Procrastination as temporal decision making

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ABSTRACT

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1 INTRODUCTION

Procrastination is prevalent. Many of us have encountered instances of working hastily on an assignment in the last minute, sitting on tax returns for weeks, repeatedly putting off going to the gym, etc. Procrastination is also experienced at social and national levels, for example, delaying action on pressing problems like climate change. The phenomenon is widespread with 80% of students and 20% of adults affected (**?**). In fact, many lose money (**?**), suffer effects on health (**?**), and waste precious time due to delays. Most procrastinators want to reduce it (**?**). But, what causes procrastination? How can it be assuaged? There is still much to know and understand.

1.1 WHAT IS PROCRASTINATION?

The first challenge in the scientific study of procrastination lies in defining it. In the broadest sense, it is the decision to delay, to do something later and not now. The crucial intuition is that not all delays can be considered as procrastination, as any efficient plan (and its subsequent execution) requires prioritising tasks in time and putting off some in favour of others. That is, one cannot do everything all at once. This calls for qualifying the delays to be considered procrastination.

A popular definition from (Steel, 2007) and colleagues conceptualises procrastination as 'to voluntarily delay an intended course of action despite expecting to be worse off for the delay'. This definition includes two components: deviating from an intended plan of action and sub-optimality. However, even without such a deviation, the intended time to act can itself be planned too late to meet a deadline. In practice, such delays are also considered procrastination (Fernie et al., 2017; Le Bouc and Pessiglione, 2022). In fact, (Fernie et al., 2017) distinguish between passive or unintentional procrastinators who delay a task despite good intentions vs active or intentional procrastinators who delay a task on purpose (in an attempt to maximise performance). With respect to sub-optimality, delays that are too late might still be optimal from the point of view of procrastinators, who might be maximising their own internal utility functions.

Others draw a distinction between task avoidance (abandoning a task altogether) and task delay, regarding only the latter as procrastination. A corollary is that any explanation of procrastination should also be able to account for why people eventually get around to doing a

task after initial reluctance (Zhang et al., 2019). It does make sense to draw a distinction between a decision to delay a task and a decision to not engage in a task in the first place. However, it must be noted that repeated procrastination can lead to a failure to complete. In fact real world examples do include such cases: students not completing all assignments with some missing the deadline (Steel et al., 2018) or delaying the redemption of vouchers to the point of foregoing them (Shu and Gneezy, 2010). Others draw a distinction between indecision and delaying a decided action, but decisions can also be actions that are delayed. In fact, some scales like the Melbourne Decision Making Questionnaire (DMQ) involve a few questions about procrastinating decisions (Mann et al., 1997) (like 'I delay making decisions until it is too late' or 'I waste a lot of time before getting to the final decision').

In Chapter 2, we fix some of the problems of these various definitions and integrate them into a classification of procrastination types.

1.2 MEASURES OF PROCRASTINATION

How are these conceptions of procrastination operationalised in real-world studies and what tools are used to measure them?

The most common way to measure procrastination is the use of self-reported scales and questionnaires. Some popular scales include the General Procrastination Scale (GPS) (Lay, 1986), Adult Inventory of Procrastination (AIP) (McCown et al., 1989), Decisional Procrastination Scale (DPS) (Mann et al., 1997), Irrational Procrastination Scale (IPS) (Steel), Pure Procrastination Scale (PPS) (Steel, 2010), etc. The items on these traditional scales capture:

1. delays beyond what is intended (eg: I find myself performing tasks I had intended to do days before; I am continuously saying "I'll do it tomorrow")
2. difficulty in meeting deadlines (eg: I don't get things done in time; I find myself running out of time)
3. doing things in the last minute (eg: I buy even essential things in the last minute; I do not do assignments until the day before a deadline)
4. wasting time (eg: in preparation for a deadline, I often waste time by doing other things or trivial matters; when I should be doing one thing I do another; I could have spent my time better)
5. unnecessary or unreasonable delays (eg: I generally delay before starting on work; I delay tasks beyond what is reasonable)
6. disadvantage due to the delay (eg: missing deadlines; efficiency or well-being suffers; my life would be better if I did some things earlier)

A factor analysis of three of the procrastination scales (GPS, AIP, DPs) yielded three factors: the first captures habitual and disadvantageous delays, the next associates with rushing and keeping appointments, and the final captures promptness (Steel, 2010).

In contrast to this irrational form of procrastination accompanied by negative outcomes and emotions, the Active Procrastination Scale (APS) was developed to capture purposeful delays made in order to improve performance or use the efficiency gained from time pressure (**?**). Critically, no evidence was found that such preferences had any association with better achievement or performance (**?**). (**?**) developed the Unintentional Procrastination Scale (UPS) to better identify specifically unintentional types, separate from voluntary delays.

There are also task-based (and task-specific) measures of procrastination behavior which simply calculate the extent, rate or pattern of delays. (Lieder et al., 2019) measured it as the completion rate in a naturalistic task consisting of writing assignments, (Steel et al., 2018) measured the cumulative sum of number of assignments submitted through the course of an undergrad psychology class, (Shu and Gneezy, 2010) also measured a completion rate of voucher redemptions and museum visits in their survey populations and more recently, **?** calculated the mean completion time of compulsory research units in a psychology course. In more controlled tasks like in (Le Bouc and Pessiglione, 2022) and (Zentall et al., 2020), procrastination is measured as percentage of choices to delay an action than doing it earlier.

1.3 CAUSES OF PROCRASTINATION

Equipped with an understanding of procrastination as a construct and tools to measure it, past studies have identified some correlates and factors that are very useful in illuminating the possible causes of procrastination.

One line of empirical work has focused on discerning personality traits and other such individual differences that are correlated with procrastination behavior which also has trait-like stability across time and contexts (**?**). The big-five framework of personality traits has been particularly popular in these attempts to find predictive factors (**?**). Conscientiousness is a factor that includes qualities of responsibility, self-regulation and self-control, organisation, discipline, achievement motivation and industriousness (**???**). Procrastination can be understood partly as a lack of self-control, organisation and other aspects of conscientiousness. Indeed, correlations between procrastination and these sub-factors of conscientiousness have been found in various populations (**??**). Subsequent meta-analyses have shown an average correlation of -0.62 (**?**). Some characteristics of another big-five personality trait, neuroticism like impulsiveness, low self-esteem, worrying, irrational beliefs about oneself, perfectionism and self-handicapping have also been proposed as reasons for procrastination (**?**). Self-efficacy and self-handicapping show high average correlation (-0.38 and 0.46) (**?**). Among other sub-factors of neuroticism, however, only impulsiveness shows a strong average correlation (**?**). In fact, effects of neuroticism disappear when conscientiousness is accounted for (**??**). On the other hand, factor analyses of

questionnaires have revealed some dimensions that include specific forms of irrational beliefs like fear of failure as reasons for procrastination (**?**). Effects of other factors like openness/ intelligence, extraversion and agreeableness do not have a significant association with procrastination(**?**). Procrastination was also linked with maladaptive coping styles to stress, like denial, self-blame and substance-abuse (**?**) and prioritisation of short-term mood regulation over long-term goals (**?**).

Another approach has been to identify characteristics of tasks that are most likely to be procrastinated. Tasks that are aversive in some way, like being too effortful, anxiety-inducing or boring are one of the most common reasons why people postpone tasks (**??**). It consistently turns up as a dimension in factor analyses of procrastination questionnaires (**?**). The timings of rewards and punishments, deadlines and time pressure in a task is also indicated to play a role. For example, students indicate that they would delay less as a task nears a deadline (**?**).

1.4 AIM OF THE PROJECT

This brief review of research in procrastination reveals the following. The numerous, complementary definitions of the construct encapsulate everything from unintentional to intentional delays, optimality, defections, necessity and advantage. This suggests that there are multiple dimensions of interest that distinguish different types of procrastination. These are also queried in the various questionnaires. Next, there are also as many explanations and reasons for why someone procrastinates as suggested by the correlations.

Our aim is to tackle the multifaceted nature of this phenomenon by constructing a taxonomy based on principles from decision theory and reinforcement learning. We integrate the many complementary understandings and routes to procrastination into the framework. This is followed by simulations of some of the explanations that elucidate details of how task characteristics and decision structure interact with these plausible mechanisms of temporal preference for delays.

2 TAXONOMY

2.1 OUR TAXONOMY AND DEFINITION

Based on the limitations of previous definitions and the notions captured by questionnaires, we propose two main types of procrastination:

1. A deliberate decision to delay a task such that it is insufficient to complete it satisfactorily or in time, due to rational or irrational reasons. Or,
2. Unintentional delaying of actions, possibly in spite of intending otherwise. This can also be due to rational or irrational reasons.

Here, being rational means acting to maximise one's personal utility function.

2.1.1 The nature of delays

How do the delays specified by the aforementioned types actually look like? The first type refers to the delays where a person sticks to an intended time of action but finds it insufficient for a deadline. These could look like decisions to delay as means to optimise performance or miscalculations in the attempt to do so. The second type captures the more conventional conceptions of reneging on an intended time point of action. It could also include repeated delaying while not committing to a future time or delays stemming from the decision to work after initially choosing to abandon the task.

As we shall see in Chapter 3, the delays can be in the start, continuation or completion of a task. So for example, a job may be started promptly, but the subsequent work might be procrastinated.

2.2 EXPLANATIONS

Now that we have laid out the types of procrastination, we turn to examining explanations for how they arise. Firstly, what persuades someone to engage in a task at all and not abandon it?

Do they commit to a time of action or not? If they don't, what makes them do the job later? Why would someone commit to doing it too late? What are the mechanisms that drive defections on these plans? This can be envisioned as a tree as shown in Figure **??**. For each of these questions, we combine previously proposed mechanisms with suggestions of our own.

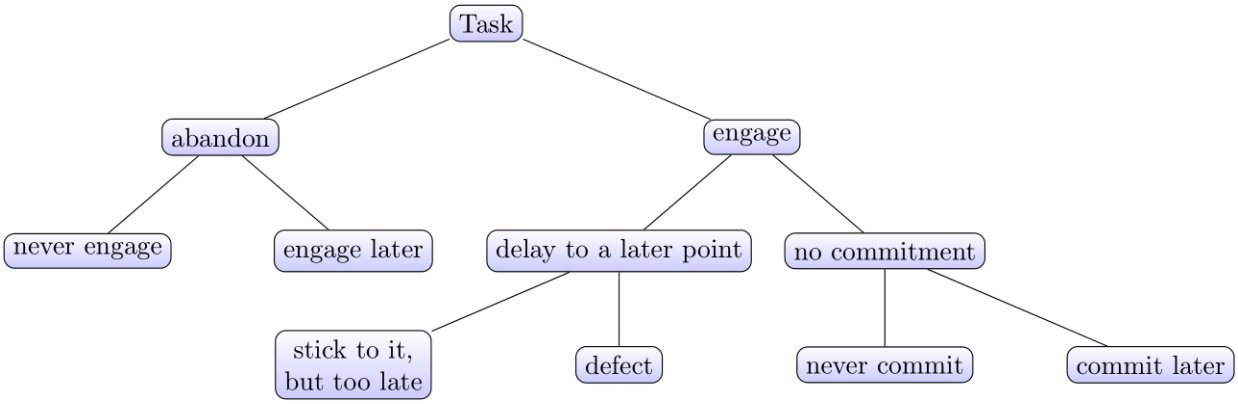

Figure 2.1. An illustration of the type of delays in the form of a tree that constitute procrastination. Possible explanations for each branch point can aid our understanding of why someone procrastinates.

2.2.1 Why engage?

The first question that arises is why it is worth engaging in a task and not abandon it all together. That is, why plan to work even if later? One motivator can be the potential reward (a good grade, better health, internal satisfaction) to be gained on completing the task successfully or an additional negative outcome on non-completion (bad grade, losing money, internal costs like feeling of failure). It could then make sense to forsake the task if the efforts required, be it physical or cognitive energy, money or time required outweigh the potential outcomes from completion. In the next sections, we discuss what might underlie a decision to delay a job that's worth engaging in.

2.2.2 Why commit but late?

Temporal discounting

A dominant explanation provided for procrastination is related to temporal discounting of outcomes. It refers to the subjective diminishment of reward with delay. (Steel and König, 2006) proposed the temporal motivation theory (TMT) of procrastination where the utility of a task scales with the expected value from the task and is inversely proportional to the delay to the reward with a discounting factor (γ) capturing sensitivity to delay:

$$Utility = \frac{E * V}{1 + \gamma * delay} \tag{2.1}$$

According to this theory, procrastinators are impulsive and hence prefer tasks with immediate rewards (can be thought of as temptations) to more temporally distant ones. Hence, working on a task with distant rewards (like an assignment that is graded after the deadline) is procrastinated. Recently, (**?**) demonstrated correlation between procrastinators in a real-world task and their respective discount factors found empirically.

(Zhang et al., 2019) generalised this framework by also including the intrinsic costs of engagement, usually negative, especially for aversive tasks. Here, procrastination is a result of opposing motivations to postpone costs of engagement in the short term and an increasing motivation (towards the delayed reward) to obtain the positive outcome. Hence, delaying can occur even if there isn't a competing reward. Procrastination happens through a series of decisions of to do a task now or not until the net utility is higher for doing:

$$Utility = \frac{E_{outcome} * V_{outcome}}{1 + \gamma_{outcome} * delay_{outcome}} - \frac{E_{engage} * V_{engage}}{1 + \gamma_{engage} * delay_{engage}} \tag{2.2}$$

People might weigh these negative and positive utilities differently. Those with more self control might weigh outcome utility more than task aversiveness. The TMT relies on the presence of a delay between doing the task and delivery of the outcomes. The motivation to engage in a task increases as the delay to receiving the reward (usually at the deadline) reduces. But, as mentioned before, tasks where the rewarding outcome is delivered immediately are also procrastinated. Further, while being a dominant explanation, procrastination behavior is not synonymous with impulsivity. As discussed before, other personality traits like fear of failure, rumination, (lack of) organisation etc also predict procrastination **??**. Hence, we also outline other explanations that do not specifically depend on discounting.

Self efficacy

Self-efficacy can be thought of as the estimated probability to achieve an outcome on doing an action. Low self-efficacy has been associated with procrastinating behavior through responses on questions testing such beliefs (Rozental and Carlbring, 2014). A simple explanation can build on the TMT, where people with low self-efficacy have a low expectancy to obtain a reward (low $E * V$) and so, it is not worth engaging in a task until relatively later to obtain a delayed reward. Such beliefs in inability can become self-fulfilling, with lower performance reinforcing belief in low efficacy which in turn can lead to procrastination and lower performance on task (Rozental and Carlbring, 2014).

This reasoning can also seem a bit simplistic. Someone who is aware of their low efficacy might decide to actually start earlier to ensure better chances of finishing the task in time. We

might find the opposite problem where, over-estimation of one's abilities or belief that a task is easier than it is, might result in a decision to start later than required. This is a gap between a person's estimates and the real ability or task difficulty. A specific case of such a bias could be the planning fallacy which involves an underestimation of the amount of time it will take to complete a task (Rozental and Carlbring, 2014).

Arousal

Procrastination might result from a belief that there is a more opportune time in the future to complete the task successfully or more efficiently. For example, performing a task closer to a deadline could improve efficiency or general arousal due to the urgency induced by the time pressure Steel (2007). People might then decide to start a task later in time to utilise the improved performance, finding themselves unable to engage due to insufficient motivation in the present. Perhaps, they do not foresee that it could leave inadequate time to complete the task. However, one could eventually learn to find the 'right time' to start a task from errors on repeated encounters with the situation. In past studies, task deadline and delay for a reward are identical, potentially conflating their separate effects.

Anticipation of a better future

Belief (correct or incorrect) that the situation will improve in the future can lead to a decision to postpone. While this could still be the optimal decision, this might lead to a subpar performance on the task.

Ego protection

Someone anticipating failure or under-performance at a task could plan to delay it long enough or engage in unrelated tasks in an act of self-handicapping, setting themselves up for failure Ferrari (1992); Rozental and Carlbring (2014). This allows them to deflect blame to the act of starting late rather than their inability, preserving their own reputation in the process.

Negative discounting

Negative discounting is the preference to have positive outcomes later and negative outcomes sooner. It accounts for more far-sighted behaviour as opposed to the traditional discounting theories discussed before which explain myopic behaviour. (Loewenstein, 1987) posits an anticipatory value associated with the time preceding an enjoyable or aversive outcome that could lead to negative discounts. So pleasurable events like a kiss from a favourite celebrity might be delayed in time in anticipation (savouring), but not forever due to a positive discounting of value. Similarly, anticipation of negative events like a shock can induce a dread that causes one to want to expedite the outcome instead of avoiding it indefinitely.

Hence, for immediate rewards, procrastination can arise directly from delays due to savoring. We could also think of negative outcomes that come at a delay which might seem less aversive in the future due to negative discounting. This could lead to a delay of actions required, say in preparation for this inevitable negative event. This may be preparing for a dreaded talk or calling your doctor to remind her of a scheduled appointment.

Heuristics

Another perspective on the impulsivity explanation comes from (Lieder et al., 2019). They posit that planning out the optimal set of actions in the future (optimal policy) is not always possible due to limited cognitive resources and even if planned, a lapse in self-control might override this long-term plan in favour of immediate impulses. This could be described as a heuristic where only short term rewards are optimised over tasks with more distant rewards like a writing assignment with a deadline, leading to a delay similar to the discounting explanation in the temporal motivation theory.

Avoiding information

People could be worried that a task will turn out to be more difficult than they thought (for example, in terms of effort required or their own skill level). Hence, they could delay starting a task to avoid finding information that would confirm their fears. The benefit of doubt is the possibility that a positive outcome can be gained while resolving uncertainty eliminates this. In short, people might delay resolving uncertainty due to a pessimistic expectation.

2.2.3 Why not commit?

Waiting for an opportune time

Unfavourable circumstances or environment in the present can lead to a decision to put off doing a task now and wait for more suitable circumstances where performance would be better. This might manifest in a non-commitment to act until better conditions are in sight. A potential danger with this is that the better future might never arrive or arrive too late (for a deadline) or the circumstances might actually get worse with time without action.

Waiting for information

When some aspects of the task are uncertain to people, it might make sense to collect more information before working, especially when a decision is irreversible. Some examples could be waiting to see if a medical problem can be mitigated without an expensive intervention, or delaying submitting a paper in the hope that it could be made better. This could lead to repetitive delaying until 'enough' information has been acquired. There are also often different preferences regarding how much information to collect before committing to a decision with some being more averse to

risk while others being more tolerant (Choi et al., 2007). For decisions about when to do a task, some might decide to wait for longer to learn or collect more information in order to perform better.

Rumination

Another basis for delaying could be rumination or worry, both of which have been linked to procrastination (Constantin et al., 2018). Rumination is repetitive negative thought about past events, while worry is also repetitive thought but about the future perhaps due to (and in an attempt to resolve) uncertainty in future outcomes. These can be conceived as an internal evidence accumulation process **??**. Both can lead to dilatory behavior through waiting to collect enough information before working, like in the previous case.

2.2.4 Why defect?

Non-exponential discounting

In the section on temporal discounting, we discussed one aspect of the discounting curves that may underlie procrastination. Namely, the subjective reduction in value with delay. Another important aspect is the shape of the curve itself. It turns out that only exponential discount curves preserve a consistent preference between different options in time. All non-exponential curves lead to preference reversal, where a choice between distant outcomes can reverse closer to the events contrary to initial intentions (Loewenstein and Elster, 1992; **?**). For our purposes, this means that a decision to work on a task in the future can be defected on closer to the time of working, hence, procrastinating yet again.

Differential discount factors

Another explanation is that procrastination could arise from steeper discounting of effort costs associated with a task than rewards, making a task look more effortful now than later, but not much more rewarding. (Le Bouc and Pessiglione, 2022) model delays as one-off or repeated decisions about when to do an effortful task (in return for immediate reward) based on a maximisation of net discounted utility from efforts and rewards:

$$d = argmax_{delay}\left(\frac{V_{reward}}{1+\gamma_{reward} * delay} - \frac{V_{effort}}{1+\gamma_{effort} * delay}\right) \tag{2.3}$$

where d is the chosen delay. From laboratory and at-home experiments, they find a steeper discounting of efforts than rewards associated with procrastination behavior.

Having different discount factors also has implications for the time consistency of the temporal decisions, even if each is exponential. The decision to work is made when it seems

better to work than not. However, when the discount rates are different, this point of intersection can shift in time, leading to a defection on previously intended point of action. We discuss this case extensively in Chapter 3.

This, of course, doesn't explain *why* such differential discounts exist in the first place. One suggestion comes from (Shu and Gneezy, 2010) who also put forth this theory in an attempt to account for the findings that people put off going to exhibitions and museums or redeeming gift vouchers, both of which have immediate pay-offs. For (Shu and Gneezy, 2010), the overestimation of present efforts could be due to an over-prediction of free time one will have in the future compared to now, perhaps inflating the perceived opportunity costs of engaging in the task now (Zauberman and Lynch, 2005) Another related idea is that people pay more attention to whether a task is feasible in the present but more on its desirability in the future (Trope and Liberman, 2003).

(Shu and Gneezy, 2010) find that introducing shorter deadlines actually improves rate of redemption / completion of tasks. Similarly, (Le Bouc and Pessiglione, 2022) find an expedition of time of effort exertion when delays are framed as precise dates to act rather than deadlines. These are not explained by the theories of differential effort perception, suggesting the role of other components like dread (Loewenstein, 1987) or arousal closer to the deadline (Steel, 2007).

Unexpected changes in task or environment

Another explanation for defections can be unexpected changes in the task or some aspect of the environment. This can mean going back on the intention to act when the anticipated suitable conditions do not arrive or deciding to work due to unexpected improvements despite initially deciding to abandon the task.

2.2.5 Learning theories

Learning theories describe how decisions to delay might be reinforced to start even later the next time, ultimately leaving insufficient time for the task. However, there can also be learning away from procrastination with repeated encounter with negative consequences of delaying a task. In fact, there is evidence that people procrastinate less with practice, and in general, with age **??**.

Delay reduction theory

The delay reduction theory is a learning theory according to which, the closer a stimulus occurs in time to a primary reinforcer, the more effective it is as a conditioned reinforcer (Fantino et al., 1993). (Zentall et al., 2020) use this to explain a series of findings of procrastinating behavior in pigeons, where the birds prefer to delay an aversive gap or an effortful pecking requirement preceding reinforcement. In fact, even in the absence of an aversive event, pigeons prefer a long followed by a short, signalled interval to reinforcement rather than a short-long chain (Zentall et al., 2018). The authors think of this as a route to procrastination, where an action or a response

made closer to a primary reinforcement is reinforced, hence prompting learning to delay actions. The assumption here is, of course, that the primary reward occurs at a fixed time in the future. (Zentall et al., 2020) actually observe that the aversive gap significantly increases preference for the delayed option compared to their original experiment in (Zentall et al., 2018).

Relief

Performing an aversive task or a task to avoid negative outcomes can induce a negative utility of anticipation with time to the outcome (dread) or engagement Loewenstein (1987). However, eventual completion of such a task can lead to an (unexpected) positive relief in proportion to the dread, which might reinforce performing an action even later in time with repeated presentations of the task.

2.3 IN WHAT SITUATIONS DO PEOPLE PROCRASTINATE?

As already hinted at in the previous section, the reasons for and type of procrastination observed is very much dependant on the type of situation and task encountered. We consider and categorise both the structure of tasks and the task attributes or characteristics that affect procrastination.

2.3.1 Task structure

Presence of deadlines and time-pressure: Procrastination is often examined in situations where a task must be completed by a deadline, where people put the task off even at the prospect of not making it in time. A popular example is the time-bound submission of assignments by students. Students often delay submissions until close to the deadline (following a hyperbolic curve), sometimes even missing the deadline (Lieder et al., 2019; Steel et al., 2018). However, dilatory behavior can also be observed in more relaxed time conditions with far-away (or no) deadlines or situations where there is no time pressure as such. For example, pigeons and people delay effortful actions in laboratory tasks where a forced choice is presented between exerting effort at two points in time (Le Bouc and Pessiglione, 2022; Zentall et al., 2020). Here, subjects are not under any time pressure but simply have to indicate their preferred time of action. Other examples with no deadlines include scheduling medical appointments or starting a workout routine or fitness program.

Delays in rewards: Procrastination is often considered in tasks where the benefits are temporally distant from the time of action. This includes submission of assignments where the grades come at a lag (Steel et al., 2018), signing up for an employer's health plan (**?**), visiting a dentist or doctor where many a time the benefit is only the prevention of future harm or saving up for retirement where the fruits of prudence can only be enjoyed several years or even decades later (Rozental and Carlbring, 2014). However, procrastination can also occur in tasks where rewards are experienced immediately. People seem to put off redeeming gift vouchers at the risk of expiry,

even if benefits are almost instant (Shu and Gneezy, 2010), subjects prefer to delay actions in controlled experiments where quantified rewards can be obtained immediately for certain efforts (Le Bouc and Pessiglione, 2022).

Change in circumstance: Task characteristics like utilities obtained from a task or efforts required to complete it, need not stay constant in time, but can be evolving. For example, one's health might be worsening with time without a doctor's care, the amount of effort needed to study and pass an exam might increase with delays and so on. In other words, the action of delay can also have consequences.

2.3.2 Task characteristics

Aversive and enjoyable tasks: People consistently indicate that tasks they find unpleasant, frustrating, boring, effortful, or anxiety-inducing (Steel, 2007) are top reasons for procrastination. Further, the more one dislikes a task, the more likely it is to be delayed (Zhang et al., 2019). Therefore, aversiveness might contribute to delays. On the other hand, tasks which people consider enjoyable or not particularly aversive like redeeming a gift voucher or visiting museums are put off too (Shu and Gneezy, 2010), though these tasks also involve some effort (like filling a form or expending time to enjoy the museum). In addition, tasks often come with an outcome utility (Zhang et al., 2019). This can be a negative outcome on failure to complete the task (like bad grades or decaying teeth) or a positive outcome on completion (like a redeemed gift).

Uncertainty in outcomes: One aspect that has been relatively unconsidered in past analysis is the uncertainty regarding different aspects of the tasks. In some tasks, the outcome from performing the task is certain, like the value of a gift voucher or the reward size from executing an action in a controlled task. In others, the outcome is uncertain, like the grade for an assignment, health outcome in the future, etc. There can be uncertainty in the efforts required to obtain (or avoid) outcomes, uncertainty regarding current state be it health status or amount of knowledge accumulated at present (for a test).

3 RESULTS

4 DISCUSSION

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