

Eindhoven University of Technology

MASTER

An inquiry on the relationships between temporal discounting, self-determination, pacing style and task prediction accuracy

Shumbiliev, D.E.

Award date:
2017

Disclaimer

This document contains a student thesis (bachelor's or master's), as authored by a student at Eindhoven University of Technology. Student theses are made available in the TU/e repository upon obtaining the required degree. The grade received is not published on the document as presented in the repository. The required complexity or quality of research of student theses may vary by program, and the required minimum study period may vary in duration.

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain

Take down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Eindhoven, July 2017

**An Inquiry on the Relationships
between Temporal Discounting,
Self-determination, Pacing Style
and Task Prediction Accuracy**

by
D. Shumbiliev

Student identity number 788518

in partial fulfilment of the requirements for the degree of

**Master of Science
in Innovation Management**

Supervisors:

First Supervisor: dr. J. Gevers, TU/e

Second Supervisor: dr. P. Calseyde, TU/e

Third Assessor: dr. J. Li, TU/e

TUE. School of Industrial Engineering.
Series Master Theses Innovation Management

Subject headings: self-determination theory, temporal discounting, work motivation, pacing style, prediction, planning fallacy, task completion times

Managerial Summary

Project managers face pressure to minimize cost-overruns and meet schedules. Achieving these goals requires accurate planning and execution of tasks within a project. However, accuracy of plans is usually hindered by the so called optimistic prediction bias as shown by previous research (Buehler et al., 1994, 1995). In addition, individuals differ in terms of the choices they make regarding the distribution of their effort along the duration of tasks which can harm synchronized execution of interdependent tasks executed by different individuals. Both of these issues may create difficulties in meeting schedules. Whereas an increased understanding of the emergence of individual effort exertion patterns can be helpful to achieve better synchronization between individuals, having a better understanding of the optimistic prediction bias is beneficial for accuracy of overall project planning.

The present study aims to explain one of the mechanisms behind the optimistic prediction bias as well as emergence of effort exertion patterns in an attempt to help managers plan and orchestrate projects. In order to achieve this goal, a research model is proposed, which comprises temporal discounting in addition to self-determination theory. Temporal discounting, in short, refers to the decrease of present subjective valuation of a future reward as the delay to that reward is increased (Kirby & Maraković, 1995). Furthermore, the rate of temporal discounting varies between individuals. Self-determination theory classifies different types of motivation, on a continuum of self-determination, based on different purposes or reasons that give rise to an action (Ryan & Deci, 2000). These two theoretical concepts, separately and in union, are utilized to explain the emergence of specific effort exertion patterns and the accuracy of task completion time estimations.

The present study utilizes the construct of pacing style as the measurable form of effort exertion patterns. Pacing style is defined as behavioral inclination for distribution of effort over time when working on situations with deadlines (Gevers et al., 2015). Deadline action pacing style represents the form of effort exertion where most of the task related effort is exerted during

late stages of a task. In contrast, early action pacing style stands for the effort exertion pattern where majority of the effort is spent at the early stages of a task. U-shaped action pacing style represents the pattern of effort where effort levels are high at both beginning and end but low during middle stages of a task. Finally, steady action pacing style represents the form of effort distribution where effort is equally distributed over time.

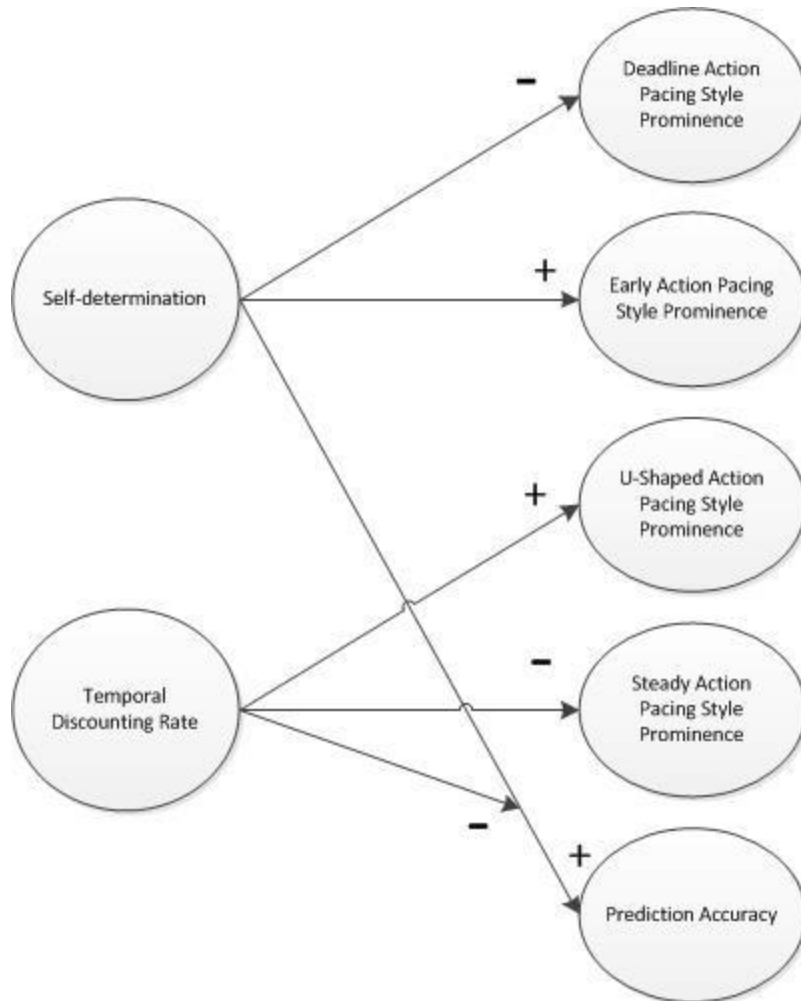


Figure 1 - Research Model

A survey was conducted with 46 subjects. Regression analyses were carried out in order to test the hypothesized relationships shown in figure 1. Results indicate that more self-

determined behavior is associated with higher prominence of early action pacing style, while less self-determined behavior is related to higher prominence of deadline action pacing style. Many projects have multiple participants executing different units of work with interdependencies. Some of those require intermediate outputs from other tasks in order to advance beyond this point of dependence. In such cases, continuous execution of one task is possible only if that intermediary output is ready before the dependent party needs it. Findings of this study provide a possible way to manage for synchronization problems of this sort. Managers can use individual self-determination profiles to anticipate participants' effort exertion pattern. Then, tasks which require intermediate outcomes can be assigned to individuals who are more self-determined, thereby reducing the probability of possible blocking situations between dependent tasks. Alternatively, if possible, managers can also try to promote self-determination by making tasks more engaging.

Another finding was that more self-determined action is associated with lower discrepancies between predicted and actual task completion times. This result indicates that individual self-determination profiles can be used to anticipate the discrepancy between estimations and actual completion times where task prediction and execution are fulfilled by the corresponding participant. Equipped with that knowledge, managers can utilize introduction of individually tailored slack into their project plans in order to buffer possible discrepancies between plans and action. This approach has a potential to yield a timelier project completion compared to no slack or a default slack. Furthermore, if possible, eager managers can take a more proactive attitude and try to match tasks with participants who are more self-determined in their actions towards those particular types of tasks.

Table of Contents

Managerial Summary	1
1. Introduction.....	6
2. Self-Determination and Effort Exertion Patterns.....	8
2.1. Types of Regulatory Style.....	8
2.2. Effort Exertion in Early and Late Stages of Task Execution	11
2.3. Types of Regulatory Style and their Relationships with Effort Exertion Patterns	
13	
3. Temporal Discounting and its Relationship with Effort Exertion Patterns	16
4. Accuracy of Task Completion Time Estimations.....	20
4.1. Prior Inquiry on the Optimistic Prediction Bias.....	20
4.1.1. Previous Research on Mechanisms behind the Prediction Bias.....	21
4.1.2. Factors Found to be Related to the Prediction Bias by Previous Research..	22
4.2. Proposed Mechanism which Contributes to Prediction Accuracy	23
4.2.1. The Discrepancy between Planned and Actual Behavior	24
4.2.2. Self-determination and Prediction Accuracy	27
4.2.3. The Impact of Temporal Discounting Rate on the Relationship between Self-	
determination and Prediction Accuracy	28
5. Method	30
5.1. Subjects	30

5.2. Measures.....	31
5.2.1. Temporal Discounting Rate	31
5.2.2. Pacing Style Prominence.....	34
5.2.3. Self-determination, Internal and External Regulation.....	36
5.2.4. Accuracy of Task Completion Time Estimation.....	37
5.2.5. Demographic and Occupational Variables.....	38
5.3. Reliability Analysis of Constructs.....	38
5.4. Data Analyses.....	39
6. Results.....	41
7. Discussion.....	44
7.1. Theoretical Implications.....	45
7.2. Managerial Implications.....	46
7.3. Limitations and Directions for Future Research	47
7.4. Epistemological Analysis of the Method	49
References.....	50

1. Introduction

In 1969, the mayor of Montreal stated that the 1976 Olympics would be featuring a state of the art coliseum which would have the first ever retractable roof built on a stadium. The whole Olympic venture was supposed to cost \$120 million. However, due to a range of reasons the stadium roof was not in place until 1989 (13 years later than planned), and had a final cost of \$120 million just by itself (Buehler et al., 1994). Similarly, initial plans for Sydney Opera House in 1957 predicted that it would be finished in 1963 with a budget of \$7 million. However, the project was finalized in 1973 (10 years later than planned) with a cost of \$102 million (Roy et al., 2005). Although many projects face similar problems, famous cases such as these exhibit how wrong initial plans for projects can turn out to be.

Project managers face pressure to minimize cost-overruns and meet schedules. Achieving these goals requires accurate planning and execution of tasks within a project. However, accuracy of plans is usually hindered by the so called optimistic prediction bias as shown by previous research (Buehler et al., 1994, 1995). In addition, individuals differ in terms of the choices they make regarding the distribution of their effort along the duration of tasks which can harm synchronized execution of interdependent tasks executed by different individuals. Both of these issues may create difficulties in meeting schedules. Due to the fact that many projects with a considerable size include multiple individuals participating in the execution of interdependent tasks, synchronization of these individual's effort exertion patterns is as important as the accurate estimation of task completion times. Whereas an increased understanding of the emergence of individual effort exertion patterns can be helpful to achieve better synchronization between individuals, having a better understanding of the optimistic prediction bias is beneficial for

accuracy of overall project planning. In other words, a better understanding of optimistic prediction bias can aid to accurate temporal planning of individual tasks of a project while an increased understanding of the emergence of individual effort exertion patterns can provide aid for accurate temporal planning of interdependencies between tasks where an intermediary output from one task is an input to another. Thus, increased understanding of these concepts can help in meeting schedules.

The present study aims to explain one of the mechanisms behind the optimistic prediction bias as well as emergence of effort exertion patterns in an attempt to help managers plan and orchestrate projects. In order to achieve this goal, a research model is proposed, which comprises temporal discounting in addition to self-determination theory. Temporal discounting, in short, refers to the decrease of present subjective valuation of a future reward as the delay to that reward is increased (Kirby & Maraković, 1995). Furthermore, the rate of temporal discounting varies between individuals. Self-determination theory classifies different types of motivation, on a continuum of self-determination, based on different purposes or reasons that give rise to an action (Ryan & Deci, 2000). These two theoretical concepts, separately and in union, are utilized to explain the emergence of specific effort exertion patterns and the accuracy of task completion time estimations in individuals. Having insight into these mechanisms may help managers to reckon with individual team members' idiosyncratic tendencies in predicting and executing tasks, thus aid in planning and orchestrating projects towards timely completion.

2. Self-Determination and Effort Exertion Patterns

In this section, self-determination theory (Deci & Ryan, 1985) will be introduced and utilized as a factor for effort exertion rate in early and late stages of task execution.

An individual who is activated or energized to meet a goal is considered to be motivated. People can vary in not just the amount of motivation they have, but also the type of motivation they have. For example, a student's high motivation to study for a course can be due to his or her curiosity and interest for content of the course or it can be due to the outcomes (teacher's or parents' approval) he or she is expecting by achieving a high grade (Ryan & Deci, 2000). Two cases mentioned in this example represent different types of motivation, respectively, intrinsic and extrinsic motivation.

In their book, called "Intrinsic motivation and self-determination in human behavior", Deci and Ryan (1985) introduced self-determination theory where they classified different types of motivations based on different purposes or reasons that trigger an action (as cited in Ryan & Deci, 2000). This theory considers different types of regulatory style (motivation) on a continuum of self-determination (Howard et al., 2016). The following subsection offers a short introduction on each distinct regulatory style identified by Ryan and Deci (2000) and their respective positions on the self-determination continuum.

2.1. Types of Regulatory Style

Although thought of as a continuum in terms of internalization and locus of causality, Ryan and Deci (2000) distinguished two main categories of motivation: extrinsic and intrinsic motivation. Authors define extrinsic motivation as acting on something due to the separable outcomes resulting from that action. Furthermore, authors state that extrinsic motivation

contrasts with intrinsic motivation, which refers to executing an activity simply for the enjoyment of activity itself rather than instrumental value of outcomes of that activity.

Deci and Ryan (1985) introduced organismic integration theory as a sub theory of self-determination theory in order to explain different types of extrinsic motivation and the contextual factors which increase or decrease internalization and integration of the regulation of these behaviors (as cited in Ryan & Deci, 2000). The term of internalization is defined as the process of taking in a regulation or value, while integration is defined as the process which leads to the more complete transformation of regulation into one’s own so that it will originate from one’s self (Ryan & Deci, 2000). Figure 2 shows taxonomy of types of human motivation as suggested by organismic integration theory.

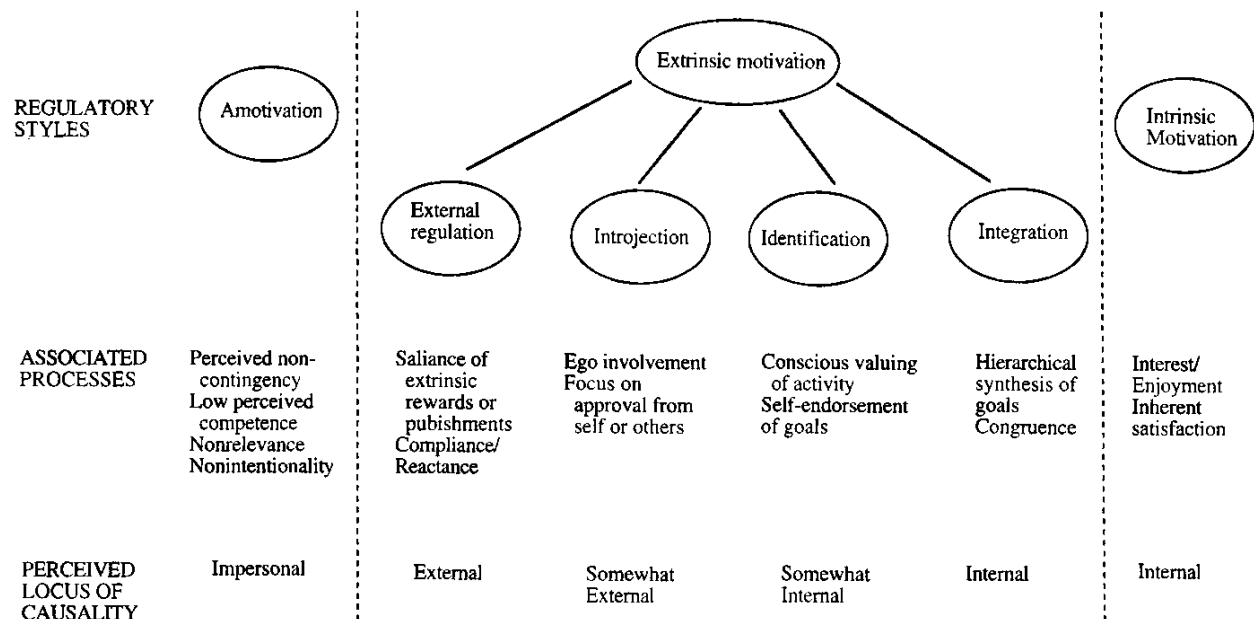


Figure 2 - Taxonomy of Types of Human Motivation (Ryan & Deci, 2000)

Amotivation, is defined by Ryan and Deci (Ryan & Deci, 2000) as the state at which an intention to act is absent. Authors state that situations such as not valuing an activity, not believing that the activity will lead to desired outcomes, or not feeling competent to execute an activity result in amotivation.

External regulation is the least autonomous type of extrinsic motivation (Ryan & Deci, 2000). This form of extrinsic motivation is characterized by experiencing an external perceived locus of causality. Ryan and Deci (2000) also state that these types of behaviors are carried out to meet an external demand or reach an externally imposed reward.

Introjected regulation, another form of extrinsic motivation, is also being controlled by external factors. That is to say, individuals execute these activities with the sense of pressure for avoiding anxiety or guilt or to enhance their ego (Ryan & Deci, 2000). In other words, introjection represents regulation by forces of self-esteem. An example of this type of motive would be the motivation of a student to study for a subject in order to avoid embarrassment caused by failing that subject.

Regulation through identification is a type of extrinsic motivation at which the individual has identified with the personal value of a behavior and because of that he or she has acknowledged its regulation as his or her own (Ryan & Deci, 2000). An example of this type of motive would be the motivation of a student to study hard for chemistry course in order to realize his or her life goal of becoming a chemist. In this example, the student has identified with the value of studying for that course.

Integrated regulation is the most autonomous form of extrinsic motivation. Integration takes place when identified regulations are completely assimilated to the self (Ryan & Deci, 2000). Self-determination of extrinsically motivated activities increases as one internalizes the reasons for those activities.

Finally, Ryan and Deci (2000) define intrinsic motivation, the most internalized form of regulation, as acting on something due to interest or enjoyment in that action rather than separable outcomes resulting from that action. White (1959) was the first to recognize intrinsic

motivation when he acknowledged that many living entities engage in curiosity-driven, playful and exploratory behavior even when there is no reward present. That behavior was not driven by instrumental reason, but more likely by the positive experiences arising from exercising and extension of individual competences. Ryan and Deci (2000) acknowledged that not every individual is motivated by any specific activity, but rather everybody is intrinsically motivated for different sets of activities.

To summarize, types of regulation are thought to be on a continuum where the more an individual internalizes the reasons for an action and assimilates them to the self, the more that individual's externally motivated actions become self-determined. To such an extent that, properties like being autonomous and unconflicted are shared between integrated forms of motivation and intrinsic motivation (Ryan & Deci, 2000).

2.2. Effort Exertion in Early and Late Stages of Task Execution

In the context of task related behavior, motivation is the manifestation of value attached to execution of a task as per expectancy theory (Vroom, 1964). Expectancy theory posits that individuals establish cognitive expectancies related to the outcomes of behavior and consequently behave in a way that is likely to result in preferred outcome states (Oliver, 1974). Likewise, in the context of task related behavior, this suggestion links motivation with behavior or effort in general in that individuals are expected to exert effort in certain task related behavior when they expect that this behavior will lead to the desired outcomes.

However, when outcomes are distant in time, they have less impact on individuals' decision to act since values of outcomes are subject to temporal discounting (Steel, 2007). Kirby and Marakovi'c (1995) define the phenomenon of temporal discounting as the decrease of present subjective valuation of a future reward as the delay to that reward is increased. In

addition, Ostaszewski and Karzel (2002) have found the discounting process to be basically the same for both rewards and losses. Since temporal discounting works in a way that diminishes the present value of a future reward or loss (value) as a function of temporal distance to the outcome, the conclusion follows that the value and therefore the drive to spend effort for an expected future outcome will decline as the reward goes further in the future.

The nature of externally induced motivation fits the notion of declining present value since this type of motivation is typically due to deadlines or rewards following after a bulk of work. Consider an employee who expects a bonus (in the form of a financial reward) when the task he or she is working on is successfully completed. The financial reward creates an extrinsic motivation (where locus of causality for action is external) to complete the task, assuming that increased financial income is desirable for the employee. However, the resulting reward is distant in time since payment of the reward requires that a set of activities have been completed. As a consequence, temporal discounting account suggests that in the beginning of the task, the instant value of working on task's activities will be at its lowest while the value will increase as the task gets closer to completion. In such situations where one's regulatory style is of low self-determined variant, the effort exertion is expected to be higher as the task comes closer to completion. In other words, individuals exhibiting motivation profiles with low self-determination are expected to be more likely to exert the majority of their effort in the late stages of a task rather than early stages.

In contrast, Ryan and Deci (2000) have stated that the more internalized the motivation, the more persistent and higher quality the engagement is. Furthermore, Ryan and Connell (1989) have reported that enjoyment of a task showed higher correlations with more internalized types of motivation. As these studies also suggest, internal forms of regulation arise due to enjoyment

of task execution or identification of the activity with one's self, therefore, the subjective value attached to the execution of such a task has virtually immediate availability. In order to make this point more vivid, consider an individual who is intrinsically motivated for executing activities of a task. Having an intrinsic motivation (the most self-determined type of motivation), this individual has rewards (enjoyment) associated with execution of the task itself. Since enjoyment of task execution can be experienced even in the beginning of the task, the reward has minimal temporal distance. Given that this temporal proximity will minimize temporal discounting, it is expected that the value derived from task execution will be high even in the beginning of the project. It is important to note that although intrinsic motivation is the most internal form of regulatory styles, identification and integration also poses varying degrees of self-determination. In situations where one shows a self-determined regulatory style, the effort exertion rate is expected to be high at the start of task execution. It is to say that individuals exhibiting motivation profiles with high self-determination are expected to be more likely to exert majority of their effort in the early stages of a task rather than late stages.

2.3. Types of Regulatory Style and their Relationships with Effort Exertion Patterns

In order to transform expectations regarding effort exertion patterns into testable hypotheses, the present study will be utilizing the construct of pacing style as the measurable form of effort exertion patterns. Pacing style is defined as behavioral inclination for distribution of effort over time when working on situations with deadlines (Gevers et al., 2015). It is to say that individuals' pacing style reflects their allocation of time in execution of a task under deadline conditions (Gevers et al., 2006).

One of the pacing styles identified by Gevers et al. (2006) is the deadline action pacing style. Individuals high on deadline action pacing style may be characterized as biased towards putting most of the effort on task execution very close to the deadline. In other words, these individuals carry out most of the work relatively close to the end of a task. Figure 3 shows the effort levels with respect to time for a deadline action pacing style.

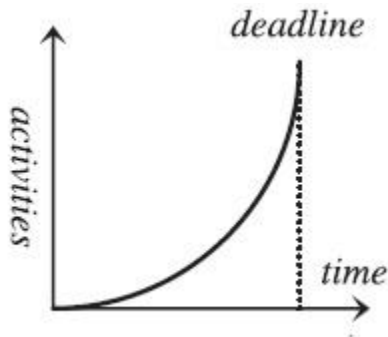


Figure 3 - Deadline Action Pacing Style

Lower self-determination suggests drivers of behavior to be more external than internal. Given that external motivators are typically deadlines or rewards which are distant in time, they have less impact on individuals' decision to exert effort in the beginning of a task while their impact increases when the task comes closer to completion. An effort exertion pattern such as this is classified as deadline action pacing style. In other words, deadline action pacing style reflects the form of effort exertion that is expected to be related to low self-determined motivation profiles. Finally, the expectation regarding the relationship between low self-determination and increased preference for effort exertion in the late stages of a task can be put into the following empirically testable form:

H1: Lower self-determination will be associated with higher prominence of deadline action pacing style.

Gevers et al. (2006) identified the early action pacing style as the opposite of the deadline action pacing style. Individuals high on early action pacing style generally spend high effort for execution of task activities very early in the planned timeline. They aim to finish tasks long before the actual deadline. Figure 4 presented below exhibits the effort levels of an early action pacing style.

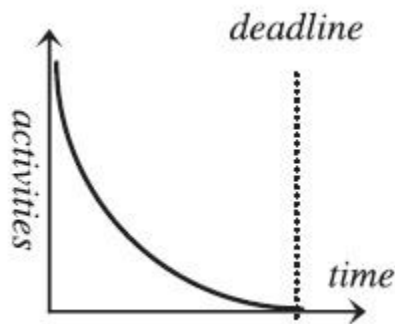


Figure 4 - Early Action Pacing Style

Individuals with higher self-determination are expected to exert more effort on the early stages of a task because, unlike individuals with lower self-determination, they experience immediate rewards from engaging in the task related behavior. An effort exertion pattern such as this is classified as early action pacing style. In other words, early action pacing style represents the form of effort exertion which is expected to be related to high self-determined motivation profiles. Finally, the expectation regarding the relationship between high self-determination and increased preference for effort exertion in the early stages of a task can be put into the following empirically testable form:

H2: Higher self-determination will be associated with higher prominence of early action pacing style.

3. Temporal Discounting and its Relationship with Effort

Exertion Patterns

Emergence of two main components, namely early and late action components, of effort exertion patterns were examined in the previous section. However, Gevers et al. (2008) identified two more effort exertion patterns, the u-shaped action pacing style, represented by a dip in effort exertion rate during the middle stages of a task, and the steady action pacing style, represented with a relatively even distribution of effort. This section will be dedicated to identification of temporal discounting as a factor contributing to the difference between u-shaped action pacing style and steady action pacing style.

U-shaped action pacing style is characterized as the tendency to systematically fuse early and late effort (Gevers & Demerouti, 2013). Gevers et al. (2015) state that individuals high on u-shaped action pacing style exhibit high levels of effort both in the beginning and towards the deadline while they take it easier during the mid-stages. Figure 5 shows the effort distribution for u-shaped action pacing style.

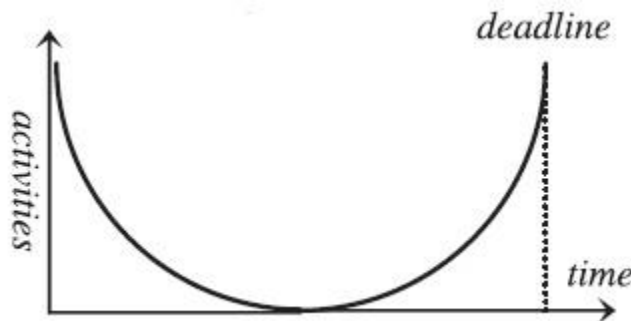


Figure 5 - U-shaped Action Pacing Style

In the present study, U-shaped action pacing style is theorized to emerge due to a combination of immediately available value derived from task execution leading to the early effort component, value attached to external regulators leading to the late action component, and

a medium to high level of temporal discounting rate driving the reduction of effort exertion rate in the middle temporal stages. The drop during the middle stages of a task is proposed to be due to diminishing marginal value.

Rachlin (1992) defines diminishing marginal value as the reduction of addition rate to a one's total utility resulting from consuming additional units of a commodity as one consumes more of that commodity. In his paper titled "Diminishing marginal value as delay discounting", Rachlin (1992) studies diminishing marginal value as a concept emerging from three basic assumptions: limited consumption rate, choice of highest valued alternative and temporal discounting. The author proposes a model which has temporal discounting rate as a factor determining diminishing marginal value. Another study linking temporal discounting and diminishing marginal value was conducted by Pine and colleagues (2009). They concluded that, outcomes of intertemporal choice tasks were best predicted by a model integrating diminishing marginal value with temporal discounting. Since motivation is the manifestation of value attached to execution of a task as per expectancy theory (Vroom, 1964), diminishing marginal value is also applicable to motivation. Following Rachlin (1992), it is proposed that individual's temporal discounting rate drives the devaluation of marginal value derived from internal regulators as well as the present subjective value of future rewards which create external regulation.

In order to make the proposition on emergence of U-shaped pacing style clearer, consider an individual who exhibits medium to high levels of temporal discounting rate and has a task in hand which is to be executed. Let's assume that this individual experiences moderate levels of enjoyment from execution of such a task (internal regulation) and also expects a moderate financial reward when the task gets completed (external regulation). The enjoyment of task

execution is expected to be driving the effort exertion rate to a moderate level in the beginning of the task. This drive is expected to reduce over time as the hypothetical individual's perceived subjective value reduces for additional units of task execution as per the diminishing marginal value account. On the other hand, the moderate financial reward anticipated at task completion has limited effect on the effort exertion rate in the initial stages due to the fact that this individual exhibits relatively high levels of temporal discounting rate and the reward is temporally distant. However, it is expected that as the task comes closer to completion, the present subjective value of the reward starts increasing and eventually the reward becomes the main reason for action. The dip in rate of effort exertion during the mid-stages, where enjoyment of task execution starts losing its value and the financial reward has not yet begun to show its main effect, is expected to be relatively steep for this individual due to hypothetical high temporal discounting rate.

In other words, the higher the discounting rate, the more rapid the drop in subjective value related to internal regulators, and the later the subjective value derived from external regulators starts showing its effect on effort levels, therefore the more the curve of effort exertion rate drops in the middle. Hence, for the purpose of empirical testability, the following hypothesis follows:

H3: Higher levels of temporal discounting will be associated with higher prominence of U-shaped action pacing style.

On the other hand, individuals who have a strong preference for steady action pacing style are characterized as having the tendency to equally distribute task execution effort over time (Gevers & Demerouti, 2013). These individuals exhibit constant work pace. Figure 6, taken from Gevers et al.'s (2006) article, is a representation of effort exertion pattern for steady action pacing style.

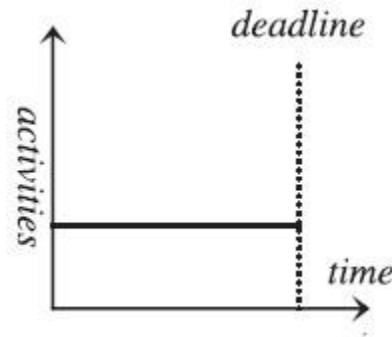


Figure 6 - Steady Action Pacing Style

This form of effort exertion pattern is theorized to emerge due to similar motivational conditions with U-shaped action pacing style with a difference: one's temporal discounting rate. As mid-task dip in effort exertion rate was proposed to be related to temporal discounting rate in the U-shaped pattern, lower level of temporal discounting rate is proposed to lead to a steadier effort exertion pattern. Take the same hypothetical individual who was constructed for the depiction of U-shaped effort pattern, with only one difference which is that this time the individual's temporal discounting rate is lower. Given the low temporal discounting rate, internal regulation is expected to fade away slower and the reward expected at the end of the task starts to drive the effort earlier compared to the previous example. Such low devaluation of both early and late action components of the effort exertion patterns will be resulting in a form which is more like steady action pacing style rather than a U-shaped pattern. Therefore, in contrast to individuals who have a strong preference for U-shaped action pacing style, individuals exhibiting a higher degree of preference for steady action pacing style are proposed to have lower temporal discounting rate. Finally, the following hypothesis puts this proposition in a testable form:

H4: Lower levels of temporal discounting will be associated with higher prominence of steady action pacing style.

4. Accuracy of Task Completion Time Estimations

Accuracy in estimations of tasks' completion times is a crucial aspect in project management field. Extensively inaccurate estimations of task completion times may lead to cost overruns and missed deadlines in projects (Roy et al., 2005). Roy et al. (2005) provide several examples of famously delayed public projects such as Sydney opera house taking 16 years to build instead of initially planned 6 years and the Channel Tunnel between England and France. This bias in estimations has drawn a large amount of attention from academia.

Although recently refuted by Flyvbjerg (2016), it is important to note that beneficial results of optimistic estimations have also been suggested by Hirschman's principle of the hiding hand which states if decision makers knew the actual costs of the projects not that many projects would ever get implemented (as cited in Flyvbjerg, 2016). In this thesis, however, the focus lies on achieving more accurate task completion time estimations. In the following subsections, after a short review of previous research on the optimistic prediction bias, a mechanism which is proposed to contribute to the understanding of the discrepancy between estimated and actual task completion times will be introduced.

4.1. Prior Inquiry on the Optimistic Prediction Bias

One, who assumes that estimations are just errors due to unpredictability, would expect that the under and over estimations are equally probable. However, numerous studies have shown that the probability distribution is skewed towards optimistic estimations (Armor & Sackett, 2006). Kahneman & Tversky (1979) have famously named this tendency as "planning fallacy".

4.1.1. Previous Research on Mechanisms behind the Prediction Bias

A series of studies have focused on ignoring the information on memory or failure to utilize that information as a core cause of optimistic predictions. Researchers have suggested that individuals fall short to remember that they have been interrupted by unexpected events in the past or do not remember all of the subcomponents required for successful execution of tasks (Roy et al., 2005).

Buehler, Griffin, and Ross (1994) have hypothesized that when making estimations, individuals focus on plan based scenarios rather than relevant past experiences. In their study, authors observed participants' planning process by employing a think out loud procedure. The results showed that 71 percent of the phrases were focused on future plans, 15 percent on deadlines, 6 percent on past success and 1 percent on past problems. Another finding presented in the same paper by Buehler et al. (1994) was that individuals tended to attribute their previous prediction failures to specific occasions which appear to be relatively unique and unlikely to recur. In another study, supporting this account, Konig et al. (2015) found that when participants were permitted to retrospectively estimate the duration of a prior task the next task duration estimation became less optimistic. Likewise, in another study, participants who were supplied with completion times of similar past projects had higher completion time estimates for upcoming projects compared to participants who did not receive that information (Shmueli et al., 2016).

In another study, Buehler and Griffin (2003) conducted two experiments with different tasks where they manipulated future focus of participants on the experimental group by asking them to make an execution plan of their task. Results of the experiments supported the

hypothesis that individuals make overly optimistic and confident estimations because, at least partly, they focus on a plan based future scenario.

On the other hand, Roy et al. (2005) have proposed that the optimistic prediction bias is due to biases in memory rather than incorrect use of memory. Authors stated that, individuals' perception of previous activities taking less than they actually do is the main reason for people underestimating. However, it is important to note that this study just tries to explain existing empirical data, gathered from previous studies, using the proposed memory bias account without providing additional empirical evidence to support its proposition.

4.1.2. Factors Found to be Related to the Prediction Bias by Previous Research

Connolly and Dean (1997) showed that when tasks were broken down to smaller subtasks the task estimations were neither optimistic nor pessimistic. However, estimations for undivided large tasks were largely optimistic. Buehler et al. (1994) focused on the role of the predictor and found that individuals did exhibit optimistic prediction biases for the tasks they are going to execute themselves, however they did not tend to have optimistic task estimations when predicting for tasks that other people will execute. Armor and Sackett (2006) investigated if individuals' optimistic prediction biases were different for real and hypothetical tasks. Their results showed that subjects expecting to participate in an activity had significantly less optimistic predictions compared to subjects not expecting to participate in the same activity.

Buehler, Messervey and Griffin (2005) have conducted a series of studies in order to understand the effects of predicting as a group on the accuracy of task estimation. First, authors showed that optimistic prediction bias existed for both individual and group predictions. Results also revealed that individual predictions were less optimistic compared to group predictions. Buehler et al. concluded that the optimism in the group prediction was mediated by the

informational focus in group discussions during estimation sessions. This mediation existed in a way that group discussion increased participants' tendency to focus on pieces of information which foster success. Consequently, the "planning for success" led to increased levels of optimism in predictions. In another study, Francis-Smythe and Robertson (1999) studied the effects of perceptions of time management on prediction accuracy. Their results showed that individuals who had the highest accuracy in estimating task durations were also the ones who perceived themselves as good time managers.

4.2. Proposed Mechanism which Contributes to Prediction Accuracy

Accuracy of estimations for task completion time is bound to execution of the same task since actual completion time is determined by the properties of the task execution process, such as total effort spent on the task. Despite this dependency, task completion times are estimated in planning sessions where there is a tendency to avoid factors other than the task's properties (Buehler et al., 1994). This idealization of reality is inherent in the planning process since planning is primarily executed by frontal cortex of human brain, which is specialized in manipulation of abstract concepts (Smith & Jonides, 1999). Kahneman and Tversky (1979) have recognized idealized planning as a problem and proposed employing statistical data from similar previous tasks in order to correct for the bias. Although, Kahneman and Tversky's approach (1979) might yield improved predictions, their approach does not offer an explanation of the involved mechanism but merely a statistical examination of overall relevant planning and execution processes.

The author of the present study realizes high probability of several mechanisms being involved in the apparent discrepancy between estimation and realization of task completion times. In an effort to explain one of the mechanisms behind the optimistic prediction bias, the

discrepancy between planned effort and actual effort exertion on tasks is going to be investigated. In other words, deviations of actual actions from the planned behavior are being proposed to have a negative association with task completion time estimation accuracy.

4.2.1. The Discrepancy between Planned and Actual Behavior

In a study by McClure et al. (2004) where the authors found that parts of the limbic system (associated with emotional responses) are involved in decisions which have immediately available rewards and regions of lateral prefrontal cortex (part of frontal cortex which is associated with planning and abstract reasoning) are activated by intertemporal choices regardless of delay. Authors provided neuroscientific support for the expectation of the discrepancy between plans and everyday actions by showing that relative engagement of those two systems is directly related to subjects' choices. Implications of these findings in the current context is that during planning sessions parts of the brain associated with planning are not sufficiently challenged by systems favoring immediate rewards hence individuals tend to plan to spend effort on a task in an idealistic way where there are no distractions of effort. However, when the time for task execution comes then other activities with immediate rewards take over to reduce the effort that is spent on task at hand. Hence, leading to a difference between plans and actual behavior, which results in misestimated completion times.

Additional support for the discrepancy comes from previous research where findings showed that individuals prefer larger and later rewards rather than smaller but sooner rewards when both of the rewards are available in the far future (smaller reward still available sooner than the larger reward), yet they their preference reverses to the smaller but sooner reward over larger but later reward when some time has passed and the smaller but sooner reward is immediately available (König & Kleinmann, 2005). Such changes in preference are usually

referred to as “preference reversals” in the literature. Preference reversals have been observed in many empirical studies. One example is Kirby and Herrnstein’s (1995) study, in which the researchers offered participants choices between delayed outcomes, while changing the delays to those outcomes. Preferences of their subjects changed from larger but later reward to smaller but sooner reward as the delays to both rewards decreased.

The following widely accepted hyperbolic formula which allows for such preference reversals in choice was proposed by Mazur (1987):

$$V = \frac{A}{(1 + kD)}$$

Where V is the discounted present value, A is the actual, non-discounted amount of the delayed outcome, D is the delay in time and k is the temporal discounting rate parameter, which varies between individuals (König & Kleinmann, 2005).

Figure 7 shows the hyperbolic temporal discounting formula in its plotted graphical form. In this figure, the curve marked with B represents the present value over time for a smaller sooner reward while the curve marked with C represents the present value over time for a larger later reward. Finally, the point A represents a significant moment in time where the preference reversal occurs. After that point the individual starts to perceive a higher value for the smaller sooner reward.

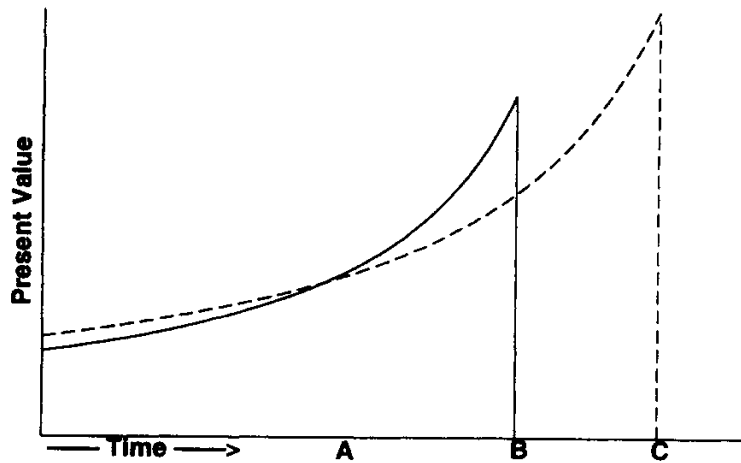


Figure 7 - Graphical Representation of hyperbolic temporal discounting (Kirby et al., 1999)

In addition to neuroscientific support presented earlier, preference reversals observed by these studies provide behavioral evidence for the discrepancy between planned and actual effort levels.

Preference reversals have the potential to introduce a difference in planned and actual effort exertion rate since individuals have been found to be prone to think that they will be able to resist the urge to prefer a smaller sooner reward in favor of a larger later reward but give in to the temptation of a smaller sooner reward as the temporal distance to both rewards eventually decreases over time. More specifically, it is proposed that during planning stages, individuals make predictions of task completion times as if they are going to spend most of their available time on task execution and not indulge in non-task related activities. However, as time comes to the actual task execution, their preferences change in the favor of non-task related activities which provide a sooner reward compared to successful task completion. As a result, a discrepancy between planned and actual effort rate emerges which in turn leads to a need for more time to complete the task than initially predicted.

4.2.2. Self-determination and Prediction Accuracy

Contemporary working arrangements have omnipresent external regulators such as deadlines and rewards predicated on task completion. However, depending on individuals' temporal discounting rate, these regulators need certain degree of temporal proximity (i.e. being close to the deadline) in order to be able to drive considerable effort. In addition to external regulation by deadlines and rewards predicated on task completion, internal regulators are expected to add an early action period to the overall effort which is going to reduce the discrepancy between actual and predicted effort. As a result, this is expected to increase accuracy of task completion time predictions.

Consider an individual, with moderate levels of temporal discounting rate, who experiences little to no internal regulation but has external regulators in the form of deadlines and task completion bonuses. Assume that this individual has analyzed the requirements of a task and predicted that 80 hours of work would be needed to complete the task. Accordingly, a supervisor has set the deadline to 10 working days (assuming 8 workhours per day) from the starting date of the task. Although, as explained in the previous section, the prediction of 80 hours assumed persistent effort rate, in first days of task execution the discounted utility of external regulators would not be enough to overcome temptations of immediately available small rewards such as chatting with colleagues, checking one's messages or engaging with ubiquitous nudges coming from mobile devices. As stated earlier, such divergence from the planned behavior is expected to contribute to lower accuracy in predictions of task completion times. On the other hand, if this hypothetical individual experienced more internal regulation, the distractions from task related behavior in the initial stages could be avoided as internal regulators are related to the self and are immediately available. In conclusion, in typical contemporary work

arrangements where external regulators are always present, the majority of workers are expected to have a phase late in the task where the effort exertion peaks. Furthermore, self-determined motivation profiles are expected to be related to higher prediction accuracy by means of adding an early phase of effort exertion in addition to the late action phase. In turn, this dual staged effort is expected to be closer to the predicted stable effort thereby reducing the discrepancy between predicted and actual effort compared to the singular late effort phase. Finally, the following hypothesis puts this proposition in a testable form:

H5: Higher self-determination will be associated with more accurate predictions of task completion times.

4.2.3. The Impact of Temporal Discounting Rate on the Relationship between Self-determination and Prediction Accuracy

Diminishing marginal value accounts state that individuals will value additional units of benefit less and less as they receive those benefits from previous actions. In the current context this tendency is proposed to imply that individuals are expected to value activities which are driven by internal regulators in a decreasing manner over time. Therefore, the early action component added by internal regulators is expected to fade away as more of the activity has been performed. Rachlin (1992) has suggested that higher temporal discounting rate leads to higher rate of diminishing of marginal value. Thus, the fading rate of the early action component is expected to be higher for individuals with higher temporal discounting rate and lower for individuals with lower temporal discounting rate. Since the early effort phase in a task was hypothesized to reduce the discrepancy between planned and actual effort, a high rate of fading in early effort phase is expected to reduce the proposed discrepancy less compared to a situation where the early action period lasts longer.

Consider two employees who were given an identical task, for which they made the same completion time prediction, and experience similar levels of external regulation due to ever present deadlines in their workplace. In addition, let both of the employees to experience high levels of intrinsic motivation so that they have a self-determined motivation profile. Furthermore, let's assume that employee A has higher temporal discounting rate compared to employee B. Although both of the employees would be expected to exhibit an early effort phase, employee A's effort rate in this early stage is expected to decline faster than employee B due to the fact that employee A having a higher temporal discounting rate. Therefore, employee A is expected to have more discrepancy between planned and actual effort, thus miss the deadline with a larger amount of time.

In other words, temporal discounting rate is expected to moderate the relationship between self-determination and task completion time prediction accuracy such that the relationship will be stronger for individuals with lower temporal discounting rate. This expectation is presented in its testable form with the following hypothesis:

H6: The relationship between self-determination and the accuracy of task completion time predictions will be stronger under lower levels of temporal discounting rate.

Finally, figure 8 exhibits all the hypotheses stated in this study in one research model.

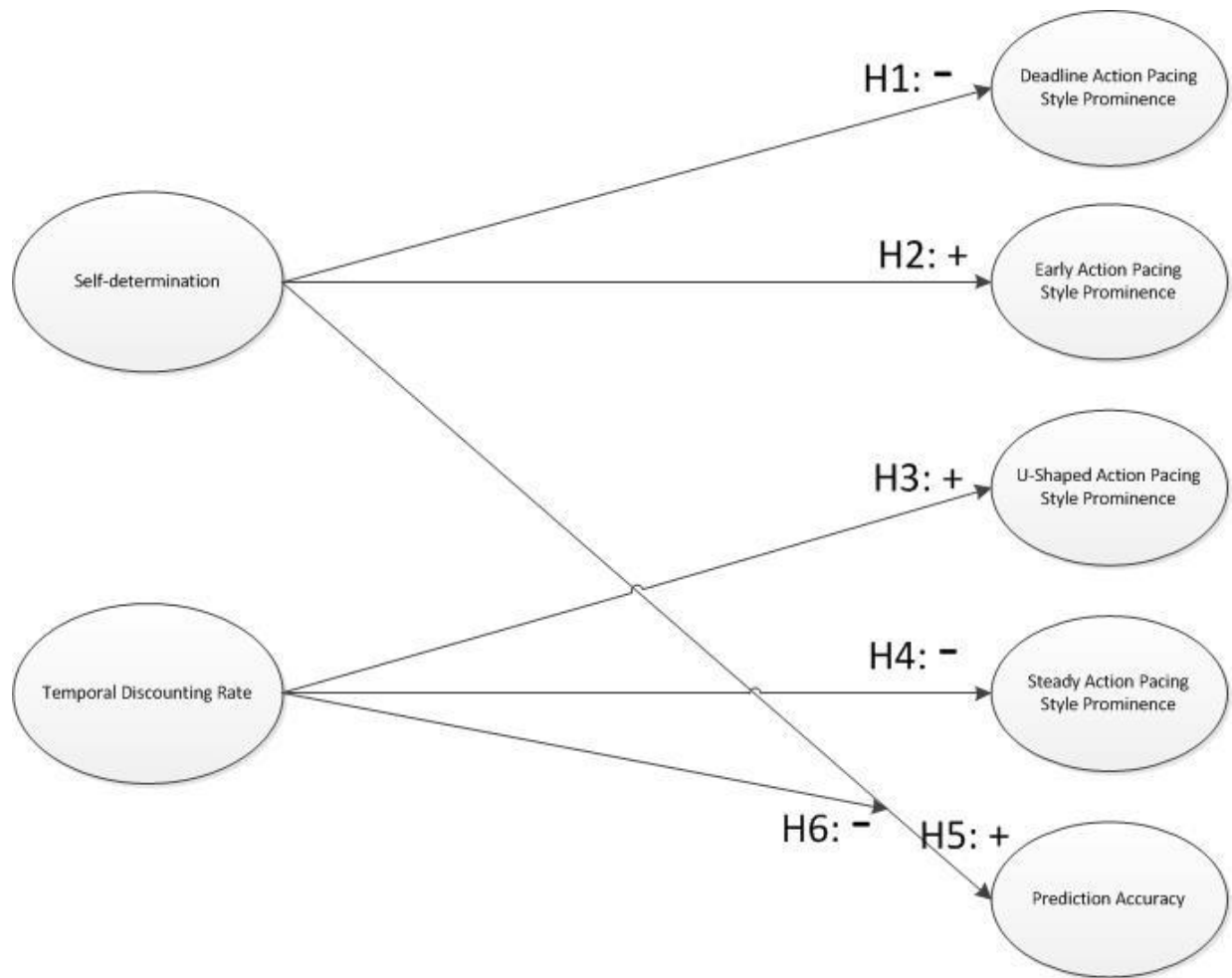


Figure 8 - Research Model with Hypotheses

5. Method

This section will provide information about measures and the data acquisition procedure employed for this study.

5.1. Subjects

The present study was conducted via a survey which collected information about professionals' temporal characteristics and task estimation accuracies in real occupational settings.

Subjects were summoned from two different sources. First one was a division of a multi-national corporation. Subjects coming from this source occupied engineering positions within the company. Participation for all employees within this division was voluntary. In order to avoid possible concerns about subject's survey answers being accessible to their managers, participation was made anonymous. The call for participation was sent to subjects by their manager. The participants filled an online survey. Second source of participants was online professional networks. All subjects were approached online. Like the first set of subjects, they completed an online anonymous survey.

52 participants started filling out the survey while 46 of them completed it. 25 of the 46 participants were from the multi-national corporation while the rest were from online professional networks. The entire sample consisted of professionals with occupations in either science or engineering. 13% of the participants were female while the rest were male. The mean age was 36.7 with a standard deviation of 7.7. Mean occupational tenure (time since starting to work in their current profession) was 10.8 years with a standard deviation of 7.0.

When employing multiple regression analysis, for the sake of generalizability, it is suggested by Hair et al. (2009) to aim for 20 samples for each predictor variable while 5 samples per predictor variable is mentioned as a bare minimum. Therefore, having two independent variables in models, a sample size of 46 meets the goal.

5.2. Measures

5.2.1. Temporal Discounting Rate

Researchers have used a variety of ways to measure temporal discounting rate, which can be grouped in two broad categories: monetary and non-monetary measures. Monetary measures use money as a reward while non-monetary measures employ other types of rewards such as

food (Rodriguez et al., 1989) and holiday duration (Borghans & Golsteyn, 2006). Another dimension at which studies can be classified is their reward proposal. Some studies were conducted using hypothetical rewards while others offered rewards with a probability or certainty. Finally, researchers have measured temporal discounting rate by either keeping the rewards stable and changing distance in time to rewards or manipulating the rewards and keeping the time to rewards stable.

In the present study, a measurement method similar to studies by Kirby and Marakovic (1996) and by Kirby, Petry and Bickel (1999) is used. In this method, participants are presented with two choices: one immediate but smaller reward and one larger but later reward. The amounts and delays are being varied in order to correspond to different discounting rates. Table 1 shows the choices, their corresponding discounting rate, and the order of the choice being presented to the subject.

Order	Reward values			<i>k</i> at indiff.	<i>k</i> rank
	SIR	LDR	Delay ^a		
13	\$34	\$35	186	.00016	1
1	\$54	\$55	117	.00016	1
9	\$78	\$80	162	.00016	1
20	\$28	\$30	179	.00040	2
6	\$47	\$50	160	.00040	2
17	\$80	\$85	157	.00040	2
26	\$22	\$25	136	.0010	3
24	\$54	\$60	111	.0010	3
12	\$67	\$75	119	.0010	3
22	\$25	\$30	80	.0025	4
16	\$49	\$60	89	.0025	4
15	\$69	\$85	91	.0025	4
3	\$19	\$25	53	.0060	5
10	\$40	\$55	62	.0060	5
2	\$55	\$75	61	.0060	5
18	\$24	\$35	29	.016	6
21	\$34	\$50	30	.016	6
25	\$54	\$80	30	.016	6
5	\$14	\$25	19	.041	7
14	\$27	\$50	21	.041	7
23	\$41	\$75	20	.041	7
7	\$15	\$35	13	.10	8
8	\$25	\$60	14	.10	8
19	\$33	\$80	14	.10	8
11	\$11	\$30	7	.25	9
27	\$20	\$55	7	.25	9
4	\$31	\$85	7	.25	9

Table 1 – Choices presented to the participant and their corresponding discounting rate at indifference point. K at Indiff. = the value of the discount rate at which the immediate and delayed value are of same value to the subject. K Rank = trials with the same values of discount rates grouped in ascending order. SIR = smaller immediate reward. LDR = larger delayed reward (Kirby et al., 1999).

In other words, 22nd item for the measurement of temporal discounting rate is “Would you prefer 25 dollars now or 30 dollars in 80 days?” If a participant chooses the immediate reward it means that this participant has a higher discounting rate than .0025. In case the choice

is in favor of the larger but later reward it means that the subject has a discounting rate which is lower than .0025. A participant with a discounting rate of .0025 is expected to be indifferent between the presented options.

Kirby and Marakovic (1995) argue that subjects' choices don't exactly produce consistent results with any single parameter value. Hence, parameter estimations made by just looking at a point of switch from immediate to delayed reward are less accurate. The rightmost column in Table 1 is introduced to overcome this obstacle. Items corresponding to the same discounting rate are grouped into same rank values. After all items are answered by a subject, the rank which provides the highest number of consistent answers is selected to be the discounting rate of that participant. That is to say, all discounting rates are checked with all answers and the one which predicts the highest number of answers is selected as that participant's discounting rate. In case more than one rank produce equal consistency then the geometric mean of those discounting rates were assigned to the subject.

This particular measurement method is preferred since it provides a discounting rate at a ratio scale. Another advantage of this method is that it defies a risk of possible perception of a bargaining condition created by adaptive methods where the larger but later reward value is increased until a point where subjects change their preference from smaller but immediate reward to larger but later reward (Read, 2001).

5.2.2. Pacing Style Prominence

Gevers, Mohammed, and Baytalskaya (2015) have constructed and evaluated the 9-item Pacing Action Categories of Effort Distribution (PACED) scale for the measurement of steady, u-shaped and late action pacing styles. Since a measure for early action pacing style is also needed for execution of the present study, three items employed by Gevers, Mohammed,

Baytalskaya and Beeftink (2008) will also be included to the questionnaire. When this method of measurement is employed, the participants are instructed as the following:

“When you have to work on a project or task with a time limit, how do you generally distribute your workload from the moment you get the project or task until the deadline? Please indicate the extent to which you agree or disagree with each statement by circling the corresponding number according to the scale below. Describe yourself as you are now, not as you wish to be in the future.” Then the participants are expected to answer the items in table 2 on a 5 point likert scale where 1 corresponds to strongly disagree and 5 corresponds to strongly agree.

1. I start projects right away and finish the work long before the deadline.
2. I do most of the work on tasks in a relatively short time before the deadline.
3. I work steadily on tasks, spreading my work out evenly over time (e.g., 3 hours per week until the deadline).
4. The effort I put into projects is high at the start, low halfway through, and high again at the end.
5. I do not get much done on projects until the due date is close.
6. I invest most of my effort toward the beginning and end of projects.
7. I pace myself to work on projects a little bit every day or every week instead of doing several hours of work all at once.
8. I do quite a bit of work at the start of tasks so that I can relax towards the end.
9. I generally do not work until there is time pressure from an approaching deadline.
10. I work in a slow, but steady, manner to complete tasks.
11. I work harder at the beginning of a project than at the end.
12. I put in more effort at the beginning of tasks as well as right before the deadline, but am less active during the middle of the work cycle.

Table 2 – Items on the Pacing Action Categories of Effort Distribution scale by Gevers, Mohammed, and Baytalskaya (2015) and items measuring early action pacing style (Gevers et al., 2008).

Items 1, 8 and 11 load on early action pacing style, items 2, 5 and 9 load on deadline action pacing style, items 3, 7 and 10 load on steady action pacing style, while items 4, 6 and 12 load on u-shaped action pacing style.

Finally, after all the scores on pacing styles are calculated, the prominence of each is computed by dividing the score of corresponding pacing style by the sum of all scores.

5.2.3. Self-determination, Internal and External Regulation

Tremblay and colleagues (2009) have developed and evaluated the work extrinsic and intrinsic motivation scale (WEIMS) which consists of 18 items rated on a 7 point likert scale. WEIMS is grounded in the self-determination theory (Ryan & Deci, 2000), therefore it covers several types of human motivation. These types include intrinsic motivation, four sub types of extrinsic motivation (integrated regulation, identified regulation, introjected regulation, external regulation) and amotivation. All six types of motivation are measured by three items each, summing up to a total of 18 items. All items of the scale are presented in table 3.

1. Because this is the type of work I chose to do to attain a certain lifestyle.
2. For the income it provides me.
3. I ask myself this question, I don't seem to be able to manage the important tasks related to this work.
4. Because I derive much pleasure from learning new things.
5. Because it has become a fundamental part of who I am.
6. Because I want to succeed at this job, if not I would be very ashamed of myself.
7. Because I chose this type of work to attain my career goals.
8. For the satisfaction I experience from taking on interesting challenges.
9. Because it allows me to earn money.
10. Because it is part of the way in which I have chosen to live my life.
11. Because I want to be very good at this work, otherwise I would be very disappointed.
12. I don't know why, we are provided with unrealistic working conditions.
13. Because I want to be a "winner" in life.
14. Because it is the type of work I have chosen to attain certain important objectives.
15. For the satisfaction I experience when I am successful at doing difficult tasks.
16. Because this type of work provides me with security.
17. I don't know, too much is expected of us.
18. Because this job is a part of my life.

Table 3 – Items on the work extrinsic and intrinsic motivation scale by Tremblay et al. (2009).

Participants are asked the following question “Why Do You Do Your Work?” and are instructed to rate each item on the extent to which it corresponds to the reasons why the subject

is involved in his or her present work. Subjects rate each item in a seven item likert scale where 1 means ‘does not correspond at all’, 4 means ‘corresponds moderately’ and 7 means ‘corresponds exactly’. Items 4, 8, 15 load to intrinsic motivation, while 5, 10, 18 load to integrated regulation, 1,7,14 load to identified regulation, 6, 11, 13 load to introjected regulation, 2, 9, 16 load to external regulation and finally items 3, 12, 17 load to amotivation.

Since internal regulation and external regulation are on one continuum of self-determination, both were measured by operationalizing self-determination where higher scores of self-determination means more internal regulation and lower scores of self-determination means more external regulation. Individuals’ relative level of self-determination was measured by work self-determination index (W-SDI). Tremblay and colleagues (2009) have specified the following formula for determination of W-SDI: $W - SDI = (+3 \times IM) + (+2 \times INTEG) + (1 \times IDEN) + (-1 \times INTRO) + (-2 \times EXT) + (-3 \times AMO)$.

5.2.4. Accuracy of Task Completion Time Estimation

Relative error will be measured by the difference between actual time and predicted time required for the task completion as a percentage of the predicted time. An output value of 50 would mean that the task has taken 50 percent more time to complete than the prediction. This formula is exhibited in figure 9.

$$Relative\ Error = \frac{X_{actual} - X_{predicted}}{X_{predicted}} \times 100$$

Figure 9 – Mathematical Representation of Relative Error

The formula in figure 9 can have output values between $-\infty$ and ∞ where a positive value indicates an optimistic prediction and a negative value indicates a pessimistic prediction. An output value of 0 would mean that the task was finished on time.

$$\text{Prediction Accuracy} = -1 \times \text{Relative Error}$$

Figure 10 – Formula for Calculating Prediction Accuracy

Since prediction accuracy is the opposite of prediction error. The present study operationalizes relative error multiplied by -1 as a measure of task completion time estimation accuracy. Participants were asked to report a typical work item which they have executed before. Participants answered the following two questions regarding their work item in terms of days: “How long did you estimate that this work item would take to finish?” and “How long did the work item actually take to finish?”. Finally, the prediction accuracy was calculated with the formula presented in figure 10.

5.2.5. Demographic and Occupational Variables

In addition to the constructs mentioned above, age, gender and tenure were also measured in this study. Participants were asked to indicate their age and gender. On the other hand, in order to distinguish between occupational and employer based tenure the participants were asked the following two questions: “How long have you been working in your current profession?” and “How long have you been working for your current employer?”

5.3. Reliability Analysis of Constructs

Regardless of the fact that scales employed for this research have been used in academic research, a reliability analysis was carried out to validate the consistency of scales. This was

achieved by using Cronbach’s alpha measure. Scales consisting of more than one item per variable were included in the reliability test. Due to the relatively low sample size and low numbers of items loading into corresponding variables (maximum of 3 items per variable) a cut off value of 0.6 was selected for Cronbach’s alpha as suggested by Hair et al. (2009).

Analyses show that sub-scales of identified regulation, early action pacing style and late action pacing style have values lower than the cut off value. This suggests that for further research alternative measures could be more appropriate for measuring these three constructs. On the other hand, as presented in table 4, remaining 7 sub-scales had reliability measures above the cut off value.

Reliability Analysis			
Construct	Sub-Construct	Number of Items	Cronbach’s Alpha
Self-Determination	Intrinsic Motivation	3	.718
	Integrated Regulation	3	.746
	Identified Regulation	3	.499
	Introjected Regulation	3	.672
	External Regulation	3	.622
Pacing Style	Amotivation	3	.678
	Early Action	3	.535
	Deadline Action	3	.518
	Steady Action	3	.604
	U-Shaped Action	3	.789

Table 4 - Cronbach’s Alpha Values for Scales

5.4. Data Analyses

All hypotheses were tested by employing regression analysis for each hypothesis. Sample characteristics are presented in Table 5.

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Temporal Discounting Rate	46	.00040	.04100	.0092163	.01102420
Work Self-Determination Index	46	-22.00	70.00	31.2826	21.23588
Prediction Accuracy	37	-200.00	4.26	-52.8251	51.36987
Early Action Prominence	46	.12	.41	.2466	.06341
Deadline Action Prominence	46	.09	.35	.2200	.06293
Steady Action Prominence	46	.11	.52	.2532	.07343
U-Shaped Action Prominence	46	.10	.44	.2802	.06854

Table 5 – Descriptive Statistics

It is important to note that only 37 of 46 participants did provide information on task estimation and completion times. Also, the mean value of -52.8251 for prediction accuracy suggests that on average participants have underestimated the completion times by approximately 52 percent. Hypotheses having prediction accuracy as their dependent variable were tested with a sample size of 37 (hypotheses 5 and 6). Hypotheses 1 through 4 were tested with a sample size of 46. No cases were outside of the three standard deviations range. Finally, Table 6 shows correlations amongst variables.

Correlations								
	N	1	2	3	4	5	6	7
1. Temporal Discounting Rate	46	1	-	-	-	-	-	-
2. Work Self-Determination Index	46	-.327*	1	-	-	-	-	-
3. Prediction Accuracy	37	-.376*	.494**	1	-	-	-	-
4. Early Action Prominence	46	.125	.324*	.262	1	-	-	-
5. Deadline Action Prominence	46	.043	-.378**	-.282	-.668**	1	-	-
6. Steady Action Prominence	46	-.126	.102	.298	.070	-.433**	1	-
7. U-Shaped Action Prominence	46	-.021	-.063	-.327*	-.387**	.163	-.739**	1

* Correlation significant at .05 level. ** Correlation significant at .01 level.

Table 6 – Correlations between Variables

6. Results

H1 proposed that low self-determination will be associated with higher prominence of deadline action pacing style. For testing H1, WSDI and TD were similarly used as independent variables with deadline action pacing style prominence being the dependent variable. The model was significant at .05 level ($p = .031$) while adjusted R square was .110. Similar to the preceding test, TD was not significant. WSDI was significant ($p = .009$) while having a standardized coefficient (β) of -0.407. In addition, the effect was negative as expected. Thus, it is concluded that, by rejecting the null hypothesis, support for H1 was found. This means that, individuals reporting less self-determined behavior were found to have increased prominence of late action pacing style.

H2 which stated that higher self-determination will be associated with higher prominence of early action pacing style, was tested by using Work self-determination index (WSDI) and temporal discounting rate (TD) as predictor variables and early action pacing style prominence as the dependent variable. The model was found to be significant at .05 level ($p = .021$) with an adjusted R square of .126. While the effect of TD was not significant, WSDI was significant ($p = .008$) and its standardized coefficient (β) was 0.409. Therefore, the null hypothesis that WSDI has no effect was rejected, providing support for H2. In other words, individuals reporting more self-determined behavior were found to have increased prominence of early action pacing style.

Model	Dependent Variable	Adjusted R^2	p	F	Independent Variables	β	p
1	Deadline Action Pacing Style Prominence	.110	.031*	3.789	WSDI	-0.407	.009**
					TD	-0.090	.547
2	Early Action Pacing Style Prominence	.126	.021*	4.250	WSDI	0.409	.008**
					TD	0.259	.086

* $p < .05$, ** $p < .01$

Table 7 - Results from the tests of Hypothesis 1 and Hypothesis 2

H3 stated that higher levels of temporal discounting rate will be associated with higher prominence of U-shaped action pacing style. H3 was tested by using WSDI and TD as predictor variables with u-shaped action pacing style prominence as the dependent variable. Model was not significant at .05 level, therefore H3 was rejected. Likewise, for testing the proposition that lower levels of temporal discounting will be associated with higher prominence of steady action pacing style (H4), WSDI and TD were once again used as independent variables while steady action pacing style prominence was the dependent variable. Model did not meet the significance level of .05, thus H4 was rejected as well. In other words, it cannot be claimed that temporal discounting rate is related to u-shaped or steady action pacing style.

Model	Dependent Variable	Adjusted R^2	p	F	Independent Variables	β	p
3	UShaped Action Pacing Style Prominence	-.040	.881	.127	WSDI	-0.078	.629
					TD	-0.046	.775
4	Steady Action Pacing Style Prominence	-.026	.648	.439	WSDI	0.069	.669
					TD	-0.103	.522

Table 8 - Results from the tests of Hypothesis 3 and Hypothesis 4

H5 proposed that more self-determination will be associated with more accurate predictions of task completion times. Testing for H5 was achieved by employing WSDI as the independent variable and prediction accuracy as the dependent variable. The model was found to be significant ($p = .002$) with an adjusted R square of .222. WSDI ($p = .002$) had a standardized coefficient (β) of 0.494 which indicated that the direction of the effect was also as expected. Therefore, it can be concluded that the data provided support for H5. This is to say that individuals reporting more self-determined behavior were found to have more accurate task completion time predictions (less divergence between actual and predicted completion times).

H6, which stated that the relationship between self-determination and the accuracy of task completion time predictions is stronger under lower levels of temporal discounting rate, was tested with a two-step regression analysis. The first step had WSDI and TD as independent variables while prediction accuracy was the dependent variable. The second step consisted of WSDI, TD and multiplication of their standardized values as independent variables with prediction accuracy as the dependent variable. Although both models were significant ($p = .003$ and $p = .010$ respectively), the interaction term introduced in the second step was not significant. Thus, H6 was rejected. In other words, the claim that temporal discounting rate moderates the relationship between self-determination and prediction accuracy cannot be made.

Model	Dependent Variable	Adjusted R^2	p	F	Independent Variables	β	p
5	Prediction accuracy	.222	.002**	11.282	WSDI	0.494	.002**
6a	Prediction accuracy	.247	.003**	6.899	WSDI	0.412	.012*
					TD	-0.227	.152
6b	Prediction accuracy	.224	.010*	4.464	WSDI	0.412	.016*
					TD	-0.228	.283
					WSDI*TD	-0.001	.996

* $p < .05$, ** $p < .01$

Table 9 - Results from the tests of Hypotheses 5 and 6

7. Discussion

The present study set out to explain one of the mechanisms behind the optimistic prediction bias as well as emergence of effort exertion patterns in an attempt to help managers plan and orchestrate projects. In order to do so, a survey was administered to test hypotheses derived in this study. Subjects of this survey were 46 professionals occupying science or engineering positions in their organizations.

Results suggested that more self-determined behavior is associated with higher prominence of early action pacing style, while less self-determined behavior is related to higher prominence of deadline action pacing style. Another finding was that more self-determined action is associated with lower discrepancies between predicted and actual task completion times.

On the other hand, hypotheses on temporal discounting rate being positively related to U-shaped action pacing style and negatively related to steady action pacing style were rejected. In addition, the hypothesis which stated that the relationship between self-determination and the accuracy of task completion time predictions would be stronger under lower levels of temporal discounting rate was also rejected. Measures utilized in this study such as pacing style and work self-determination index are overall measures which are not measured for each task. The assumption that the average data would be enough to reveal the hypothesized relationships despite the coarse nature of measures was found not to be the case for the unsupported hypotheses. Future research can try to remove the dependency for such an assumption by employing more precise measurements which carry information on the task level as detailed in the limitations section.

7.1. Theoretical Implications

Pacing style construct introduced by Gevers et al. (2006) has been found to be related to numerous variables linked to various forms of performance by other studies. The present study has proposed and found partial support for a conceptual model which can explain the emergence of different pacing styles. This model can be beneficial to the body of research on pacing styles in such way that the researchers will have a mechanism to understand this construct in terms of more fundamental concepts. Once equipped with the knowledge gathered from this study and pacing style's relationships to desirable outcomes revealed by other studies, researchers can start to ask questions regarding possible ways of increasing likelihood of desirable outcomes by influencing pacing style exhibited by participants.

Another finding of the present study suggests a positive relationship between self-determination and prediction accuracy. This presents an opportunity for researchers studying the planning fallacy as different constructs from relatively well studied topic of motivational research can be utilized to improve one's understanding of the planning fallacy or finding ways to influence it. For instance, methods for promoting self-determined motivational profiles can be researched and prescribed for managerial use to achieve less discrepancy between actual and estimated task completion times. On the other hand, when influencing individuals' motivational profiles is not an option, planning methods which just take this relationship into account during project planning can also provide advantages. Even if individual tasks within a project are not improved in terms of meeting the original completion time estimates, factoring individualized slack (according to individuals' self-determination profile) into project plans can provide help for timely project completion. Finally, although it should be interpreted with caution due to the limitations of this study which are stated below, it could be said that this relationship provides

partial support for the proposed mechanism which explains the optimistic prediction bias in terms of the discrepancy between planned and actual effort exertion.

7.2. Managerial Implications

Contemporary project management practices require planning and adherence to plans. Projects' timeliness is an inextricable metric for evaluation of projects' and managers' performance. Findings of the present study provide possible means to assist project managers in timely project completion.

Many projects have multiple participants executing different units of work with interdependencies. Some of those require intermediate outputs from other tasks in order to advance beyond this point of dependence. In such cases, continuous execution of one task is possible only if that intermediary output is ready before the dependent party needs it. Findings of this study provide a possible way to manage for synchronization problems of this sort. Managers can use individual self-determination profiles to anticipate participants' effort exertion pattern. It is sensible to expect that intermediate outputs to be delivered earlier by individuals who exert a considerable amount of effort in early stages of a task. One finding of the present study is that early action pacing style is related to higher self-determination. Managers can assign tasks which require intermediate outcomes, to individuals who are more self-determined, thereby reducing the probability of possible blocking situations between dependent tasks. Alternatively, if possible, managers can also try to promote self-determination by making tasks more engaging.

Even wider application area for the findings of the present study is the planning practices commonly employed by project managers. Planning sessions where task completion times are estimated, have become one of these common place activities. Then, project managers use these estimations to calculate an overall project completion time. Managers can benefit from the

finding that more self-determination is related to lower discrepancy between actual and predicted task completion times. Individual self-determination profiles can be used to anticipate the discrepancy between estimations and actual completion times where task prediction and execution are fulfilled by the corresponding participant. Equipped with that knowledge, managers can utilize introduction of individually tailored slack into their project plans in order to buffer possible discrepancies between plans and action. This approach has a potential to yield a timelier project completion compared to no slack or a default slack. Furthermore, if possible, eager managers can take a more proactive attitude and try to match tasks with participants who are more self-determined in their actions towards those particular types of tasks.

Finally, this study started with the goal of explaining one of the mechanisms behind the optimistic prediction bias as well as emergence of effort exertion patterns in an attempt to provide managers additional information which can be used in planning and orchestrating projects. Despite the fact that not all hypotheses were supported, the relationships discovered by the study and their managerial implications indicate a certain level of achievement.

7.3. Limitations and Directions for Future Research

In addition to having a relatively small sample size, the present study asked participants to recall a typical task then report estimated and actual time it has taken to complete that task in order to measure prediction accuracy. The retrospective nature of this approach has a possible drawback of introducing a bias in selection of tasks to be reported. Future research can remedy that bias by recording predictions before tasks are executed and actual completion times once they are completed.

Furthermore, pacing style measure was employed as a proxy to actual effort exertion patterns, which is not ideal as this proxy approach can confound relationships between variables.

A better way would be asking participants to record actual effort exertion rate daily. In addition, pacing style and self-determination were measured for overall work experience, not for a specific task. This coarse nature of the data collected in this study might bring in statistical obstruction and make it hard to reveal relationships even if they exist. Future research can resolve this issue by measuring these constructs for each task or project specifically.

Another limitation of the present study is that work extrinsic and intrinsic motivation scale (WEIMS) by Tremblay et al. (2009) measures how strong particular regulatory styles correspond to individuals' perception of why they do their work. Implication being that the measurement is about how a type fits to respondents' situation, rather than the amplitude of the specific type of motivation they experience. An alternative scale (newly developed or retrieved from existing literature) which measures amplitude in addition to fit to a type of motivation, in combination with afore mentioned daily measurement of effort exertion rate will allow future research to test the conceptual model proposed in this study more precisely. This limitation has also necessitated reliance in the relatively safe assumption that external regulators such as deadlines are omnipresent in contemporary work arrangements. When the magnitude for each type of regulation is known, researchers can investigate their relationship to effort exertion rate and prediction accuracy in a more detailed way than just relying on regulation type information.

Finally, as this research mainly focused on the actual effort rate exertion during tasks, another avenue left for further exploration is the idealization of the future effort exertion rate. This is the other component of discrepancy between planned and actual effort exertion rate which in turn contributes to the optimistic prediction bias. Future research can direct attention to ways of making this idealization correspond more with reality.

7.4. Epistemological Analysis of the Method

Present section will be focusing on epistemological limitations of the method employed, which is a rather unexamined topic in studies of this kind. On the other hand, providing an examination should be helpful for unlikely readers who are less acquainted with this sort of scientific inquiry. The aim is to make implicit assumptions explicit in order to avoid being in a position of self-designation in absoluteness of knowledge acquisition.

The current study employed a methodology which consists of proposing a theoretical model, deriving empirically testable hypotheses from that model and finally administering empirical tests of hypotheses. However, this methodology lacks backwards transience of verification, meaning that even if all hypotheses are accepted that does not automatically translate into verification of the model proposed. This backwards transience property is only present where all other possible explanations, which can produce the same hypotheses, are ruled out. Unfortunately, achieving such clarity is virtually impossible for research in social sciences.

References

- Armor, D. A., & Sackett, A. M. (2006). Accuracy, Error, and Bias in Predictions for Real Versus Hypothetical Events. *Journal of Personality and Social Psychology, 91*, 583–600.
- Borghans, L., & Golsteyn, B. H. (2006). Time discounting and the body mass index Evidence from the Netherlands. *Economics and Human Biology, 4*, 39–61.
- Buehler, R., & Griffin, D. (2003). Planning, personality, and prediction: The role of future focus in optimistic time predictions. *Organizational Behavior and Human Decision Processes, 92*, 80–90.
- Buehler, R., Griffin, D., & Ross, M. (1994). Exploring the "Planning Fallacy": Why People Underestimate Their Task Completion Times. *Journal of Personality and Social Psychology, 67*, 366-381.
- Buehler, R., Griffin, D., & Ross, M. (1995). It's About Time: Optimistic Predictions in Work and Love. *European Review of Social Psychology, 6*, 1-32.
- Buehler, R., Messervey, D., & Griffin, D. (2005). Collaborative planning and prediction: Does group discussion affect optimistic biases in time estimation? *Organizational Behavior and Human Decision Processes, 97*, 47–63.
- Connolly, T., & Dean, D. (1997). Decomposed Versus Holistic Estimates of Effort Required for Software Writing Tasks. *Management Science, 43*, 1029-1045.
- Deci, E. L., & Ryan, R. M. (1985). *Intrinsic motivation and self-determination in human behavior*. New York: Plenum.
- Flyvbjerg, B. (2016). The Fallacy of Beneficial Ignorance: A Test of Hirschman's Hiding Hand. *World Development, 84*, 176-189.

- Francis-Smythe, J. A., & Robertson, I. T. (1999). On the relationship between time management and time estimation. *British Journal of Psychology*, *90*, 333-347.
- Gevers, J. M., Rutte, C. G., & Eerde, W. v. (2006). Meeting Deadlines in Work Groups: Implicit and Explicit Mechanisms. *Applied Psychology: an International Review*, *55*, 52–72.
- Gevers, J., & Demerouti, E. (2013). How supervisors' reminders relate to subordinates' absorption and creativity. *Journal of Managerial Psychology*, *28*, 677-698.
- Gevers, J., Mohammed, S., & Baytalskaya, N. (2015). The Conceptualisation and Measurement of Pacing Styles. *Applied Psychology: An International Review*, *64*, 499-540.
- Gevers, J., Mohammed, S., Baytalskaya, N., & Beeftink, F. (2008). The Development and Validation of a Pacing Style Scale. *Paper presented at the annual meeting of Academy of Management*. Anaheim CA.
- Hair, J. F., Black, B., Babin, B., & Anderson, R. E. (2009). *Multivariate Data Analysis*. New Jersey: Prentice Hall.
- Howard, J., Gagné, M., Morin, A. J., & Broeck, A. V. (2016). Motivation profiles at work: A self-determination theory approach. *Journal of Vocational Behavior*, *95*, 74-89.
- Kahneman, D., & Tversky, A. (1979). Intuitive prediction: Biases and corrective procedures. *Management Science*, *12*, 313-327.
- Kirby, K. N., & Herrnstein, R. (1995). Preference Reversals Due to Myopic Discounting of Delayed Reward. *Psychological Science*, *6*, 83-89.
- Kirby, K. N., & Maraković, N. N. (1995). Modeling myopic decisions: Evidence for hyperbolic delay-discounting within subjects and amounts. *Organizational Behavior and Human Decision Processes*, *64*, 22–30.

- Kirby, K. N., & Marakovic, N. N. (1996). Delay-discounting probabilistic rewards: Rates decrease as amounts increase. *Psychonomic Bulletin & Review*, 3(1), 100-104.
- Kirby, K., Petry, N., & Bickel, W. (1999). Heroin addicts have higher discount rates for delayed rewards than non-drug-using controls. *Journal of Experimental Psychology*, 128, 78-87.
- König, C. J., & Kleinmann, M. (2005). Deadline Rush: A Time Management Phenomenon and Its Mathematical Description. *The Journal of Psychology*, 139, 33-45.
- König, C. J., Wirz, A., Thomas, K. E., & Weidmann, R.-Z. (2015). The Effects of Previous Misestimation of Task Duration on Estimating Future Task Duration. *Current Psychology*, 34, 1-13.
- Mazur, J. (1987). An adjusting procedure for studying delayed reinforcement. In M.L. Commons, J.E. Mazur, J.A. Nevin, & H.Rachlin (Eds.). *Qualitative analyses of behaviour*, 5, 55-73.
- McClure, S. M., Laibson, D. I., Loewenstein, G., & Cohen, J. D. (2004). Separate Neural Systems Value Immediate and Delayed Monetary Rewards. *Science*, 306, 503-507.
- Oliver, R. L. (1974). Expectancy Theory Predictions of Salesmen's Performance. *Journal of Marketing Research*, 11, 243-253.
- Ostaszewski, P., & Karzel, K. (2002). Discounting of Delayed and Probabilistic Losses of Different Amounts. *European Psychologist*, 7, 295–301.
- Pine, A., Seymour, B., Roiser, J. P., Bossaerts, P., Friston, K. J., Curran, H. V., & Dolan, R. J. (2009). Encoding of Marginal Utility across Time in the Human Brain. *The Journal of Neuroscience*, 29, 9575–9581.
- Rachlin, H. (1992). Diminishing Marginal Value as Delay Discounting. *Journal of the Experimental Analysis of Behavior*, 57, 407-415.

- Read, D. (2001). Is time-discounting hyperbolic or additive? *Journal of Risk and Uncertainty*, 23(1), 5-32.
- Rodriguez, M. L., Mischel, W., & Shoda, Y. (1989). Cognitive person variables in the delay of gratification of older children at risk. *Journal of Personality and Social Psychology*, 57, 358-367.
- Roy, M. M., Christenfeld, N. J., & McKenzie, C. R. (2005). Underestimating the Duration of Future Events: Memory Incorrectly Used or Memory Bias? *Psychological Bulletin*, 131, 738–756.
- Ryan, R. M., & Connell, J. P. (1989). Perceived locus of causality and internalization: Examining. *Journal of Personality and Social Psychology*, 57, 749-761.
- Ryan, R. M., & Deci, E. L. (2000). Intrinsic and Extrinsic Motivations: Classic Definitions and New Directions. *Contemporary Educational Psychology*, 25, 54–67.
- Shmueli, O., Pliskin, N., & Fink, L. (2016). Can the outside-view approach improve planning decisions in software development projects? *Information Systems Journal*, 26, 395-418.
- Smith, E. E., & Jonides, J. (1999). Storage and Executive Processes in the Frontal Lobes. *Science*, 283, 1657-1661.
- Steel, P. (2007). The Nature of Procrastination: A Meta-Analytic and Theoretical Review of Quintessential Self-Regulatory Failure. *Psychological Bulletin*, 113, 65–94.
- Tremblay, M. A., Blanchard, C. M., Taylor, S., Pelletier, L. G., & Villeneuve, M. (2009). Work Extrinsic and Intrinsic Motivation Scale: Its Value for Organizational Psychology Research. *Canadian Journal of Behavioural Science*, 41, 213–226.
- Vroom, V. H. (1964). *Work and motivation*. New York: Wiley.

White, R. W. (1959). Motivation Reconsidered: the Concept of Competence. *Psychological Review*, 66, 297-333.