Impatient to Receive or Impatient to Achieve:

How Goal Gradients and Time Discounting Jointly Determine Intertemporal Choice

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Abstract

Time discounting suggests that people devalue future outcomes, such that they value the objectively same amount of benefit more if it occurs sooner, rather than later in time. However, receiving future benefits is often the outcome of achieving specific goals. Until such goals have been completed, people face uncertainty as to whether they will attain the reward or how much reward they will receive. Prior research has documented the goal gradient—stronger motivation to complete a goal when goal completion is more proximate. Much of the research in the separate literatures on time discounting and goal gradient effects potentially confound the two. The current research disassociates the effects of goal gradient and time discounting on intertemporal choices, by experimentally separating the timing of goal completion and the timing of receiving a reward. People's decisions are sensitive to both the timing of both goal completion and, separately, of receiving financial rewards. We propose improved models of intertemporal choice and demonstrate the difference when estimating discount factors.

Keywords: time discounting, intertemporal decisions, present bias, goal gradient, goal completion, uncertainty

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Decisions often involve making trade-offs between outcomes that occur at different times. Research on time discounting has shown that outcomes are less valued when they occur after a longer delay, sometimes even more so than normatively justified (see Frederick et al., 2002 and Urminsky & Zauberman, 2015 for reviews). Therefore, choices between receiving a smaller benefit sooner or waiting to receive a larger benefit often constitute a trade-off.

From the time-discounting perspective, the trade-off between present and future occurs because a delayed reward is inherently less valuable due to the opportunity cost, such as the lost interest that could have been earned on the reward once it is received. In this view, people engage in subjective discounting of the value of future rewards based on the length of the delay, and then compare the discounted "net present value" of the choice options to make their decision.

However, future benefits rarely occur in isolation, but instead are often received contingent on some form of goal completion, broadly defined. This may involve some combination of investing effort, completing a task, achieving an objective, or resolving uncertainty. A consumer receives a product only after completing their order. Goal completion may involve multiple stages: to receive a tax refund, the person must first file the tax returns, the returns must be processed and approved by the tax authority, and often some intermediate currency, such as a check, is then received, all before the actual financial rewards are received. Similarly, in a loyalty program, efforts result in earning reward points, sometimes at a fixed rate but other times at an uncertain rate, before earning a reward, which may be in the form of a coupon that can only be used later, towards a future purchase. In all of these examples, there are one or more temporally distinct stages in which some aspect of the goal is completed, each of which typically resolves at least some uncertainty about the magnitude or likelihood of the aimed-for reward.

Long ago identified in animal behavior (Hull, 1932), the goal gradient is the tendency to accelerate progress towards a goal when the completion of the goal is nearer. Goal gradient effects have been documented as an important aspect of human decision-making when people engage in goal-seeking behavior. For example, Kivetz et al. (2006) found that customers in a coffee-shop rewards program accelerated their purchases as they neared the goal of earning a free coffee.

Prior research on both time discounting and goal pursuit has typically conflated the timing of goal completion and reward receipt. As a result, empirical research designs have generally confounded measures of time discounting with measures of goal gradient effects, potentially resulting in misestimates in both literatures. Evidence of impatience in time discounting studies could instead result, at least in part, from a goal-gradient effect: a greater motivation to complete the sooner goal of acquiring the smaller-sooner reward, compared to the more delayed goal of acquiring the larger-later reward. Conversely, evidence for goal-gradient effects of heightened motivation when closer to the goal could reflect time discounting: greater motivation resulting from the higher subjective net present value of the goal outcome when it is less delayed in time.

The current research aims to disentangle these two effects—time discounting and goal gradient—in people’s intertemporal preferences, by resolving this confound and testing whether people’s intertemporal decisions are driven by time discounting, goal gradient or a combination of the two.

Theoretical Background

Time Discounting and Intertemporal Choice

Time discounting describes people's intertemporal choices between outcomes that differ in the timing (for reviews, see Frederick et al., 2002; Urminsky & Zauberman, 2015). In this literature, the current value of a future outcome is determined by a discount function, which reduces the value based on the length of the delay to the outcome. The standard normative economic model of time discounting, the exponential discounting model, assumes that the value of future outcomes declines monotonically with the delay, based on a per-period fixed discount rate, representing the subjective interest rate. As a result, preference between two options will depend only on the magnitude of the options and the difference in timing between the two options.

Prior empirical research has documented numerous ways in which people's choices diverge from normative exponential discounting. Estimated discount rates are typically higher than the market interest rate, even for high-stakes real choices (Warner & Pleeter, 2001), suggesting that people are generally more impatient than the standard economic model predicts, especially for small amounts (Chapman & Elstein, 1995; Loewenstein & Thaler, 1989; Thaler, 1981). In addition, people's choices are often inconsistent over time, such that the implied interest rate is lower when choice options are more delayed, which has been characterized as hyperbolic discounting (Ainslie, 1975) or present-bias (O'Donoghue & Rabin, 1999, 2015). As a result, people make more patient choices when the same two-option trade-off is further in the future (e.g., the "common delay" effect; Coller & Williams, 1999; Green et al., 1994; Keren & Roelofsma, 1995; Loewenstein & Prelec, 1992). To explain seemingly excessive impatience and time-inconsistent preferences, prior literature on intertemporal choice has proposed that people are generally “short-sighted” or “impulsive” (Ainslie, 1975; Hoch & Loewenstein, 1991; but see Jang & Urminsky, 2023 for a contrary view). As explanations of basic time preferences, time discounting models have been assumed to capture people’s discounting of utility in general, not just the opportunity costs of delayed financial resources.

Testing discounted *utility* models with choices between time-specific monetary amounts assumes that the additional utility, relative to what would have been experienced without a reward, is realized at the time the reward is received, under the assumption that the utility is derived from consuming the reward as soon as it is received. However, people may not necessarily consume an earned reward immediately. Consumers in loyalty programs often pass up opportunities to redeem their points even when there is no incentive to stockpile them (Stourm et al., 2015). People also procrastinate in using resources and consuming experiences (Shu & Gneezy, 2010), including items like gift cards that are steeply discounted when people make prospective trade-offs, particularly when they have low connectedness to their future self (Bartels & Urminsky, 2011). Thus, measures of time discounting usually capture a “required rate of return for financial flow” (Cohen et al., 2020), which is different from discounting the consumption enabled by the additional monetary rewards, and may more broadly encompass discounting of other benefits from receiving monetary rewards. For this reason, some researchers interested in discounting of specifically utility have attempted to measure time preferences over actual consumption, such as exerting effort, instead of using choices between monetary rewards (Augenblick et al., 2015).

In particular, opportunities for arbitrage limit the ability to measure general time preferences using intertemporal monetary trade-offs and suggest that discount rates above the lowest interest rate available to the decision-maker should not be observed (Chabris et al., 2016).

People who are in immediate need of money tend to exhibit higher discounting of future rewards (Noor, 2009), but people generally exhibit impatience that is substantially higher than could be explained by available interest rates. For example, preferences for lump-sum payments over high-yield annuities among retiring military members suggest high discount rates (Warner & Pleeter, 2001).

As further evidence that intertemporal monetary choices reflect more than just discounting of utility, impatience in choices can be inconsistent with impatience in consumption. For example, Reuben et al. (2015) found that among the presumably impatient participants who chose to receive a smaller amount immediately over a larger amount two weeks later, the majority of the participants had still not cashed the check one week later. In fact, nearly half of the “impatient-choosing” participants (53.5%) had still not cashed the check two weeks later, which was after the timing of the larger-amount option they had previously rejected.

Evidence that intertemporal monetary choices are influenced by factors other than discounting of utility suggests that there may be sources of utility other than consumption. Kőszegi and Rabin (2009) proposed that people derive utility from changes in beliefs about present and future consumption (e.g., learning about an increase or decrease in wealth). This is consistent with Hsee and Tsai’s (2018) identification of a broader set of utilities beyond consumption utility, referred to as *cognition utilities*, including *news utility* (e.g., feeling or experience upon hearing news about receiving a reward in the future).

The existence of these other motives influencing intertemporal choices suggests the need for an alternative, broader perspective on intertemporal decisions. People making intertemporal choices may construe the relevant trade-offs in terms of their implications for goal pursuit. In particular, the widely documented preference for sooner monetary rewards may occur, in part, due to sooner rewards being construed as more proximal to goal completion, and therefore more motivating.

Goal Pursuit and Preferences for Early Goal Completion

In the early days of psychology, researchers studying animal learning found relationships between proximity to reinforcers and motivation. Multiple studies found that a rat runs faster or pulls harder when closer to a previously conditioned reward (Brown, 1948; Hull, 1932). These findings have been characterized as evidence for the *goal gradient* as a basic principle of motivation: the tendency to invest effort when approaching a goal increases with proximity to the goal.

While this research was conducted with animals conditioned to expect a reward, subsequent researchers integrated the notion of a goal gradient into theories of human motivation (Atkinson, 1957; Lewin, 1951; Miller, 1944). However, it was not clear under what circumstances the implications of goal gradient motivation would extend to human behavior. In particular, humans engage in higher-order rule-based conceptual reasoning, including planning and prospective decision-making, which may suppress conditioning-based motivational processes in some situations (Sloman, 1996). In fact, early attempts to develop analogs of animal-research lab experiments for human research did not detect goal gradient effects of positive “approach” goals (walking speed to a food or monetary reward: Adams, Hammeke and De Haven 1978; pulling on an apparatus to smoke a cigarette, Smith 1969).

However, subsequent research has documented goal gradient effects in human decision-making, by focusing on subjective conceptual proximity to goals rather than physical proximity. Kivetz et al. (2006) demonstrated behavioral goal gradient effects based on relative goal progress, in the context of both working towards a reward and consumer purchasing in pursuit of a loyalty program reward (see also Nunes & Drèze, 2006). Other studies have documented behavioral goal gradient effects in physical exertion when the goal is visible (Cheema & Bagchi, 2011), earning badges in online information forums (von Rechenberg et al., 2016), and online gaming loyalty (Teng, 2017).

A range of other findings of differences in people's attitudes and perceptions in relation to goal proximity can also be understood in terms of the goal gradient. Approach motivations increase closer to the time of jumping from an airplane among experienced (but not inexperienced) parachutists (Epstein & Fenz, 1965). Project completion is seen as more important, relative to other considerations, when completion is nearer (Humphrey et al., 2004). People anticipate goal gradient effects, predicting ex-ante that they will experience higher regret from missing a goal when they are closer to attaining it, i.e., missing the goal by a narrower margin, such as in losing a contest or missing a train (Gilbert et al., 2004). These findings suggest that goal gradient effects in humans are not just conditioned behavioral responses to in-the-moment cues but are implicated in cognitive reasoning about prospective outcomes.

While the goal gradient has generally been tested in pursuit of a single goal in isolation, it also has important implications for how people manage multiple goals. Specifically, a comparison of relative goal gradients predicts that people will tend to be more motivated by the subjectively more proximal goal. Pope and Fillmore (2015) find that students taking multiple AP tests are more likely to pass the second test if they have more days off between the two tests, which is consistent with initially investing more effort in preparing for the first test compared to the second test. People choose to complete more physically proximal goals (Rosenbaum et al., 2014) and more temporally proximal goals (Zhu et al., 2018) first, even when doing so results in more overall effort or lower reward. In the financial domain, debtors are more likely to make a payment towards the credit card with a balance that they are close to paying off (Amar et al., 2011), even if it is against their economic interest (e.g., in terms of minimizing interest; Besharat et al., 2014). People also prefer to stay with a task instead of switching to another task with a higher reward when they are near completing the task (Jhang & Lynch, 2015), and choose healthcare options with a shorter wait period but with a smaller health benefit (Roberts & Fishbach, 2020).

The Consequences of Goal Completion

Research on goal gradients has generally equated goal completion with a reward. In the classic animal behavior studies, the approach gradient in behavior was observed relative to an expected food reward, while avoidance gradients were defined relative to a physically painful experience. In the context of human decision-making, goal completion is more conceptual, with cognitive implications that go beyond merely experiencing physiological consequences.

While goal completion often involves receiving some form of reward, the nature of that reward can vary and can be quite different from a form of physiologically reinforcing immediate consumption. The reward may confer deferred utility, as in Kivetz et al. (2006)'s "buy-ten-get-one-free" coffee program, where goal completion involved buying a tenth coffee that earned the customer a free coffee, redeemable on their next visit. Even when goal completion involves an immediate reward, to the degree that reward is in the form of a storable good or a currency, the incremental reward is likely to be consumed at a later time, after goal completion.

Furthermore, people are motivated to complete goals even in the absence of obvious external rewards (Argo et al., 2020; Jhang & Lynch, 2015). Even goals that do not involve explicit rewards can serve as reference points (Heath et al., 1999). This suggests that goal completion itself can be an effective, albeit intangible, motivating reward. Consistent with this interpretation, people sometimes even value incomplete progress, in which the utility from goal completion remains, more than an already completed task (Ruan et al., 2023). In fact, prior research has suggested that such intangible goal completion rewards may be an explanation of the incremental effort attributable to the goal gradient (Kivetz et al., 2006).

In addition to the tangible and intangible rewards, goal completion has other important consequences. Goal completion typically communicates that no further investment of resources (e.g., effort, time, money) is required. In particular, as we discuss next, goal pursuit typically involves at least some uncertainty that is resolved by goal completion. In sum, we will treat goal completion as a psychologically complex event, involving some combination of commonly relevant but theoretically distinct outcomes, beyond consumption utility from tangible rewards, which may vary by the specific goal circumstances.

The Role of Uncertainty in Intertemporal Choice and Goal Pursuit

People generally seek to resolve uncertainty. Feelings of uncertainty about the future have been linked to negative affect, such as anxiety and worry (MacLeod et al., 1991). People also avoid risk or uncertainty, at times with little normative justification (Kahneman & Tversky, 1979), even valuing uncertain prospects less than the worst possible realization of the outcome (Gneezy et al., 2006). Beyond eliminating the inherently uncomfortable state, the resolution of uncertainty may serve as a reward itself by satisfying curiosity or information need (Hsee & Ruan, 2016; Loewenstein, 1994; Ruan et al., 2018).

Intertemporal choice and choice between risky outcomes exhibit similar patterns of deviation from the respective “normative” model (Keren & Roelofsma, 1995; Urminsky & Kivetz, 2011), leading some to propose that the evaluation of delayed and probabilistic outcomes can be explained by a single discounting model (Prelec & Loewenstein, 1991; Rachlin et al., 1991; also see Green & Myerson, 2004) or that both share a similar underlying psychological process (Trope & Liberman, 2010) or individual-level trait (e.g., cognitive ability; Dohmen et al., 2010). Further, people's risk aversion is generally found to be correlated with their impatience (Anderhub & Güth, 2001; Clot et al., 2017; Eckel et al., 2005; Leigh, 1986).

Another perspective is that perceived uncertainty may underlie time preferences in general and may specifically explain excess impatience relative to normative standards. For instance, people may see delayed rewards, even those presented as guaranteed to occur, as involving more risk of non-payment (Chabris et al., 2016). While experimental studies have attempted to control for this potential confound (Andreoni & Sprenger, 2012a), uncertainty may be seen as inherently increasing with delay (Andreoni & Sprenger, 2012b; Frederick et al., 2002; Halevy, 2008), contributing to more "impatient" choices (Epper et al., 2011). In sum, the literature suggests that intertemporal choice and resolution of uncertainty may be related in such a way that seemingly impatience choices also partially reflect preferences for resolving uncertainty.

Uncertainty is likewise an inherent characteristic of actively pursuing a future goal. Until a goal has been achieved, there exists a risk of not attaining the goal. In fact, uncertainty is central to theories of goal pursuit, which posit that motivation is determined not only by the importance or value of the goal but also by the subjective likelihood of attaining the goal (i.e., the *expectancy*, Atkinson, 1957, 1964; Kruglanski et al., 2018; Plante et al., 2013). During goal pursuit, people may seek to resolve this uncertainty by using cues of their likelihood of completing the goal. Information on how fast they are making progress toward their goals (Huang & Zhang, 2011), or inferences from subgoal completion or other indicators of goal progress can resolve uncertainty, and motivate goal pursuit (Fishbach et al., 2014; Harkin et al., 2016; Rai et al., 2023).

Correspondingly, goal completion generally involves the resolution of substantial uncertainty. At the time that the requirements for achieving a goal are met, most if not all of the uncertainty about whether the reward will be received is eliminated, even if the actual receipt of the reward remains in the future.

Building on the notion of uncertainty as an information gap, the subjective sense of goal completion is contingent on receiving the missing information that affirms completion, which may co-occur with or precede receiving a reward. Therefore, the motivation for goal completion includes, at least in part, the desire to resolve some uncertainty about whether a goal has been or will be successfully attained.

Importantly, we propose that the psychological benefits of goal completion can occur when people have a subjective sense of goal completion, even if the goal has not been technically 100% completed, as in the case of completing goal requirements but not having yet received the reward. In goals with multiple phases, some degree of subjective goal completion may occur when one type of uncertainty has been resolved. For example, a person dealing with their taxes may experience the benefits of subjective goal completion once after completing all their work to file the tax return, and then again after the tax authority approves the tax refund and mails the check, all before any funds have been received.

Applying the notion of a goal gradient to the uncertainty-resolution aspect of goal completion suggests that people will favor goals involving uncertainty that can be resolved sooner, rather than later. Consistent with this prediction, some research has documented a general preference for sooner uncertainty resolution (Ahlbrecht & Weber, 1996), although this preference may be attenuated among people who savor uncertainty about positive outcomes (Lovallo & Kahneman, 2000). Resolution of uncertainty can itself serve as a reward and boost motivation and is most effective when provided immediately (Shen et al., 2015). In sum, the ability to resolve uncertainty earlier can be a characteristic of more motivating goals, even holding the timing of the actual goal reward fixed.

Given the implications of uncertainty on goal pursuit, it is possible that the uncertainty underlying time discounting reflects people's uncertainty about goal completion. Hinting at this analog, Michel and Grusec (1967) described intertemporal choice (for both monetary rewards and products) in terms of expectancy and value and found the probability (expectancy) moderated sensitivity to delays. Ballard et al. (2022) speculated that the change in uncertainty about goal achievement over time may underlie the goal-gradient effect. Assuming that people have a goal to receive the reward in an intertemporal choice, time preference may in part reflect not only a time-sensitive motivation to attain that reward but also a motivation to resolve uncertainty about goal completion sooner.

The Potential Confound Between Time Discounting and Goal Gradient

These parallels between time discounting, which involves a lower valuation of more temporally distant rewards, and the goal gradient, which involves lower motivation to pursue goals with more temporally distant completion, raise the possibility of confounds, or potentially even an equivalency, between the two.

First, the goal gradient could just be an artifact of time discounting. To the degree that more delayed goal completion implies a more delayed reward for that goal completion, the net present value of the delayed reward will be lower when completion is more delayed, reducing the expected return on effort invested, and favoring goals with earlier completion. If the benefits from achieving two goals are similar in magnitude, then from a time-discounting point of view, the net present value of completing the sooner goal is likely to be higher, proving a strong and potentially normative reason for prioritizing and preferring the earlier goal. Conversely, procrastination as low motivation to pursue a goal can be explained in terms of discounting the reward that is still in the distant future (Schouwenburg & Groenewoud, 2001; Steel, 2007).

Most prior research has generally not tested whether the goal gradient effect is driven by placing a higher value on the reward closer in time—in other words, due to time discounting of the reward from goal completion—or motivation from proximity to goal completion independent of objective value. The one exception is Kivetz et al. (2006), who found that consumers completed a goal more quickly when subjective proximity was manipulated to be higher, by framing 10 required purchases as 10 out of 12 instead of 10 out of 10 purchases. Since there was no difference in actual requirements, this finding goes against a time-discounting explanation based on objective time (though not one based on subjective time).

Second, and conversely, findings in time discounting could be explained in terms of a goal gradient, to the degree that making an intertemporal choice is interpreted in terms of goal conflict (Urminsky & Kivetz, 2011). In this view, preferences for a sooner-smaller reward over a larger-later reward reflect a greater motivation to pursue the goal involved in receiving the smaller-sooner reward. Crucially, according to this interpretation, the goal completion that people would be motivated to achieve involves not only the objective reward but all of the associated subjective rewards. Therefore, the high observed impatience may reflect the additional motivation that comes from earlier goal completion, including closing mental accounts and reduction of uncertainty.

Because the goal gradient and time discounting have been generally studied separately, fundamental theoretical questions remain unresolved that can be answered by testing the goal gradient effect as a potentially separable motivational effect from time discounting. In this paper, we decouple the timing of objective rewards and psychological benefits from goal completion to disassociate these two constructs, each theorized as the basis of decision-making over time.

The Proposed Model of Intertemporal Goal Pursuit

We propose an integrative account of impatient choices, which can capture both people discounting the value of delayed rewards and being more motivated to pursue outcomes involving sooner psychological benefits from goal completion. We do this by expanding standard models of monetary time discounting. This approach allows us to test either for sensitivity only to goal completion timing or only to the timing of receiving rewards as special cases.

In a discounting model, the current valuation of a delayed payment of $$V$ to be received at time t_p can be expressed as $V * f(t_P)$, where *f* is a *discount factor*. We begin with the standard exponential discounting model (Samuelson, 1937), which assumes a single, constant discount factor applying to the delayed payment, adjusted by the length of the delay: $f(t_P) = \delta_P^{t_P}$, where δ_P represents the degree of discounting per unit of delay.

While the goal-gradient effect has been described in terms of a stronger *motivation* in pursuit of a goal when the reward is more proximate, the predictions of the goal-gradient account can also be modeled as *impatience* to achieve the goal. Adopting the time-discounting approach, we can similarly define the goal gradient in terms of impatience for goal completion, represented as discounting by delays until goal completion: $f(t_G) = \delta_G^{t_G}$, where t_G is the timing of goal completion and δ_G represents the degree of goal-based discounting per unit of delay. In this perspective, people are more driven in goal pursuit when completion is nearer because goal completion that is nearer is valued more. While actually receiving a reward is clearly an important benefit of goal completion, in our approach, we will define t_G and δ_G specifically in terms of the subjective benefits of goal completion, independent of the objective reward itself.

In sum, our extended discounting model can be written as a multiplicative function of discounting due to goal completion delay and due to payment delay:

$$f(t_G, t_P) = \delta_G^{t_G} \delta_P^{t_P}$$

This model assumes separate time-consistent preferences for goal completion and payments. We rely on this as our main model to test our account that goal gradient and time discounting both underlie time preferences.

One common finding in the time discounting literature is that people have time-inconsistent preferences (Thaler, 1981), commonly observed as higher discounting in the short term than in the long term. To explore whether people have time-inconsistent preferences in the dimension of goal completion or payments, we extend the widely used and more general quasi-hyperbolic discounting model (Laibson, 1997) in the same approach as our main model:

$$f(t_G, t_P) = \beta_G^{GD} \delta_G^{t_G} \beta_P^{PD} \delta_P^{t_P}$$

In this model, GD = 0 if t_G = 0 (i.e., in the "present" period), and GD = 1 if t_G > 0, while PD = 0 if t_P= 0, and PD = 1 if t_P > 0. In this model, $\beta_G^{GD}$and β_P^{PD} each represents an additional preference for present-period goal completion and payment timing (often called present bias), respectively.

The Current Research

We test our account across nine studies (five studies were pre-registered; the other four studies were conducted in 2014, prior to the adoption of pre-registrations, and were not pre-registered). In our experiments, we distinguish the delay to goal completion and the delay to the receipt of the monetary reward and examine the simultaneous influence of goal gradient and time discounting on people's choices.

To disassociate goal completion from the reward, we rely on the notion that goals inherently involve uncertainty until they are completed. As the reward is contingent upon goal completion, goal completion is what ensures that a person receives the reward, even though the reward may be received at a later time. While the goal may not be fully completed until the reward is received, we assume people gain benefits from a subjective sense of goal completion from receiving cues (information or tokens) that fully reduce a particular source of uncertainty about receiving the reward.

First, in an incentive-compatible experiment, we demonstrate that people have a preference for sooner goal completion (Study 1). Goal completion is operationalized as having their effort reviewed and approved on an online worker platform. In an intertemporal choice involving options with different approval dates, people generally prefer an earlier approval-date option, holding constant the date when the compensation is paid out (i.e., payment made), consistent with impatience for goal completion.

We then test the uncertainty-resolution aspect of goal completion, using the context of lotteries, where the attainability of the reward remains uncertain until the lottery drawing resolves the uncertainty. We find that preference for the lottery option with a smaller payoff is stronger not only when it offers an earlier payment date (consistent with time discounting), but also when it offers an earlier drawing date, consistent with goal gradient (i.e., lottery tickets; Studies 2, 3a, 4a). We further replicate our finding in another context, when a reward will be delivered as a pre-paid debit card. Goal completion occurs when people receive a physical card in the mail while the actual payment may be received later when the funds on the card become available (Studies 3b, 4b).

Further, we elicit people's valuation of the rewards jointly based on the goal completion delay and payment delay. Using the elicited valuations, we estimate the degree of impatience for goal completion (a goal completion discount factor) separately from the degree of preference for the sooner reward (a standard payment-based discount factor) using our extended discounting model (Studies 5a-b, 6). We find that people discount based on both delays to the payment and goal completion.

Full data, study materials, and code for analyses are available on the OSF repository: https://osf.io/ft3gb/?view_only=42e01107e26c4d9fa476b002ba28ac06.

Study 1: Preference for Early Task Approval in Intertemporal Choice

We first tested whether people have a preference for early goal completion in an intertemporal choice between sooner and later goal completion date options. In Study 1, we employed the context of working on a short task for a monetary reward. We recruited U.S. participants from Amazon Mechanical Turk (MTurk). Workers on MTurk regularly engage in short tasks or ad hoc jobs for payments that are contingent on their successful performance on the tasks. We operationalized workers' goal completion as getting an actual task performance reviewed and approved, which would resolve the uncertainty about whether they qualified for the payment as well as how much payment they qualified for. We asked participants to make consequential choices between doing a task with an early approval date (i.e., the date on which their performance on the task will be reviewed and payment approved) or a task with a later approval date. Importantly, the timing of receiving compensation for the task varied independently of the goal completion timing.

Method

We recruited 170 U.S. participants from Amazon Mechanical Turk, based on a pre-registered (https://aspredicted.org/X3X_9YK) target sample size of 150 participants, after exclusions. We received 168 completed responses from unique IP addresses. We excluded three participants who failed our instructional attention check and analyzed a final sample of 165 participants (*M*age = 42.88, SD = 12.95; 54% women). This study was sufficiently powered to detect a 15% deviation from 50% in binary choice.

Participants made a series of five consequential choices. In each choice, they chose between two tasks with three components: the range of bonus payment amount (as compensation for completing the task), the "approval date" (when the task would be reviewed and the participants would be notified of their bonus amount, i.e., the timing of goal completion), and the "payment date" on which the bonus would be issued (see Table 1). Both tasks in each choice were described as promising at least a $0.20 bonus payment and as involving short data-entry and data-checking tasks. We informed participants that one of their five task choices would be randomly chosen and they would be doing that task.

In the first choice, the two tasks had exactly the same bonus amounts and payment dates ("same monetary amount and payment date"), but different approval dates (choice 1, Table 1). One task was to be reviewed on the day of the study and the other was to be reviewed eight days after the survey date (i.e., March 22). This first choice thus tested whether people prefer to do a task that involves sooner goal completion, all else equal.

In the subsequent four choices, we presented participants with options involving different trade-offs, in randomized order. In the "monetary difference" choices (choices #2 and #3 in Table 1), the task options had different bonus amounts (either 90 cents or one dollar). In one choice (#2), only the bonus amounts differed, and both the approval date (8 days later) and payment date (11 days later) were the same in both task options. In the other choice (#3), the task with the smaller maximum bonus had an earlier approval date (i.e., reviewed on the same day, as opposed to 8 days later) than the other option. This pair of choices allows us to test whether offering sooner goal completion can increase willingness to accept a smaller expected bonus amount because it reduces the uncertainty about the compensation sooner.

Similarly, in the “payment date difference” choices (choices #4 and $5), the options had the same maximum bonus amount ($1) but different payment dates (in 11 days vs. in 9 days). In one choice (#4), both options had the same approval date (in 8 days). In the other choice ($5), the option with a later payment date (in 11 days, as opposed to in 9 days) offered an earlier approval date (same day, as opposed to in 8 days). This pair of choices allows us to test whether offering sooner goal completion can increase willingness to accept compensation (i.e., monetary reward) later.

After making these five choices, participants completed short demographic questions (gender and age). Then, as per our instruction, we randomly picked one task from each participant's five selected tasks and informed them of the result. They could then complete a short spelling check task for the chosen compensation.

Table 1

Task Choices and Results (Study 1)

Part 1	**Same monetary amount and payment date**	
	Task 1	Task 2
Bonus	Up to $1.00	Up to $1.00
Approval date	Same day	In 8 days
Payment date	In 11 days	In 11 days
% choosing Task 1	90% (148/165, $\chi^2(1) = 102.42$, $p < .001$)	

Part 2	**Monetary difference**				**Payment date difference**			
	2. Same Approval Date		3. Different Approval Date		4. Same Approval Date		5. Different Approval Date	
	Task 1	Task 2	Task 1	Task 2	Task 1	Task 2	Task 1	Task 2
Bonus	Up to $0.90	Up to $1.00	Up to $0.90	Up to $1.00	Up to $1.00	Up to $1.00	Up to $1.00	Up to $1.00
Approval date	In 8 days	In 8 days	Same day	In 8 days	In 8 days	In 8 days	Same day	In 8 days
Payment date	In 11 days	In 11 days	In 11 days	In 11 days	In 11 days	In 9 days	In 11 days	In 9 days
% Task 1	13% (21/165)		33% (55/165)		15% (24/165)		52% (86/165)	
McNemar's test	$\chi^2(1) = 28.66$, $p < .001$				$\chi^2(1) = 53.16$, $p < .001$			

Note. Approval and payment dates were described to the participants both as calendar dates (e.g., March 22) and as days from the day of the survey (e.g., in 8 days).

Results

In the first choice ("same monetary amount and payment date"), the majority of the participants (90%, 148/165, compared to 50%, $\chi^2(1) = 102.42$, $p < .001$) chose the task with an earlier approval date. Given options with different goal completion timing, participants exhibited a strong preference for the sooner goal completion even though the payment date was the same in both options and therefore there was no difference in when they would actually receive the payment from completing the task.

Next, we examined the two "monetary difference" choices to test whether participants exhibited a preference for the early approval date even when the task options differed in the amount of the maximum bonus amount. When the options only differed in the maximum bonus amount (choice #2), the majority of the participants chose the task with a higher maximum bonus, with only 13% (21/165) choosing the task with a smaller maximum bonus. However, the task with the smaller maximum bonus payment was chosen significantly more when the task had an earlier approval date (choice #3; 33%, 55/165, vs. 13%, $\chi^2(1) = 28.66$, $p < .001$), despite the payment timing remaining the same. This result suggests that people are willing to sacrifice some anticipated compensation for sooner goal completion, or just to learn that they got approved for the compensation sooner. This cannot be explained solely by time discounting, which assumes that people make choices based on payment timing.

Lastly, we examined the two "payment date difference" choices and found similar results when the choices presented a trade-off between the payment date and the approval date. When the approval date was the same in both options (choice #4), only 15% (24/165) chose the task with a later payment. However, the preference for the later-payment option significantly increased when it offered an earlier approval date (choice #5: 52%, 86/165, vs. 15%; $\chi^2(1) = 53.16$, $p < .001$). This result suggests that people can be even willing to accept a later payment date for earlier goal completion, which cannot be explained by time discounting alone.

Discussion

Time discounting suggests that people devalue rewards that occur in the future. In fact, doing so can be normative due to the opportunity cost of money. Therefore, when choosing between two rewards that occur on different dates, the reward that will be received farther in the future is preferred less than a reward equivalent in objective value but closer in time. Therefore, time discounting predicts that our participants would have based their decisions solely on the timing of the payments.

However, we found that people generally preferred to learn whether and how much reward they would receive sooner than later, even when the timing of the payments was constant across the options. Some participants were even willing to accept costs (by going with a smaller expected bonus) or a delay to the payment (the later payment date) for early approval of the task. This finding cannot be accommodated solely by the time discounting account. Instead, the participants' preference for sooner *goal completion* is consistent with goal gradient theories. Specifically, based on our conceptualization of goal completion as involving resolution of uncertainty, people preferred to reach the state where the uncertainty about the reward is reduced sooner rather than later.

When a reward is contingent on investing effort to finish a task as in this study, in general, goal completion may involve other benefits, such as a sense of accomplishment, self-enhancement, or anticipating no more future effort. We next examine contexts that do not involve effort-provision, to isolate the role of resolution of uncertainty in preferences for sooner goal completion.

Study 2: Allocating Tickets Across Lotteries with Different Drawing Dates

In Study 2, we investigate the role of resolving uncertainty in goal completion preferences using lotteries. Lotteries inherently entail uncertainty about the reward—a person will receive the reward only if they are selected as the winner when the lottery is drawn, at which time the uncertainty is resolved. Based on this idea, we manipulated goal completion timing as the "drawing date" of the lotteries (i.e., the date on which the winner will be drawn and announced), independently of the payment date (i.e., when the lottery prize will be paid to the winner).

Specifically, we asked each participant to allocate ten lottery tickets across two lottery options. We examined whether people allocate more tickets toward the lottery with an earlier drawing date, all else equal to measure preference for sooner goal completion. To draw a parallel with time discounting, we compare this to the preference for the lottery with an earlier payment date.

Method

Adult participants were recruited from Qualtrics's consumer survey panel. At the end of an unrelated consumer research survey, the respondents were presented with the questions for the current study. We received 417 complete responses from unique IP addresses, which constituted our final sample (demographic information was not collected in this survey). This study was conducted prior to the adoption of pre-registrations and was not pre-registered. Participants were randomly assigned to one of nine between-subjects conditions (described below).

Participants assumed that they had ten lottery tickets they could allocate between two lotteries which both had the same odds of winning (1 in 100 chance), but one had a smaller prize ($10) than the other ($14). The drawing dates (when the winners are revealed) and payment dates (when winners receive the money) of the lotteries differed across the nine conditions (Table 2).

In the three control conditions, the drawing date and payment date for both lotteries all occurred on the same date (i.e., no delay in either drawing or payment). These conditions served as a benchmark for the participants' allocation preference across two lotteries, purely based on the prize.

The remaining conditions involved a delay in the larger prize lottery relative to the smaller prize lottery, as in common intertemporal choice. Departing from common intertemporal choice tasks where only the amounts and payment dates varied, however, our lottery options varied in terms of the drawing date, payment date, or both. In the two "simultaneous delay" conditions, both the drawing and the payment occurred on the same date for each lottery, but the dates were later for the larger prize lottery than for the smaller prize lottery. This represents a case where goal completion and payment always occur simultaneously. In the two "payment delay" conditions, the drawing for both lotteries occurred at the same time, but the larger prize lottery's payment date was later. These conditions test the effect of payment delay, holding everything else constant. Lastly, in the two "goal completion delay" conditions, the payments for both lotteries occurred at the same time, but the larger prize lottery's drawing was held later. These conditions test the effect of goal completion delay, holding everything else constant.

Given these two options, in each condition, participants allocated ten tickets across the smaller prize lottery and larger prize lottery options.

Table 2

Dates and Results (Studies 2-3)

	Smaller lottery/card		Larger lottery/card		Study 2 (N=417) (btw-subjects)	Study 3a (N=426) (btw-subjects)	Study 3b (N=298) (within-subjects)
Choice condition	Goal (weeks)	Payment (weeks)	Goal (weeks)	Payment (weeks)	Average # tickets allocated to larger lottery	% choosing larger-amount lottery	% choosing larger-amount option
Control (no delay):					Average: 6.70	70% (106/152)	
1	1	1	1	1	6.86	75% (40/53)	96%
2	3	3	3	3	6.72	68% (36/53)	95%
3	5	5	5	5	6.54	65% (30/46)	97%
Simultaneous delay (same delay to goal completion and payment):					Average: 4.85	45% (41/91)	
4	1	1	3	3	4.68	40% (19/47)	36%
5	3	3	5	5	5.02	50% (22/44)	40%
Payment delay (same goal completion timing across the options):					Average: 5.60	49% (48/97)	
6	1	1	1	3	5.36	44% (23/52)	36%
7	3	3	3	5	5.81	56% (25/45)	40%
Goal completion delay (same payment timing across the options):					Average: 5.13	45% (39/86)	
8	1	3	3	3	4.74	51% (23/45)	81%
9	3	5	5	5	5.46	39% (16/41)	84%

Results and Discussion

In the control conditions, when the lotteries only differed in terms of the prize (i.e., winning amount from the lottery), participants allocated 6.70 (SD = 2.83) tickets on average to the larger lottery. This result establishes sensitivity to the prize amounts and serves as a benchmark for people's baseline preferences for allocating tickets across the two lotteries.[1]

[1] Participants allocated significantly fewer than 10 tickets to the larger lottery, although it was the dominant option. This is consistent with the diversification heuristic (Read & Loewenstein, 1995), and may reflect a lay belief that doing so is beneficial for hedging their chances of winning across the two different lotteries.

Compared to the control condition questions, in the “simultaneous delay” conditions, participants allocated fewer tickets to the larger prize lottery (*M* = 4.85, SD = 2.66; Welch’s t-test, $t(210.8) = 4.99$, $p < .001$), allocating more to the smaller prize lottery that had both an earlier drawing and payment date than in the control condition. These conditions test the commonly assumed situation in which the payment occurs simultaneously with the resolution of uncertainty about the payment. While the result is consistent with time discounting, because goal completion occurred at the same time as payment, we cannot determine whether the shift in preference is driven by preferring sooner goal completion (goal gradient) or sooner payment (time discounting).

Next, we examine the two other conditions, in which we kept one date constant between the options and only varied the other date, disassociating time discounting and goal gradient effects. Compared to the control condition, in the “payment delay” conditions, where the drawing dates were held constant and only the payment dates differed, participants also allocated fewer tickets to the larger prize lottery than in the control conditions (*M* = 5.60, SD = 3.08, $t(178.9) = -2.68$, $p = .008$). This result is consistent with time discounting: Delayed *payments* are devalued, resulting in a preference for sooner payment, all else equal.

Similarly, compared to the control conditions, participants allocated fewer tickets to the larger prize lottery in the “goal completion” delay conditions where the options only differed in drawing date (*M* = 5.13, SD = 3.10, $t(211.06) = -3.97$, $p < .001$). Participants preferred to allocate more resources to the lottery that offered earlier drawing dates even when the payment dates of the lotteries did not differ. This result cannot be explained by time discounting (as the two lotteries had the same payment timing) and instead reflects preferences for earlier goal completion, consistent with our findings from Study 1.

As an exploratory analysis, we examined if there was a marginal effect of the payment delay in the presence of the goal completion delay, and vice versa. Allocations in the simultaneous delay conditions were not significantly different from the goal completion delay conditions ($t(197) = 0.69$, $p = .49$). That is, in this context, keeping the trade-off in the goal completion timing the same, differing the payment delay trade-off did not have an additional effect on allocation preference. However, we found a marginally significant difference between the simultaneous delay conditions and the payment delay conditions ($t(174.64) = 1.75$, $p = .08$). In other words, the later payment lottery became more attractive when it provided sooner goal completion. This result raises the possibility that sensitivity to goal completion timing may not be limited to choices in which there are no payment timing differences. We revisit this question of whether people only rely on goal completion timing as a secondary "tie-breaker" when payment timing is the same or rely on both of them, later in Study 4.

Next, we test similar comparisons using binary choices instead of allocations.

Study 3: Choices Between Two Options

In Study 3, we tested if our results from Study 2 extended to choices (as opposed to the allocation of lottery tickets). An intertemporal choice between a smaller and larger reward with different payment dates represents a common trade-off in decision-making. We tested people's choices between a smaller amount but sooner goal completion or payment timing and a larger amount but later goal completion or payment timing in two contexts: lotteries as in Study 2 (Study 3a) and receiving a reward on a debit card by mail (Study 3b).

Study 3a: Choosing Between Two Lotteries

Study 3a again used the context of lotteries as in Study 2. Instead of allocating tickets across two lotteries, however, participants explicitly chose one lottery to enter.

Method. The data collection was run concurrently with Study 2 and followed the same procedure. We received 426 complete responses with unique IP addresses from Qualtrics consumer panel respondents (no demographic information was collected).

Participants each chose between two lottery options: one with a smaller prize ($10) and the other with a larger prize ($14), both with the same odds of winning (1 in 100 chance). Participants were randomly assigned to one of nine between-subjects conditions that determined the lotteries' drawing dates and payment dates, which were the same as Study 2 (Table 2).

Results. The results were largely consistent with how participants allocated lottery tickets in Study 2. Compared to the control conditions where the majority chose the larger prize lottery (70%, 106/152), we found a significantly lower preference for the larger prize lottery in the "simultaneous delay" conditions, where the larger lottery had both a later drawing and payment date than the smaller prize lottery (45%, 41/91; $\chi^2(1) = 13.50$, $p < .001$).

Further, we found a similar sensitivity to changes in payment dates alone, with a significantly lower preference for the larger prize lottery in the "payment delay" conditions than in the control condition (49%, 48/97; $\chi^2(1) = 9.45$, $p = .002$), consistent with time discounting.

Participants were also sensitive to changes in goal completion timing alone, with a significantly lower preference for the larger lottery in the "goal completion delay" conditions compared to the control (45%, 39/86; $\chi^2(1) = 12.72$, p < .001). Participants were more likely to choose the smaller prize lottery when it had an earlier drawing date, consistent with our prediction. Earlier drawing dates offer a sooner resolution of uncertainty about winning the prize, which made the smaller lottery more attractive, even when both lotteries had the same payment date.

As our exploratory analysis in Study 2, we compared the simultaneous delay conditions to the goal completion delay conditions. Here, we did not find a significant difference (consistent with Study 2; $\chi^2(1) = 0$, $p = 1$). While the preference for the larger prize lottery was directionally higher in the payment delay conditions compared to the simultaneous delay conditions, the difference was not significant ($\chi^2(1) = 0.21$, p = .64; in contrast to the marginally significant difference in Study 2).

Study 3b: Receiving a Pre-Paid Debit Card

In Study 3b, we introduced a third context: an issuance of a physical debit card with cash benefits to be loaded on the card. We manipulated the date on which the debit card arrives in the mail as the goal completion timing and the date on which the funds on the card can be used as the payment timing. We assumed that people would perceive receiving the physical card as resolving some uncertainty about whether they will receive the card and further reducing uncertainty about whether they will eventually receive the funds. Receiving the card would therefore be interpreted as a goal completion. We operationalized payment timing as the date on which the funds on the debit card would first be made available.

Method. We recruited 360 U.S. participants from MTurk, aiming for a target sample size of 300 participants. We received 358 complete responses from unique IP addresses. We excluded 15 participants who failed an instructional attention check and an additional 45 participants who failed a comprehension check about the stimuli (described below). We analyzed the resulting sample of 298 responses (M_{age} = 42.65, SD = 12.73; 50% women, 2 indicated 'other'). This study was pre-registered (https://aspredicted.org/995_Q16).

We used the same nine pairs of goal completion and payment timings (across four timing conditions) from Studies 2 and 3a, except that each participant made all nine choices, in a within-subjects design.

Specifically, participants were asked to assume that they were eligible to receive some cash benefits that were to be issued on a prepaid debit card. There was to be no cost to receiving and using the card.

Participants made nine choices, each between a smaller-amount debit card option ($32) or a larger-amount debit card option ($35). Across the nine choices, the options differed in the dates of receiving the debit card in the mail ("delivery date", representing goal completion timing), and when the card would be activated making the funds available to be used ("activation date," representing payment timing), according to the same timing combinations in Study 3a (Table 2; except that the conditions were within-subjects in this study).

After making all choices, participants completed a short comprehension check, asking about their understanding of the activation date. Only those who correctly answered that the money can be used after the card is activated (instead of as soon as the card is received) were included in the analyses.

Results. First, we jointly tested overall sensitivity to goal completion and payment timing using linear regression on participants' choices of the debit card option (1: larger amount option, 0: smaller amount option; i.e., linear probability model). As regressors, we coded the difference in the goal completion timing between the options ("goal completion delay") and the difference in payment timing ("payment delay"). We clustered standard errors at the participant level to account for the within-subjects repeated measures. We found significant sensitivity to the payment delays ($B_{Payment}$ = -0.26, SE = 0.012, $t(2679) = -21.02$, $p < .001$). Further, we also found significant sensitivity to the goal completion delays (B_{Goal} = -0.038, SE = 0.0067, $t(2679) = -5.71$, $p < .001$), albeit smaller than the sensitivity to payment delays (a statistically significant difference, $B_{Payment} - B_{Goal} = -0.22$, SE = 0.014, t(2679) = -19.79, $p < .001$). These results are consistent with our earlier findings: People are not only impatient for delays in the payment timing (here, when the funds become accessible), but also the goal completion timing (when they receive the debit card, even though it does not necessarily mean they can use the fund right away).

In an exploratory follow-up regression, we included an interaction term between payment delays and goal completion delays and found a positive significant interaction (B = 0.035, SE = 0.0058, $t(2678) = 5.98$, $p < .001$). This suggests the effect of goal completion delays was significantly smaller when there was also a payment delay (i.e., simultaneous delay vs. goal delay conditions), and vice versa.

We also examined the choices in each condition separately compared to the control condition, as in prior studies. Given the within-subjects repeated measures, we conducted a linear regression over participants' choices with a dummy variable for each of the different conditions (with the control condition as the baseline condition) and clustered standard errors at the participant level.[2] Participants were less likely to choose the large amount option in the "simultaneous delay" questions, compared to the control questions (B = -0.58, SE = 0.027, $t(2678) = -21.57$, $p < .001$). This again suggests impatience, but it is unclear whether it is from sooner goal completion or sooner payment.

In the "payment delay" questions where there was only payment delay but no goal completion delay, people were also more impatient, where the smaller amount option had earlier

[2] This analysis was not a priori pre-registered but was added to present the results in the same way as Study 3a.

activation dates than in the control questions (B = -0.58, SE = 0.028, $t(2678) = -21.09$, $p < .001$), consistent with time discounting. Further, people were also more impatient in the "goal completion delay" questions where there was only a goal completion delay but no payment delay, where the smaller-amount option offered an earlier delivery date compared to the control questions, keeping payment dates equal (B = -0.14, SE = 0.020, $t(2678) = -7.15$, $p < .001$). This is again consistent with a preference for sooner goal completion.

In a similar exploratory analysis as before, we found significantly higher impatience in the simultaneous delay questions compared to the goal completion delay questions (B = -0.44, SE = 0.027, $t(2678) = 16.48$, $p < .001$), but not compared to the payment delay questions (B = 0, SE = 0.015, $t(2678) = 0$, $p = 1$).

Discussion

Time discounting suggests that people devalue outcomes that occur in the future. Therefore, an outcome farther in the future is preferred less than an outcome equivalent in objective value but closer in time. Our account, based on the goal gradient, suggests that people also prefer sooner goal completion. Consistent with this, we find that people exhibit impatience, willing to forgo a larger benefit for a smaller benefit not just to receive the payment sooner, but also to attain the cue for goal completion sooner (e.g., debit card in the mail).

In our exploratory analyses in Studies 2-3, we did not find a consistent difference when comparing the "simultaneous delay" conditions and "payment delay" conditions (i.e., testing if there was a marginal effect of providing an early goal completion timing in the larger-later option). From a multi-attribute decision perspective, the lack of evidence for an additional shift in preference when adding a goal completion delay to a choice involving delayed payments may suggest that people use a lexicographic strategy (Payne et al., 1993), prioritizing payment delays over goal completion delays. In this account, people incorporate the differences in the goal completion timing into their decision only when there is no difference in payment timing between the options. If this is the case, then the presence of a difference in payment timing would be a boundary condition for the effect of different goal completion timing. However, this interpretation is inconsistent with the results from Study 1 (and the marginally significant result from Study 2).

The alternative account is that people engage in trade-offs between payment delay and goal completion delay (i.e., a shorter delay in one dimension may compensate for a longer delay in the other). It is possible that the variations of delays we used in Studies 3a and 3b were not sufficiently informative to detect the effect of goal timing when payment timing differed. In Study 4, we use a more targeted design to test between the lexicographic and trade-off accounts.

Study 4: Preference for Sooner Goal Completion with Delays in Payment Timing

In Studies 4a-b, we examined whether people are jointly sensitive to both goal completion timing and payment timing (as in the trade-off account) or are only sensitive to goal timing when there is no difference in payment timing (as in the lexicographic account). To have a more informative test of this than we had in the previous three studies, all choices involved a payment delay (one day or more) between the smaller amount and larger amount options. Further, differences in both goal completion and payment timing between the two options were more varied than in prior studies, ranging between one day and four weeks (as opposed to only between no delay or three weeks' delay in the previous three studies).

As in Studies 3a-b, we tested choices between lotteries (Study 4a) and prepaid debit cards (Study 4b).

Study 4a: Lotteries

Method. We recruited 218 U.S. participants from MTurk, aiming for a target sample size of 200. We received 208 complete responses from unique IP addresses. We excluded 7 participants who failed our instructional attention check and analyzed a final sample of 201 valid responses (M_{age} = 42.14, SD = 13.10; 57% women). This study was pre-registered (https://aspredicted.org/HZS_8YD).

Each participant made twenty-one choices (in randomized order) a smaller prize lottery ($30) and a larger prize lottery ($40), with different lottery drawing dates (i.e., goal completion timing) and payment dates. Across the choices, the delays between the options ranged between one day and four weeks, for both goal completion and payment timing (see Table 3). Small and large payment delays were matched with different lengths of goal completion delays to construct specific tests. For example, in three choices where payment delay differed by one day between the options, one choice involved a one-day difference in goal completion and the other two a two-week difference (choices #1-3 in Table 3). Likewise, in four choices where the payment delay differed by two weeks, the difference in goal completion delay varied between one day, one week, and two weeks (choices #14-17). Similarly, differences in payment delays were also paired with a variety of differences in goal completion delays. This design allows for identifying sensitivity to goal completion and payment timing separately.

We also varied whether the soonest delay in the stimuli was tomorrow or in one week, between-subjects, to explore the effect of a "common delay." The delays in the one-week condition were created by approximately shifting the timings in the tomorrow condition by one week into the future, i.e., by adding a one-week common delay. The test of whether preferences are consistent when a common delay is added tests a deviation from the standard exponential discounting (Prelec & Loewenstein, 1991; Thaler, 1981). Specifically, the normative exponential discounting model predicts that people's time preferences only depend on the delay between the options (i.e., the additional waiting time required to receive the larger-later reward in exchange for the smaller-sooner reward), and not when the delay begins (e.g., the timing of the earliest reward). Therefore, under the normative model, adding a common delay should not affect preferences. On the other hand, some accounts have suggested that people have higher impatience for rewards that are closer in time (e.g., hyperbolic discounting or quasi-hyperbolic discounting models). Prior research has found the common delay effect consistent with diminishing impatience (i.e., more patience when options are delayed to the future; Coller and Williams 1999; Green, Fristoe and Myerson 1994; Keren and Roelofsma 1995; Kirby and Herrnstein 1995).

Table 3

Timings in Studies 4a-b

	"Tomorrow" condition				"One-week" condition			
	Smaller option (Study 4a: $30, Study 4b: $35)		**Larger option** ($40 in both Studies 4a-b)		**Smaller option** (Study 4a: $30, Study 4b: $35)		**Larger option** ($40 in both Studies 4a-b)	
	Goal	Reward	Goal	Reward	Goal	Reward	Goal	Reward
1	tomorrow	tomorrow	in 2 days	in 2 days	in 1 week	in 1 week	in 1 week and 1 day	in 1 week and 1 day
2	tomorrow	in 2 weeks	in 2 weeks	in 2 weeks and 1 day	in 1 week	in 3 weeks	in 3 weeks	in 3 weeks and 1 day
3	tomorrow	in 3 weeks	in 2 weeks	in 3 weeks and 1 day	in 1 week	in 4 weeks	in 3 weeks	in 4 weeks and 1 day
4	tomorrow	tomorrow	in 1 week	in 1 week	in 1 week	in 1 week	in 2 weeks	in 2 weeks
5	tomorrow	in 3 weeks	in 1 week	in 4 weeks	in 1 week	in 4 weeks	in 2 weeks	in 5 weeks
6	tomorrow	in 3 weeks	in 2 weeks	in 4 weeks	in 1 week	in 4 weeks	in 3 weeks	in 5 weeks
7	tomorrow	in 3 weeks	in 3 weeks	in 4 weeks	in 1 week	in 4 weeks	in 4 weeks	in 5 weeks
8	tomorrow	in 3 weeks	in 4 weeks	in 4 weeks	in 1 week	in 4 weeks	in 5 weeks	in 5 weeks
9	tomorrow	in 4 weeks	in 1 week	in 5 weeks	in 1 week	in 5 weeks	in 2 weeks	in 6 weeks
10	tomorrow	in 4 weeks	in 2 weeks	in 5 weeks	in 1 week	in 5 weeks	in 3 weeks	in 6 weeks
11	tomorrow	in 4 weeks	in 3 weeks	in 5 weeks	in 1 week	in 5 weeks	in 4 weeks	in 6 weeks
12	tomorrow	in 4 weeks	in 4 weeks	in 5 weeks	in 1 week	in 5 weeks	in 5 weeks	in 6 weeks
13	tomorrow	tomorrow	in 1 week	in 2 weeks	in 1 week	in 1 week	in 2 weeks	in 3 weeks
14	tomorrow	tomorrow	in 2 days	in 2 weeks and 1 day	in 1 week	in 1 week	in 1 week and 1 day	in 3 weeks
15	tomorrow	in 2 weeks	in 2 weeks	in 4 weeks	in 1 week	in 3 weeks	in 3 weeks	in 5 weeks
16	tomorrow	in 3 weeks	in 2 weeks	in 5 weeks	in 1 week	in 4 weeks	in 3 weeks	in 6 weeks
17	tomorrow	in 1 week	in 2 weeks and 1 day	in 3 weeks and 1 day	in 1 week	in 2 weeks	in 3 weeks and 1 day	in 4 weeks and 1 day
18	tomorrow	tomorrow	in 1 week	in 3 weeks	in 1 week	in 1 week	in 2 weeks	in 4 weeks
19	tomorrow	in 3 weeks	in 3 weeks	in 6 weeks	in 1 week	in 4 weeks	in 4 weeks	in 7 weeks
20	tomorrow	in 4 weeks	in 3 weeks	in 7 weeks	in 1 week	in 5 weeks	in 4 weeks	in 8 weeks
21	tomorrow	tomorrow	in 1 week	in 4 weeks	in 1 week	in 1 week	in 2 weeks	in 5 weeks

Results. We first fitted participants' choices (1: choosing the larger prize lottery, 0: choosing the smaller prize lottery) on the difference in lottery drawing dates between the options (goal completion delay), the difference in payment date (payment delay), controlling for the common delay conditions (e.g., immediate goal completion for the smaller lottery vs. adding one week to all the timing) using linear probability regression model.

We found a significant effect of payment delays ($B_{Payment}$ = -0.11, SE = 0.0091, $t(4217)$ = -12.25, $p < .001$). Consistent with time discounting, participants were less willing to wait for the larger prize lottery the longer the payment delay from the smaller prize lottery.

Importantly, we also found a significant effect of goal completion delays (B_{Goal} = -0.036, SE = 0.0063, $t(4217)$ = -5.73, $p < .001$), albeit significantly smaller than the effect of payment delays ($B_{Payment}$ - B_{Goal} = -0.076, $p < .001$). Consistent with the goal gradient, participants were less willing to wait for the larger prize lottery, the longer the delay in getting goal completion (learning whether they had won), relative to the smaller prize lottery. Given that all choices in the study involved payment delays (with the larger prize lottery always had a later payment date), this shows that participants were still sensitive to how soon they would complete the goal and resolve uncertainty about whether they won the lottery, even when there was a meaningful difference in the timing of actually receiving the monetary reward (prize).

In addition, there was a significant effect of the common delay conditions ($B_{\text{One-week (vs. tomorrow)}}$ = 0.13, SE = 0.051, $t(4217) = 2.59$, $p = .010$). Overall, participants in the one-week condition were more patient than in the tomorrow condition, choosing the larger-later option more in general, consistent with prior work on time-inconsistent preferences.

In an exploratory analysis, we tested the interaction between goal completion delays and payment delays, controlling for the common delay conditions. The interaction was not significant ($B_{\text{Payment Delay X Goal Delay}}$ = 0.0006, SE = 0.005, $t(4216) = 1.18$, $p = .24$), suggesting the sensitivity to delays in either dimension (payment or goal completion) was not moderated by extent of delay in the other dimension.

In another exploratory analysis, we tested the interactions between the common delay conditions and each of the goal completion delays and payment delays. The common delay did not significantly moderate the effect of either type of delay ($B_{\text{Payment Delay X One-week (vs. tomorrow)}}$ = 0.031, SE = 0.018, $t(4215) = 1.75$, $p = .08$; $B_{\text{Goal Delay X One-week (vs. tomorrow)}}$ = -0.005, SE = 0.013, $t(4215) = -0.37$, $p = .71$). In separate analyses for each of the common delay conditions, we found consistently significant effects of payment delay and goal completion delay (soonest date is tomorrow: $B_{\text{Payment Delay}}$ = -0.13, SE = 0.013, $t(2160) = -9.46$, $p < .001$; $B_{\text{Goal Delay}}$ = -0.034, SE =

0.0092, $t(2160) = -3.67$, $p < .001$; soonest date one week: $B_{\text{Payment Delay}} = -0.096$, SE = 0.012, $t(2055) = -7.88$, $p < .001$; $B_{\text{Goal Delay}} = -0.039$, SE = 0.0087, $t(2055) = -4.42$, $p < .001$).

Overall, these results suggest that inconsistent with the lexicographic account, as people were still sensitive to goal completion delays even in the presence of meaningful payment delays. Instead, the results are consistent with the trade-off account (people weighing both dimensions of delays).

Study 4b: Debit Card

Method. We recruited 225 U.S. participants from MTurk, aiming for a target sample size of 200 after exclusions. We received 225 complete responses from unique IP addresses. After excluding 4 participants for failing our instructional attention check and 20 additional participants for failing our comprehension check about the debit card timing (as in study 3b), we analyzed a final sample of 201 valid responses ($M_{\text{age}} = 41.95$, SD = 12.48; 55% women, 2 indicated 'other'). This study was pre-registered (https://aspredicted.org/Z3M_ZC5).

The design of Study 4b was the same as Study 4a, except that we used the context of receiving a pre-paid debit card (as in Study 3b) and the amounts in the sooner and later options were $35 and $40, respectively (based on pre-tests).

Results. We conducted the same linear regression analysis as in Study 4a. Replicating the prior results, we again found a significant negative effect of the payment delays, which was the delays in the fund activation date of the prepaid card in this case ($B_{Payment} = -0.15$, SE = 0.010, $t(4217) = -14.75$, $p < .001$). This reflects impatience for the payment, as time discounting suggests.

Importantly, we also found a significant negative effect of goal completion delays (i.e., delay in the delivery of the debit card; $B_{Goal} = -0.014$, SE = 0.0054, $t(4217) = -2.56$, $p = .01$), albeit again significantly smaller than the effect of payment delays ($B_{Payment}$ - B_{Goal} = -0.14, $p < .001$). People preferred to receive the debit card earlier, controlling for when the funds would be made accessible. This is consistent with a preference for sooner goal completion. As sensitivity to goal completion timing was significant even though the payment timing differed across the options in all choices, this supports the trade-off account over the lexicographic account again. Unlike in Study 4a, there was no significant overall effect of the common delay (B = 0.064, SE = 0.051, $t(4217) = 1.26$, $p = .21$).

In the same exploratory analysis as Study 4a, we tested the interaction between goal completion delays and payment delays, controlling for the common delay conditions. The interaction was not significant ($B_{\text{Payment Delay X Goal Delay}}$ = 0.0014, SE = 0.0045, $t(4216) = 0.33$, $p = .74$), suggesting the sensitivity to delays in either dimension (payment or goal completion) was not moderated by extent of delay in the other dimension.

Further, we found no significant interaction between common delay and each of payment delays and goal completion delays ($B_{\text{Payment X Common Delay}}$ = 0.029, SE = 0.021, $t(4215) = 1.38$, $p = .17$; $B_{\text{Goal X Common Delay}}$ = -0.015, SE = 0.011, $t(4215) = -1.41$, $p = .16$). However, examining each common delay condition separately, the results were more nuanced. In the tomorrow condition, only the effect of payment delays was significant, and not the effect of goal completion timing in the tomorrow condition (B_{Payment} = -0.17, SE = 0.015, $t(2055) = -11.60$, $p < .001$; B_{Goal} = -0.006, SE = 0.0089, $t(2055) = -0.64$, $p = .52$). In the one-week condition, both effects were significant (B_{Payment} = -0.14, SE = 0.015, $t(2160) = -9.46$, $p < .001$; B_{Goal} = -0.021, SE = 0.0063, $t(2160) = -3.33$, $p < .001$).

Discussion

Across Studies 4a-b, where all choices involved a delay in payment (as large as four weeks), we again found that participants were sensitive to the goal completion delays, or impatient for goal completion. Specifically, participants preferred the "smaller-sooner" option in terms of the payment timing more when it offered an earlier lottery drawing date or earlier delivery of the debit card, relative to the larger-later option. These results are inconsistent with a lexicographic account, where people first consider the payment delays between the options, only using goal completion delays as a tie-breaker when the options have the same payment timing. Instead, these results support a trade-off-based account, in which people are jointly sensitive to goal completion delays and payment delays.

We also did not find a significant interaction between goal completion delays and payment delays in either study. That is, the sensitivity to goal completion delays did not significantly differ whether the payment delays were relatively small (e.g., one day) or large (e.g., four weeks). The effect of goal completion delays was generally smaller than the effect of payment delays in both studies, suggesting people avoid payment delays more than comparable goal completion delays, overall.

Next, we test and measure the joint effect of goal completion and payment by fitting our extended discounting model.

Study 5: Estimating Discount Factors

Our results thus far show that people not only prefer to receive payments earlier but also prefer sooner goal completion, specifically in terms of reducing the uncertainty associated with receiving the payments. Thus far, we have illustrated this preference in allocating resources (Study 2) and choice (Studies 1, 3-4).

Next, to better relate our findings to the literature on time discounting, we quantify these effects in terms of discount factors, using our proposed extended discounting model. To do so, we employ titration tasks (Green et al., 1994), a method commonly used to elicit people's indifference points between sooner and delayed rewards. In a typical titration task, participants make a series of intertemporal choices between two options that differ in the timing of the outcomes. Across the choices, the experimenter varies the payment amount of one timing option, keeping the payment amount of the other timing option the same. Experimenters can estimate the participant's indifference point by identifying at what amount of the first timing option the participant switches their preference to the other timing option. The indifference point allows for modeling intertemporal preferences and calculating the preference parameters as specified in the model of the researcher's choice (Urminsky & Zauberman, 2015) without making additional functional-form assumptions about choices.

We fit our extended discounting model, encompassing discounting over both payment delays and goal completion delays, to estimate separate discount factors for the respective delays (i.e., the degree to which an outcome is devalued by the delay in payment timing, and separately by the delay in goal completion timing).

Study 5a

***Participants*.** We recruited 297 U.S. participants from MTurk. We received 260 complete responses from unique IP addresses. We further excluded 2 participants who failed our attention check and 17 participants for whom an indifference point could not be identified in any of the titration tasks (due to inconsistent responses; discussed below). This resulted in the final sample of 241 participants (M_{age} = 33.99, SD = 10.46; 41% women). This study was not pre-registered.

Procedure. Each participant was presented with 14 titration tasks, each task presenting 15 choices between a different pair of two lotteries options, a “sooner” and a “later” lottery, as shown in Figure 1. The lotteries in each task had the same probabilities of winning (either 1 in 10 or 1 in 100, randomized between-subjects), but different lottery drawing dates and/or different payment dates (Table 4). The later lottery always had either a later drawing date or a later payment date than the sooner lottery. The prize in the sooner lottery started at $0 and either increased by $10 to a maximum of $140 or increased by $100 to a maximum of $1,400 (also randomized between-subjects). The prize of the later lottery was the same across all choices and was equal to the maximum of the sooner lottery options (either $140 or $1,400).

For example, as shown in Figure 1, when the prize of the later lottery was $140, the prize of the other lottery was titrated from $0 to $140, in increments of $10, across the sequence of choices. Whether the titrated lottery was presented on the left or right was counterbalanced across participants.

Figure 1

Sample Titration Task from Study 5a

	Lottery A Drawing this week Payment in 3 weeks	Lottery B Drawing in 3 weeks Payment in 3 weeks	
Lottery A pays $0	○	○	Lottery B pays $140
Lottery A pays $10	○	○	Lottery B pays $140
Lottery A pays $20	○	○	Lottery B pays $140
Lottery A pays $30	○	○	Lottery B pays $140
Lottery A pays $40	○	○	Lottery B pays $140
Lottery A pays $50	○	○	Lottery B pays $140
Lottery A pays $60	○	○	Lottery B pays $140
Lottery A pays $70	○	○	Lottery B pays $140
Lottery A pays $80	○	○	Lottery B pays $140
Lottery A pays $90	○	○	Lottery B pays $140
Lottery A pays $100	○	○	Lottery B pays $140
Lottery A pays $110	○	○	Lottery B pays $140
Lottery A pays $120	○	○	Lottery B pays $140
Lottery A pays $130	○	○	Lottery B pays $140
Lottery A pays $140	○	○	Lottery B pays $140

We approximated the participant's overall indifference value, i.e., the amount of payment for the sooner lottery that would make the participant indifferent between the sooner lottery and the later lottery, as the average of two values: the largest payment in the sooner lottery where the participant still preferred the later lottery, and the smallest payment of the sooner lottery where the participant preferred the sooner lottery (i.e., the two choices between which the participant's preference shifted, or the switching point). For example, in Figure 1, if a participant chose Lottery B for all amounts of Lottery A up to $90 and chose Lottery A when its payment was $100 and above, the indifference value was approximated to be $95. In the edge cases, we coded participants' indifference value as $0 if they always chose the sooner lottery, or as the amount equivalent to the payment of the later lottery if they always choose the later lottery. If a participant was inconsistent, violating transitivity, we could not recover their indifference point.

We only included participants whose indifference points could be estimated in *all* of the titration tasks.

Based on this method, we identified 14 indifference values from each participant, each value representing an indifference value for a different trade-off involving goal completion timing and/or payment timing.

Table 4

Goal Completion and Payment Timings for Titration Tasks in Studies 5a-b

			Sooner Option (Titrated) 5a: \$0-140 or \$0-1,400 5b: \$0-35 or \$0-\$350		**Later Option (Fixed)** 5a: \$140 or \$1,400 5b: \$35 or \$350	
Task			Goal (Approval date)	Reward (Payment date)	Goal (Approval date)	Reward (Payment date)
1	Both payment and goal completion delays	Simultaneous delays	this week	this week	3 weeks	3 weeks
2			this week	this week	6 weeks	6 weeks
3			3 weeks	3 weeks	6 weeks	6 weeks
4		Separated delays	this week	this week	3 weeks	6 weeks
5			this week	3 weeks	6 weeks	6 weeks
6			this week	3 weeks	3 weeks	6 weeks
7	Payment delay only (same goal completion timing)		this week	this week	this week	3 weeks
8			this week	this week	this week	6 weeks
9			this week	3 weeks	this week	6 weeks
10			3 weeks	3 weeks	3 weeks	6 weeks
11	Goal completion delay only (same payment timing)		this week	3 weeks	3 weeks	3 weeks
12			this week	6 weeks	3 weeks	6 weeks
13			this week	6 weeks	6 weeks	6 weeks
14			3 weeks	6 weeks	6 weeks	6 weeks

Estimating Discounting Factors. For each scenario, we calculated a ratio of the indifference value (A) and the later lottery's payment amount, which was fixed (B): r = A/B. First, based on time discounting only, the ratio can be expressed as a function of the weekly payment-based discount factor δ_P and the timing of the payments for the lotteries, t_P^A (sooner lottery's payment timing) and t_P^B (later lottery's payment timing):

$$r = \frac{A}{B} = \delta_P^{(t_P^B - t_P^A)} \quad \text{(Eq. 1)}$$

The parameter δ_P measures people's degree of impatience specifically for the payment, i.e., how much they devalue the monetary reward based on payment delay. A value of 1 represents indifference to the timing of the payments, and values below but close to 1 are interpreted as time discounting with high patience. In contrast, a low value signals a strong devaluation of future payments and impatience to receive payments sooner. The smaller δ_P is, the more impatient people are to receive payment early. (The weekly discount factor of $\delta_P = 0.98$, for example, commensurates with requiring an approximate 2% weekly interest rate, which surmounts to 180% annual interest rate when compounded). This estimates a standard exponential time-discounting model.

Our proposed extended model similarly accommodates people's impatience for goal completion, thus enabling us to quantify devaluation specifically based on goal completion delays (e.g., based on the lottery drawing dates, t_G^A for the sooner lottery and t_G^B for the later lottery) in terms of a discount factor, δ_G, such that:

$$r = \frac{A}{B} = \delta_G^{(t_G^B - t_G^A)} \quad \text{(Eq. 2)}$$

This *goal completion* discount factor, δ_G, measures how much people are willing to sacrifice in terms of the amount to attain sooner goal completion. As with the payment discount factor δ_P, a value of 1 represents indifference to goal completion timing. A value below 1 can be interpreted as a preference for sooner goal completion, with a lower value representing high impatience for goal completion. Quantifying the impatience for goal completion using this approach allows us to incorporate goal completion timing into a time discounting model. Specifically, jointly accounting for both goal completion and payment timing, we can estimate the following model, i.e., our extended discounting model:

$$r = \frac{A}{B} = \delta_G^{(t_G^B - t_G^A)} \delta_P^{(t_P^B - t_P^A)} \quad \text{(Eq. 3)}$$

Results. In the analyses below, we fitted our models to the indifference ratios using non-linear regression. We used clustered standard errors to account for the correlated errors due to the within-subjects design.

We first fitted our extended model based on exponential discounting (Eq. 3) and jointly estimated the discounting factors for goal completion and payment. We found not only significant discounting ($\delta < 1$) based on payment timing (weekly discount factor, $\delta_P = 0.960$ vs. 1; SE = 0.0026, $t(3372) = 15.41$, $p < .001$), but also significant discounting based on goal completion timing ($\delta_G = 0.982$ vs. 1, SE = 0.0017, $t(3372) = 10.39$, $p < .001$). Consistent with our findings from prior studies, the goal completion discount factor was significantly larger than the payment discount factor ($\delta_P - \delta_G = -0.022$, SE = 0.0025, $t(3372) = -8.63$, $p < .001$), representing a smaller (but significant) degree of impatience from goal completion delay compared to impatience from payment delay.

Given that people jointly exhibit impatience for goal completion and discount based on payment timing, estimating one factor without accounting for the other could represent a confound. In particular, estimating time discounting without accounting for goal completion timing could result in biased estimates of impatience for monetary payments.

To illustrate this problem, we fitted an exponential discounting model only using the payment-based discount factor (Eq. 1), which yielded an estimate of the payment discount factor 0.950 (significantly different from 1, SE = 0.003, $t(3373) = 16.39$, $p < .001$). This estimate is smaller (i.e., indicating higher discounting or impatience) than our initial estimate of 0.960 when we also accounted for the varying goal completion timings. Because the drawing dates of the sooner-payment lottery were either the same as or earlier (and never later) than the drawing dates of the later-payment lottery in the current study, not accounting for the impatience for the goal completion specifically led to an *underestimation* of the payment-based discounting factor in this case, i.e., to overestimating the degree of payment-based impatience.

Extended Quasi-Hyperbolic Model. Additionally, as an exploratory analysis, we tested for the possibility of deviation from the exponential discounting model which assumes a constant discount factor across time. Specifically, we test time-inconsistent discounting (i.e., the possibility of a time-varying discount factor) in the short term versus long term, using the quasi-hyperbolic discounting model (Laibson, 1997). The quasi-hyperbolic discounting model extends the standard exponential discounting model by incorporating an additional short-term discount factor, β, that applies to the "present period." The full discount factor is therefore defined as f(t) = $\beta\delta^t$ if $t > 0$ and f(0) = 1. With β < 0, this model predicts higher impatience for rewards that are closer in time, as posited by the hyperbolic discounting model (Ainslie, 1975), or *present-biased* preferences (O'Donoghue & Rabin, 2015). However, unlike the hyperbolic discounting model (which assumes a completely different functional form), the quasi-hyperbolic discount function accommodates the possibility of normative exponential discounting (e.g., when β = 1).

Based on the payment timing only, we can separately identify a long-term discount factor δ_P and a separate short-term discounting parameter β_P. We apply the short-term discount factors (βs) to the soonest timing available in the stimuli, which was the current week ("this week") in Studies 5a-b (as opposed to future weeks, i.e., in three or six weeks).[3]

$$r = \frac{A}{B} = \beta_P^{(1[t_P^B=0]-1[t_P^A=0])}\delta_P^{(t_P^B-t_P^A)} \text{ (Eq. 4)}$$

[3] The precise timing of when the short-term discount factor, β, applies (i.e., the definition of the "present" period) has not been clearly established in the literature. A common assumption is that it applies to immediate rewards (e.g., within a day) but in practice, it is commonly applied to the most immediate time period available in the data. In our exercises, we are interested in whether the rate of discounting in the short term (for short delays) and in the long term differs in general. For our purposes, we use the soonest time available in the stimuli ("this week" in Studies 5a-b, "tomorrow" in Study 6). See Jang and Urminsky (2023) for a more detailed discussion and evidence that time-inconsistency most likely to be observed with longer delays than previously assumed.

where the indicator function, $1[t = 0]$, has a value of 1 if time t is in the present period and 0 otherwise. Extending this model to separately account for impatience for goal completion:

$$r = \frac{A}{B} = \beta_G^{(1[t_G^B=0]-1[t_G^A=0])}\beta_P^{(1[t_P^B=0]-1[t_P^A=0])}\delta_G^{(t_G^B-t_G^A)}\delta_P^{(t_P^B-t_P^A)} \text{ (Eq. 5)}$$

Here, β_G and β_P denote the additional discounting that applies only in the short term (i.e., for rewards that are closer in time) for goal completion and payment, respectively.

We fitted this extended quasi-hyperbolic discounting model (Eq. 5) to the indifference ratios, using non-linear regression and clustered standard errors at the participant level. For payment timing, we found no significant short-term discounting (β_P = 1.01, SE = 0.0074, $t(3370)$ = -1.07, p = .29), but significant long-term discounting, as before (δ_P = 0.959, SE = 0.0028, $t(3384)$ = 14.41, p < .001). For goal completion timing, we found significant short-term discounting (β_G = 0.985, SE = 0.0066, $t(3370)$ = 2.29, p = .022), as well significant long-term discounting (δ_G = 0.985, SE = 0.0019, $t(3370)$ = 7.88, p < .001). The goal completion parameters were significantly different from the payment-based parameters, larger for short-term discounting (i.e., $\beta_P - \beta_G$ = 0.023, SE = 0.011, $t(3370)$ = 2.08, p = .038) and smaller for long-term discounting (i.e., $\delta_P - \delta_G$ = -0.026, SE = 0.0031, $t(3370)$ = -8.37, p < .001).

Again, ignoring goal completion timing (Eq. 4), would result in an underestimated long-term payment discount factor of δ_P = 0.947 (SE = 0.0033, $t(3372)$ = 15.81, p < .001, compared to 1), lower than our estimate when impatience for goal completion was accounted for. The short-term payment discount factor for payment ignoring goal completion, β_P =1.02 (SE = 0.0074, $t(3372)$ = -3.18, p = .001), was overestimated.

Study 5b: Debit Card

Method. We recruited 155 participants from MTurk. We received 135 complete responses from unique IP addresses. Further excluding 9 participants for failing our attention check and 7 participants for inconsistencies in any of the titration tasks, we analyzed 119 valid responses (M_{age} = 33.39, SD = 10.49; 42% women). This study was not pre-registered.

The design of Study 5b was similar to Study 5a. Participants received fourteen titration tasks, each presenting a different trade-off in goal completion and/or payment timing (same timings as Study 5a). The key difference was that the scenario involved receiving a prepaid debit card, as in Study 3, with options involving a trade-off between the delivery date of the debit card (goal completion timing) and the date on which the fund on the card would be activated and spendable (payment timing). In addition, the reward amount of the later-payment option was randomly assigned to be either $35 or $350, between-subjects. The amount of the sooner option varied between $0 to $35 (or $350) in $2.5 (or $25) increments, across 15 choices in each titration task. Using the same procedure as Study 5a, we identified 14 indifference values (one from each titration task) for each participant.

Results. We used the same estimation method as in Study 5a, fitting different models to the calculated indifference ratios (ratio of the indifference value and the fixed amount in the later-payment option) using non-linear regression and clustering standard errors at the participant level.

We first fitted our extended exponential discounting model (Eq. 3) to jointly estimate the payment and goal completion discount factors. We found significant discounting based on payment timing (δ_P = 0.950, SE = 0.0049, $t(1664) = 10.22$, $p < .001$) and also significant discounting based on goal completion timing (δ_G = 0.984, SE = 0.0026, $t(1664) = 6.04$, $p < .001$). The goal completion discount factor was significantly larger than the payment discount factor ($\delta_P - \delta_G = -0.034$, SE = 0.0044, $t(1664) = -7.83$, $p < .001$; i.e., a smaller degree of impatience over goal completion delays than over payment delays), consistent with prior results.

The payment discount factor would have been underestimated without accounting for impatience for goal completion (i.e., fitting Eq. 1; $\delta_P = 0.941$, SE = 0.0056, $t(1665) = 10.40$, $p < .001$). As in Study 5a, not accounting for goal completion timing makes people seem more impatient for payments than they actually are.

We again explored time inconsistency by fitting our extended quasi-hyperbolic discounting model (Eq. 5). For payments, we found a short-term discount factor greater than 1 ($\beta_P = 1.025$, SE = 0.0095, $t(1662) = -2.66$, $p = .008$), suggesting higher patience in the short term (contrary to the predictions from prior research) in the context of the current study. We further found significant long-term discounting ($\delta_P = 0.947$, SE = 0.0052, $t(1662) = 10.22$, $p < .001$). For goal completion, we found significant short-term discounting ($\beta_G = 0.970$, SE = 0.010, $t(1662) = 2.99$, $p = .003$). The long-term discounting for goal completion was still significant after accounting for short-term discounting ($\delta_G = 0.990$, SE = 0.0026, $t(1662) = 3.83$, $p < .001$), albeit higher than our previous estimate (0.984).

The parameters based on goal completion timing were significantly different from those based on payment timing, for both the short-term discount factors, βs ($\beta_P - \beta_G = 0.055$, SE = 0.014, $t(1662) = 4.07$, $p < .001$), indicating steeper short-term discounting for goal completion than for payment, and long-term discount factors δs ($\delta_P - \delta_G = -0.043$, SE = 0.0051, $t(1662) = -8.37$, $p < .001$), indicating less long-term discounting for goal completion than for payment.

When we use a model that fails to account for impatience for goal completion (Eq. 4), the estimated short-term payment discount factor (β_P) is 1.03 (SE = 0.010, $t(1664) = -3.03$, $p = .003$) and the long-term payment discount factor (δ_P) is 0.937 (SE = 0.0063, $t(1664) = 10.42$, $p < .001$). Compared to the estimates from our extended model, these estimates show an upward bias for the short-term discount factor but a downward bias for the long-term discount factor.

Discussion

In Studies 5a-b, we calculated the degree of impatience separately for payment and goal completion, using a model-fitting approach. We estimated people's valuation of the monetary reward that is delayed in terms of goal completion or payment, by measuring the amount that they are willing to instead receive instead, in order to receive goal completion or payment sooner. We found results consistent with our prior findings: People are not only sensitive to the timing of the payments but also to the timing of goal completion, i.e., the time when the uncertainty about achieving the reward is reduced.

The modeling approach specifically allowed us to quantify the degree of goal gradient in terms of discounting of options with delayed goal completion, as has commonly been done in prior research to quantify the degree of time discounting. Using this approach, our results suggest that people are willing to forgo some future benefits in exchange for sooner goal completion (e.g., early drawing of the lottery or receiving the debit card sooner), similar to how time discounting describes people as devaluing future rewards based on payment delays. Further, using the implied discount factor specific to goal completion timing, we could quantify the degree of goal gradient relative to the time discounting of the payment. The goal completion discount factor was consistently smaller than the payment discount factor, suggesting people are relatively more patient for delayed goal completion than for delayed payment (while still overall impatient). Further, we demonstrate that failure to account for the goal gradient can lead to a biased estimate of people's discounting of delayed payments, suggesting greater impatience in monetary discounting than is the case.

In addition, by adapting the quasi-hyperbolic discounting model, we also found that the impatience for goal completion and impatience for payment not only differ in terms of long-term discounting but also potentially have different time-varying patterns. That is, we found steeper short-term discounting, and therefore time inconsistency, for goal completion, but not for payments.

Study 6: Discount Factor for Job Payment

In Study 6, we return to the context of getting paid for completing a job, similar to Study 1. Using the same titration method as the prior set of studies, we elicited the indifference value for the amount of compensation for a one-time job, based on the schedule for job approval and payment. Unlike Studies 5a-b, all trade-offs involved payment delays, and we varied the extent of the trade-off in goal completion timing between the options for the given payment delay. Using this design, we further illustrate how goal gradient can confound time discounting, including testing a case where the later-payment option offers a sooner goal completion than the sooner-payment option.

Method

We recruited 225 U.S. participants from MTurk, aiming for a pre-registered (https://aspredicted.org/3K6_NGJ) target sample size of 200. We received 225 complete responses from unique IP addresses. After excluding four participants for failing the instructional attention check and 19 additional participants for inconsistency in one or more of the titration tasks, we analyzed a final sample of 202 responses (M_{age} = 41.78, SD = 11.74; 53% women; 3 indicated 'other').

Participants read a scenario about receiving compensation for completing a one-time job and evaluated different payment schedules, which specified when the job would be reviewed and approved (approval date, representing goal completion) and when the payment of the compensation would be made if the job is approved (payment date). Each participant was presented with eight titration tasks (Table 5). In each titration task, participants were presented with a series of choices between two payment schedule options: a sooner-payment option and a later-payment option. The trade-off in the approval date between the options differed across the titration tasks.

We counterbalanced whether the titrated amounts were presented in an increasing or decreasing order. In each titration task, participants first viewed a list of choices where the sooner payment option ranged between $260 and $500, in $20 increments, while the later payment options were kept constant at $500. If a participant chose the sooner payment option in all choices (i.e., their indifference point was not elicited within the $260 and $500 range), they were shown a second list of choices, where options ranged from $0 to $240.[4]

As baselines, in two tasks (tasks 1 and 4 in Table 5), the approval date coincided with the payment date in both options ("simultaneous delay"). The trade-offs in these tasks represented intertemporal choices between a smaller-sooner option and a larger-later option, in which goal completion co-occurs with payment of the reward.

We designed four other tasks to test sensitivity to goal completion timing. In these tasks, the later-payment option offered an "expedited" approval date by either one month (tasks 2, 5) or two months (tasks 3, 6) compared to the baseline tasks (keeping the approval date of the sooner-payment option the same). For example, in tasks 3 and 6, by expediting the approval date of the later-payment option by two months, the approval date was brought up to *tomorrow*.

In addition, we designed two tasks (tasks 7, 8) to further explore time inconsistency in preferences for goal completion and payment timing. Keeping the delays between the options the

[4] This was done to limit the number of choices participants would have to make to minimize fatigue. The initial range ($260-$500) is sufficient to capture even excessive discounting in the current design (monthly payment discount factor of about 0.7).

same, both in terms of approval dates and payment dates, we shifted the timing of one component in both options. This allows us to test the *common delay effect*, i.e., decreasing impatience when the same amount of delay is added to both the sooner and larger options. Specifically, in task 7, the approval dates in both options were expedited by one month relative to task 4. Comparing these two tasks allows us to test the common delay effect over goal completion timing. In task 8, the payment dates in both options were expedited by one month, relative to task 7. Comparing these two tasks allows us to test the common delay effect over payment timing.

Table 5

Goal Completion and Payment Timings for Titration Tasks and Results in Study 6

			Sooner Option (Titrated)		**Later Option (Fixed, $500)**			
Task	Payment timing trade-off	Larger-later option goal completion timing	Goal (Approval date)	Payment (Payment date)	Goal (Approval date)	Payment (Payment date)	Mean indifference value	Payment discount factor (monthly; ignoring goal timing)
1	tomorrow vs. 2 months	Baseline (Simultaneous as payment)	tomorrow	tomorrow	2 months	2 months	$374.21	0.865
2		Expedited by 1 month	tomorrow	tomorrow	1 month	2 months	$380.35	0.872
3		Expedited by 2 months	tomorrow	tomorrow	tomorrow	2 months	$390.00	0.883
4	1 month vs. 2 months	Baseline (Simultaneous as payment)	1 month	1 month	2 months	2 months	$415.15	0.830
5		Expedited by 1 month	1 month	1 month	1 month	2 months	$423.22	0.846
6		Expedited by 2 months	1 month	1 month	tomorrow	2 months	$439.60	0.879
7	Additional choices	Goal completion for both options expedited by 1 month from Choice 4	tomorrow	1 month	1 month	2 months	$413.96	0.828
8		Payment for both options expedited by 1 month from Choice 7	tomorrow	tomorrow	1 month	1 month	$402.87	0.806

Results

We first examined the tasks where the trade-off in the payment dates was tomorrow versus in two months (tasks 1-3). For each task, we calculated a payment discount factor, ignoring goal completion timing (i.e., Eq. 1). In the baseline task where the goal completion and payment delays were simultaneous (task 1), the estimated (monthly) payment discount factor

(δ_{P1}) was 0.865. Compared to this baseline, expediting the approval date of the later-payment option led to significantly higher discount factors (by one month, task 2: δ_{P2} = 0.872; difference from task 1: δ_{P2} - δ_{P1} = 0.011, SE = 0.0042, $t(402) = 2.61$, $p = .010$; by two months, task 3: δ_{P3} = 0.883; δ_{P3} - δ_{P1} = = 0.018, SE = 0.0042, $t(402) = -4.30$, $p < .001$), which we attribute to the difference in goal completion timing.

We found similar results in tasks 4-6, where the payment dates were one month versus two months. In the baseline simultaneous-delay scenario (task 4), the monthly payment discount factor (δ_{P4}) was estimated as 0.830. Expediting the approval date of the later-payment option led to a significantly higher discount factor (by one month, task 5: δ_{P5} = 0.846; difference from task 4: δ_{P5} - δ_{P4} = 0.016, SE = 0.0057, $t(402) = 2.85$, $p = .005$; by two months, task 6: δ_{P6} = 0.879; δ_{P6} - δ_{P4} = 0.049, SE = 0.0093, $t(402) = 5.26$, $p < .001$).

These results again illustrate how estimates of the payment discount factor can be confounded by a separable preference for early goal completion. Specifically, the discounting of delayed rewards could be partly due to the later reward often having more of a delay in goal completion. While keeping the payment date the same, allowing for sooner goal completion led to a greater “patience”, represented by a higher overall discount factor.

Next, using all titration tasks, we fitted our extended exponential discounting model to estimate separate discount factors for goal completion and for payment (Eq. 3). We found significant discounting based on both payment (δ_P = 0.871, SE = 0.0094, $t(1614) = 13.73$, $p < .001$) and goal completion delays (δ_G = 0.974, SE = 0.0042, $t(1614) = 6.07$, $p < .001$). Again, the goal completion discount factor was significantly larger than the payment discount factor (δ_P - δ_G = -0.10, SE = 0.0094, $t(1614) = -10.96$, $p < .001$).

We also fitted the extended quasi-hyperbolic model (Eq. 5) to test for time-inconsistent discounting. We found a short-term discount factor for payment larger than 1, the opposite of diminishing impatience predicted by hyperbolic discounting (β_P = 1.032, SE = 0.012, $t(1612) = -2.61$, $p = .009$), but significant long-term discounting (δ_P = 0.861, SE = 0.011, $t(1612) = 12.92$, $p < .001$). For goal completion, we found significant short-term discounting (β_G = 0.978, SE = 0.0057, $t(1612) = 3.80$, $p < .001$), consistent with diminishing impatience, as well as long-term discounting (δ_G = 0.985, SE = 0.0048, $t(1612) = 3.05$, $p = .002$). These patterns are generally consistent with those found in Studies 5a-b.

However, our exploratory tests of time inconsistency using the specific pairs of tasks designed to test the common delay effect (i.e., changing the goal or payment timing for *both* options by one month) showed inconsistent results with the “present-bias” implied by the model-fit findings. Compared to task 7, we did observe a significantly smaller discount factor in task 8 where the payment timing in both options was expedited by one month, holding everything else constant (again based on payment timing only, Eq. 1; δ_{P7} = 0.828 vs. δ_{P8} = 0.806; $\delta_{P7} - \delta_{P8}$ = 0.022, SE = 0.0093, $t(402) = -2.38$, $p = .018$), suggesting diminishing impatience with regard to payment delays that was not captured in the model parameter β_P. However, compared to task 4, we found no significant difference in task 7 where both options’ goal completion timings were expedited by one month (δ_{P4} = 0.830 vs. δ_{P7} = 0.828; $\delta_{P4} - \delta_{P7}$ = 0.0024, SE = 0.0053, $t(402) = 0.45$, $p = .65$), which suggests constant discounting with regard to goal completion delays, again inconsistent with the significant β_G parameter in the model.

Discussion

In the context of getting paid for completing a job, we again found that people are also willing to forgo part of the compensation not just to receive the payment earlier, but also to get approved for the compensation sooner, i.e., to achieve sooner goal completion.

Compared to when goal completion coincided with payment (i.e., simultaneous delays), decoupling the goal completion from payment by offering an earlier approval date in the later-payment option led to a higher valuation of that option, represented by higher estimated discount factors, i.e., greater patience for delay of payment when goal completion is sooner.

While we found evidence for time-inconsistent discounting for goal completion based on the estimation of the quasi-hyperbolic discounting model, with steeper discounting in the short term ($\beta_G < 1$), we did not find higher impatience in the short term when we compared the specific tasks that allow for testing the common delay effect. This inconsistent result suggests that the short-term discounting factor for goal completion estimated from the quasi-hyperbolic model may be due to participants having a lower monthly discount factor for a one-month interval (1 month vs. 2 months) than for a two-month interval (tomorrow vs. 2 months), i.e., subadditive discounting (Read, 2001; Read & Roelofsma, 2003), rather than diminishing impatience. On the other hand, we found the opposite pattern for payment delays. Whereas the quasi-hyperbolic model estimate of the β_R was greater than 1, indicating higher patience in the short term, we found a significant common delay effect consistent with diminishing impatience, which suggests the opposite. This seemingly conflicting pattern may even reflect *super*additive discounting described in Scholten and Read (2006).

General Discussion

Time discounting describes people's intertemporal choices as driven by a reduced valuation of the utility from consuming a reward the longer its receipt is delayed, hence also referred to as *discounted utility* models. However, studies measuring time preferences have documented that people exhibit impatience, preferring the sooner rewards and devaluing delayed rewards more than would be dictated by normative considerations, even when consumption of the rewards may not occur upon receipt. This pattern has been particularly pronounced in time preferences elicited over monetary rewards, where people preferred to receive a check with a smaller-sooner amount, even if they did not immediately use the received rewards for consumption (e.g., cash it out; Reuben et al., 2015). Other considerations, such as perceived uncertainty or news utility, may influence intertemporal choices. These suggest a need for a framework for time discounting that encompass a broader definition of utility during intertemporal decisions, over and beyond consumption utility.

We looked to *goal gradient*–higher motivation when goal completion is more proximate–as one factor that may contribute to time preferences. Time discounting and goal gradient have often been confounded, due to the fact that rewards often accompany goal completion. Yet, some evidence suggests there are aspects of people's time preferences attributable to goal gradient that are not consistent with time discounting (i.e., greater investment when a goal is more proximal in the absence of a tangible reward or holding the payment timing fixed; Argo et al., 2020; Heath et al., 1999; Jhang & Lynch, 2015; Kivetz et al., 2006). By contrast, little has been known in the prior literature about whether time discounting is distinct from goal gradient, as receiving rewards often precedes goal completion, and thus is generally more often confounded.

To disassociate the influence of goal gradient and time discounting on intertemporal choice, we elicited people's time preferences in nine studies, separately varying the options' goal completion timing and payment timing across choices.

We first established that people prefer an option that offers earlier goal completion, such as getting approved for compensation (Study 1), lottery drawings (Studies 2, 3a), or receiving a physical card that would carry the payment (Study 3b), independent of the timing of the payment (the actual reward). At the same time, people also prefer an option that offers rewards early, consistent with time discounting, holding all else equal. Importantly, people were willing to accept a smaller payment that offers earlier goal completion over a larger reward that offers later goal completion, exhibiting a discounting-like behavior, or *impatience* for goal completion.

Furthermore, the observed preferences are not just a tie-breaker when people are otherwise indifferent between two options. We independently varied both the delay between the goal completion and payment in the options, to implement trade-offs between the two, and we found sensitivity to each, even when the other factor varied as well (Study 4).

Lastly, we proposed and estimated our extended discounting model (Studies 5-6), which posits that the net present value of an option is not only based on discounting due to the payment delay (by payment discount factor, δ_P, as in the prior discounting literature), but also by a separate goal completion discount factor, δ_G, accounting for the delay in goal completion. In our studies, both factors, δ_P and δ_G, were estimated to be significantly less than 1 (e.g., time indifference), supporting impatience for both payment and goal completion.

Our results highlight the potential confound in standard ways of measuring people's time preferences, as typically implanted in the prior literature. Had we not accounted for the different goal completion timings across the options and instead analyzed choices only based on payment timing, our estimate of people's discount rate would have been substantially biased (as illustrated in Studies 5-6), overestimating people's impatience to receive payments.

Our account can help explain some puzzling results from prior research, due to the limitations of the standard time discounting framework. For example, in Reuben et al. (2015), people may take the smaller-sooner option, even when not planning on cashing the check until later, because taking the check earlier provides subjective goal completion (similar to our debit card example).

Further, we find that impatience for goal completion can occur purely based on the resolution of uncertainty about the goal, unconfounded by other factors. Namely, we find impatience for goal completion unconfounded by the timing of the provision of effort and resources (e.g., time doing the task). Both in measurements of goal gradient and time discounting, researchers have measured people's willingness to expend effort at different times, for instance, eagerness to complete goals by examining at what time people embark on the task or exert effort (e.g., make the purchase that earns them the reward point; initiate a task or homework). While effort provision is often followed by and necessary for goal completion, effort tasks still confound goal completion and time discounting (on disutility from expending effort), and sometimes perceived availability of time (e.g., in procrastination). In contrast, we held constant the timing of the effort across options (e.g., Study 1). These support the notion of the conceptual, cognitive aspect of goal completion, that is the resolution of uncertainty itself can be rewarding, over and above tangible rewards.

In our studies, we operationalized goal completion as receiving either information or a token (e.g., non-activated debit card) that resolves uncertainty about the goal of receiving the rewards. It is important to acknowledge that uncertainty likely will not be *entirely* resolved until the rewards are received. Different forms of goal completions (e.g., workers getting their task approved, a lottery drawing, or receiving a debit card) may vary in the nature and degree of uncertainty resolved, and therefore in the degree or likelihood of subjective goal completion. Further, while we focused on one instance of goal completion in each scenario, some goals may also involve multiple phases, each phase resolving one type of uncertainty, as in our earlier example of a taxpayer first experiencing goal completion after filing the tax return and another after the IRS approves the tax return (before receiving the fund). Future research is needed to examine how people subjectively construe goal completion in a given goal-pursuit context that unfolds over time and how impatience may vary for different types of goal completion.

The main objective of the current investigation was to test whether goal completion and payment timing both affect time preferences. For this purpose, we assumed the simplest discounting model, which treats the rate of discounting as constant across time (i.e., the exponential model). A common finding in time discounting, however, is that the discount rate varies over time, leading to time-inconsistent choices (Thaler, 1981). We explored this possibility by employing an extended quasi-hyperbolic discounting model (Laibson, 1997). We found stronger evidence for short-term discounting of goal completion ($\beta_G < 1$) than for short-term discounting of payment timing, over the relatively short time periods tested. This raises an intriguing possibility, that present bias (O'Donoghue & Rabin, 1999, 2015) may have more to do with inconsistent time preferences for goal completion than for monetary payments. However, the results may instead be explained by subadditive discounting (Read, 2001) of goal completion. Future research is needed to systematically examine the nature and prevalence of time inconsistency specifically in terms of goal completion timing.

Lastly, prior research has found the interventions designed to reduce discounting varied in their effect sizes (Rung & Madden, 2018). One possibility is that different intervention designs differentially reduce the impatience for goal completion or for payment. Future research is required to better understand what factors moderate goal-based impatience and separately payment-based impatience and can contribute to reduced discounting.

In conclusion, time discounting refers to the tendency to value immediate rewards more than delayed rewards. However, delayed rewards are often tied to achieving specific goals, which creates uncertainty. The goal gradient effect suggests that motivation increases as goals approach completion. Previous research has typically neglected the distinction between time discounting and the goal gradient, confounding their effects. This research experimentally separated the timing of goal completion and reward receipt to examine their individual effects on intertemporal choice. The findings demonstrate that people’s decisions are jointly sensitive to both the timing of goal completion and the timing of receiving rewards. We offer improved models for intertemporal choices that take into account both of these effects.

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