}$
$t = 5$ if	$\delta^2 < \frac{3}{5}$	and	$\delta^2 \geq \frac{1}{2\phi}$
Plan not doing it			if none of the above hold

Notes: The table gives conditions under which the alternative possible timings are optimal perspective of period $k = 0$ if individuals are exponential discounters or naively present-biased at $k = 0$. Further details are provided in the supplementary appendix.

Table 1 clearly shows that a participant may plan not to do the task, if the participation constraints are not satisfied, e.g. because the exchange rate ϕ is such that the wage paid is insufficient. If at least one of the participation constraint holds, then the anticipated optimal timing for the effort only depends on the size of her exponential discount factor, δ. A participant with a low level of patience (i.e. a low δ) will plan to do the task later.

[12]This is in line with Augenblick & Rabin (2018) who identify the present-bias parameter β from a comparison between immediate and future effort choices but elicit sophistication as captured by $\hat{\beta}$ from *incentivized* predictions about future effort. The assumption is also supported by their empirical results which suggest limited sophistication regarding future effort

[13]If the women are sophisticated about their present bias at time $k = 0$, the analysis is somewhat more complicated as the individual then takes into account that even if she would like to complete the task on a particular day from the perspective of time $k = 0$, when she arrives at that particular day, she may procrastinate due to her present-bias. A fully sophisticated individual will realize this and will therefore correctly estimate when she will actually do the task (which may not be equivalent to the optimal date from the $k = 0$ perspective). Therefore an individual who is fully sophisticated at time $k = 0$ will behave in a time-consistent way and act exactly as planned (even though she is present-biased)

Therefore, the plan revealed in the first part of the experiment can (if we assume naivete or standard exponential discounting at time $k = 0$) be used to classify the individual as a High or Low Discounter.[14] We will classify participants as Low Discounters if they anticipate doing the task in period $t = 1$ and as High Discounters otherwise.[15]

4.2.2 Future vs Immediate Effort Choices: Eliciting Time-Inconsistency

The second part of the elicitation involves comparing the time $k = 0$ plan of future effort to immediate effort choices made in periods $k = 1$, $k = 3$ and $k = 5$, in order to elicit possible time-inconsistency. Solving for the optimal timing in Equation (2) for $k = \{1,3,5\}$ also amounts to doing a number of pairwise comparisons. However, in contrast to period $k = 0$, we now allow for both sophistication and naivete at time $k \geq 1$ in our analysis. This is to allow for a situation where sophisticated women realize that they may not carry out the task if they delay it, only once they receive the first message about actually doing the task. This situation yields an interesting special case.

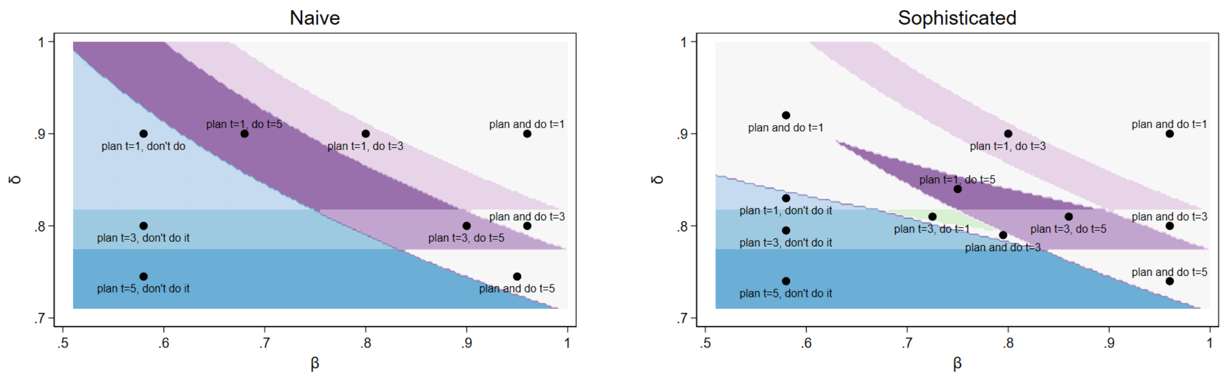
Figure 2 illustrates the theoretical predictions of planned and actual behavior for different combinations of the parameters δ and β and for different assumptions regarding the level of sophistication of the women.[16] In particular, we consider full naivety ($\beta < \hat{\beta} = 1$) and full sophistication ($\beta = \hat{\beta} < 1$) at time $k \geq 1$. The figure clearly illustrates that planned behavior is determined only by the size of the exponential discount factor δ as discussed in the previous subsection. Actual behavior in contrast depends on both β and δ as well as on the level of sophistication. The light gray areas in Figure 2 indicate that the task is carried out as planned. This may happen for a number of reasons: i) people are time-consistent ($\beta = 1$), ii) people are future biased ($\beta > 1$) but to a sufficiently low degree, or iii) people have present-biased preferences ($\beta < 1$) but to a sufficiently low degree or they are sophisticated and do the task on time to avoid a delay which again may imply that the task is not done. The blue shaded areas indicate situations where individuals plan to do the task but fail to do it. This may happen if people have strongly present-biased preferences ($\beta < 1$). Purple areas indicate that the task is carried out with delay which also may happen if people have present-biased preferences. Finally, the green area indicates that the task is carried out earlier than planned which may happen in special circumstances if the individual is present-biased and sophisticated at time $k = 1$ but not at time $k = 0$. Specifically, consider a

[14] For a fully sophisticated individual the optimal timing anticipated in period $k = 0$ depends not only depend on δ but also on β. This is since actual behaviour depends on both δ and β as illustrated by Figure 2. The fully sophisticated individual realizes this and adjusts her time $k = 0$ anticipation to reflect this.

[15] We group participants who anticipate doing the task on day $t = 3$, $t = 5$ or never into High Discounters because we have very few people in our sample who plan to do the task at time $t = 5$ or never.

[16] Further details are in the supplementary appendix

Figure 2: Model Implied Planned and Actual Behavior for Different Levels of β and δ



Notes: The figure shows the planned and actual behavior predicted by the $\beta\delta$ model assuming naivite ($\beta < \hat{\beta} = 1$) in the left panel and sophistication ($\beta = \hat{\beta} < 1$) at time $k \geq 1$ in the right panel. For the figure we have set $\phi = 1$.

participant who at time $k = 0$ naively prefers that the task is done at time $t = 3$ over doing it at time $t = 1$ which again is preferred over time $t = 5$. Then, if at time $k = 1$ she still prefers that the task is done but now is willing to delay the task until period $t = 5$, she may realize that if she does delay, the task will end up being delayed to period $t = 5$ where it will not be done. Then it ends up being better to do the task now (i.e. earlier than planned) than to delay. This effect is similar to the result in O'Donoghue & Rabin (1999) that sophistication may make individuals do a task early.

We group participants in our experiment according to this color code as the colors represent different behaviors that can serve as noisy measures of underlying time preferences:

- **On-timers**: According to our model the task is carried out as planned, if people have time-consistent preferences, if they have nearly time-consistent preferences, or in some cases if they have strongly present-biased preferences and are sophisticated about this.

- **Late-or-never-doers**: These are women who are present-biased and possibly naive about it.

- **Early-doers**: These are women who are either future-biased or they have present-biased preferences and are sophisticated about it.

5 Implementation and Sample Selection

The data collection took place from the 19th of March to the 29th of June 2019. In total, a sample of 18,400 women was drawn randomly from the population of MomConnect users.

We used the following criteria: i) on the 19th of March 2019, there were between 105 and 130 days until their expected due date, and ii) the women were 18 years or older. We sampled from the entire country and did not place a restriction on language. We have information on their preferred language, whether they live in an urban or rural area and whether they signed up with a smart phone or an older mobile phone without smart-phone capabilities.

This sample of women received a text-message invitation in English 105 days prior to their estimated due date asking whether they would like to participate in a research study on healthy pregnancy behavior for which they could earn phone credits. In line with our pre-study expectations, approximately 24% (4226) of the contacted women opted in to participate.[17] These women were then randomized into six different treatment arms that were run in parallel. In total, 694 of the women were randomly assigned to the treatment arm relevant for the current paper.[18]

A time-line of their participation can be seen in Figure 3. In an initial survey, participants were asked some baseline questions, including how many older children they had and whether they thought iron supplements were important for a healthy mother and child.[19] Fifteen days after opting in to the study, the women received the instructions for the real-effort time-preference task of writing words backwards. A total of 546 participants took part in the time-preference task. Approximately five weeks later, in the final week of data collection for this study, the women were asked to complete a short survey consisting of eight questions including questions about iron intake, iron deficiency and symptoms, perceived difficulty of remembering to take iron supplements, and experienced side effects.[20]

For our main analysis, we limit our sample to women who took part in the time-preference task *and* answered all eight questions of the final survey. This leaves us with a final sample

[17] In a representative text message based survey in Mexico during the N1H1 pandemic, response rates were 5.8%. Studies that provide respondents with free mobile phones, unsurprisingly, usually have higher response rates Pop-Eleches et al. (2011).

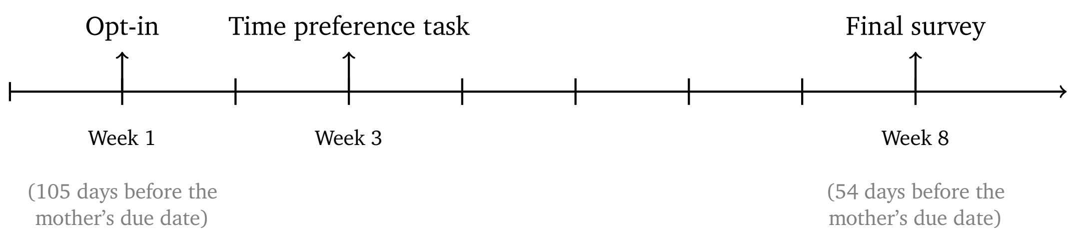
[18] Further details regarding the other treatment arms of this project can be found in the companion paper which investigates the mechanisms on how reminders affect behavior (Barron et al. 2022). The other treatment arms do not include the time preference elicitation task. There is thus no overlap between the papers.

[19] In the theoretical framework in Section 3, we assume that taking iron supplements has perceived health benefits. Empirically we find support for this as almost all mothers respond that they think that iron supplements are very important in order to be i) a healthy mother and ii) having a healthy baby. On a scale from 0 (not important) to 7 (very important), 94 % of the participants responds with a 5 or higher in each of the two questions (see Figure 6 and 7 in the supplementary appendix).

[20] During the period between the time-preference elicitation task and the final survey, the participants also received additional text messages and reminders relating to a healthy pregnancy.

of 480 women.[21]

Figure 3: Timeline of the experiment



6 Results

6.1 Demographics

Table 10 in the appendices reports some basic demographic information for the individuals in our final sample. The average woman was born in 1992, making her 27 years old at the time of our data collection. Thirty-five percent of our sample has English as their preferred language. Twenty-nine percent of the women live in urban areas and on average the participants have one older child and 12 years of schooling. The table also tests whether there is biased selection on observables into our final analysis sample. In comparison to the full sample of women who opted in, our final sample shows a slightly lower share of urban women. Otherwise, there are no observable differences.

6.2 Behavior in the Time-Elicitation Task

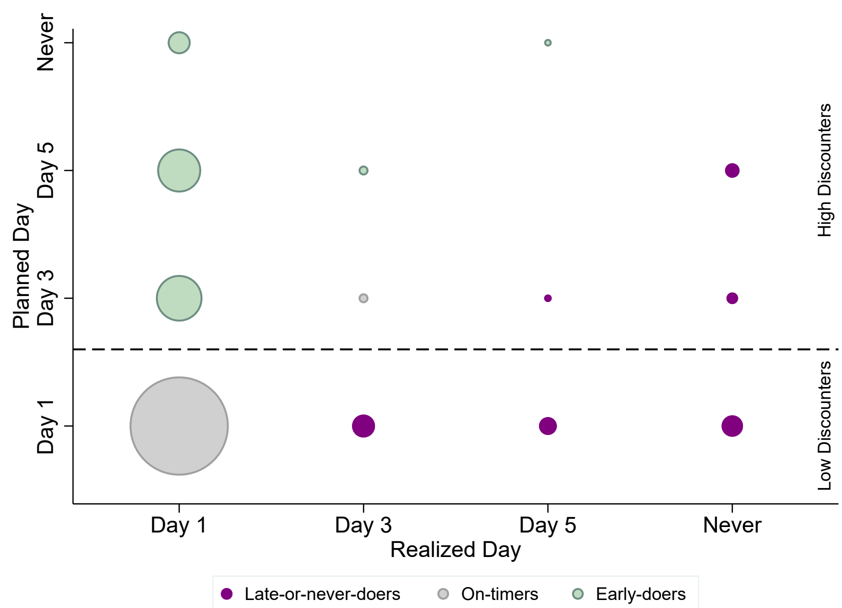
Among the 480 women in our final sample, 333 (70%) reported that they planned to do the task on the first day, whilst 69 (14%) and 63 (13%) women answered that they would wait and do it on day 3 or 5, respectively. Fifteen women (3%) stated that they did not plan

[21] Table 11 in the supplementary appendix tests for selection on time preferences into the final sample. We elicit time-preferences for 66 women who are not in our final sample because they do not complete the final survey. There are no statistically significant differences between the time-preference measures for the women in the final sample and those not included in the final sample. However, there is a slight over-representation of Late-Doers among the women excluded because of missing survey responses. This would potentially work against finding the hypothesized effect.

to do the task. In practice, 432 (90%) of the women actually did the task on the first day.[22] This implies that a large fraction of our sample (121 women) actually did the task earlier than they had planned. Yet, the majority of the women (301 participants) did the task as planned. Only 43 of our participants did the task later then planned or not at all, despite having stated that they would do it.

As discussed in section 4.2.1 and section 4.2.2 we use this behavior to classify the women in two ways. First, we classify women into Early-Doers, Late-Doers and On-Timers. Second, we classify the women as being either Low or High Discounters based on when they planned to do the task. Individuals that planned to do the task on day 1 are called "Low discounters", while everyone else is labelled "High discounters". Figure 4 reports the distribution of women according to the categorizations, showing the On-Timers in grey, the Early-Doers in green and the Late-Doers in purple and Low Discounters below the dashed line while High Discounters are those above the dashed line.

Figure 4: Categorization



Notes: Markers weighted by observations (size), colored using indicators of present-future bias.

[22]Women got paid independently of whether they made mistakes or not (i.e. they were paid for completion as opposed to being fully correct). We chose this implementation in order to avoid that women who completed the task nearly perfectly (e.g. using capital letters instead of lower case letters) did not get payed, and to avoid discriminating against women with learning difficulties. We do not view this as deception as participants were told that payment depended on completion of the task, and not that "completion" required everything to be completely correct. Our programming was very strict in terms of what was considered a mistake. A comma sign between words or the use of a capital letter would being classified as mistakes. Therefore, a fifth of our sample, was classified as having mistakes. In order to not lose too much power, we therefore classify women as doing the task if they attempted to do the task on a particular day, irrespective of whether it was recorded as correct or not.

By the construction, an individual cannot be classified as both a Low Discounter who plan to do the task on the first possible day and as an Early-Doer. At the same time, since many of our participants chose to do the task on the first day, 136 out of 147 High Discounters are also classified as Early-Doers. This means that the High Discounter and Early-Doer groups are nearly overlapping. Therefore we focus on the High Discounters and Late-Doers in our empirical analysis.

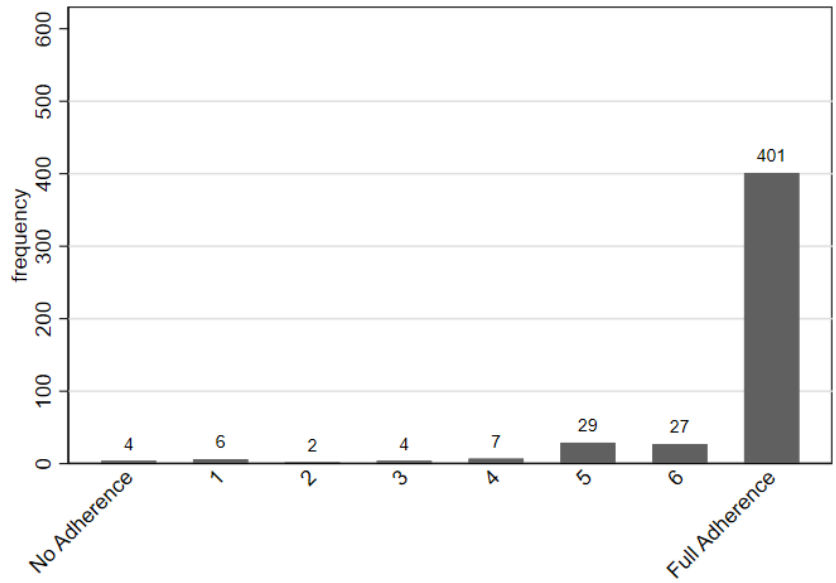
6.3 Self-reported Adherence

Our main outcome variable is self-reported adherence. The variable is measured as a response to the question: "How many days did you take your iron pills last week? (1-7)". We ask about the past week, rather than about the entire pregnancy, because imperfect and motivated recall becomes more of an issue when asking individuals to report outcomes from a longer time window. It is a common practice in surveys to use short, recent time intervals in order to avoid recall bias.[23] However, it is important to keep in mind that even when considering the shorter period of a week, taking an iron pill on a particular day may not be a particularly memorable moment, and self-reported medication adherence should therefore be seen as a proxy for actual adherence. In addition, research suggests that self-reported estimates tend to be upward biased (Wilson et al. 2009). However, self-stated measures of medication adherence are widely used in the the literature and have been found to correlate strongly with objective measures.[24] This suggests that the over-reporting shifts the measured distribution of adherence to the right, but remains informative regarding the relative adherence of different individuals (i.e. regarding who adheres more and who adheres less). Stated adherence thus provides a good proxy of the variation in adherence, even if the level effects should be viewed with caution. Since the mothers could not have anticipated this question in that particular week, the measurement should be representative of the average week during the pregnancy.

[23] For example in time-use and household-expenditure surveys. For a discussion of the pros and cons of different recall lengths in the domain of health, see, e.g. Clarke et al. (2008) and Stull et al. (2009).

[24] See for example the review of HIV medication adherence by Simoni et al. (2006) who find significant correlations between individual's self-reported adherence and virus levels in 85% of the reviewed studies. Note that this is found despite large differences in the recall period used across studies. Seven days is the most common recall period, but recall periods may be up to 6 months long. In addition, more recent studies, such as Marrone et al. (2016) also find strong correlation between stated medication adherence and virus load among HIV positive patients when asking patients about the number of pills a patient missed in the last 7 days.

Figure 5: Iron Intake Last Week



Notes: The figure reports the distribution of the answers to the question: *How many days did you take your iron pills last week? 0 to 7.* In total 79 out of the 480 respondents reported missing at least one of their iron pills.

Figure 5 reports the distribution of self-reported adherence, showing that individuals in our sample tended to display a high degree of adherence to their iron supplements, with only 79 out of 480 reporting that they did not take their iron pills on every day during the preceding week.

6.4 Hypothesis Testing

The central question that we ask in this paper is whether we can use elicited time preferences from an extremely simple, low-cost, real-effort task to predict which individuals will be more likely to adhere to their iron supplements.

6.4.1 The Relationship between the Discount Factor and Adherence

Our first hypothesis is that self-reported adherence is increasing in the discount factor δ, i.e. women who discount future effort more are more likely to delay and therefore less likely to take their supplements. We investigate this question in Table 2. The first column reports the results from an OLS regression, showing the relationship between the number of pills taken during the last week and whether an individual is classified as a High Discounter according to our time-preference task.[25] In line with the hypothesis, we find that High Discounters take fewer pills than Low Discounters, with results being significant at the 5% level. In columns 2 and 3, we provide an additional test of this hypothesis. Since the key distinction in adherence behavior appears to be between full adherence (i.e. taking the pills on all seven days) and partial adherence (i.e. taking pills on fewer than seven days), we construct a binary variable that reflects whether an individual missed an iron pill on at least one day, or not. Replacing the continuous outcome variable with this binary outcome variable, columns 2 (OLS) and 3 (Logit) provide further support in favor of the hypothesis, showing that High Discounters are more likely to be partial adherers. Being a High Discounter is therefore significantly correlated with not fully adhering to the prescribed medication plan.[26]

Table 2: Adherence and High vs Low Discounters

	OLS Nr of Pills (1)	OLS Missed Pills =1 (2)	Logit Missed Pills =1 (3)
High Discounters	-0.267**	0.082**	0.573**
	(0.126)	(0.039)	(0.256)
Constant	6.779***	0.111***	-2.045***
	(0.070)	(0.025)	(0.222)
Failure Dummy	Yes	Yes	Yes
Observations	480	480	480
R^2	0.016	0.014	

Notes: Regressions include the 480 participants that answered all eight questions of the final survey. Missed Pills =1 is a dummy variable which is 0 if the participant reported having taken all 7 pills last week, and which is 1 if she missed one pill or more. High Discounters is a dummy variable where planning to do the task on day 1 is denoted 0 and planning to do the task on day 3 or 5, or not planning to do the task is denoted with a 1. Failure Dummy is a dummy for technical problems leading to payment delay. Regressions include the 480 participants that answered all eight questions of the final survey. robust standard errors in parentheses *** p < 0.01, ** p < 0.05, * p < 0.1.

[25] For some women, there was a payment failure after they finished the time-preference task. Because of an error in the code, they only received their payment for the task a few days later. We therefore control for this payment failure in all regressions. The failure cannot have had an effect on the time-preference task, but it could plausibly affect the motivation to answer questions in later stages of the experiment.

[26] We conducted several exercises to test the robustness of this result to the inclusion of additional covariates. Table 15 in the appendices reports these results and shows that the estimates are robust to adding a measure of self-reported risk aversion, controlling for the respondent's language, and controlling for their education level. The results are also robust when excluding participants who did not anticipate doing the task (see Table 17 in the supplementary appendix).

6.4.2 The Relationship between Time-Consistency and Adherence

Our second hypothesis is that adherence is lower for individuals who display time-inconsistent delay. To examine this hypothesis, Table 3 examines the relationship between adherence behavior and discounting, including our type classification of individuals as Late-Doers. Columns 1a and b show that the effect for High Discounters shown above is robust to the inclusion of the Late-Doer dummy. In addition, the point estimates for the Late-Doers dummy are consistent with our hypothesis that people who plan to do the time-preference task early, but then procrastinate or fail to do it, take fewer pills and are more likely to have missed a pill. However, these effects are neither significant in regressions for the full sample, nor in regressions using the sub-samples of High and Low discounters, respectively (see columns 2a, 2b, 3a, and 3b). One potential explanation for the lack of significance is the unanticipated low degree of variation in the outcome variable which reduced the power of or the analysis. [27]

In table 14 in the supplementary appendix, we also show the same regressions as in table 3, but including also the Early-Doers as an explanatory variable. As mentioned earlier, there is a large overlap between the Early-Doer and High Discounter groups in our sample. Therefore, it is no surprise that table 14 does not display any significant relations between being an Early-Doer and adherence.

Table 3: Discounting, Late Doers and Adherence

	Full Sample OLS Nr of Pills (1a)	Full Sample OLS If Missed Pills (1b)	High Discounters OLS Nr of Pills (2a)	High Discounters OLS If Missed Pills (2b)	Low Discounters OLS Nr of Pills (3a)	Low Discounters OLS If Missed Pills (3b)
High Discounters	-0.286**	0.086**				
	(0.128)	(0.039)				
Late Doers	-0.383	0.074	-1.269	0.262	-0.140	0.022
	(0.237)	(0.064)	(0.821)	(0.174)	(0.189)	(0.065)
Constant	6.837***	0.099***	6.635***	0.176***	6.803***	0.102***
	(0.074)	(0.027)	(0.110)	(0.045)	(0.074)	(0.028)
Failure Dummy	Yes	Yes	Yes	Yes	Yes	Yes
Observations	480	480	147	147	333	333
R^2	0.025	0.017	0.054	0.024	0.010	0.008

Notes: Results in column 1a and 1b are shown for the 480 participants who have done the full survey and use the full information on all attempts to do the task at any of the possible days. Column 2a-2b and 3a-3b show results using the subsamples of High discounters and Low discounters, respectively. High Discounters is a dummy variable where planning to do the task on day 1 is denoted 0 and planning to do the task on day 3 or 5, or not planning to do the task is denoted with a 1. Late doers are people who planned to do the word task sooner, did it later or did not do it. Missed Pills =1 is a dummy variable which is 0 if the participant reported having taken all 7 pills last week. OLS Regressions. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

[27] These results are robust to excluding participants that stated that they did not think they would do the task (see Table 17 and 18 in the supplementary appendix), and are also robust to controlling for risk preferences (see Table 16 in the supplementary appendix).

7 Heterogeneous Effects and Robustness

This section further explores the interpretation and robustness of the results above. To do this, we examine the role played by external circumstances and personal characteristics.

7.1 The Role of "Busyness"

One question that might come to mind is whether our results are driven by time preferences or simply by the fact that some women are busier than others. It may be the case that our simple time-preference task is providing a measurement of how busy and cognitively constrained mothers are in their everyday lives, as opposed to being a "clean" measure of time preferences.

To investigate this, we approximate busyness in three ways. First, throughout their pregnancy, the mothers receive multiple messages as part of the larger experiment which they are asked to respond to. One might expect that women who are busier, in general, would take a longer time to answer these messages. Second, the timing of messages depends on the individual estimated due date of each expectant mother. Since the women have different due dates that are as good as random, they receive the same message on different days of the week. This provides us with exogenous variation in which day of the week a given message is received. We can use this variation to examine the role of being busy under the assumption that busyness varies between weekdays and the weekend. Lastly, it is plausible that women who already have kids at home might be busier than those who are pregnant with their first child. We use each of these three measures of busyness to provide evidence about whether busyness is a central mechanism driving our results.

First, we examine how quickly the expectant mothers replied to other messages, unrelated to the time-preference task. At the end of the first week after signing up for the study, participants received an incentivized text message asking them to reply with the first 4 digits of their ID number. This was nine days before the time-preference task and the purpose of the question was to see if the participant was still actively engaged and responsive in the study.[28] Table 19 in the supplementary appendix shows that there is no correlation between answering the text message in the first hour or not answering at all and on the other hand when they planned to do, or actually did the time-preference task. We take this as evidence that our time-preference task is not driven by a general state of being busy when receiving the texts.[29]

[28]This task was also designed to allow us to check whether the cellphone number remained associated with the correct person throughout the study.

[29]All text messages in this experiment were sent out at 7.00 AM.

Second, we examine whether the day-of-the week of receiving the message informing them about the time-reference task influenced their anticipated or actual behavior in the task. For some women, Day 1 falls on a Friday, Day 3 on a Sunday, and Day 5 on a Tuesday. If a woman is less busy on weekends, then she might decide to do the task on Sunday (i.e on day 3), thus looking like a High Discounter to us. However, Table 20 in the appendices investigates if there is any difference in planning or completion of the task, depending on the day that the task was received. Doing so, Table 20 find no significant day-of-the-week differences in any of the outcomes from the time-reference task, indicating that this is not a large concern in this setting.

Third, we replicate our regressions from Table 2 and 3, but now include "number of kids" as a control (see Tables 21 and 22 in the appendices.) The "number of kids" is in itself not significant, except for in column 3a and 3b in Table 22 for the sub-sample of Low discounters. In these regressions, mothers with more kids report higher adherence. However, these exercises also show that our main results on time preference remain unchanged when the "number of kids"variable is included. Overall, these results indicate that individual heterogeneity in general "busyness" of the expectant mothers is not the primary driver of our results.

7.2 Self-Perception of Recall Difficulty

One mechanism that could be driving our results is that there is heterogeneity in the ease with which different women are able to remember to take their medication. To explore this, we use the answers to one of the survey questions in which we asked mothers to report whether they found it difficult to remember to take their iron supplements: "*Do you find it difficult to remember to take the iron pills?*" *Yes or No.* In Table 4, we examine whether this recall difficulty variable is related to our time-preference measures. The results show that High Discounters are more likely to report that they found it difficult to remember to take their iron supplements (Column 1). These results are robust when including *Late-doers* (Column 2). Although the sign is consistently positive, and in line with thinking that *Late-doers* also find it harder to remember to take their iron supplements, these results for *Late-doers* are not significant in any specification.

These results provide support for our main results as they show that in addition to being predictive of adherence outcomes, our High-discount measure is also related to measurements of recall difficulty. One further interesting implication of these results is that they point towards a potential relationship between time preferences in the effort domain and recall difficulty – individuals think that they will wait with doing the task also report finding

Table 4: Self-Reported Recall Difficulty

	Full Sample Difficult to remember (1)	Full Sample Difficult to remember (2)	High Discounters Difficult to remember (3)	Low Discounters Difficult to remember (4)
High Discounters	0.076**	0.081**		
	(0.033)	(0.033)		
Late Doers		0.091	0.099	0.088
		(0.058)	(0.144)	(0.063)
Constant	0.054***	0.040**	0.117***	0.043**
	(0.020)	(0.020)	(0.040)	(0.019)
Failure Dummy	Yes	Yes	Yes	Yes
Observations	480	480	147	333
R^2	0.017	0.024	0.009	0.015

Notes: Results in column 1 and 2 are shown for the 480 participants who have done the full survey and use the full information on all attempts to do the task at any of the possible days. Column 3 and 4 show results using the subsamples of High discounters and Low discounters, respectively. High Discounters is a dummy variable where planning to do the task on day 1 is denoted 0 and planning to do the task on day 3 or 5, or not planning to do the task is denoted with a 1. Late doers are people who planned to do the word task sooner, did it later or did not do it. Difficult to remember is a dummy variable where 1 indicates that the participant thinks that remembering her iron pills is difficult, and 0 that she does not find it difficult. OLS Regressions. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

it more difficult to remember to do tasks that involve exerting effort.

However, it is important to keep in mind potential caveats to the results reported in this table. While the measurement of recall difficulty was completed several weeks after the time-preference task, it was completed at the same time as subjects self-reported their iron intake during the previous week. Therefore, cognitive mechanisms could induce subjects who reported missing taking iron pills during the previous week to inflate their statements regarding the recall difficulty in comparison to individuals who reported taking their iron pills every day. In particular, a preference for consistency, excuse-driven behavior or ex-post justification could induce a correlation between the two measurements (iron intake and recall difficulty). While this is not an issue for our main results, it is a potential alternative explanation for the results in Table 4. Nevertheless, in spite of this caveat, we view these results to be supportive of our main results and also point towards an interesting possible relationship between memory and time preferences that warrants further investigation.

7.3 Schooling and Language

In this section, we explore whether educational factors could play a role in generating the relationship between time preferences and adherence that we observe. This would be the case, for example, if education influenced both measured time preferences and adherence.

While the task required no special knowledge of the English language it is plausible that those with more years of schooling and those who have English as their preferred language found it easier to complete the task, which might have affected their willingness to complete the time-preference task. For example, Golsteyn et al. (2014) find that 13-year-old adolescents' time preferences correlate strongly with their later school attainment and one could also hypothesize the opposite causality that schooling could affect elicited time preferences.

In terms of adherence it is also plausible that individuals with more education display different adherence behavior. Research by Nielsen et al. (2019) on Danish children diagnosed with type 1 diabetes finds that maternal education is strongly correlated with their child's metabolic control, which in turn depends strongly on adherence. This suggests that more educated mothers find it easier to follow the doctors' recommendations.

In our sample, 42% of participants report having completed 12 years of schooling, which is the length of South African primary and secondary school. However, it is also important to note that there is a high rate of repetition in South African schools, so completing 12 years of schooling often does not imply that the individual completed secondary (high) school (see, e.g, Lam et al. 2011, Branson et al. 2014, Van der Berg et al. 2019). In terms of the distribution, 34% report having completed more than 12 years of schooling and 25% report having less than 12 years of schooling. In Tables 15 and 16 in the supplementary appendix, we replicate our main regressions including years of schooling. While only being significant on the 10 % level, our results are still in line with those of Nielsen et al. (2019); mothers with more years of education display better adherence. This is interesting in view of the fact that our study takes place in a completely different context to that of Nielsen et al. (2019). Our results gives suggestive evidence that women with higher education take more pills and are less likely to miss pills, compared to women reporting lower levels of education. Looking at the High discount variables, we see that the directions of the coefficients remain consistent with our main results, but lose some significance. This is likely to be explained by the intertwined relationship between time preferences and schooling. Interestingly, the coefficient signs for *Late-doers* stays consistent, but the significance level is increased when adding the variable for education. Column 3 in Table 16 in the supplementary appendix shows that *Late-doers* reports to have taken fewer iron pills the past week, compared to other participants. The results are significant on the 10% level.

Tables 15 and 16 in the supplementary appendix also show that women who reported English as their preferred language are less likely to report that they missed pills. However, the inclusion of these variables does not affect our main results.

7.4 Health Outcomes

Health outcomes are difficult to measure in our setting and while it was not the main focus of the paper, we nevertheless elicited several self-reported indicators of iron deficiency in the survey. We find no relationship between being a High Discounter in the effort task and the stated level of iron in the blood as confirmed by a doctor (Table 5, columns 1–3). We also find no significant estimates for the question "How many days did you feel very tired or dizzy last week? Please reply a number from 0 to 7." (columns 4–6). This is not surprising because feeling dizzy or tired during pregnancy could result from a number of causes and is thus only indicative of low iron in the blood. With one exception, there is also no significant relationship between being a Late-Doer and the stated health measures. Column 3 shows that in the sub-sample of High Discounters, Late-Doers are less likely to report that they have low iron levels. [30] Given that the results only hold in this sub-sample, they do not lead to a general conclusion.

[30]Table 23 in the supplementary appendix show that these surprising results are not driven by the 40 people in the reference group who answer "Don't know", when asked if they have low iron levels. The results are reduced in size but the negative sign and coefficient for Late-Doers in the High Discounting sub-group holds when excluding the women who say "Don't know" from the sample.

Table 5: Health outcomes

	Full Sample Low Iron (1)	Full Sample Low Iron (2)	High Discounters Low Iron (3)	Low Discounters Low Iron (4)	Full Sample Tired or Dizzy (5)	Full Sample Tired or Dizzy (6)	High Discounters Tired or Dizzy (7)	Low Discounters Tired or Dizzy (8)
High Discounters	0.024	0.023			0.244	0.264		
	(0.032)	(0.032)			(0.175)	(0.175)		
Late Doers		-0.016	-0.117***	0.011		0.388	0.742	0.292
		(0.049)	(0.034)	(0.061)		(0.309)	(0.695)	(0.344)
Constant	0.109***	0.112***	0.113***	0.125***	2.130***	2.070***	2.343***	2.060***
	(0.025)	(0.027)	(0.037)	(0.030)	(0.131)	(0.135)	(0.203)	(0.147)
Failure Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	480	480	147	333	480	480	147	333
R^2	0.003	0.003	0.012	0.008	0.008	0.012	0.013	0.009

Results in column 1-2 and 5-6 are shown for the 480 participants who have done the full survey and use the full information on all attempts to do the task at any of the possible days. Column 3 and 7 show results using the subsample of High discounters and column 4 and 8 show results for the subsample of Low discounters. High Discounters is a dummy variable where planning to do the task on day 1 is denoted 0 and planning to do the task on day 3 or 5, or not planning to do the task is denoted with a 1. Tired or Dizzy is a measure from 0 to 7 of how many days last week the participant felt tired or dizzy. Low Iron Levels is a dummy variable where 1 indicates that a person does have low iron levels and 0 does not have low iron levels, had low iron levels before or don't know. OLS Regressions. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

8 Conclusion

In recent years, there has been a shift in health care towards a greater focus on prevention rather than treatment (CDC 2009). Treating illness is more resource intensive and less effective than preventing illness. While in medicine, research concentrates on genetic research and biomarkers to predict susceptibility to particular illnesses, behavioral science can complement these approaches when it comes to illnesses that are behavior based rather than genetic or a combination of both. Thus, from a health policy perspective being able to predict health behavior and to intervene before problems arise is an important step towards improving health care and reducing long-term costs.

In this paper, we show that time-preferences correlate with medication adherence. In a field study with a final sample of 480 pregnant women in South Africa, we show that our low-cost and simple time-preference elicitation task allows us to predict self-reported adherence rates, even in a sample that shows little overall variation in reported adherence. Women who plan to delay completing the time-preference task are less likely to have full medication adherence compared to those who plan to do the task at the earliest possible time. There is some indication that women who are time-inconsistent are also less likely to take iron pills every day.

Our findings suggest limited predictive power of demographic observables which include where the women live, their age, and the number of older kids. Yet, in many cases health campaigns will target individuals based on such observables.

Reviewing randomized control trials aimed to improve medical adherence, Kini & Ho (2018) recommend patient education, medication regime management, clinical pharmacist consultation, cognitive behavioral therapy, medication-taking reminders, and incentives to promote adherence. The authors raise concerns about feasibility and scalability due to the high costs of a number of these interventions. One way to address cost concerns is to improve the screening process to exclude people with low expected effect from the treatment.

In this paper, we show that the minority of participants who expect themselves to procrastinate an effort task, who we classify as High discounters, are much more likely to later report problems with their medication adherence. These are the types of participants who should be targeted in order to achieve cost-effective interventions.

Better predictions of adherence enables better ex-ante policy targeting. This may be of key importance when it comes to reducing the annoyance cost or even backlash an intervention may cause among individuals who do not need the intervention and feel distracted and annoyed by unnecessary interventions and nudges. Previous studies on nudging and generic health campaigns, usually nudged everyone in the same way. With effect sizes of around 2–8% in most nudging studies, this means that many individuals were nudged without changing their behavior (DellaVigna & Linos 2020). Combining diagnostic tools with nudges or other behavioral interventions could improve the effectiveness of nudges in heterogeneous populations. A recent paper by Campos-Mercade et al. (2020) took a similar approach to ours by showing that prosociality, as measured in an incentivized game, predicts adherence to health recommendations during a pandemic.

Individual level data from time preferences experiments has already been used successfully to optimize work contracts for health care workers giving out polio vaccine in Pakistan Callen et al. 2018. Similar techniques could be used to address health care interventions in other settings as well. Our low-cost diagnostic measurement tool that can be implemented over basic text messages might be especially beneficial for use in developing countries where people might have infrequent access to their health care providers and non-adherence might be harder to detect in time. In several countries (such as India or Kenya), similar mHealth communication systems to MomConnect already exist to improve the health of women and children. In our sample, sorting the women in high and low discounters was sufficient to predict whether they would adhere to their medication several weeks later. This is good news for policy makers, as it simplifies the procedure compared to eliciting present-bias or other forms of dynamic inconsistency. While the elicitation of precise estimates for *delta* and *beta* has its place in the literature, the practical application of using preferences as a diagnostic tool in preventive healthcare will depend on the ease with which it can be implemented and understood by policy makers.

This paper is a first step in the direction of developing more targeted nudges based on individuals' preferences and characteristics, such as patience. Further research should test our tool or similar tools in a variety of health settings.

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9 Appendix

9.1 Text messages in the Effort Task

9.1.1 Day 0

MCN: Up for a word task?
Earn airtime by writing words backward like this:
baby, parent = ybab, tnerap
Complete the task and get R20 in 7 days time.
The sooner you do it, the easier it is.
You choose when to do it:
Do it tomorrow (1 day) - write 4 words
Do it in 3 days - 6 words
Do it in 5 days - 10 words.
We will send you words tomorrow.
In how many days do you think you will answer?
Reply "1" "3" "5" or "No days".
Receive R5 now for this answer.
For more info, text MORE.

MCN is an acronym which signals to the mothers that the text comes from MomConnect. If the mother Reply "1" "3" "5" or "No days" she gets the following text:

You will now receive R5 for answering.
Tomorrow you will receive words to write backwards

If the mother replies with the word "MORE" she also receives the following information:

In this question, we ask when you think you will write words backwards.
We do this to investigate the importance of timing when doing tedious tasks.
Reply "1" "3" "5" or "No days" and receive R5 today for this answer.
In the following days, we'll send you the words.
If you write them backwards, you will get R20 in a week's time.

9.1.2 Day 1

MCN: Please reply by writing these 4 words backwards:
baby, parent, bottle, mom
Do it today and get R20 airtime in 6 days' time.
If you don´t do it today, you get another chance if
you reply to a text in 2 days with 7 words to write backwards.

If the mother replies with the words written backwards she receives the following information:
Thank you, you will receive R20 in airtime in 6 days.

9.1.3 Day 3

MCN: Please reply by writing these 6 words backwards:
baby, parent, bottle, mom, sleep, child.
Do it today and get R20 airtime in 4 days' time.
If you don't do it today, you get another chance if
you reply to a text in 2 days with 10 words to write backwards

If the mother replies with the words written backwards she receives the following information:
Thank you, you will receive R20 in airtime in 4 days.

9.1.4 Day 5

MCN: Please reply by writing these 10 words backwards:
baby, parent, bottle, mom, sleep, child, play, love, dad, happy.
Last chance to do the task for your R20 airtime in 2 days' time.

If the mother replies with the words written backwards she receives the following information:
Thank you, you will receive R20 in airtime in 2 days.

9.1.5 Day 7

If the mother replies with the words written backwards at any of the days of the experiment, she receives the following information:

MCN: You will now receive your R20 for the word task you did. Have a great day!

9.2 Technical supplementary appendix for the Interpretation of the Time-Preference Task

This supplementary appendix provides the technical details related to the interpretation of future and immediate effort choices in the time-preference task.

9.2.1 Preferred Behavior at Time $k = 0$

Assuming that the individual is naive about possible present bias at time $k = 0$, the table below provides conditions for when the different possible timings are preferred from the point of view of time $k = 0$. That is given the discount factor δ these are the plans the individual would like to implement ex ante if possible.

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Table 6: Pairwise Comparisons and Conditions for Optimality at $k = 0$

	Preferred to $t = 1$	Preferred to $t = 3$	Preferred to $t = 5$	Preferred to never
$t = 1$		$\delta^2 \geq \frac{2}{3}$	$(\delta^4 \geq \frac{2}{5})$	$\delta^6 \geq \frac{1}{5\phi}$
$t = 3$	$\delta^2 \leq \frac{2}{3}$		$\delta^2 \geq \frac{3}{5}$	$\delta^4 \geq \frac{3}{10\phi}$
$t = 5$	$(\delta^4 \leq \frac{2}{5})$	$\delta^2 \leq \frac{3}{5}$		$\delta^2 \geq \frac{1}{2\phi}$
Never	$\delta^6 < \frac{1}{5\phi}$	$\delta^4 < \frac{3}{10\phi}$	$\delta^2 < \frac{1}{2\phi}$	

Notes: conditions in brackets are implied by other conditions in the row and are thus never binding.

9.3.2 Deriving Actual Behavior at time $k > 0$

This section derives optimal behaviour in periods $k = 1$, $k = 3$ and $K = 5$. Consider the behavior of an individual with present-biased preferences. We solve the problem backwards as the sophisticated agent would do.

Period $t = 5$

When period 5 arrives $k = 5$ the agent will do the task if the participation constraint is satisfied i.e. if

$$\beta\delta^2 \geq \frac{1}{2\phi} \tag{3}$$

Consider an individual who planned to to the task in period $t = 5$. Recall that for these individuals $\frac{3}{5} > \delta^2 \geq \frac{1}{2\phi}$ if they are time consistent or naive at time $k = 0$. For individuals with time-consistent preferences ($\beta = 1$), the participation constraint in Equation (3) is identical to the original participation constraint and it is satisfied for anyone who planned $t = 5$. For people who are present-biased($\beta < 1$) and naive ($\hat{\beta} = 1$) at time $k = 0$, the participation constraint may not be satisfied if β sufficiently low even if the individual originally planned to do the task at time $t = 5$. Note that when δ is close to the lower bound in the interval $I_5 = [\frac{1}{2\phi}; \frac{3}{5}]$ and the individual thus planned to do the task at time $t = 5$ then a β just below unity is sufficient to violate the participation constraint in Equation (3). If δ is close to the upper bound in I_5 then a smaller value of β is required for violations of Equation (3). For an individual with future bias ($\beta > 1$), the participation constraint may be satisfied now even if it was not satisfied at the planning stage ($k = 0$) and the individual may therefore do the task even if she did not plan to do it (i.e. women with $\delta < \sqrt{\frac{1}{2\phi}}$ may now do the task).

Period $t = 3$

When period 3 arrives, i.e. $k = 3$, the individual does the task in period $t = 3$ if

$$\beta\delta^4 \geq \frac{3}{10\phi} \text{ and } \beta\delta^2 \geq \frac{3}{5} \tag{4}$$

or if

$$\beta\delta^4 \geq \frac{3}{10\phi} \text{ and } \beta\delta^2 < \frac{3}{5} \text{ and } \hat{\beta}\delta^2 < \frac{1}{2\phi}. \tag{5}$$

In Equation (4), the first inequality ensures that the individual prefers that the task is done now to not at all and the second inequality ensures that the individual prefers doing the task now to delaying to time $t = 5$. These are the conditions that are required to ensure that the individual prefers doing the task at time $t = 3$. We can compare this to the conditions for planning at time $k = 0$ to the the task at $t = 3$. For women who are time-consistent or naive at time $k = 0$, such a plan implies that $\delta^2 \in \left[\frac{3}{5}; \frac{2}{3}\right]$ and $\delta^4 \geq \frac{3}{10\phi}$ (see in Table 1). A time-consistent individual thus also carries out the task as planned if she planned to do it at time $t = 3$. However, the conditions in Equation (4) may not be satisfied for an individual with present-biased preferences ($\beta < 1$) even if she originally (naively) planned $t = 3$ and as a result she may delay the task. This may either happen because the individual no longer prefers that the task is done (the first inequality is not satisfied) or because the individual prefers that the task is done in the next period. Realizing this the woman may also do the task in period $t = 3$ if she knows that by postponing she risks that she will never actually do the task even if she prefers doing the task now at time $t = k = 1$ to never doing it. This is captured by the conditions in Equation (5). The first inequality in Equation (5) ensures that the individual prefers that the task is done now to not at all and the second inequality implies that she would prefer to delay to the next period while the third inequality states that the individual predicts that the task will not be carried out if it is delayed. Clearly a smaller $\hat{\beta}$ makes is more likely that the second inequality is satisfied. Intuitively the stronger the predicted future present bias the less likely it is that the women will predict that the task will be done in period $t = 5$ if it is delayed. For an individual who is naive about her future present bias at time $k = 3$ the second inequality reduces to the $k = 0$ non-participation constraint for doing the task in period $t = 5$. For an individual who is sophisticated about her future present bias at time $k = 3$ the condition is equivalent to the actual non-participation constraint when $k = 5$ (see above).

Period $t = 1$

When period 1 arrives, i.e. $k = 1$, the individual does the task in period $t = 1$ if

$$\beta\delta^6 \geq \frac{1}{5\phi} \text{ and } \beta\delta^2 \geq \frac{2}{3} \text{ and } \beta\delta^4 \geq \frac{2}{5} \tag{6}$$

or if

$$\beta\delta^6 \geq \frac{1}{5\phi} \text{ and } \beta\delta^2 < \frac{2}{3} \text{ and } \beta\delta^4 \geq \frac{2}{5} \text{ and } \left(\hat{\beta}\delta^2 < \frac{3}{5} \text{ or } \hat{\beta}\delta^4 < \frac{3}{10\phi}\right) \tag{7}$$

or if

$$\beta\delta^6 \geq \frac{1}{5\phi} \text{ and } \beta\delta^2 < \frac{2}{3} \text{ and } \beta\delta^4 < \frac{2}{5} \text{ and } \left(\hat{\beta}\delta^2 < \frac{3}{5} \text{ or } \hat{\beta}\delta^4 < \frac{3}{10\phi}\right) \text{ and } \hat{\beta}\delta^2 < \frac{1}{2\phi} \tag{8}$$

or if

$$\beta\delta^6 \geq \frac{1}{5\phi} \text{ and } \beta\delta^2 \geq \frac{2}{3} \text{ and } \beta\delta^4 < \frac{2}{5} \text{ and } \left(\hat{\beta}\delta^2 \geq \frac{3}{5} \text{ and } \hat{\beta}\delta^4 \geq \frac{3}{10\phi}\right) \tag{9}$$

The inequalities in Equation (6) are the conditions that ensure that the individual at time $k = 1$ prefers to do the task now (i.e. at time $t = 1$) rather than to delay to a future period. If this is the case, she does the task immediately.

The inequalities in Equation (7) are the conditions that describe a situation where the individual at time $k = 1$ prefers that the task is done in period $t = 3$ rather than at time $t = 1$ ($\beta\delta^2 < \frac{2}{3}$) but also prefers doing it in period $t = 1$ to period $t = 5$ ($\beta\delta^4 \geq \frac{2}{5}$). Note that these two conditions also imply that $\delta^2 > \frac{3}{5}$, i.e. that the individual prefers at time $k = 1$ that the task is done at time $t = 3$ to at time $t = 5$. However, when one of the inequalities in the bracket holds she predicts that if she delays to period $k = 3$, she will delay again to time $k = 5$ (and possibly never do the task). Therefore it is better to do the task immediately to avoid unnecessary delay.

The conditions in Equation (8) ensure that the individual would actually like the task to be done but would prefer that it is done in a later time period ($\beta\delta^2 < \frac{2}{3}$ and $\beta\delta^4 < \frac{2}{5}$) but she predicts that the task will not be done if it is delayed. Therefore it is again optimal to do the task now to avoid delaying and not getting the task done.

Finally, Equation (9) describes a situation where the individual prefers that the task is done to not at all but prefers at time $k = 1$ that it is done in period $t = 5$ to that it is done in period $t = 1$ ($\beta\delta^4 < \frac{2}{5}$) which again is better than if it is done in period $t = 3$ ($\beta\delta^2 \geq \frac{2}{3}$). Note that these two conditions together also imply $\delta^2 \leq \frac{3}{5}$, i.e. that the individual at time $k = 1$ prefers if the task is delayed from period $t = 3$ to $t = 5$. However, by delaying from period $t = 1$ she predicts that the task will be done in period $t = 3$ rather than delayed to period $t = 5$. Then it is better to do the task now.

For a time-consistent individual with $\beta = \hat{\beta} = 1$ this reduces to

$$\delta^6 \geq \frac{1}{5\phi} \text{ and } \delta^2 \geq \frac{2}{3}$$

We note that the situations captured by Equation (7)[31], (8)[32] and (9)[33], cannot arise (i.e. all inequalities cannot be satisfied simultaneously), as the time-consistent individual will have the same preferences when making decisions at time $k = 3$ and $k = 5$ as she does at time $k = 1$. Therefore she will continue to rank the utility associated with doing the task in the different periods in the same way. As a result, the individual does the task at time

[31] In particular $\delta^2 < \frac{2}{3}$ and $\delta^4 \geq \frac{2}{5}$ imply $\delta^2 \geq \frac{3}{5}$ which contradicts $\delta^2 < \frac{3}{5}$. In addition, $\delta^4 < \frac{3}{10\phi}$ and $\delta^6 \geq \frac{1}{5\phi}$ imply $\delta^2 \geq \frac{2}{3}$ which contradicts $\delta^2 < \frac{2}{3}$. Hence, the situation cannot arise.

[32] One can show that $\delta^4 < \frac{3}{10\phi}$ and $\delta^6 \geq \frac{1}{5\phi}$ imply $\delta^2 \geq \frac{2}{3}$ which contradicts $\delta^2 < \frac{2}{3}$. At the same time, $\delta^2 < \frac{1}{2\phi}$ and $\delta^6 \geq \frac{1}{5\phi}$ imply $\delta^4 \geq \frac{2}{5}$ which contradicts $\delta^4 < \frac{2}{5}$. Hence, the situation described by Equation (8) cannot arise.

[33] In particular $\beta\delta^2 \geq \frac{2}{3}$ and $\beta\delta^4 < \frac{2}{5}$ imply $\delta^2 < \frac{3}{5}$ which contradicts $\delta^2 \geq \frac{3}{5}$.

$t = 1$ only if the conditions in the equation above satisfied.

For a naive $\beta \neq \hat{\beta} = 1$ the conditions reduce to

$$\beta\delta^6 \geq \frac{1}{5\phi} \text{ and } \beta\delta^2 \geq \frac{2}{3} \text{ and } \beta\delta^4 \geq \frac{2}{5}$$

Again the situations captured by Equation (7)[34], (8)[35] and (9)[36] cannot arise (i.e. all inequalities cannot be satisfied simultaneously), as the naive individual (wrongly) *predicts* that he will have the same preferences when making decisions at time $k = 3$ and at time $k = 5$ as a time-consistent individual. Therefore, the individual does the task at time $t = 1$ only if the conditions in the first equation are satisfied because she thinks that she will choose to act as a time-consistent individual in future periods. Note that the conditions in the first equation differ from the comparable conditions for the time-consistent individual because of the present-bias parameter. When $\beta < 1$ the conditions are less likely to be satisfied i.e. it is less likely that a naive individual will do the task in period $t = 1$ compared to a time-consistent individual. In contrast, it is more likely that the conditions will be satisfied if $\beta > 1$ i.e. in the case of future bias.

For a sophisticated individual with $\beta = \hat{\beta} \neq 1$ the conditions reduce to

$$\beta\delta^6 \geq \frac{1}{5\phi} \text{ and } \beta\delta^2 \geq \frac{2}{3} \text{ and } \beta\delta^4 \geq \frac{2}{5}$$

or if

$$\beta\delta^6 \geq \frac{1}{5\phi} \text{ and } \beta\delta^2 < \frac{2}{3} \text{ and } \beta\delta^4 \geq \frac{2}{5} \text{ and } \left(\beta\delta^2 < \frac{3}{5} \text{ or } \beta\delta^4 < \frac{3}{10\phi}\right)$$

or if

$$\beta\delta^6 \geq \frac{1}{5\phi} \text{ and } \beta\delta^2 < \frac{2}{3} \text{ and } \beta\delta^4 < \frac{2}{5} \text{ and } \left(\beta\delta^2 < \frac{3}{5} \text{ or } \beta\delta^4 < \frac{3}{10\phi}\right) \text{ and } \beta\delta^2 < \frac{1}{2\phi}$$

or if

$$\beta\delta^6 \geq \frac{1}{5\phi} \text{ and } \beta\delta^2 \geq \frac{2}{3} \text{ and } \beta\delta^4 < \frac{2}{5} \text{ and } \beta\delta^4 \geq \frac{3}{10\phi}$$

The first condition here is identical to that for naively present-biased individuals. But the remaining conditions do not become irrelevant because the sophisticated individual in con-

[34]In particular $\beta\delta^2 < \frac{2}{3}$ and $\beta\delta^4 \geq \frac{2}{5}$ imply $\delta^2 \geq \frac{3}{5}$ which contradicts $\delta^2 < \frac{3}{5}$. In addition, $\delta^4 < \frac{3}{10\phi}$ and $\beta\delta^6 \geq \frac{1}{5\phi}$ imply $\beta\delta^2 \geq \frac{2}{3}$ which contradicts $\beta\delta^2 < \frac{2}{3}$. Hence, the situation cannot arise.

[35]One can show that $\delta^4 < \frac{3}{10\phi}$ and $\beta\delta^6 \geq \frac{1}{5\phi}$ imply $\beta\delta^2 \geq \frac{2}{3}$ which contradicts $\beta\delta^2 < \frac{2}{3}$. At the same time, $\delta^2 < \frac{1}{2\phi}$ and $\beta\delta^6 \geq \frac{1}{5\phi}$ imply $\beta\delta^4 \geq \frac{2}{5}$ which contradicts $\beta\delta^4 < \frac{2}{5}$. Hence, the situation described by Equation (8) cannot arise.

[36]In particular $\beta\delta^2 \geq \frac{2}{3}$ and $\beta\delta^4 < \frac{2}{5}$ imply $\delta^2 < \frac{3}{5}$ which contradicts $\delta^2 \geq \frac{3}{5}$.

trast to the naive individual realizes that preferences are different in future periods meaning that the ranking of the utility associated with the different timings as well as the participation constraints may not be satisfied in future periods.

Optimal Behavior under Different Assumptions

Now let us characterize optimal behavior under different assumptions regarding the individual's time preferences.

Time-Consistent Preferences

First consider the time-consistent individual ($\beta = \hat{\beta} = 1$). She will plan and do the task in accordance with the plan as detailed in the table below.

Table 7: Planned and Actual Behavior Predicted for Individuals with Time-Consistent Preferences

	Timing optimal		Participation constraint
Plan and do $t = 1$ if	$\delta^2 > \frac{2}{3}$	and	$\delta^6 \geq \frac{1}{5\phi}$
Plan and do $t = 3$ if	$\delta^2 \in \left[\frac{3}{5}; \frac{2}{3}\right]$	and	$\delta^4 \geq \frac{3}{10\phi}$
Plan and do $t = 5$ if	$\delta^2 < \frac{3}{5}$	and	$\delta^2 \geq \frac{1}{2\phi}$
Plan not to do it			if none of the above hold

We note that the participation constraint is what ensure that the utility from doing it in the stated period is positive and the conditions on δ stated under "Timing optimal" are the conditions that ensure that the utility is maximized when the task is done at the specified point in time. Note that it is therefore not possible that for given timing t the conditions for optimal timing are met but the the participation constraint is not met in period t but it is met in a future period. Therefore the conditions above fully describe the optimal choice and behavior of the time-consistent individual.

Present-Bias and Naivete

Now, let's consider the behavior of a naive individual with $\beta \neq \hat{\beta} = 1$. This individual will ex-ante plan to behave exactly as the time-consistent individual but will behave as described by the table below.

Table 8: Actual Behavior Predicted for Individuals with Naive Time-Inconsistent Preferences

	Timing optimal		Participation constraint
Do $t = 1$ if	$\beta\delta^2 > \frac{2}{3}$ and $\beta\delta^4 > \frac{2}{5}$	and	$\beta\delta^6 \geq \frac{1}{5\phi}$
Do $t = 3$ if	$\beta\delta^2 \in \left[\frac{3}{5}; \frac{2}{3}\right]$	and	$\beta\delta^4 \geq \frac{3}{10\phi}$
Do $t = 5$ if	$\beta\delta^2 < \frac{3}{5}$	and	$\beta\delta^2 \geq \frac{1}{2\phi}$
Don't do it			if none of the above hold

That is the individual may delay doing the task or fail to do the task if $\beta < 1$ in which case she is naively present biased. The individual may do the task early if $\beta > 1$ in which case she is naively future biased. Note, however, that doing the task early is not possible if the individual planned to do the task at time $t = 1$.

Time-Inconsistent Preferences and Sophistication

Now, let's consider the behavior of an individual who is naive at time $k = 0$ and sophisticated at time $k = 1$ that is $\beta \neq \hat{\beta} = 1$ when planning at time $k = 0$ but $\beta = \hat{\beta} \neq 1$ at time $k \geq 1$. This individual will ex-ante plan to behave exactly as the time-consistent individual but will behave as described by the table below.

Table 9: Actual Behavior Predicted for Individuals with Sophisticated Time-Inconsistent Preferences at time $k \geq 1$

	Timing optimal
Do $t = 1$ if	$\beta\delta^2 > \frac{2}{3}$ and $\beta\delta^4 > \frac{2}{5}$ and $\beta\delta^6 \geq \frac{1}{5\phi}$
or if	$\beta\delta^6 \geq \frac{1}{5\phi}$ and $\beta\delta^2 < \frac{2}{3}$ and $\beta\delta^4 < \frac{2}{5}$ and $\left(\beta\delta^2 < \frac{3}{5} \text{ or } \beta\delta^4 < \frac{3}{10\phi}\right)$
or if	$\beta\delta^6 \geq \frac{1}{5\phi}$ and $\beta\delta^2 < \frac{2}{3}$ and $\beta\delta^4 < \frac{2}{5}$ and $\left(\beta\delta^2 < \frac{3}{5} \text{ or } \beta\delta^4 < \frac{3}{10\phi}\right)$ and $\beta\delta^2 < \frac{1}{2\phi}$
or if	$\beta\delta^6 \geq \frac{1}{5\phi}$ and $\beta\delta^2 \geq \frac{2}{3}$ and $\beta\delta^4 < \frac{2}{5}$ and $\beta\delta^4 \geq \frac{3}{10\phi}$
Do $t = 3$ if	$\beta\delta^2 \geq \frac{3}{5}$ and $\beta\delta^4 \geq \frac{3}{10\phi}$
or if	$\beta\delta^4 \geq \frac{3}{10\phi}$ and $\beta\delta^2 < \frac{3}{5}$ and $\beta\delta^2 < \frac{1}{2\phi}$
Do $t = 5$ if	$\beta\delta^2 < \frac{3}{5}$ and $\beta\delta^2 \geq \frac{1}{2\phi}$
Don't do it	if none of the above hold

An individual who is sophisticated at time $k = 0$ and thus realizes already when asked when she expects to do the task, that she may procrastinate, she will predict her own behavior and the plan will coincide perfectly with the behavior detailed in the table above. That is in this case planned behavior depends not only on her realization of δ but also on her realization of β.

For an individual, who is naive at the time when the plan is made but who becomes sophisticated at time $k=1$, may delay the task (or fail to do it) if $\beta<1$ and may do it early if $\beta>1$ (and if task was not planned for $t=3$). However, compared to the naive individual, she is more likely to do the task earlier because she is disciplined by her sophistication. This is what is reflected in the additional situations which can lead to task completion in periods $t=1$ and $t=3$ compared to those for the naive individual.

Doing It Early: Present-Biased Sophisticates

O'Donoghue & Rabin (1999) show that it is possible that a person who is sophisticated about her present bias at the time when she may choose to do a task, may choose to do the task early compared to a time-consistent individual. In this respect we are interested in showing whether and in what circumstances doing it earlier than planned cannot be rationalized by sophistication at time $k=1$. Note that sophistication at time $k=0$ implies that the task is done as planned. It may imply that the task is done earlier than a time-consistent individual would have done but it cannot rationalize doing the task earlier than planned.

To show that sophistication at time $t=1$ also cannot explain doing the task early, consider first an individual who at time $k=0$ planned to do the task in period $t=5$. Then (assuming naivety at time $k=0$), we know that $\delta^2\in[\frac{1}{2\phi};\frac{3}{5})$ for this plan to be optimal. Note that the interval $I_5=[\frac{1}{2\phi};\frac{3}{5})$ is non-empty if $\phi>\frac{5}{6}$ i.e. people can only plan to do the task at time $t=5$ if $\phi>\frac{5}{6}$. By Equation (5), for someone who is sophisticated (i.e. $\hat{\beta}=\beta$)) doing it at time $t=3$, i.e. one period early, is optimal if $\beta\phi\in(\frac{3}{10\delta^4};\frac{1}{2\delta^2})$. This interval is non-empty if $\delta^2>\frac{3}{5}$ which is never satisfied when $\delta^2\in I_5$. That is it is never optimal to plan at time $k=0$ to do the task at $t=5$ but then at time $k=3$ choose to do the task at time $t=3$ instead. Similarly, consider whether the individual might already to the task in period $t=1$. First, note that Equation (7) implies that $\delta^2>\frac{3}{5}$ and therefore this cannot be satisfied. Equation (9) implies $\delta^2\leq\frac{3}{5}$ and $\beta\delta^2\geq\frac{3}{5}$ which is only jointly satisfied if $\beta\geq1$, i.e. only if the individual is future biased. Finally, Equation (8) implies $\beta\phi\in(\frac{1}{5\delta^6};\frac{1}{2\delta^2})$. This interval is non-empty if $\delta^4>\frac{2}{5}$ which is never satisfied when $\delta^2\in I_5$. That is it is never optimal to plan at time $k=0$ to do the task at $t=5$ but then at time $k=1$ choose to do the task at time $t=1$ instead.

Now consider an individual who at time $k=0$ planned to do the task in period $t=3$. Then (assuming naivety at time $k=0$), we know that $\delta^2\in I_3=[\frac{3}{5};\frac{2}{3})$ for this plan to be optimal. We check whether the conditions for doing it early are satisfied for $\beta=\hat{\beta}<1$. First, note that in Equation (7) $\beta\delta^4\geq\frac{2}{5}$ and $\beta\delta^2<\frac{3}{5}$ implies $\delta>\frac{2}{3}$ which conflicts with $\delta^2\in I_3$. In addition, $\beta\delta^6\geq\frac{1}{5\phi}$ and $\beta\delta^4<\frac{3}{10\phi}$ implies $\delta^2>\frac{2}{3}$ which also conflicts with $\delta^2\in I_3$. Hence, Equation (7) cannot be satisfied in this case. By the same line of argument, Equation (9) implies

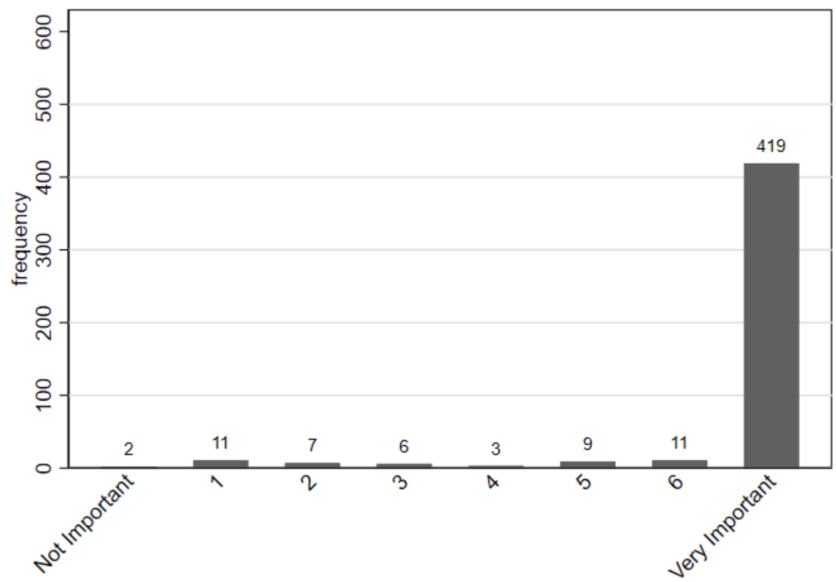
$\delta^2 > \frac{2}{3}$ and thus cannot be satisfied if the plan $t = 3$ is optimal. By the same argument a situation cannot arise where $\beta\delta^4 < \frac{3}{10\phi}$ holds in Equation (8) when the individual planned $t = 3$. However, it is possible that we jointly have the following conditions:

$$\beta\delta^6 \geq \frac{1}{5\phi} \text{ and } \beta\delta^2 < \frac{2}{3} \text{ and } \beta\delta^4 < \frac{2}{5} \text{ and } \left(\beta\delta^2 < \frac{3}{5} \text{ and } \beta\delta^4 \geq \frac{3}{10\phi}\right) \text{ and } \beta\delta^2 < \frac{1}{2\phi}$$

while we also have $\delta^2 \in [\frac{3}{5}; \frac{2}{3})$ and $\delta^2 \geq \frac{3}{10\phi}$. By similar arguments as above, one can show that $\beta\delta^6 \geq \frac{1}{5\phi}$ and $\beta\delta^2 < \frac{1}{2\phi}$ imply that $\delta^4 \geq \frac{2}{5}$. Hence, the situation can arise when the individual at time $k = 0$ prefers to do the task at time $t = 3$ but also prefers doing the task at time $t = 1$ to doing it at time $t = 5$ and when at time $k = 1$ she instead prefers delaying to either period but knows that if it is delayed to $k = 3$ it will be delayed again and ultimately will not be done.

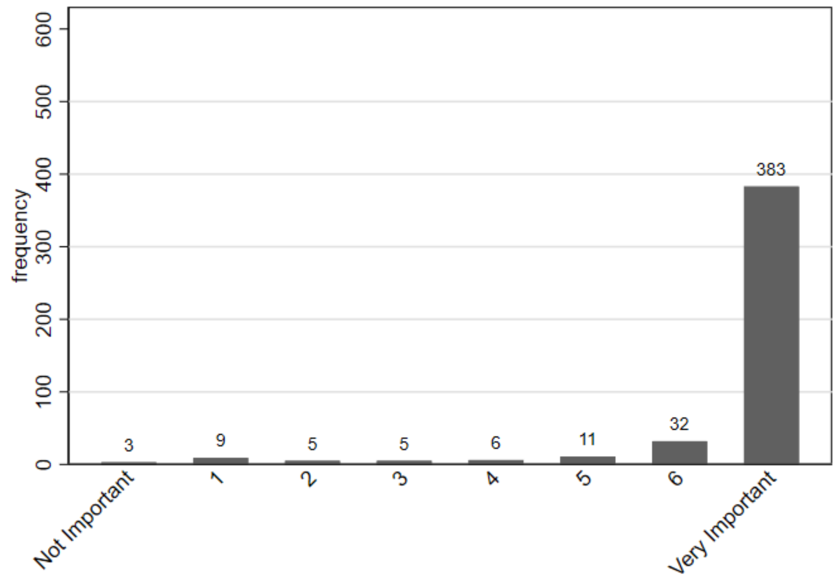
9.4 Tables and Figures

Figure 6: Iron Intake Important for Healthy Mothers



Notes: To be a healthy mom, is it important to take iron pills? How important do you think it is? Reply with a number from 0 (not important) to 7 (very important). In total 468 women in our sample answered this question.

Figure 7: Iron Intake Important for Healthy Babies



Notes: To have a health baby, are iron pills important? How important do you think it is? Reply with a number from 0 (not important) to 7 (very important). In total, 454 women in our sample answered this question.

Table 10: Testing for Selection into the Sample

	Out-of-sample	In-sample	Treatment Comparison
Birthyear	1991	1992	0.63
	(5.84)	(5.34)	
English	0.67	0.65	-0.01
	(0.47)	(0.48)	
Urban	0.39	0.29	-0.10**
	(0.49)	(0.46)	
Number of Previous Children	1.05	0.98	-0.07
	(1.01)	(1.13)	
N	214	480	

Notes (i) Standard deviations are reported in parentheses, (ii) The Treatment Comparison column reports the difference between the means of the In-sample and Out-of-sample groups, with a Wald test used to test for a statistically significant difference, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 11: Testing for Selection on Time Preferences into the Sample

	Out-of-sample	In-sample	TreatComparison
High Discounters	0.36	0.31	-0.06
	(0.48)	(0.46)	
Late Doers	0.15	0.09	-0.06
	(0.36)	(0.29)	
Early Doers	0.26	0.28	0.03
	(0.44)	(0.45)	
On Timers	0.59	0.63	0.04
	(0.50)	(0.48)	
N	66	480	

Notes High Discounters is a dummy variable where planning to do the task on day 1 is denoted 0 and planning to do the task on day 3 or 5, or not planning to do the task is denoted with a 1. Late doers are people who planned to do the word task sooner, did it later or did not do it. Early doers planned to do the task late but did it sooner OR did not plan to do it but did it in the end. On timers are people who do the task when they planned.

Standard deviations are reported in parentheses. The Treatment Comparison column reports the difference between the means of the In-sample and Out-of-sample groups, with a Wald test used to test for a statistically significant difference, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 12: Descriptive Statistics

	Means (std)
Time Preference Variables	
Time Preference Plan	1.78
	(1.45)
Attempt on Day 1	0.90
	(0.30)
Success fraction day 1 (conditional)	0.81
	(0.40)
Attempt on Day 3	0.04
	(0.19)
Success fraction day 3 (conditional)	0.67
	(0.49)
Attempt on Day 5	0.02
	(0.14)
Success fraction day 5 (conditional)	0.50
	(0.53)
Future Bias	0.28
	(0.45)
Present Bias	0.09
	(0.29)
Consistent	0.63
	(0.48)
Questionnaire	
Q1.Weekly Iron Intake	6.59
	(1.17)
Q2.Difficulty Remembering [=1]	0.10
	(0.30)
Q3.Failure to Carry out plans	4.64
	(3.74)
Q4.Willingness to take risks	4.26
	(3.84)
Q5.Iron pills – Stomach feels bad	0.12
	(0.33)
Q6.Weekly days tired / dizzy	2.35
	(1.81)
Q7.Low iron levels [=1]	0.10
	(0.31)
Q8.Years of Schooling	12.04
	(2.54)
N	480

Notes: (i) The table reports means and standard deviations for variables that we use in our main analysis, e.g. *Time Preference Plan* is the average number of days respondents plan to take to complete the task, *Attempt on day 1* is a binary indicator variable for an attempt on the first day, whereas *Success fraction on day x* reports the rate of success, conditional making an attempt on day x, *Future Bias, Present Bias* and *Consistent* are defined in the main text.

Table 13: Variable Definitions

Variable	Description
Birthyear	Expectant mother's year of birth
Language	Indicator [=1] if respondent's mother tongue language is English.
Urban	Indicator [=1] if respondent resides in an Urban area.
Numer of Previous Children	Number of children born to respondent prior to current pregnancy.
Q1.Weekly Iron Intake	How many days did you take your iron pills last week? (Please reply a number from 0 to 7)
Q2.Difficulty Remembering [=1]	Do you find it difficult to remember to take the iron pills? (Reply with yes or no.)
Q3.Failure to Carry out plans	How often do you plan to do something and then don't do it? (Reply 0 (never), 1, 2, 3, 4, 5, 6, 7, 8, 9, or 10 (always))
Q4.Willingness to take risks	In general, how willing are to take risks? (Please reply on a scale from 0 (completely unwilling) to 10 (very willing)
Q5.Iron pills – Stomach feels bad	Keep going! Does your stomach feel bad if you take iron pills? (Reply yes or no.)
Q6.Weekly days tired / dizzy	How many days did you feel very tired or dizzy last week? (Please reply a number from 0 to 7.)
Q7.Low iron levels [=1]	Did your doctor or nurse tell you that you have low iron levels? (Reply 1) Yes 2) No 3) Not anymore 4) Don't know ... recoded to "yes" =1, else =0)
Q8.Years of Schooling	How many years did you go to school? Reply with number of years.

Notes: (i) The table describes variables used in the main analysis.

Table 14: Adherence and time consistency

	Full Sample OLS Nr of Pills (1a)	Full Sample OLS If Missed Pills (1b)	High Discounters OLS Nr of Pills (2a)	High Discounters OLS If Missed Pills (2b)	Low Discounters OLS Nr of Pills (3a)	Low Discounters OLS If Missed Pills (3b)
High Discounters	-1.152*	0.317**				
	(0.673)	(0.160)				
Late Doers	-0.180	0.020	-0.918	-0.013	-0.140	0.022
	(0.188)	(0.065)	(1.100)	(0.401)	(0.189)	(0.065)
Early Doers	0.945	-0.252	0.353	-0.277		
	(0.681)	(0.165)	(0.740)	(0.362)		
Constant	6.816***	0.105***	6.282***	0.453	6.803***	0.102***
	(0.074)	(0.027)	(0.749)	(0.365)	(0.074)	(0.028)
Failure Dummy	Yes	Yes	Yes	Yes	Yes	Yes
Observations	480	480	147	147	333	333
R^2	0.036	0.025	0.055	0.030	0.010	0.008

Results in column 1a and 1b are shown for the 480 participants who have done the full survey and use the full information on all attempts to do the task at any of the possible days. Column 2a-2b and 3a-3b show results using the subsamples of High discounters and Low discounters, respectively. High Discounters is a dummy variable where planning to do the task on day 1 is denoted 0 and planning to do the task on day 3 or 5, or not planning to do the task is denoted with a 1. Late doers are people who planned to do the word task sooner, did it later or did not do it. Early doers planned to do the task late but did it sooner OR did not plan to do it but did it in the end. By the construction of our task, no one can be a low discounter (plan to do the task on day one) and be an Early doer (do the task before they planned to do it) at the same time. The reference group for inconsistent discounter is on timers who do the task when they planned. Missed Pills =1 is a dummy variable which is 0 if the participant reported having taken all 7 pills last week. OLS and Logit Regressions. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

Table 15: Adherence and Discounting. Robustness, Risk, Language, and Education

	OLS Nr of Pills (1)	OLS If Missed Pills (2)	OLS Nr of Pills (3)	OLS Missed Pills =1 (4)	OLS Nr of Pills (5)	OLS Missed Pills =1 (6)
High Discounters	-0.271**	0.087**	-0.272**	0.085**	-0.248*	0.074*
	(0.125)	(0.039)	(0.125)	(0.039)	(0.127)	(0.039)
Risk Taking	-0.004	0.004				
	(0.013)	(0.004)				
English Speaking			0.154	-0.078**		
			(0.114)	(0.037)		
Years of School					0.031	-0.014*
					(0.026)	(0.008)
Constant	6.798***	0.090***	6.686***	0.158***	6.404***	0.286***
	(0.085)	(0.031)	(0.095)	(0.034)	(0.335)	(0.097)
Failure Dummy	Yes	Yes	Yes	Yes	Yes	Yes
Observations	480	480	480	480	480	480
R^2	0.016	0.016	0.020	0.024	0.021	0.024

Results are shown for the 480 participants who have done the full survey and use the full information on all attempts to do the task at any of the possible days. Risk-taking is a measure from 0 to 10, where the participant answers the flowing question: In general, how willing are to take risks? Please reply on a scale from 0 (completely unwilling) to 10 (very willing). English Speaking is a dummy variable where 1 indicate that English is their preferred language and, 0 indicate that they prefer another language. The variable Years of School is the participants reported number of years of education. High Discounters is a dummy variable where planning to do the task on day 1 is denoted 0 and not planning to do the task or planning to do the task on day 3 or 5 is denoted with a 1. Failure Dummy is a dummy for technical problems leading to payment delay. OLS Regressions. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

Table 16: Discounting, Late Doers and Adherence - Robustness, Risk, Language, and Education

	Full Sample OLS Nr of Pills (1)	Full Sample OLS If Missed Pills (2)	Full Sample OLS Nr of Pills (3)	Full Sample OLS If Missed Pills (4)	Full Sample OLS Nr of Pills (5)	Full Sample OLS If Missed Pills (6)
High Discounters	-0.291**	0.091**	-0.293**	0.089**	-0.268**	0.077**
	(0.128)	(0.040)	(0.128)	(0.039)	(0.130)	(0.039)
Late Doers	-0.384	0.075	-0.395*	0.080	-0.377	0.071
	(0.237)	(0.065)	(0.236)	(0.063)	(0.241)	(0.067)
Risk Taking	-0.005	0.005				
	(0.013)	(0.004)				
English			0.165	-0.080**		
			(0.114)	(0.037)		
Years of School					0.030	-0.014*
					(0.026)	(0.008)
Constant	6.861***	0.078**	6.740***	0.147***	6.472***	0.273***
	(0.087)	(0.033)	(0.093)	(0.034)	(0.345)	(0.100)
Failure Dummy	Yes	Yes	Yes	Yes	Yes	Yes
Observations	480	480	480	480	480	480
R^2	0.025	0.019	0.029	0.028	0.029	0.026

Results are shown for the 480 participants who have done the full survey and use the full information on all attempts to do the task at any of the possible days. Risk-taking is a measure from 0 to 10, where the participant answers the flowing question: In general, how willing are to take risks? Please reply on a scale from 0 (completely unwilling) to 10 (very willing). English Speaking is a dummy variable where 1 indicate that English is their preferred language and, 0 indicate that they prefer another language. The variable Years of School is the participants reported number of years of education. Failure Dummy is a dummy for technical problems leading to payment delay. High Discounters is a dummy variable where planning to do the task on day 1 is denoted 0 and planning to do the task on day 3 or 5, or not planning to do the task is denoted with a 1. Late doers are people who planned to do the word task sooner, did it later or did not do it. Missed Pills =1 is a dummy variable which is 0 if the participant reported having taken all 7 pills last week.
Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

Table 17: Adherence and Discounting - Restricted sample

	OLS Nr of Pills (1)	OLS Missed Pills =1 (2)	Logit Missed Pills =1 (3)
High Discounters	-0.238*	0.084**	0.582**
	(0.126)	(0.041)	(0.264)
Constant	6.760***	0.113***	-2.030***
	(0.069)	(0.025)	(0.222)
Failure Dummy	Yes	Yes	Yes
Observations	465	465	465
R^2	0.013	0.014	

From the 480 participants that answered all eight questions of the final survey, the regressions in this table exclude the 15 particpants answering that they do not plan to do the task or writing words backwards. Missed Pills =1 is a dummy variable which is 0 if the participant reported having taken all 7 pills last week, and which is 1 if she missed one pill or more. High Discounters is a dummy variable where planning to do the task on day 1 is denoted 0 and planning to do the task on day 3 or 5, or not planning to do the task is denoted with a 1. Failure Dummy is a dummy for technical problems leading to payment delay. Regressions include the 480 participants that answered all eight questions of the final survey. Robust standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 18: Discounting, Late Doers and Adherence - Restricted sample

	OLS Nr of Pills (1a)	OLS If Missed Pills (1b)	High Discounters OLS Nr of Pills (2a)	High Discounters OLS If Missed Pills (2b)	Low Discounters OLS Nr of Pills (3a)	Low Discounters OLS If Missed Pills (3b)
High Discounters	-0.255**	0.087**				
	(0.128)	(0.041)				
Late Doers	-0.380	0.073	-1.267	0.257	-0.140	0.022
	(0.237)	(0.064)	(0.819)	(0.174)	(0.189)	(0.065)
Constant	6.819***	0.102***	6.622***	0.182***	6.803***	0.102***
	(0.072)	(0.027)	(0.120)	(0.048)	(0.074)	(0.028)
Failure Dummy	Yes	Yes	Yes	Yes	Yes	Yes
Observations	465	465	132	132	333	333
R^2	0.022	0.017	0.060	0.024	0.010	0.008

From the 480 participants that answered all eight questions of the final survey, the regressions in column 1a and 1b exclude the 15 participants answering that they do not plan to do the task or writing words backwards. Column 2a-2b and 3a-3b is restricted in the same way and show results using the subsamples of High discounters and Low discounters, respectively. High Discounters is a dummy variable where planning to do the task on day 1 is denoted 0 and planning to do the task on day 3 or 5, or not planning to do the task is denoted with a 1. Late doers are people who planned to do the word task sooner, did it later or did not do it. Missed Pills =1 is a dummy variable which is 0 if the participant reported having taken all 7 pills last week. OLS and Logit Regressions.
Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

Table 19: How Quickly They Answer Other Messages

	High Discounters (1)	Actually do task 1,3,5 (2)	Actually Delay (3)
Answer First Hour	-0.061	0.003	-0.002
	(0.048)	(0.071)	(0.025)
No Answer	-0.023	0.003	0.006
	(0.072)	(0.106)	(0.039)
Constant	0.394***	1.185***	0.064***
	(0.046)	(0.078)	(0.025)
Failure Dummy	Yes	Yes	Yes
Observations	480	460	460
R^2	0.014	0.001	0.000

Column 1 in this table include all 480 participants in our main sample. In column 2 and 3, the sample is restricted further, as the main explanatory variable here is when the participants did the word task. These regressions therefore only include participants who actually made an attempt to reply in this task, excluding 20 individuals. Variable definitions: No Answer is a binary variable for the 61 participants that did not reply to an additional question asking them too reply with their first 4 digits in their social security number. Answer First Hour is a dummy variable where 1 denotes a person that answered the 4 digits social security number question within the first hour, which 270 women did. Plan to Delay is a dummy variable where planning to do the task on day 1 is denoted 0 and planning not to do the task or planning to do the task on day 3 or 5 is denoted with a 1. The variable Actually Delay is a binary variable where 0 denotes if a person performs the task on day 1, and 1 denotes if a person delays to do the task untill to day 3 or 5. Failure Dummy is a dummy for technical problems leading to payment delay. OLS regressions. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

Table 20: Day of the Week

	High Discounters (1)	Actually do task 1,3,5 (2)	Actually Delay (3)
Monday	-0.106	0.050	0.039
	(0.078)	(0.098)	(0.039)
Tuesday	-0.062	0.116	0.043
	(0.082)	(0.123)	(0.040)
Wednesday	-0.105	0.058	0.006
	(0.078)	(0.115)	(0.032)
Thursday	-0.082	0.163	0.063
	(0.082)	(0.127)	(0.042)
Friday	-0.061	0.106	0.051
	(0.085)	(0.119)	(0.042)
Saturday	0.038	0.011	0.004
	(0.090)	(0.109)	(0.034)
Constant	0.410***	1.122***	0.038
	(0.064)	(0.072)	(0.025)
Failure Dummy	Yes	Yes	Yes
Observations	480	460	460
R^2	0.021	0.007	0.010

Column 1 in this table include all 480 participants in our main sample. In column2 and 3, the sample is restricted further, as the main explanatory variable here is when the participants did the word task. These regressions therefore only include participants who actually made an attempt to reply in this task, excluding 20 individuals. High discounting is a dummy variable where planning to do the task on day 1 is denoted 0 and planning not to do the task or to do the task on day 3 or 5 is denoted with a 1. The variable Actually Delay is a binary variable where 0 denotes if a person performs the task on day 1, and 1 denotes if a person procrastinates to day 3 or 5. Failure Dummy is a dummy for technical problems leading to payment delay. OLS regressions. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

Table 21: Vitamin Adherence and Discounting. Robustness, nr Kids.

	OLS Nr of Pills (1)	OLS If Missed Pills (2)	Logit If Missed Pills (3)
High Discounters	-0.291**	0.089**	0.610**
	(0.126)	(0.040)	(0.258)
Number of Kids	0.015	-0.011	-0.080
	(0.052)	(0.020)	(0.161)
Constant	6.767***	0.121***	-1.968***
	(0.092)	(0.034)	(0.281)
Failure Dummy	Yes	Yes	Yes
Observations	473	473	473
R^2	0.018	0.016	

From the 480 participants that answered all eight questions of the final survey, the regressions in this table include only the 473 individuals from which we have information on how many kids they already have. The variable Number of Kids contains this information on how many kids the participant already has. Missed Pills =1 is a dummy variable which is 0 if the mother reported having taken all 7 pills last week, and which is 1 if she missed one pill or more. High Discounters is a dummy variable where planning to do the task on day 1 is denoted 0 and not planning to do the task or planning to do the task on day 3 or 5 is denoted with a 1. Failure Dummy is a dummy for technical problems leading to payment delay. OLS and Logit Regressions. Robust standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 22: Discounting, Late Doers and Adherence - Robustness Kids

	Full Sample OLS Nr of Pills (1a)	Full Sample OLS If Missed Pills (1b)	High Discounters OLS Nr of Pills (2a)	High Discounters OLS If Missed Pills (2b)	Low Discounters OLS Nr of Pills (3a)	Low Discounters OLS If Missed Pills (3b)
High Discounters	-0.311**	0.092**				
	(0.129)	(0.040)				
Late Doers	-0.390	0.075	-1.256	0.257	-0.172	0.032
	(0.237)	(0.064)	(0.822)	(0.175)	(0.186)	(0.064)
Number of kids	0.019	-0.012	-0.096	0.030	0.132**	-0.053***
	(0.052)	(0.020)	(0.072)	(0.024)	(0.057)	(0.019)
Constant	6.825***	0.110***	6.716***	0.152***	6.689***	0.149***
	(0.094)	(0.034)	(0.120)	(0.053)	(0.099)	(0.035)
Failure Dummy	Yes	Yes	Yes	Yes	Yes	Yes
Observations	473	473	144	144	329	329
R^2	0.027	0.019	0.063	0.034	0.024	0.028

From the 480 participants that answered all eight questions of the final survey, the regressions in column 1a and b table include only the 473 individuals from which we have information on how many kids they already have. Column 2a-2b and 3a-3b are restricted in the same way and show results using the subsamples of High discounters and Low discounters, respectively. High Discounters is a dummy variable where planning to do the task on day 1 is denoted 0 and planning to do the task on day 3 or 5, or not planning to do the task is denoted with a 1. Late doers are people who planned to do the word task sooner, did it later or did not do it. Missed Pills =1 is a dummy variable which is 0 if the participant reported having taken all 7 pills last week. The variable Number of Kids contains this information on how many kids the participant already has. OLS Regressions. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

Table 23: Health outcomes - excluding individuals who don't know their iron levels

	Full Sample Low Iron (1)	Full Sample Low Iron (2)	High Discounters Low Iron (3)	Low Discounters Low Iron (4)
High Discounters	0.031	0.031		
	(0.036)	(0.035)		
Late Doers		-0.019	-0.134***	0.015
		(0.052)	(0.039)	(0.066)
Constant	0.117***	0.120***	0.130***	0.133***
	(0.027)	(0.029)	(0.042)	(0.032)
Failure Dummy	Yes	Yes	Yes	Yes
Observations	440	440	131	309
R^2	0.004	0.004	0.014	0.008

Results in column 1-2 are shown for the 440 participants who have done the full survey and who did not answer Don't know to the question about their iron levels. Column 3 and 4 show results using the subsamples of High discounters and Low discounters, respectively and is also restricted to exclude individuals who anser that they Don't know if they have low iron levels. High Discounters is a dummy variable where planning to do the task on day 1 is denoted 0 and planning to do the task on day 3 or 5, or not planning to do the task is denoted with a 1. Late doers are people who planned to do the word task sooner, did it later or did not do it. Low Iron Levels is a dummy variable where 1 indicates that a person does have low iron levels and 0 does not have low iron levels, had low iron levels before or don't know. OLS and Logit Regressions. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.