UC Riverside

UC Riverside Electronic Theses and Dissertations

Title

Patterns of Student Writing Across Time: The Dynamic Temporal Relationships Between Anxiety and Procrastination

Permalink

https://escholarship.org/uc/item/00n017pn

Author

Horton, Calen James

Publication Date

2021

Copyright Information

This work is made available under the terms of a Creative Commons Attribution-NonCommercial-NoDerivatives License, availalbe at https://creativecommons.org/licenses/by-nc-nd/4.0/

Peer reviewed|Thesis/dissertation

eScholarship.org Powered by the California Digital Library
University of California

UNIVERSITY OF CALIFORNIA
RIVERSIDE

Patterns of Student Writing Across Time: The Dynamic Temporal Relationships Between Anxiety and Procrastination

A Dissertation submitted in partial satisfaction
of the requirements for the degree of

Doctor of Philosophy

in

Psychology

by

Calen J. Horton

September 2021

Dissertation Committee:
Dr. Carolyn Murray, Chairperson
Dr. Kate Sweeny
Dr. Sonja Lyubomirsky

Copyright by
Calen J. Horton
2021

The Dissertation of Calen J. Horton is approved:

_____

_____

_____

Committee Chairperson

University of California, Riverside

Acknowledgements

I have been sitting and staring at a blank screen now for an hour, trying to figure out the best way to express my gratitude to the people who made this dissertation possible. But, of course, I am falling into an old trap; there is no best way. There is only the humble, slightly embarrassing, awkward way that comes with being blunt and honest, with all its associated vulnerability.

So, here goes. First, I want to express my deep love and appreciation for all of my friends. I suppose that's not a manly sentiment, but as a society we've all agreed to do away with that whole toxic masculinity thing now, right? So it should be safe to say. I don't mean it in the sappy, culturally constrained, awkward-affection sense that people usually mean when they use the term "love." My meaning is more elemental than that; I love thunderstorms and good books and long drives down Interstate 5, and the way the world smells after it rains. I love cooking, coffee, and whiskey. I love fountain pens and writing. And I love my friends. You are the vivid details that have kept me plugged in to the day-to-day experience of life for the last several years and I will always appreciate you for the simple fact of who you are. You have filled my life with electricity and light. It wasn't always like that; there was a time several years back when I was adrift, and everything was very grey and dark, and you helped to pull me out of it. Thank you all.

To my brother Ryan Horton: You are and have been my closest friend and confidante for well over a decade now. Your patience and tolerance have seen me through some of the most difficult times in my life, and your wise counsel has often

charted the way out for me. Thank you. Also, we almost got killed by a moose, together. Not sure how that fits in, but it needed to be said.

To Trevor Basil and Ashley Miller: The two of you are more than just friends; you are my co-conspirators; I have loved all of our talking, and laughing, and plotting, and arguing, and joking. I have loved the sushi, the good advice, the trips to Costa Mesa, the long talks about friends, and family, and history, and dreams. Our friendship doesn't stop here, and I hope that over the following years I can repay each of you at least a small fraction of the joy you have brought me.

To my students, but especially to Edwin Marin, Alysia Burbidge, Dakota Wylde, Cristian Duran, and Abigail Stone: we have known each other long enough that I consider each of you to be a dear friend, and your brilliance and growth still amaze me to this day. You will always have my friendship and support.

To my friends Lisa Walsh, Karin Johnson, Arielle Manganiello, Behzad Zareian, Alex Aaronson, and Arlene Sagastume: I am not sure how I wound up surrounded by so many amazing, patient, supportive people. Thank you each for your kindness, your encouragement, and your willingness to listen, and I hope that I have been able to return that kindness to you and that I will be able to do so even more in the future.

Most importantly, To Dr. Carolyn Murray: It is not an exaggeration to say that the last four years, which have been some of the best of my life, have only been possible because of your kindness, your accommodation, and your guidance. Better still, working with you has rekindled a deep love of academia that, for several years, I thought had been lost. Whatever particular brand of crazy I get up to from here on out, I dedicate to you.

My list is longer than just those written above. I wish that I could give everyone the detailed individual treatment that they deserve, but I don't have the space. That being said, I would like to extend my thanks to the following people: Christine Koscheka, Isabela Perez, Dr. Thomas Sy, Dr. Kate Sweeny, Dr. Sonja Lyubomirsky, Dr. Dan Ozer, Dr. David Funder, Dr. Howard Friedman and Dr. Robert Rosenthal. In addition, I would like to thank Alex Leung, Travis Miller, Julia Revord, Elisa Chang-Huh, Amy and Annie Villanueva, Dr. Adviye Tolunay and Dr. Adam Felton. And to any who should be on here who, through my own foolishness, I have missed—thank you as well. My life is richer for having known all of you, no matter how briefly.

To my family: To Mom and Dad, Hunter and Andrew (and Ryan), and Bill and Kahni. May God bless all of you, as you have blessed me with your kindness and love.

And finally, to Christian James Henry, and to Dr. William Dunlop, both of whom are unable to read this: I will miss you.

‘

ABSTRACT OF THE DISSERTATION

Patterns of Student Writing Across Time: The Dynamic Temporal Relationships Between Anxiety and Procrastination

by

Calen J. Horton

Doctor of Philosophy, Graduate Program in Psychology
University of California, Riverside, September 2021
Dr. Carolyn Murray, Chairperson

Procrastination has a long association with anxiety, struggle, and emotional turmoil, to the point where modern researchers rarely question the existence of an association between the two. However, a growing body of evidence suggests that while anxiety reliably predicts self-reports of procrastination, its predictive ability decreases or vanishes when measures of behavioral procrastination (also called delay) are used instead. This paradox, if true, has wide ranging implications for the study of procrastination, but few researchers thus far have subjected it to critical examination. Through a series of five chapters this research addresses the question of the depressed correlation between anxiety and delay. The first chapter traces the roots of the paradox to the early division of procrastination research between the two fields of clinical psychology and behavioral psychology. The second chapter uses meta-analysis to examine the relationship between anxiety and delay as well as the relationship between anxiety and self-reported procrastination, contrasting the two to determine if researchers are correct in concluding that the relationship between anxiety and delay is absent. The third chapter suggests that

the depressed correlation between anxiety and delay may be due to poor operationalization of delay, and demonstrates a high-resolution alternative measure of student writing using revision data collected via Google Docs, a popular online word processor. The fourth chapter uses Google Docs revision data to examine the relationship between anxiety and delay. The fifth chapter reviews the evidence of the first four, synthesizing them and offering insights and suggestions for future research. Ultimately, the study finds evidence for a relationship between anxiety and delay, though its magnitude is sufficiently small that it justifies further inquiry into the reasons for the depressed relationship. The analyses of the Google Docs revision data suggests that the reason for the depressed correlation between anxiety and delay is that anxiety, though prompting procrastinators to delay, also prompts non-procrastinators to work earlier. The two relationships cancel out across a classroom of students, giving the illusion of a depressed correlation between anxiety and delay. The final chapter discusses the implications of these findings as well as the broader implications of the methods used to uncover them.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Chapter One: A Brief History of Procrastination

Introduction

In the late summer of 1830, a young Victor Hugo received a message from his publisher containing good news and bad news. The good news was that the publisher had extended the deadline for his newest novel, a sprawling epic spanning the full scope of fifteenth-century Paris. Hugo had fallen in love with the gothic architecture of the grand French cathedrals, with their flying buttresses and stained glass, their bells and bell towers, their art and their magnitude. The government had neglected the cathedrals for decades, much to the shame of France. Hugo, a well-respected author, hoped that a popular novel capturing French society in its full medieval glory would force the officials of Paris to look at their city's historic monuments and realize what they had been neglecting. He started his project in 1929 full of enthusiasm but, as the months passed, he found another project to be passionate about. And then another. By late 1930 he was far behind schedule.

The bad news was that the publisher had grown tired of hearing excuses and no longer had any patience to offer him. The new deadline was nearly impossible. He had until February of 1831, a little over five-and-a-half months, and no later (see Hugo, 1864).

Hugo decided to forge ahead anyway. Since every moment was now precious, everything but his work on the novel had to go; he could allow no more projects, distractions, or frivolities to keep him from his work. The only problem Hugo had was that other projects, distractions, and frivolities were attractive enough to him that he had already ignored his novel in favor of them for over a year. Something needed to be done,

so to address his problem Hugo worked out a strategy that has become a favored legend among procrastinating writers.

To start, he bought everything he needed to keep his study stocked, including a new bottle of ink. Then, he struck a deal with one of his servants; each morning he would give the servant every stitch of his clothing, and the servant would hide them for the day, only returning them at a pre-arranged time in the evening. Therefore, unable to leave the privacy of his home without scandalizing the entirety of Paris, Hugo would at last be able to devote himself to his work. The plan succeeded; on the 17th of January 1931, with two weeks to spare (and not a drop of ink left in the bottle), he sent the publisher his manuscript for *The Hunchback of Notre Dame*. The novel spanned 900 pages, and it had to be published in three volumes. It would quickly become one of the most famous pieces of literature ever written.

The Paradox of Procrastination

Victor Hugo's story is all the more appropriate for psychologists because the version above can be traced back to an article published in *The Journal of Applied Behavior Analysis*. The legend had circulated among authors for a while, but Wallace and Pear (1977) committed it to print, and although they admitted that it was likely apocryphal, they also expressed the hope that it might be true.[1] Since then, the story has

[1] As it turns out, they were half-correct. The story is true but the original version is less stark. The earliest account comes from Victor Hugo's wife, Adele Hugo (see Hugo, 1864). In her version there was no servant, and Hugo left himself no outerwear but a large, gray, ugly shawl, which was his daily uniform from approximately September 1830 to January 1831. Adele Hugo noted in her work that her husband Victor was morose and depressed while writing the novel (Hugo, 1864, p. 157). It is noteworthy that the story Hugo worked on at this time (*Hunchback of Notre Dame*) featured an ugly, unsightly character (Quasimodo) who spent his life confined to a small tower with only a single job to do, who also yearned for freedom.

become so popular that some writers have even suggested that struggling authors should try Hugo's method themselves (e.g., Beck, 2020).

There are better reasons to discuss Victor Hugo's story than its popularity, however. The story nicely captures the paradox of procrastination. The paradox is this: by late 1830, Hugo knew that his novel was the most important thing to him. He had already abandoned every other project for the next critical five months so he could write. He knew with great clarity why he wanted to write, and what he hoped to achieve: money, fame, and a transformation of public policy towards the restoration of gothic architecture. He had already succeeded as an author; for Hugo, writing meant returning to familiar territory and a vocation he adored. It is fair to say that by September of 1830 there was no goal that Hugo held more precious than his novel.

So, why did he need to cage himself inside of his own house? What was happening inside his head that he could not simply do what he had chosen? This is the paradox of procrastination, and psychological researchers have been trying to resolve this paradox for decades.

The Problem of Procrastination

Many will recognize Victor Hugo's procrastination problem immediately. By some estimates, nearly 95% of college students report that they procrastinate (e.g., Ellis & Knaus, 1977), and studies of procrastination in student samples suggest that approximately one-third of students may be severe procrastinators (Day, Mensink & O'Sullivan, 2000). One reason that Hugo's story is so popular may be that readers enjoy

his wild and shocking solution to the same familiar problem they struggle with, even if they would never try his method for themselves.

However, even though it is familiar, procrastination is strange. It seems logical that most people, when presented with a choice between two options, will pick the one that benefits them the most. This was the view of Socrates, one of the great students of the human condition, who believed that being virtuous was in people's best interest, and that if they failed to pursue the good and virtuous things in life, it must mean that they did not fully understand how it was beneficial for them (Nakhnikian, 1973). However, Victor Hugo's story suggests that there are situations where one can have a perfectly clear vision of what is in their best interest and still need to fight against a hidden, unruly aspect of their own mind, just to make themselves do the sensible thing.

Hugo's internal battle also serves as a reminder of the scope of procrastination. Some researchers have suggested that procrastination is a recent phenomenon (Milgram, 1992), but while that may be true in some sense, it is very clear from a review of the historical record that procrastination has been a natural tendency of humanity from the beginning. Injunctions against procrastination appear in the Code of Hammurabi, along with penalties against the procrastinator to compensate those who were harmed by such behaviors (Harper, 1904). References to procrastination are carved in hieroglyphic text onto the sandstone walls of Egyptian tombs (Leprohon, 2013). Procrastination has plagued the highest achievers, from geniuses such as Leonardo da Vinci (Catani & Mazzarello, 2019) to world leaders such as Bill Clinton (Duffy, 1994), and has been just

as real to nineteenth-century Parisian authors, such as Victor Hugo, as it is to modern office workers today.

A final note is that Hugo's internal battle also serves as a reminder of the potential consequences of procrastination. It is difficult to reckon with the costs of procrastination because they often remain hidden from view. An especially pernicious aspect of procrastination is that it takes from people things that they *could* have had, but since they never got to hold them in their hands, they are left with no concept of what they lost. How many friends were never met, how many books were left unwritten, how many opportunities were lost under the tyranny of tomorrow? Near-misses like *The Hunchback of Notre Dame* are informative because one can imagine what would have happened if such work had never existed. If Hugo's last-minute rush had failed, then it certainly would have affected the course of his life and his art. It likely would have affected the course of modern literature. Also, per Hugo's goal, the novel's success had shamed Paris into repairing the derelict Cathedral of Notre Dame due to the upsurge of interest in historic landmarks after the novel was published (Nash, 1983). If Hugo had failed, it may well have changed the course of modern architecture and historical preservation.

In recent years, some researchers have managed to attach numbers to the cost of procrastination, to unsettling effect. For example, Kasper (2004) reported that procrastinating on taxes in 2002 may have led to errors costing as much as $400 per tax return, meaning that procrastination may have cost taxpayers as much as $450 million dollars for that year alone. Steel and Ferrari (2013) found in a world-wide sample that procrastination mediates the relationship between sex and education level, suggesting that

it may be partially responsible for men's tendency to lag behind women in educational achievement. Procrastination can also lead to behaviors that promote severe long-term health problems (Sirois, 2016). In such situations the cost of procrastination has to be tallied in lost years, not lost dollars. Meaningful insights about the causes of procrastination could inform strategies to ameliorate these damages. Answers, then, are highly prized by psychologists.

The Present Dissertation

A critical problem in procrastination research centers around the question of what provides the raw motivational force that compels people to procrastinate. It seems fair to say that procrastination is a "hot" psychological problem. It is not simply a cool and calculated weighing of options. Rather, it is experienced by procrastinators as an internal conflict, marked by emotion. Procrastinators report that many of their motivations are related to emotion (Solomon & Rothblum, 1984), and research has shown that procrastinating is accompanied by different emotions over time (Pychyl, Lee, Thibodeau & Blunt, 2000; Tice & Baumeister, 1997). An immense literature has sprung up on the relationship between procrastination and emotion, testing the hypothesis that specific emotions such as depression, anxiety, shame, guilt, and anger cause procrastination. These theories have enjoyed wide acceptance, but the evidence for them is mixed, and leading researchers in the field have actively questioned the causal role of emotion in procrastination (Steel, 2007; Steel, Svartdal, Thundiyil & Brothen, 2018).

Of the different emotions, arguably the one that has received the greatest attention from researchers is anxiety. It has been implicated as a potential cause of procrastination

from the beginning; Solomon and Rothblum (1984), in their seminal work on procrastination, identified fear of failure as one of two primary reasons students gave for procrastinating. Additionally, anxiety occupies a unique spot because other emotions may prompt procrastination by increasing anxiety. Fee and Tangney (2000), for example, found that shame-proneness is related to procrastination, but while this could mean that procrastination is caused by the feeling of shame itself, it could also be due to the anxiety associated with anticipating a possible future episode of shame. Whatever the cause of the anxiety, Ferrari, Johnson and McCown (1995) have suggested that the associated mechanism is reinforcement; when a procrastinator puts off their work; they are relieved of the anxiety associated with it, inadvertently reinforcing their avoidant behavior.

As intuitive as this sounds however, there are some problems with this hypothesis. Namely, while there is a great deal of literature reporting a relationship between anxiety and procrastination when they are assessed using self-report measures, the relationship is much weaker when considering actual behavior. The present research addresses the various aspects of this problem.

Literature Review

Defining Procrastination

The simplest definition of the word *procrastination* is inherent in the word itself, which is practically unaltered from its original Latin form. The Online Etymology Dictionary defines procrastination as a composite word consisting of the root *pro*, meaning "forward," and *crastinus*, meaning "belonging to tomorrow." In its pure form,

then, procrastination literally means to move something forward to tomorrow (Harper, n.d.a).

However, it is not possible to capture the behavior denoted by "procrastination" without also accounting for its motive. There are many reasons to delay something until tomorrow. Delays can happen because of unforeseeable events, or because a person is too exhausted to be punctual, or because a person does not have the tools or information needed to finish a task effectively. A procrastinator, on the other hand, has no good justification for delaying. Most definitions of procrastination in modern dictionaries account for this. The *American Heritage Dictionary*, for example, defines procrastination as: "To postpone or delay needlessly." (Houghton Mifflin, n.d.a)

Psychological researchers are more rigorous in their definition of procrastination, as it is a necessary step in operationalizing it for study. While there is some variation among definitions, almost all psychological definitions contain two components, *delay* and *irrationality* (e.g., Sabini & Silver, 1981). Steel (2007) summarizes the two components by defining procrastination as "to voluntarily delay an intended course of action despite expecting to be worse off for the delay."

For the purposes of this dissertation, procrastination is defined in terms of these two components. The first component is that procrastinators *delay*. If a person is procrastinating, it means that they are delaying something until later. If a group of people are procrastinators, it means they tend to delay more than non-procrastinators. While procrastination may encompass many behaviors, the tendency to move things forward in time is the *sine qua non* of the construct. The second component is that the delay is

irrational. This can have multiple meanings; irrationality can mean that the strategy of procrastination prevents people from living up to their capabilities. It can mean that it prevents them from getting what they want, or from getting the best outcome in a given situation. It can also mean that the procrastination behavior is not "planful" and is influenced by irrational forces like cognitive distortions, emotions, or behavioral volatility. The specific shade of meaning applied to the irrationality of procrastination does not change how irrationality is used throughout the research presented here. What matters is that the procrastinator knows that their decision to delay is a poor choice, but they procrastinate anyway.

Procrastination: A Brief History

The late 1970's and early 1980's are a unique inflection point in the history of procrastination research; the dominant theories of procrastination were largely established in this time frame (e.g., see Burka & Yuen, 1983; Ellis & Knaus, 1977), and the 1980's saw the creation of almost every major survey measure that researchers use to study procrastination. It is understandable that some researchers have concluded that little was going on in procrastination research before this time (e.g. Knaus, 2000).

However, it makes more sense to think of procrastination as a subject that started much earlier and bloomed when the dominant paradigms of psychology shifted in a way that allowed it to be effectively studied. Procrastination is defined by the two components of *delay* and *irrationality*, and it is a particular historical quirk of the construct that for most of the twentieth century the two components were divided between two sub-fields of psychology. One sub-field, behaviorism, was uniquely suited to studying *delay*,

especially in animals, but theoretical and methodological barriers made it difficult for them to incorporate *irrationality* into their research. Another sub-field, clinical psychology, was uniquely suited to the detailed documenting of *irrationality*, but did not have a well-developed set of empirical methods that would enable them to study *delay*. The end result was that clinical psychologists talked openly about procrastination but did not do a great deal of empirical research on it, while behaviorists researched the motivational mechanisms underlying procrastination without talking about it directly. This division between the two components of procrastination, and their association with the fields of psychoanalysis and behaviorism, has laid the groundwork for inconsistencies that still persist today, and it is therefore worth reviewing them further for context.

Clinical Psychology

Freudian Psychoanalysis. The clinical tradition is uniquely suited to the study of the irrational aspects of procrastination since their daily practice involves tackling irrationality and its consequences in their clients. This dynamic, of helping people who are often irrationally engaged in behaviors that make it difficult for them to be helped, has been central to therapy from the start. Freud, the father of psychoanalysis (and arguably psychotherapy in general) not only embraced the irrational aspects of human nature, but he imputed to them a causal force in personality (Freud, 1922). While it is possible that some of Freud's focus on irrationality was a result of his own preferences and personality, one can hardly ignore the importance of his situation. Freud did not make his clients irrationally self-destructive; they came to him that way, making his job

as a clinician to help them and to describe how he did it so that other therapists could do the same.

Freud's theories are extensive and have been well documented (for perhaps the most fair-minded recent introductory treatment, see Funder, 2018). It is worthwhile to note here that shortly after the turn of the 20th century Freud had already identified a cluster of character traits that could be considered progenitors to the modern understanding of conscientiousness and procrastination. These traits consisted of *orderliness,* or a penchant for organization that could easily degenerate into a neurotic fixation on detail; *obstinacy*, or a tendency for diligence that could easily degenerate into belligerence; and *parsimony*, or an innate frugality that could easily degenerate into greed (Freud, 1908/1959; Abraham, 1923). Freud noted that when, in his clinical work, he encountered people with this particular cluster of traits, they tended to report having completed their toilet training later than others. Freud connected the two inductively. He had no prior theory that might lead him to connect personality and toilet training, and was puzzled by it himself, but had seen the pattern often enough that he felt it was worth reporting. His monograph on the topic was a scandal among his contemporaries.

Freud later elaborated on this initial observation, connecting it to the anal-erotic state of his psychosexual development theory (Freud, 1917). The connection grew in popularity to the point where it is now a colloquialism, expressed when one person refers to another as *anal* or *anal-retentive.*[2] Jones (1918), a contemporary of Freud, elaborated

[2] There may be some truth to this connection. It is worth restating that Freud (1908) initially formulated the connection based on clinical observation of his patients, and only later built theories based on it. While the theories themselves are dubious and likely to be shaped primarily by the peculiarities of psychoanalytic doctrine, the initial connection Freud observed may be sound. It is very likely that Freud, in his clinical practice, stumbled across patients who exhibited

at length on the relationship between procrastination and the anal character, suggesting that procrastination originated in early tendencies to delay toilet usage, which were then generalized to work patterns later in life.

General Psychopathology. Freudian interpretations of procrastination eventually fell out of favor with psychologists, and research such as that of Hetherington and Brackbill (1963) found little support for the notion of procrastination as an *anal-retentive* behavior pattern. Generally speaking, however, procrastination remained the domain of clinical psychologists. For example, procrastination was included in the publication of the *DSM-1* in 1952 as one of the symptoms of a passive-aggressive personality disturbance (American Psychiatric Association, 1952).

Clinical interpretations of procrastination were also being used to explain learning patterns in education. For example, Liss (1941), in describing students, identified procrastination as one pattern of behavior associated with anxiety. Other research, such as that of Weiner (1971), suggested that passive-aggressive underachievers used inactivity and delay as subtle forms of rebellion, enacted unconsciously (and therefore irrationally). While some empirical research in educational psychology addressed procrastination from a non-clinical standpoint (e.g. Lum, 1960), in these cases procrastination was a subscale of larger inventories that gauged study habits in general, often assessed by only a few questions. Ultimately, the most authoritative voices on procrastination from this time appear to have been clinical.

---

symptoms of severe ADHD, since ADHD has been associated with procrastination, hoarding, bouts of hyper-focus, and severe dysregulation in basic functions like regularity of bodily functions. The resulting theories of the *anal character* may have been the result of Freud and his colleagues stumbling around in their attempts to articulate and explain their observations because the core tenets of psychoanalysis were not sufficient to understand or explain ADHD appropriately.

Rational-Emotive Behavioral Therapy. While the original association of procrastination with irrationality occurred in the context of Freudian psychoanalysis, the most significant treatment of the relationship came from Rational-Emotive Behavior Therapy (Ellis, 1962). Ellis' theories allowed for a unique treatment of procrastination. While other clinical theories tended to treat procrastination as part of a larger psychopathology with developmental origins, Ellis' theories allowed for procrastination to be treated as the result of clearly defined irrational patterns of thinking that could be addressed in therapy. This allowed for very specific conjectures to be made about the relationship between procrastination and irrationality. Ellis and Knaus (1977) thoroughly outlined these connections in their seminal work on procrastination, which still remains a definitive treatment of the topic.

Ellis and Knaus' (1977) work is particularly useful here, because it provides a clear bridge between broader forms of irrationality and more specific types impelled by emotion. One of the motives that Ellis and Knaus suggest for procrastination, for example, is *self-downing*, or a tendency to have a low self-image and to believe that failure is proof of one's own worthlessness, leading to an irrational fixation on perfection. In their formulation, the reason that this particular form of irrationality produces procrastination is because, among other reasons, it generates emotions like depression and anxiety. These emotions sap a person of their motivation to perform a task, and also creates such an aversive anxious state that the person will sabotage themselves in order to avoid experiencing that state. A second irrational motive suggested by Ellis and Knaus is *low frustration tolerance*, or an irrational belief that one cannot manage frustration (or

should not have to), that impels a person to stop persevering at low levels of stress. Ellis and Knaus argue that those with low frustration tolerance will respond to even low levels of anxiety, agitation, or anger with a tendency to leave or quit a task, since they have already mentally dismissed the possibility that they might cope with such emotions and work through them. These themes of anxiety and agitation recur frequently in a great deal of the subsequent literature on procrastination. Solomon and Rothblum (1984), for example, found in a factor analysis of a student sample that students' reasons for procrastination could be largely accounted for by two primary factors. The first factor, *Fear of Failure*, contains the same conceptual components as Ellis and Knaus' (1977) *self-downing*; the items loading on the factor reflected low self image and a neurotic drive towards perfectionism. The second factor, *Task Aversion*, contains the same conceptual components as Ellis and Knaus' *low frustration tolerance*; the items loading on the factor reflected lack of energy and interest and a tendency to give up quickly because of unpleasantness or frustration.

Behavioral Psychology

During the middle portion of the twentieth century, behavioral psychologists conducted a rich program of research on the relationship between work and time that was often applied in varied forms to developing a better understanding of procrastination. However, they rarely referred to it as *procrastination,* perhaps because they worked with animals, and any reference to procrastinating would come with tacit implications about animal motives that most behaviorists considered too nebulous to be of scientific use.

Nonetheless, behavioral psychologists were very familiar with the temporal dimension of research since it was the most natural dimension to use for mapping their observations of both human and animal behavior. One early principle uncovered by behaviorists was that the tendency of an animal to learn a specific behavioral response was directly related to the size of the temporal gap (i.e., the interval) between the animal's behavior and the subsequent reward (Watson, 1917). By the 1940's, behaviorists had begun to make generalizations from animal models of behavior under temporal delay to human problems; Mowrer and Ullman (1945) observed that some forms of irrational human behavior (which they defined as behavior that was consistently more punishing than rewarding) could be explained when one considered temporal distances between behaviors and their consequences.

Schedules of Reinforcement. In the 1950's, Ferster and Skinner (1957) released their landmark work on schedules of reinforcement. While earlier work on reinforcement had established that learning a behavior was strengthened by minimizing the temporal distance between the behavior and its subsequent reward, Ferster and Skinner's work showed something quite different. When an animal with a well-learned behavior (like bar-pressing), was rewarded for the behavior at constant, predictable intervals of time (a *fixed-interval schedule*), the frequency with which the animal performed that behavior often increased as the time of reinforcement drew nearer. In other words, temporal distance of reward not only affected how rapidly a behavior was learned, but also how rapidly it was performed. On Ferster and Skinner's graphs of animal behavior this took the form of a positively accelerated curve that formed a scalloped shape when the

behavior was mapped across time. The shape is highly reminiscent of the curvilinear relationship between work and time that characterizes the *delay* component of procrastination in modern research.

The behavioral literature on fixed-interval schedules of reinforcement is likely of interest but, due to its scope and complexity, cannot be reviewed here.[3] However, behavioral researchers did notice the similarity between the scallop-shaped behavioral responding of animals on fixed-interval schedules and the behavior of humans under deadline pressure. This led to multiple studies applying such theories to the behavior of students (e.g., Baron & Galizio, 1976; Mawhinney et al. 1971[4]) and also to wider domains such as the bill-passing behavior of the United States Congress (Critchfield et al., 2003; Weisberg & Waldrop, 1972). Since behaviorists were applying their insights to situations that clearly mirror procrastination as it is understood today, it is reasonable to assert that for much of the 1950's, 1960's, and 1970's, behavioral psychologists were the specialists in the empirical study of procrastination, though they focused primarily on the *delay* component and did not often address *irrationality*.

Personalized Systems of Instruction. The behavioral approach saw its fullest realization in the research conducted on the Personalized Systems of Instruction (PSI), pioneered by Keller in the 1960's (Ferster, 1968; Keller, 1967, 1968). Keller sought to demonstrate that it was possible to structure courses so that students could learn a complicated body of material at their own pace, under their own volition, while their

[3] For readers interested in a review, Ainslie (1975) attempted to integrate this research and use it to outline a theory of impulse control that could shed light on behaviors such as procrastination. Of particular interest in that paper is the relationship between time and preference-reversal, or the point where one behavior (like working on an essay) suddenly becomes preferred over another (like avoiding the work).

[4] See also Michael (1991) and Jarmolowicz, Hayashi & Pipkin (2010) for later research along this line

instructor focused on directing and supporting learning, instead of lecturing. The system was popular, but those who tried to implement it found quickly that procrastination was a problem (e.g. Morris, Surber & Bijou, 1978).

Research on Keller's Personalized Systems of Instruction is noteworthy for two reasons. The first is that PSI adherents produced one of the first major bodies of empirical research on procrastination in an educational context. While there had been studies researching this paradigm prior to those conducted on PSI (e.g., Lum, 1960; Mawhinney et al, 1971), procrastination posed a unique problem to the self-paced courses envisioned by Keller, since too many students delaying work until the last moment had the potential to put an undue burden on the teacher and staff implementing the system. As a result, many researchers started to treat procrastination as a problem worth addressing. Though most did not include measures that captured the *irrationality* aspect of procrastination, they nonetheless dealt with counterproductive student behaviors, and they also explored classroom-structuring methods that would decrease delay (Powers, Edwards & Hoehle, 1973; Semb, Glick & Spencer, 1979).

The second reason PSI-related research is noteworthy is that the patterns laid down by the research into Keller's PSI courses ultimately became the gold standard for high-quality research exploring procrastination. This standard informed the seminal research on procrastination (e.g. Solomon & Rothblum, 1984) and informs modern research as well; studies utilizing self-paced courses based on Keller's model are widely considered to constitute some of the most rigorous and well-designed work in modern

procrastination research (e.g., Steel, Brothen, & Wambach, 2001; Steel, Svartdal, Thundiyil & Brothen, 2018).

The Blooming of Procrastination Research

By the late 1970's there were two well-developed traditions of procrastination research, each with their own theoretical focus and unique methods for dealing with the problem of irrational delay. The clinical tradition had gone a great way towards exploring the treatment of procrastination and its relationship to irrationality, including emotion. However, clinical psychologists had done little empirical research, and many of their theories were generated inductively from interactions with clients.

The behavioral tradition had begun to develop a substantive body of empirical research on the tendency to delay behavior when it was reinforced at fixed temporal intervals. They had quickly drawn the connection between this and procrastination behavior, and a lively secondary cluster of empirical research had popped up on the side, exploring scalloped patterns of behavioral delay in relation to various fields of practical interest such as government, writing, and education. These behaviors were occasionally called procrastination, but little research was being actively done on the relationship between delay and other psychological variables.

The unique contribution of the 1970's and 1980's is that researchers during that time fused the research on procrastination from these two traditions. Suddenly, procrastination was treated as a separate topic, worthy in its own right. Prior to that, procrastination had been treated as an epiphenomenon or an indicator of other, more fashionable constructs. In the clinical tradition procrastination was considered a symptom

of larger psychological disorders. In the behavioral tradition it was either a manifestation of a schedule of reinforcement or, when present in the classroom, a behavior that researchers tried to remedy with various forms of classroom design. Social and personality psychologists, on the other hand, sought to understand the internal dynamics of procrastination as well as its relationship to the broader network of psychological variables surrounding it, including its causes and correlates, as well as its effects on school performance, health, work, and beyond (e.g., Van Eerde, 2003).

Studying the relationship of procrastination to the full network of psychological variables necessitated the creation of accessible measures of procrastination. Between 1975 and 1990 several major procrastination questionnaires were created. The researchers who made these questionnaires had to solve the problem of fusing together the insights gained from the behavioral and clinical traditions of psychology. To do this, they created measures with items drawn from clinically derived theory, and then they "anchored" the measures using behavioral paradigms to demonstrate their validity. For example, Solomon and Rothblum (1984) demonstrated the validity of their procrastination inventory using a method built around self-reported quizzes, which drew inspiration from Keller's PSI paradigm. Other researchers (e.g., Lay, 1986; Tuckman, 1991) created similar paradigms to test their own newly constructed measures.

After the initial demonstration that the survey measures of procrastination did correlate with a tendency to delay work, many researchers happily assumed that the questionnaires could reliably serve as a stand-in for measuring behavioral delay. In the mind of many researchers, if a new construct correlated with a survey measure of

procrastination it was safe to assume, without verification, that it also correlated with the tendency to delay work in real-world contexts. Ferrari et al. (2007), for example, claimed to have assessed behavioral delay across six countries spanning four continents, but in their study actual behavioral delay was not measured at all; rather, their study used two well-known procrastination questionnaires that were thought, based on patterns of intercorrelations in previous research, to assess different clusters of motives for procrastination (Ferrari, 1992).

There are two issues with this approach. First, much of the theory of procrastination passed on to social-psychological researchers appears to be grounded primarily in clinical observation. Procrastination theory was constructed largely on the self-reports of patients and was then passed to researchers who tested these paradigms empirically using the self-report of their participants. It is possible that some variables and theories have bounced around the field of procrastination research for close to five decades without any researcher ever checking to see if they are actually related to behavioral measures of delay. This is not a fatal flaw, but it does mean that any problems with procrastination researchers' choice of methods are amplified. If, for example, there was found to be a serious problem with the way self-report measurement has been employed in studying procrastination, researchers would not have the luxury of imagining that there is a body of research from the past which they can lean on for support.

The second is that while behavioral measures are considered the "gold standard" in procrastination research, they are employed very rarely and there is no guiding body of

methodological literature that researchers can draw from to design the type of detailed studies that enable them to study delay behavior in depth. This makes it especially difficult to disentangle questions about the relationship between the *irrationality* and *delay* components of procrastination. The nuances of the relationship between irrational motives and delay are poorly understood, and such nuances will likely remain elusive as long as researchers continue to paper over them with questionnaires.

The Problem of Anxiety and Procrastination

Defining Anxiety. There are many possible variables that could serve as a starting point for a researcher who wants to understand the irrational motives that cause procrastination. However, it is difficult to imagine a better starting point than anxiety. It is one of the oldest constructs in psychology, having been an active topic of study in the medical field at approximately the same time the first tentative programs and laboratories in psychology were being founded (see Johnson, 1875), and it also seems to be a key piece in the grand puzzle of the human psyche.

The *American Heritage Dictionary* defines *anxiety* as being "uneasy and apprehensive about an uncertain event or matter; worried" (Houghton-Mifflin, n.d.b). Its linguistic roots in old Latin and Proto-Indo-European denote choking, implying the physical sensation of tension and constriction.[5] Anxiety is often thought of as a muted form of fear, and this conceptualization is not entirely wrong. However, fear implies a fight-or-flight response. As McNaughton and Corr (2004) have noted, however, while

[5] The Latin root is *anxius*, a derivative of the verb *angere*, meaning "to choke or squeeze." This happens to also be the root of the word *anger* (and also *angst, anguish,* and *angina*). Presumably the tradition of usage that led to the modern word "anxious" refers to the feeling of being choked, while the tradition that led to the modern word "anger" refers to doing the choking. (Harper, n.d.b)

fear impels an organism to flee from a threat, anxiety usually accompanies situations where an organism has to approach a threat. Incorporating this distinction into their own neuropsychological model of anxiety, McNaughton and Corr suggest that it is better to think of anxiety as the byproduct of mental conflict. This conflict occurs most often in the context of an approach-avoidance dilemma, where an organism must approach something that it wants to flee from. As McNaughton and Corr note, however, it can also occur in the context of approach/approach or avoidance/avoidance conflicts, where an organism must choose between two desirable (or undesirable) options.

For the purposes of the present research, anxiety is defined using the language of conflict. Anxiety is the unpleasant, aversive feeling (i.e., physiological arousal) that occurs when an individual is caught between multiple goals (or impulses) and must select among them.

Anxiety and its Permutations in Procrastination Research. Multiple theorists have attempted to describe how anxiety leads to procrastination. The general assumption is that when a person working on a project experiences internal conflict, the anxiety aroused as a result is unpleasant. There are multiple ways to resolve this unpleasantness, but the easiest one is to avoid the behavior that is causing the anxiety (i.e., working on the project). If the worker chooses to stop the conflict by avoiding the work, the reduction in anxiety reinforces the behavior of leaving, creating a pattern that grows stronger over time (Ellis & Knaus, 1977; Ferrari, Johnson & McCown, 1995). By this logic, state anxiety should prompt procrastination. Additionally, traits that predispose a person towards experiencing state anxiety more often should produce more moments of conflict,

which in turn, should present more opportunities to reinforce avoidant behavior. Therefore, measures of trait anxiety, trait negative emotionality, and trait neuroticism should all predict a greater tendency to delay work.

Researchers have gone beyond this, however, and have built on many of the theories that were laid out by clinical psychologists. Ellis and Knaus (1977), for example, did not simply argue that basic anxiety leads to procrastination. In fact, they pointed out that the emotion alone probably would not prompt procrastination unless it was also supplemented by unhealthy, irrational ways of thinking about work and oneself. In particular, they suggested that an irrational fear about being judged negatively by others (which they referred to as *self-downing*), coupled with an unhealthy compulsive belief that one *must* avoid such negative judgments, prompts a sort of irrational lockdown that amplifies anxiety levels to the point that they sabotage their ability to work. In their words, "overweening anxiety may not serve as the only cause for procrastination, but it certainly helps!" (Ellis & Knaus, 1977, p. 17)

Building on this, researchers in the last several decades have expanded far beyond state anxiety, trait anxiety, and broad traits like neuroticism in explaining procrastination, defining many specific and contextualized forms of anxiety that are supposed to contribute in unique ways. Procrastination has, therefore, been linked to evaluation anxiety (Brownlow & Reasinger, 2000), social anxiety (Ko & Chang, 2019), fear of failure (Solomon & Rothblum, 1984), death anxiety (Donovan, 1995), and contextualized forms of anxiety such as reading anxiety (Collins, Onwuegbuzie & Jiao, 2008), statistics anxiety (Onwuegbuzie, 2004), and test anxiety (Carden, Bryant & Moss, 2004).

Does Anxiety Predict Procrastination?

Meta-Analytic Estimates. On balance, the evidence supports the hypothesis that anxiety and procrastination are related. Steel's (2007) meta-analysis of the literature tested the relationship between several anxiety related variables and procrastination. He found an average effect size of r = .24 for the relationship between neuroticism and procrastination across 59 studies (N = 10,720). He also found an average effect size of r = .18 for the relationship between fear of failure and procrastination across 57 studies (N = 10,785).[6] Steel did argue that these effect sizes were small and should not be construed as support for a relationship between anxiety (or neuroticism in general) and procrastination. However the notion that effect sizes in the range of r = .18 to r = .24 should be considered small has been drawn into question; Funder and Ozer (2019) have suggested that effect sizes in that range should be considered theoretically meaningful because, among other reasons, the consequences of even a small correlation between two variables have the ability to compound across time. Thus, even with a modest correlation between fear of failure and procrastination, such as r = .18, one should give due consideration as to how that might affect students' performance across four years of college, where they typically have several hundred opportunities to fear failure—and several hundred opportunities to procrastinate.

Anxiety and Delay. On the surface, then, it would seem that researchers have amassed a very large body of evidence that supports a relationship between anxiety and

[6] Steel used the label *Fear of Failure* to encapsulate several questionnaires. Some are measures of specific types of anxiety, such as Fear of Failure and Evaluation Anxiety. Other measures, such as Social Perfectionism and Self-Consciousness, may not be clear measures of anxiety but assess variables so close to it that they can be considered functionally indistinguishable.

procrastination. In fact it is difficult to understand why such a conclusion might be objectionable, if the only information one had to go on was the broad meta-analytic trend of the literature.

However, several studies of anxiety and procrastination that incorporated measures of behavioral delay have found that anxiety does not appear to be a strong predictor of delay at all. Steel et al., (2000; 2018) found no evidence of a positive relationship between anxiety and measures of actual delay in the self-paced courses they studied. This echoes the findings of previous researchers such as Lay and Silverman (1996), Moon and Ilingworth (2005), and others.

One problem raised earlier is that theories about the relationship between procrastination and emotion originated in the self-reports of clients to their clinical psychologists. These ideas filtered into the research literature through the influential works of Ellis and Knaus (1977) and Burka and Yuen (1983) and they were quickly adopted by researchers who tested them using the self-report of participants. This is a form of mono-method bias; a set of hypotheses derived from patients who said that they procrastinate because of their anxiety were then "confirmed" by researchers who showed, using questionnaires, that other people (research participants) also say they procrastinate because of their anxiety. In a worst-case scenario, much of the research conducted on procrastination could, in fact, better be described as research on how procrastinators talk about their procrastination. This is problematic because psychologists, if they hope to be useful, need to offer meaningful insight into what procrastinators do, and why they do it, so that useful methods can be develop for changing these behaviors This is purely a

worst-case scenario, however; at present there is not even enough research to gauge how problematic this method-bias is, since well-designed behavioral studies are still rare in the procrastination literature.

The Missing Relationship. The absence of behavioral evidence has prompted some skepticism among procrastination researchers about whether anxiety predicts actual procrastination at all. Lay and Silverman (1996) argued that it does not, and Steel (2007) argued strongly that the meta-analytic correlations found between procrastination and the various forms of anxiety and neuroticism should not be construed as support for an actual relationship because of the lack of evidence that it actually relates to delay. However, this does not mean that there is no relationship at all. It simply means that, if there is a relationship, it is not clearly visible using summary measures of delay across broad samples of students. There are good arguments to be made that the absence of a clear relationship between anxiety and delay should be taken as a signal that further exploration is needed.

The best argument, perhaps, is the nature of anxiety itself. The neuroscience of anxiety suggests strongly that it is a natural product of motivational conflict (McNaughton & Corr, 2004), occurring when a person must choose between conflicting emotions, or when they must suppress one in favor of another. Procrastination is a form of motivational conflict (Steel, 2007) so it seems evident that anxiety should be involved in the process in some form. In the absence of a clearly identifiable relationship, it is more logical to conclude that more searching is needed, rather than assuming that there is nothing to see.

A second, related, argument is that behavioral evidence suggests that anxiety *should* affect individuals' ability to work. The most compelling single study was conducted by Estes and Skinner (1941), who directly pitted anxiety against work. Estes and Skinner first conditioned rats to "work" for food by repeatedly pressing a lever, and then taught the rats that the presentation of a specific tone would be followed by an electric shock. Then they let the rats work, interrupting their efforts periodically with the tone/shock combination. The anticipatory period between the time the tone started and the time the shock was delivered disrupted the rats' behavior and severely repressed their work. Even more interesting; after the tone/shock combination was delivered and the rats were able to resume their work, they picked up the pace, presumably to make up for lost time.

These pieces of evidence suggest that researchers should expect to see *some* relationship between anxiety and delay. The exact nature of that relationship, however, is unclear, and its absence from well-designed studies that measure delay is intriguing. When faced with two forms of measurement that seem to provide conflicting results, blind dismissal of either form of measurement is just as problematic as blind acceptance. For scientists, strange discrepancies have always been the golden road to discovery. The proceeding chapters are devoted to a further study of this discrepancy, first seeking to determine, meta-analytically, whether it is true, and then introducing new methods for exploring the relationship between anxiety and procrastination.

Chapter Two: Anxiety, Procrastination and Delay – A Meta-Analysis

Introduction

The History of Anxiety as a Predictor of Procrastination and Delay

In the early 1980's, as social and personality psychology assimilated the findings from the clinical and behavioral traditions into their own research on procrastination, early empirical studies supported the clinical viewpoint that anxiety and procrastination were related. An early factor analysis of procrastinators' motives conducted by Solomon and Rothblum (1984) showed that one factor, which Solomon and Rothblum labelled *fear of failure*, accounted for the majority of the variance in students' motives for procrastinating. Later research by McCown, Johnson and Petzel (1989) used principal components analysis to explore patterns of relationships between procrastination and personality, identifying three separate subtypes of procrastination. Two of the subtypes that they found were associated with high levels of neuroticism. At around the same time other research demonstrated that anxiety correlated with both self-reported procrastination and students submission times for their term papers, though the correlation of anxiety with submission times was notably weaker than the correlation of anxiety with self-reported procrastination (Beswick, Rothblum & Mann, 1988).

This initial research was a heartening confirmation that there was a relationship between procrastination and anxiety. However, some problems are, in retrospect, apparent even in this early research. For example, while Solomon and Rothblum (1984) did find that a single factor, *fear of failure*, explained a disproportionately large amount of the variance in their data, the group that scored highly on *fear of failure* was small. In

contrast, the group scoring high on the second factor, *task aversion,* was a much larger and more heterogeneous group.

Ultimately, though, there did not appear to be much reason to question the relationship between procrastination and anxiety, or between procrastination and closely related constructs such as fear of failure, fear of evaluation, and test anxiety, since research in the late 1980's and early 1990's found support for each of these relationships (e.g. Beswick et al., 1988; McCown, Petzel & Rupert, 1987; Milgram, Dangour & Ravi, 1992). Over time, researchers proposed more ambitious and complex models of the relationship between anxiety and procrastination (for a representative examples, see Gautam, Polizzi & Mattson, 2019)

In the mid-1990's, however, dissenting researchers began to identify inconsistencies with the accepted theories. One of the first, Lay and Silverman (1996), noted that findings regarding anxiety and procrastination were inconsistent, with some researchers (e.g. Lay, 1995) finding no relationship while others did (e.g. Beswick et al., 1988). Lay and Silverman (1996) tested the relationship between anxiety and students' self-reported procrastiation behavior leading up to an exam and found no relationship. Later findings echoed these results, and a pattern began to emerge; Lay and Silverman had asked students to report on their delay behavior, rather than their trait procrastination. Other studies that found small or absent relationships between anxiety and "procrastination" were often operationalizing procrastination as delay behavior, either objectively (e.g. Moon & Illingworth, 2006; Steel et al., 2001) or with carefully administered self-report questionnaires (e.g. Pychyl et al., 2000). Over time, the pattern

became clear to researchers, who began to express doubts about the relationship between anxiety and delay (e.g. Steel, 2007).

However, nobody has yet addressed these doubts using meta-analysis. Individual studies can provide insight, but ultimately it is the study of cumulative trends across many studies that provides the strongest evidence for an argument (see Rosenthal, 1991, pp. 3-5 for a discussion of the importance of cumulation). In the case of procrastination research, scholars are still constructing complex models of the relationship between procrastination and anxiety and confidently generalizing them to to behavior (e.g. Wang, 2021). The field may benefit from a meta-analytic study of the relationships between anxiety and various measures of procrastination and delay, to determine whether the research evidence accumulated thus far supports such generalization. The present study seeks to address this gap. First, however, it is useful to ask why a differential pattern in correlations exists in the first place.

Problems with Self-Reported Procrastination

Why would anxiety correlate with procrastination when a participant is asked to fill out a questionnaire about themselves but not when a researcher measures their behavior? It may be that researchers have started with some incorrect assumptions. When a researcher generalizes from a correlation between anxiety and self-reported procrastination to the tendency of anxious students to study at the last minute, they are relying on an implied model of procrastination. This model tacitly assumes that the variables that predict what a person says about themselves should also predict what they do. However, for that model to be true, some formal assumptions must be met.

1) What a person says and what they do should be correlated with each other.
2) A variable that affects what a person says should do so because it first produces changes in what they do, that are then reported faithfully and accurately.
3) The variable should not produce changes in what the person says by some other route.

The evidence in the procrastination literature overwhelmingly supports the first assumption. Studies have found correlations between procrastination measures and actual delay in the range of r = .30 to r =.40 (see Steel et al., 2001, 2018), and meta-analytic studies of procrastination have found an average correlation of r = .29 between self-reported procrastination and the tendency to miss a deadline (Van Eerde, 2003), as well as many other forms of delay behavior (Svartdal et al, 2020). What people say about their procrastination tendencies is a strong predictor of their tendency to actually procrastinate.

The problem is that the evidence reviewed so far suggests that the second and third assumptions are not true. Procrastination measures may reflect delay, but anxiety does not appear to affect delay, so any relationship between anxiety and people's self-reports of procrastination probably happens via some other route. Given the nature of the variables that can influence self-report—including many that are related to emotion and self-concept (see Schwarz, 1999; Schwarz & Clore, 1983)—this alternative path of influence is not only possible, but almost inevitable.

Self-Reported Procrastination and Self-Concept

A change in self-reported levels of procrastination between two measurement episodes could certainly indicate a change in how much a person delayed in each episode.

However, it could also indicate a change in how the person filling out the self-report measure construes their own behavior. For example, in one study students were approached twice in an academic term, once after each midterm, and asked to report how much they had procrastinated in the week leading up to the midterm. This was coupled with a measure of self-forgiveness that assessed how harshly each student criticized themselves over their procrastination (self-forgiveness was operationalized as lower criticism). The analyses showed that among those students who self-rated as high procrastinators on the first midterm, those who showed more self-forgiveness reported lower levels of procrastination on the second midterm (Wohl, Pychyl & Bennett, 2010).

The researchers took this to mean that the participants who were high in self-forgiveness delayed less in their studies prior to the second midterm. However, their actual delay behavior was not measured at all. A second plausible explanation is simply that people high in self-forgiveness interpreted their behavior in kinder terms the second time around, which is what one might expect from someone who has chosen not to criticize themselves for previous behavior. Regardless of what one might think about the feasibility of this second argument, it must be acknowledged that, as the study was designed, there is no easy way to rule it out. However, of the five limitations that the researchers addressed in the discussion section of their paper, none mentioned the problems that might be introduced by their sole use of self-report.

This criticism is not meant to suggest that self-forgiveness and procrastination are unrelated; a wealth of clinical experience and tradition suggests that self-forgiveness is an almost necessary part of the process of overcoming self-defeating behaviors (Ellis &

Knaus, 1977). However, it does highlight an important point; in the absence of clear empirical evidence that a psychological variable predicts delay, it leaves a very large logical gap in the foundation of a study when a researcher simply assumes that it does so. Until procrastination researchers have taken the additional step of showing that their theories predict behavior, any recommendations for behavior change based on research studies that rely solely on self-report could be misleading. This is especially true with a variable like anxiety, which has a well-established relationship with self-concept (see Rosenberg, 1962; Sowislo & Orth, 2013) and has also been found in multiple studies to be unrelated to delay (e.g. Steel et al., 2018).

Routes of Influence for Self-Concept. The assumption that relationships between anxiety and delay are faithfully mirrored in relationships between anxiety and self-report is especially problematic because a substantive body of research has existed alongside procrastination research for decades that demonstrates that external variables confound self-report. In fact the seminal articles in this body of research (e.g. Schwartz & Clore, 1983) predate most of the seminal empirical articles in the field of procrastination by at least one year. This literature studies how self-report can be influenced by the personality, cognition, and expectations of the person who gives the report, and suggests that anxiety can exert influence on self-report through multiple routes, both directly and also through its overlap with self-concept.

Affective Influences on Self-Report. There are at least three ways that affective variables such as trait anxiety can influence self-report measures directly (see Schwarz & Clore, 1983). First, the emotion itself can serve as a source of information that a person

may use to inform their answers to the questions with which they are presented. For example, if a chronically negative student reads a procrastination questionnaire and, prompted by the questions, feels some lingering frustration or shame when they think about procrastination, they may interpret these emotions as indications that they have a performance issue that merits the feelings. This interpretation could then influence their ratings.

A second possibility is that affect may direct a person's response to certain classes of information as they try to figure out the causes of their feelings. For example, a student who is feeling depressed when asked about their procrastination tendencies, when trying to make sense of their mood, may selectively pay attention to behaviors that they deem personal failures. A third possibility, closely related, is that a person's mood when filling out a questionnaire could affect self-report via mood-congruent recall. So, for example, a student asked a question about procrastination who feels anxious is more likely to selectively recall moments in their history associated with the feeling of anxiety. If they then selectively recall periods of delay associated with anxiety, ignoring periods of delay that are not, the resulting over-focus on moments of high-anxiety delay could influence their ratings. These suggestions merely account for mood at the time of the questionnaire's presentation, but to the degree that variables such as trait anxiety promotes a general negative mood or predisposes a participant to respond negatively to questions that probe their procrastination tendencies, Schwarz and Clore's (1983) insights offer a clear outline of ways that anxiety may influence survey measures of procrastination.

Self-Concept Influences on Self-Report. Beyond the direct effects of emotion and mood on self-report, variables such as trait anxiety also overlap with self-concept (Rosenberg, 1962; Sowislo & Orth, 2013). Schwarz (1999) offers insights into the ways that self-concept can influence the process of self-report. A person filling out a self-report questionnaire goes through several steps in forming their self-evaluation. The first is integrating information relative to their behavior. The second is using the integrated information to form a mental representation of their behavior. The third is forming a mental representation of the standard to which they are comparing their behavior. With these mental representations in place, the individual can form a judgment of how they measure up to that standard.

This process seems particularly important in self-evaluations of procrastination because the individual not only needs to determine how much they delay but also needs to evaluate whether their delay is irrational. This implies a standard of rational, or "normal" behavior to which the individual must compare themselves. This integrate-and-compare process creates many opportunities for self-concept to influence self-reports of procrastination, since there are at least three points in the chain that can be influenced by self-concept.

The first possible point of influence is the information the person integrates in the first place. As Schwarz (1999) notes, when individuals integrate information about themselves they do not usually try to integrate all possible information that bears on the question at hand; rather, they do a truncated search, stopping when they determine that they have integrated enough information to provide a useful answer. Self-concept, in a

manner similar to affect, may selectively influence the classes of information that a student refers to in order to integrate information, and may also determine what information they consider sufficient for their report. Consistent with the idea of self-confirmation bias (e.g. White et al., 1993), a student who is predisposed to view themselves negatively may only feel like they have enough information when they have recalled episodes that reinforce their negative self-view.

The second point of influence is the person's beliefs about where they actually stand relative to others. For example, even if a student knows precisely how much they delayed writing an essay in the few days before it was due, they still need to determine where that places them among their peers. Since the exact behavior of their peers is unknown to them, it is likely that the student will have to estimate how their behavior compares to others. This process of estimation may be influenced by self-concept; meta-analyses have shown a strong positive relationship (r = .34) between self-esteem and the tendency to rate oneself as better than average across many domains of behavior (Zell et al., 2020). The meta-analytic findings of Steel (2007) regarding self-concept and procrastination are congruent with this hypothesis; the average correlation found between procrastination and self-esteem was r = .27, while the average correlation between procrastination and self-efficacy was r = .38.

The third point of influence is the person's comparisons of their behavior to their own internal standards for how they ought to behave. Low self-esteem and self-efficacy often involve discrepancies between one's ideal self and one's actual self (Markus & Nurius, 1986), and research on procrastinators has demonstrated that they have a larger

discrepancy between their perceptions of their *actual* self and their perceptions of their *ought* self (Ferrari, Driscoll & Diaz-Morales, 2007), or ideal self, providing yet another way that self-concept may influence ratings of procrastination.

Hypotheses

The above list of possible confounding influences is not exhaustive. It is also not possible to distinguish between them meta-analytically because of the fine-grained distinctions between them. However they do share a common feature that suggests a hypotheses about the relationship between anxiety, delay, and procrastination. In each possible interfering process, anxiety is "incorporated" into self-evaluations as a result of integrating information and evaluating one's own behavior. If that is the case, then the strength of the relationship between anxiety and a measure of procrastination (or delay) may relate to the degree of integration that a person goes through before they make their self-report. With a "pure" behavioral variable like objectively measured delay, there is no chance at all for integration because the information is gathered from an outside source, such as data from an online course portal. With a trait measure, there is a large amount of integration because the person must evaluate their overall behavior instead of focusing on a specific instance in time.

There is an intermediate category in the literature, however, and that is situations where participants are asked to self-report their own behavior in a narrow time window, either with a numeric estimate (e.g. "How many minutes did you spend studying on Saturday night?"), or with a general impression of how they performed during a specific period with clear temporal boundaries (e.g. "How much did you procrastinate in the two

days prior to the examination?"). In either situation, it might be expected that participants would provide estimates that are less influenced by self-concept than a self-report of their own traits because they are integrating and evaluating less information. Additionally, because they have a closer temporal proximity to the information on their behavior, they should be able to report on it more accurately.

It is likely that even these more specific numeric judgments can be influenced by self-concept, since reporting on them is subject to processes of recall and inference that may be biased by other aspects of self-knowledge (e.g. Bradburn et al., 1987; Schwarz, 1999). However, since they are more proximal to the actual behavior being questioned, this bias due to self-concept may not be as strong. Accordingly, it is reasonable to expect the correlation between anxiety-related variables and this category to occupy an intermediate position, being stronger than the relationship between anxiety and objectively measured delay, but weaker than the relationship between anxiety and self-reported trait procrastination.

Based on this, in the present analysis the measures of procrastination and delay discussed thus far are divided into three categories. The first, Self-Reported Procrastination, consists of trait measures of procrastination and also self-reported measures that ask participants to integrate information over time periods that are either very broad (e.g. "How much did you procrastinate last semester?") or that have unclear temporal boundaries (e.g. "How much do you usually put off your homework in math class?"). The second, Self-Reported Delay, consists of measures that ask people to reflect on a clear time period within recent memory, and to report specific behaviors or narrowly

defined evaluations about that time period. The third category, Objective Delay, consists of measures taken from "outside" of the procrastinator, either through hard-coding an objective feature of the procrastinator's behavior (such as a digital timestamp marking the time a student accessed a quiz), or through asking a third party to report on the procrastinator's behavior.

The hypothesized relationship between the three proposed categories are as follows:

> ***Hypothesis 1.*** The average effect size of the relationship between anxiety and Objective Delay will not be significantly different from zero.
>
> ***Hypothesis 2.*** The average effect size of the relationship between anxiety and Self-Reported Procrastination will be significantly higher than the average effect size of the relationship between anxiety and Objective Delay.
>
> ***Hypothesis 3.*** The average effect size of the relationship between anxiety and Self-Reported Delay will occupy an intermediate space between the effect sizes for the relationships between anxiety and Objective Delay and that of anxiety and Self-Reported Procrastination.

Method

Paper Selection

To canvas the field of psychological research on procrastination, both the PsycInfo and Web of Science databases were searched for all articles containing the keyword "procrastinat*."[7] In conjunction, the two databases returned 4417 articles, many

[7] Use of an asterisk (*) in a search engine will return permutations of the root of a word. So, searching for "procrastinat*" will return results for "procrastinate," "procrastinator," "procrastination" and other words constructed from the root "procrastinat-".

of which were duplicates. This initial list of articles was further narrowed down by searching for all articles that contained a reference to anxiety or a related construct; searches were conducted for any articles in the initial lists containing the words *anxi*, fear, nervous*, stress,* or *neurotic** anywhere in the article text. The completed list, when the results of all searches were combined and duplicates were removed, consisted of 817 articles.

The reduced list of articles was then subjected to a second round of review. The lead researcher read the abstracts for all 817 articles and removed papers that did not meet the basic criteria for the meta-analysis. Papers were removed if they were not empirical studies, if the abstract indicated that the topic had nothing to do with anxiety or emotion, or if they were in an inaccessible language. Only articles in English and Spanish were kept, as those were the languages accessible to the lead researcher. In any situation where the abstract did not contain reference to emotion or anxiety but the topic suggested that the article might contain such measures (such as an article on well-being), it was deemed better to err on the side of inclusion and the article was kept, since any ambiguous papers that did not contain the necessary measures would be excluded in the third round of review.

Random Assignment. The final list consisted of 441 separate items, including peer-reviewed journal articles, dissertations, and book chapters. Spreadsheet software was used to randomize the list by creating a column with a random number for each item. The list was then sorted according to the randomized column. To search for effect sizes the research team proceeded through the list from top to bottom. Since the list was

randomized this effectively implemented a random selection procedure. Books and dissertations, however, were not accessible to the research team in the required time-frame, so it should be emphasized that the results reported here represent a random selection of academic journal articles only.

Supplemental Targeted Search. One problem with the randomization procedure listed above is that the number of research articles assessing Objective Delay or Self-Reported Delay was so small that the random-selection procedure was not sufficient to ensure that enough studies were included to adequately represent the construct. To remedy this a targeted approach was employed: PsycInfo, Web of Science, and Google Scholar were searched for articles that included measures of Objective Delay or Self-Reported Delay. Articles that assessed these constructs were read completely and their reference sections were searched for similar articles. The published works of researchers who conducted a study involving a measure of delay were searched to see if there were any additional studies that could be used.

Inclusion Criteria. In order for a measure to be included in the study it had to satisfy the following criteria: it needed to report a correlation between a measure of procrastination (or delay), and a measure of anxiety or a closely related construct (e.g. stress, neuroticism, negative mood, or context-specific anxiety). If the article did not report a correlation then it was still retained if it included a statistic expressing a linear relationship between anxiety and procrastination (or delay) that could be converted into an equivalent bivariate correlation (i.e. a *t*-statistic*, z, F,* or a *B* or *β* from a simple linear regression model). Due to time constraints, the present analysis reports on a truncated

sample of the data. Data-collection for the project is still ongoing, though the random selection process implemented ensures that the data presented is a representative sample of academic journal articles that report correlations between anxiety-related measures and Self-Reported Procrastination. Additionally, the targeted search procedure for articles on Objective Delay and Self-Reported Delay has ensured that many of the existing effect sizes in the literature for those types of measures have been found. The most updated sample, which serves as the basis for the following analyses, consists of a total of 210 effect sizes collected from 72 unique samples across 63 academic journal articles. The full list of journal articles included in the meta-analysis can be seen in Appendix A.

Analytic Strategy. The basic unit of the meta-analysis was the sample: effect sizes were determined to be unique if they were derived from a unique sample within a study, not from a study itself. In practice this made very little difference and left the majority of effect sizes untouched. However, in rare studies where participants were split into separate groups (for example, high vs. low achievers) and separate effect sizes were reported for each, the effect sizes for the groups were kept separate.

All effects were first converted into Pearson's *r* values and were then transformed using Fisher's *r*-to-*z* transformation, per the recommendation of Rosenthal (1991). In the case of multiple effect sizes measured within a single sample, the effect sizes were averaged together to create a single, average effect size for that sample. Meta-analytic models were constructed for both fixed and random effects, and 95% confidence intervals were derived for each model. Hypothesis tests were conducted by determining whether or not the hypothesized null effect fell within the 95% confidence intervals; an effect was

considered significantly different from zero if its confidence interval did not contain zero, and two effect sizes were considered different from each other if their confidence intervals did not overlap. The effect sizes and their confidence intervals were translated back to Pearson's *r* values before being reported in order to maximize their interpretability. In addition, the table includes the number of studies and the total sample used to compute the effect sizes, as well as the computed results of the *Q* statistic employed to test the hypothesis that the studies were homogeneous. A statistically significant value for *Q* implies that the studies were not homogeneous and indicates the presence of between-sample moderator variables.

In addition to the 95% confidence intervals for the fixed and random-effects models, 95% prediction intervals were derived for the random effects models. Unlike a 95% confidence interval, which marks the upper and lower boundaries of the area thought to hold the "true effect size" of the target, the 95% prediction interval marks the upper and lower boundaries of the range of effect sizes likely to be found by future studies. It is perhaps best to think of the 95% prediction interval as the "window" defining where future studies will continue to find effect sizes if researchers in the field were to continue employing the same methods and approaches used to generate the original sample of studies.

In addition to the meta-analytic tests, forest plots were generated for each of the three categories of measures model (Self-Reported Procrastination, Self-Reported Delay, Objective Delay) as a visual display of the regression results, and funnel plots were generated for each model to visually scan for publication bias. All analyses were

conducted using the 'metafor' (Veichtbauer, 2010) package in the R statistical programming language, and graphs were constructed using the graphing functions available in both the 'metafor' package and the 'ggplot2' (Wickham, 2016) package.

Results

The first hypothesis of this study was that the relationship between anxiety and Objective Delay would not be significantly different from zero. The analyses did not support this hypothesis at all. Table 1 shows the results of the meta-analytic models constructed for the measures of procrastination and delay. Both the fixed and random-effects models for Objective Delay have 95% confidence intervals that do not contain zero; it appears that there is a statistically significant relationship between anxiety and delay, although it should be noted that the relationship is a small one, $r = .094$. The results of the Q test, $Q(5) = 6.33$, $p = .275$, are not statistically significant, suggesting that the effect sizes are homogenous. This conclusion is offered tentatively, however, because there are very few effect sizes ($K = 6$) that were found and incorporated into the meta-

Table 1

Summary of Meta-Analytic Models

Type	*k*	*N*	*Q*	Fixed Effects		Random Effects		
				r	*95% CI*	*r*	*95% CI*	*95% PI*
Procrastination	69	33850	738.79***	.357	[.348, .366]	.296	[.266, .324]	[.080, .485]
Delay (Self-Report)	6	717	3.69	.144	[.144, .215]	.144	[.070, .215]	[.070, .215]
Delay (Objective)	6	1310	6.33	.093	[.038, .146]	.094	[.030, .156]	[-.003, .188]
Summary	72	34042	786.42***	.353	[.343, .362]	.286	[.256, .316]	[.058, .485]

*** = p < .001
95% CI = Confidence Intervals, 95% PI = Prediction Intervals

analytic estimate. The forest plot of the effect sizes for the random-effects model of the relationship between anxiety and Objective Delay can be seen in Figure 1.

The second hypothesis was that the correlation between anxiety and Objective Delay would be smaller than the correlation between anxiety and Self-Reported Procrastination. This hypothesis was supported; the 95% confidence intervals of the two effect sizes did not overlap with each other. A few points are worth noting here; the first is that the effect size for the relationship between anxiety and Self-Reported Procrastination is higher in this meta-analysis than it is in those of Steel (2007) and Van Eerde (2003). A likely reason for this is that the present analysis classified 'anxiety' in a broad sense that allowed for the inclusion of measures related to variables such as negative affect and stress. While some of the difference in the effect size of the relationship between anxiety and Self-Reported Procrastination may be due to these different definitions, it should be noted that the larger effect size itself is not an objection to the confirmation of hypothesis two. The 95% confidence interval for the relationship between anxiety and Objective

Figure 1

Forest Plot of Effect Sizes for Objective Delay

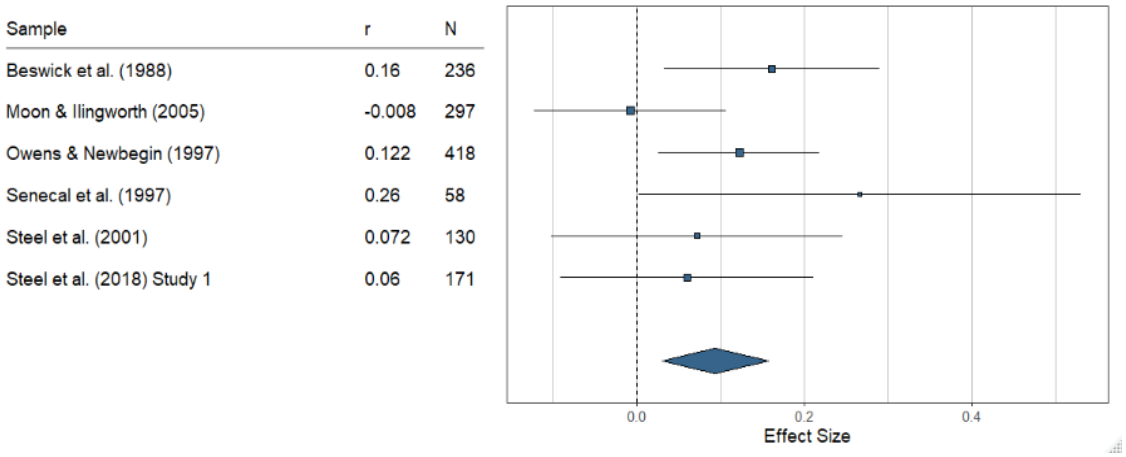


Figure 2.

Forest plot of effect sizes for Self-Reported Procrastination

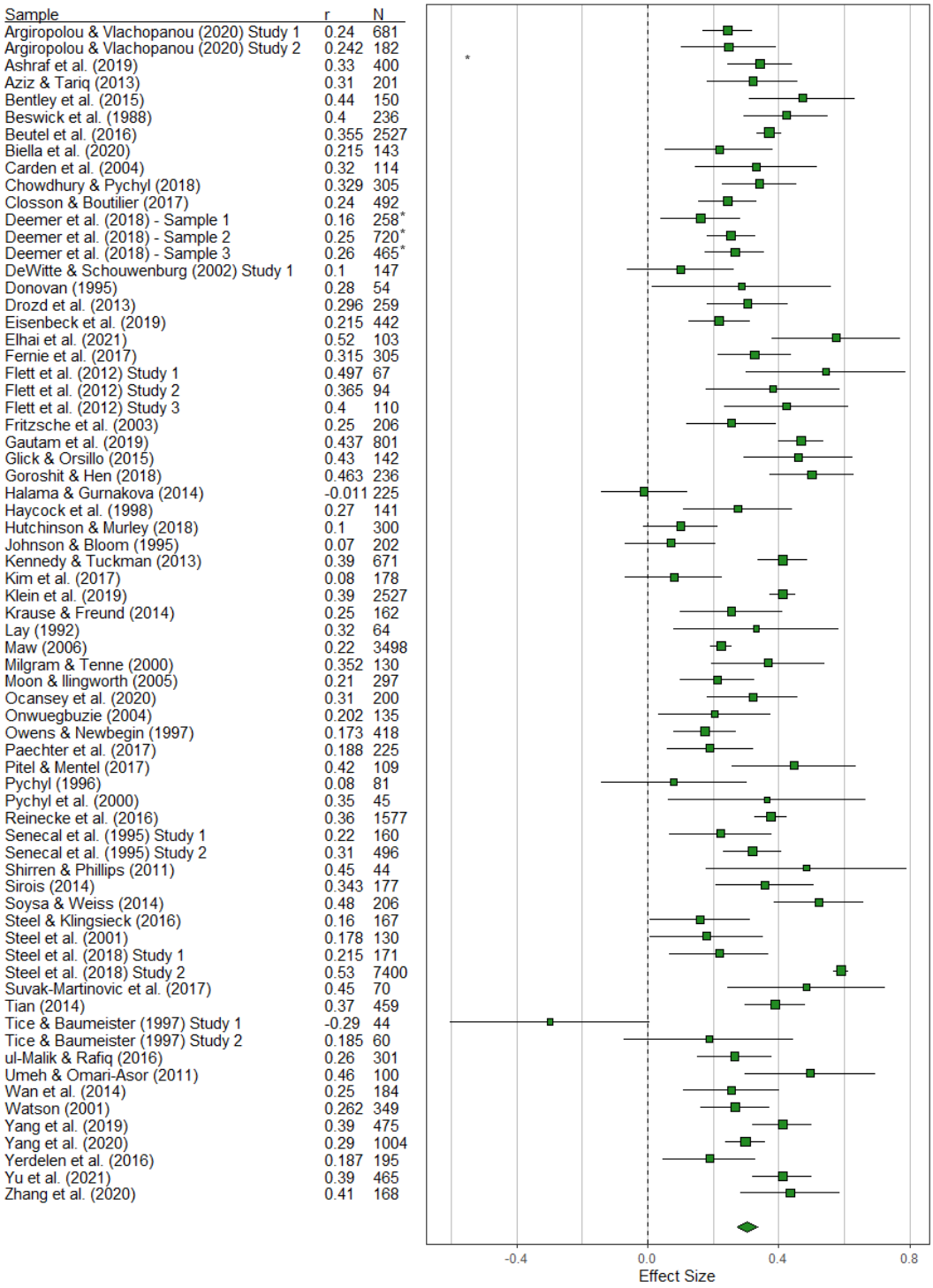
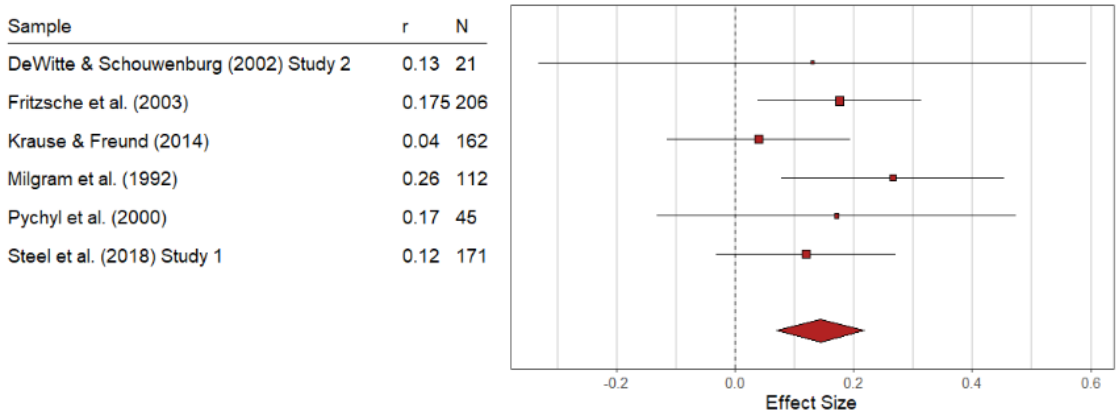


Figure 3.

Forest Plot of Effect Sizes for Self-Reported Delay



Delay also does not overlap with the confidence intervals derived by Steel (2007) or Van Eerde (2003) in their own meta-analyses, for most of the anxiety-related constructs they tested.[8] The second point worth noting here is that the effect sizes for Self-Reported Procrastination are highly heterogeneous; this is evidenced by a significance test of the *Q* value, $Q(38) = 738.78$, $p < .001$, and is consistent with other meta-analytic findings. The forest plot of the effect sizes for Self-Reported Procrastination can be seen in Figure 2.

The third hypothesis was that the effect size for Self-Reported Delay would occupy a space between the effect size for Objective Delay and the effect size for Self-Reported Procrastination. This hypothesis was not supported. While the effect size for Self-Reported Delay was between the other two effect sizes, and while it was significantly lower than the effect size for Self-Reported Procrastination, there was a great deal of overlap between the confidence intervals for Self-Reported Delay and

[8] There is one exception to this; the 95% confidence interval for Objective Delay did overlap slightly with the 95% confidence interval for the *Impulsive-Unrelated Neuroticism* effect size in Steel's (2007) meta-analysis. Other than that the effect sizes do not overlap.

Objective Delay; it is not possible to conclude, based on the data here, that the two effect sizes are different from each other. The forest plot for Self-Reported Delay can be seen in Figure 3. As with Objective Delay, the *Q* test of the variance in the studies suggests that the effect sizes for Self-Reported Delay are not heterogeneous, $Q(5) = 3.69$, $p = .595$.

Discussion

Implications

Anxiety and Delay. A few key findings have emerged from this meta-analysis. The primary finding is a simple confirmation of what researchers have long suspected; the relationship between anxiety and self-reported procrastination is inflated when compared to more objective measures of how much individuals actually delay their work. In the analyses conducted here, Self-Reported Procrastination evidenced much stronger correlations with anxiety than either Self-Reported Delay or Objective Delay. It is worth taking a moment to consider what this means for current research on procrastination. The average correlation between anxiety and Self-Reported Procrastination is $r = .357$. For Self-Reported Delay, the average is roughly half that ($r = .144$), and for Objective Delay, less than one third (r - .093). These findings suggest that, when talking about the relationship between anxiety and procrastination, it is not safe to generalize from self-report measures to actual behavior.

Unfortunately, this dichotomy creates a trap in the procrastination literature. The strength of the relationship between anxiety and Self-Reported Procrastination means that it is not only likely but expected that one will find significant results in studies based around the two. The effect sizes in this study were gathered across a wide variety of

measures of anxiety; while not conclusive, it seems that Self-Reported Procrastination is likely to correlate with almost any measure of trait anxiety or negative emotionality. In the random sample of studies collected here it is rare to *not* find a significant relationship between anxiety and Self-Reported Procrastination. Thus, a budding procrastination researcher who has a novel anxiety-based theory or measure that they want to test against procrastination will likely find that self-reports of procrastination are a "soft" test of their new idea. They will likely find a correlation because questionnaire measures of procrastination correlate strongly with anxiety in general, and not their measure specifically.

Unfortunately, because of the much smaller correlation between anxiety and actual delay, the usefulness of such findings rests on a shaky foundation. It is not possible to draw firm conclusions about whether a given relationship between anxiety and a procrastination questionnaire will replicate when a behavioral measure of delay is used. Assuming such a replication is probably counterproductive for those who genuinely want to understand the nomological network of variables surrounding a person's choice to delay their work. The trap, then, is that the self-report methods that are the most accessible to researchers and the most flexible in their application to advanced research designs are also the most likely to return results that are ambiguous in terms of their application to actual behavior. The present study has only tested this in regard to anxiety, but these results should also give pause to researchers who study the relationship between self-reported procrastination and other variables.

The solution to this problem is not to conduct fewer studies that use self-report measures. Rather, the solution is to conduct more studies that use behavioral measures alongside self-report. Two implications flow naturally from this approach. First, there is an opportunity available for researchers who want to explore the relationship between anxiety and delay; the deficit of studies on the relationship between the two means that there is a great deal of useful conceptual territory to cover, especially for researchers who hope to compare objectively measured delay with self-report.

Second, researchers who use self-report measures to make claims about the dense network of emotional variables predicting procrastination behavior should be held to the additional standard of including behavioral measures in their model as a validity check. It is not presently safe to assume that the nomological network of variables surrounding self-reported procrastination mirrors the network of variables surrounding actual behavioral delay. Until further research has explored the network of objectively measured behavioral delay, determining where it is similar to self-report and where it differs, it should not be assumed that the relationships between variables in one network generalize to the other. The good news is that measures of delay are far more accessible now than they were in the past. The use of online course portals makes it very simple for a researcher interested in studying procrastination to look at online assignment submission times as well as when students access course materials, post responses to discussion assignments, and more (e.g. Martin et al., 2020). Using such data, it is simple to design comparative studies that use both self-report and objective measures of delay to study the behavior of students inside the classroom.

Self-Reported vs. Objective Delay. The meta-analytic effect size for the relationship between anxiety and Self-Reported Delay does not appear to differ from the one for the relationship between anxiety and Objective Delay. The confidence intervals of the two effect sizes overlap substantially, so the hypothesis that there is an intermediate category where procrastinators' self-reports are "corrupted" by self-concept, but not to the degree that they are when procrastination is measured as a trait, was not supported.

This could be due to the number of studies that were incorporated into the meta-analysis; it is possible that as more studies are found a more definitive measurement of the effect sizes will determine that they are different. But if that is not the case, then these findings do offer some interesting possibilities for researchers, suggesting that it may be possible to assess delay with self-report in a way that preserves its distinct character and interrelationships with other variables.

There are a great many pitfalls to using verbal report to assess specific behaviors (see Schwarz, 1999, for a lucid review of the challenges), but researchers conducting studies that rely primarily on questionnaires would still likely benefit from including self-report questions that ask participants to give specific descriptions of their behavior as it occurred in a narrow, clearly defined, recent window of time. Asking students at the end of the quarter, for example, to report on how many minutes they studied during each of the three days before the final exam, may be a good way to assess how much students delay studying. Similarly, using something like the Day Reconstruction Method (Kahneman et al., 2004) to estimate students' behavior on the day their term paper is due

may allow for measurements of delay that are less biased by self-concept. This may be one way to make measuring delay more accessible to researchers, and if it were to become common practice then over time it would lead to a substantive accumulation of findings that shed further light on how well such self-reported delay approximates actual delay behavior.

Limitations and Future Directions

Variations Within Self-Report. It is not possible to conduct a detailed meta-analysis of procrastination measures without being struck by researchers' overwhelming reliance on self-report data. One side-effect of this, however, is that researchers have designed a great many self-report measures to assess different aspects of the procrastination construct. One limitation of this meta-analysis is that it did not account for these differences in self-report measures, focusing instead on the distinction between Self-Reported Procrastination, Self-Reported Delay, and Objective Delay.

However, the variety of self-report measures offers a great opportunity for not only comparing measures, but for comparing properties of measures. Previous studies have shown that some measures uniquely emphasize irrational aspects of procrastination, while others can vary in terms of how much they measure constructs like lack of punctuality that can be considered peripheral to true procrastination (Steel, 2010). Other research has found that some measures emphasize procrastination about making decisions while others emphasize procrastination about acting on decisions already made (Ferrari, 1992). Still other research has found that measures can assess procrastination at different stages of the work process such as initiating, striving, completing and submitting a

project (e.g. Svartdal et al, 2020). Given the many measures that exist, it may be fruitful to systematically compare individual scales and their properties to determine if there are more meaningful distinctions to be made in the Self-Reported Procrastination category. A similar approach can be employed for measures of anxiety.

Missing Categories. Another limitation of this study is that the sorting of articles into three separate levels of "integration" was somewhat arbitrary. There are subtle gradients of distinction between the levels of Self-Reported Procrastination, Self-Reported Delay, and Objective Delay that were lost because there simply were not enough measures of delay to capture the full range of possible levels. Distinctions can be made, for example, between measures of delay that were collected using truly objective methods like computer records and measures of delay that were collected by relying on the report of others, such as teachers and parents. Distinctions can also be made between general self-reports of one's behavior across a time period (e.g., "How often in the last week did you put off studying?") and specific numeric reports (e.g., "How many minutes did you study yesterday?"). Within trait measures of procrastination, distinctions can be made between self-report measures that assess the full scope of one's procrastination tendencies and those that assess it in specific contexts, like math class.

Unfortunately very few studies were found that fit many of these categories. Only one study was found, for example, that correlated anxiety with teachers' reports of student procrastination (Owens & Newbegin, 1997). This once again highlights the utility of expanding research on procrastination to include alternative forms of measurement.

A Final Note: Addressing the Missing Effect

This study has primarily focused on the hypothesis that incorporating extraneous information about self-concept can artificially inflate the relationship between anxiety and self-reported procrastination. This may explain the strong correlation between anxiety and self-reported procrastination, but alternative explanations are still possible.

One alternative, for example, is that integration could cut the other way, incorporating information that correctly reveals a relationship between anxiety and procrastination. This is possible because measures of delay are, of necessity, only partial information, providing an estimate of how a person behaves in a bounded time and place. These measures may fail to capture a relationship between anxiety and procrastination if they do not measure the correct instance of behavior. Procrastination researchers have noted, for example, that a project can be split into multiple stages (Steel et al., 2018). It is possible that the relationship between procrastination and anxiety may be more readily apparent at one stage than another.

A second reason is that researchers may not be assessing enough behavior, or that they may not be assessing it over a long enough period of time. Some relationships may not be particularly evident in a single instance of behavior, but due to the tendency of individual differences to compound over time they may become apparent once enough instances of behavior are sampled (Funder & Ozer, 2019). This cumulative effect can have profound consequences across time; Abelson (1985) noted, for example, that the correlation between a major-league baseball player's RBI (average runs batted in) and their likelihood of hitting the ball during a single time at bat was very low (r = .056). The

consequences of such a small correlation during a single swing are, as the number of swings increases, enough to use RBI to differentiate between the performance of the best and worst players. Regarding procrastination, researchers have been quick to point out the minuscule relationship between anxiety and behavioral postponement during an academic quarter. Steel et al. (2001), for example, correlated a measure of delay with a measure of mood administered at four time points during an academic quarter; the average correlation was $r = .09$, which is also very low. A student, on the other hand, evaluates much more than a single quarter, integrating a general impression of their behavior over the course of their lifetime. It is possible the correlation between anxiety and self-reported procrastination may be substantially larger because the individual is drawing on a much broader temporal range of information.

A final possibility is that the absence of a correlation between procrastination and delay does not reflect the integrative process (or lack thereof) at all. It may be that a classroom is composed of different types of students who respond in differential ways to anxiety. This echoes the early findings of Solomon and Rothblum (1984), who noted that only a small portion of their students endorsed fear of failure as a reason for procrastination. It has also been noted by Steel (2007), who suggested that anxiety might trigger procrastination *in procrastinators*, while other variables determine whether someone fits the "procrastinator" category. If procrastinators and non-procrastinators respond differently to anxiety, for example, the differences may cancel out over the full group of students in the sample, leaving a depressed or non-existent correlation.

It is likely that the discrepancy between self-report measures of trait procrastination and more objective measures of delay reflect multiple processes. It is not difficult to imagine, for example, that one process might depress the correlation between anxiety and delay while another exacerbates the correlation between anxiety and self-reports of procrastination. The rest of this dissertation explores this possibility, starting with a discussion of measurement issues that may interfere with measuring delay in a way that would allow researchers to study such questions, as well as how to resolve such measurement issues.

Chapter Three: The Use of Google Docs Revision Data in Assessing Procrastination

Introduction

Picture a researcher who is interested in studying the effect of family interactions on a student's choice to delay work. Conceptually, at least, this would make for an interesting line of research; for a procrastinating student, a family is a rich and wonderful vein of distraction waiting to be tapped. There are irritating siblings, parents who do not seem to understand the importance of a quiet, undisturbed room, and awkward visits from extended relatives. The possibilities for unravelling the thread of a good workday are endless.

For a typical student working on a week-long project in the presence of their family, each day of the week consists of a series of connected episodes, complete with characters, themes, plans, victories, surprises, and failures. Interspersed in the middle of this episodic narrative is the student's behavior, which is the primary variable of interest for the procrastination researcher. Ideally, the researcher would like to know about specific instances of behavior; when, where, and how does the student's work get delayed? How many times does the student sit down with the intention to work, only to find themselves pushing work back due to an argument with a sibling, or a mother who wants her pomodoro timer back, or the irresistible allure of the family cat? Which family member causes the student to delay more?[9] When, during the day, do such delays happen? How quickly is the student able to return to their work? Answers to these questions would shed light on the subtle interactions between the student and their family that culminate in the student's usual, panicked rush to complete their project three hours

[9] The answer to this question is clearly the cat.

before it is due.

What would it mean for the procrastination researcher's ability to answer such questions, however, if they decided that the only variable they would use to measure work was the time that the student submitted their project? It seems evident that reducing the entirety of the student's work process to the final moment of the project would cut out a great deal of the information that the researcher really wants and needs to know.

After a bit of consideration it should be clear that this example is not fictional. Rather, it is standard practice for those who try to assess procrastination using behavioral measures of delay. While the harsh reality of research is that it is not possible to collect perfect data, it is a good practice to periodically compare the numbers that researchers use to the full picture of the behavioral and psychological realities that the numbers are supposed to summarize, in order to determine how well those numbers fit. By this test, procrastination researchers could do better.

Measuring Delay

Table 2 lists the measures of objective delay that were included in the meta-analysis in Chapter Two, along with several properties of each of the measures.[10] Three of the studies operationalized delay as the time that students completed their assignments, while a fourth (Moon & Illingworth, 2005) recorded the day that a test was taken; since the resolution of the measure was at the "day" level, the coded event technically cannot

[10] The list here does not include all of the measures of objective delay used in the procrastination literature. It is, however, appropriate for this dissertation for two reasons. First, the list captures the measurements that are most germane to research on procrastination and anxiety. Second, while some notable methods of measuring delay have been left out (see Lay, 1986; Tuckman, 1991; and especially Svartdal et al., 2018) this list does include the study that represents the "upper bound" of measurement design in the procrastination literature (Steel et al., 2018).

Table 2

Properties of Measures Used to Study Anxiety/Delay Relationship

Study	Measure	Events	Type	Resolution	Window	*r*
Beswick et al. (1988)	Paper submission coded as early, on time, late	1	End	Ordinal	Event	.160
Moon & Illingworth (2005)	Number of days until students took a test after it was made available..	5	Start/End	Day	Week	-.008
Owens & Newbegin (1997)	Teacher report of student's behavior during term	1	Summary	Term	Term	.122
Senecal et al. (1997)	Exact time that a boring/difficult task was started during 1hr session.	1	Start	Second	Hour	.26
Steel et al. (2001)	Quiz completion time	10-14	End	Second	Week	.072
Steel et al. (2018) - Study 1	Assignment completion time	77	End	Second	Term	.060

be localized to the start or stop of the test. One study operationalized delay by looking at the time students started a task, but the ability to measure delay using start-time was due to the fact that the study was conducted in a laboratory (Senecal et al., 1997). The last study was a notable deviation from the other five; instead of coding the time of an event, it relied on the evaluation of an outsider (a teacher) to summarize the behavior of their students over the academic term (Owens & Newbegin, 1997).

It is reasonable to pause here for a moment and ask <u>how</u> procrastination researchers could do better. It is not immediately apparent why the measures detailed above are less than ideal. In fact, almost any behavioral measure can be established as a face-valid measure of delay as long as researchers can demonstrate that procrastinators do

it later. Lay (1986), for example, gave a take- home task to passengers in an airport along with a pre-stamped return envelope. He found a positive correlation between their self-reported procrastination (measured before they boarded their flight) and the post-date on the envelope that his participants used to send the completed task back to him. The participants clearly delayed; is there any value in measuring more?

The answer to that question depends mainly on the goal of the researcher. For a researcher whose primary interest is figuring out how to ameliorate the burden of student procrastination on teachers, the focus may be on metering, or spacing, the submission of assignments in the classroom so that they do not arrive in a sudden wave at the end of the quarter. In this case, knowing about the times that students complete and submit their assignments is valuable. However, for a researcher who is trying to understand the mechanics of procrastination to find insights that help procrastinators address their own problems, there is a great deal of value in knowing more about the process in the middle. Procrastination often places a substantial emotional strain on the procrastinator (Tice & Baumeister, 1997), and a strong case can be made that avoidant behaviors like procrastination, and the avoidant motivations that drive them, are immensely taxing in the long-term to a person's health and well-being (Elliot, 2006; Sirois, 2016). The amount of strain that a procrastinator feels is almost certainly related to the time that they complete their work. However, it is also reasonable to assume that the amount of strain is related to how much of the procrastinator's work piles up in the hours prior to its completion. A student who has to complete 80% of their workload for an essay in the four hours before the deadline is likely to be much more miserable than a student who only has to complete

10%, even if they turn it in at the same time. In other words, the shape of the work arc across time matters. A notable problem with most of the measures of procrastination in Table 2, however, is that they do not map the shape of work; they only record the start or end point.[11]

The Shape of Work

One way to understand why this causes a problem with studying procrastination is to compare it to a well-known high-precision measure of work. Perhaps the best example of a classic, precise mapping of work is Ferster and Skinner's (1957) monograph on schedules of reinforcement. Ferster and Skinner's work took a simple behavior (e.g. bar-pressing for rats, or key-pecking for pigeons) and leveraged a mechanized system, the Skinner box, to map every occurrence of that behavior in a specific time window with very high resolution. The result is a record of behavior so precise that it is almost entirely different from normal longitudinal studies that sample behavior at only a few intervals (e.g. Moon & Illingworth, 2005). A standard longitudinal study assessing work at five time points may require an advanced latent growth model to demonstrate that it follows a curvilinear trajectory ($p < .05$). Conversely, a researcher studying one of Skinner's graphs of the key-presses that a pigeon emits as it works for barley kernels on a fixed-interval schedule can follow the curvilinear trajectory simply by tracing the work record with their finger. If the researcher remains unconvinced, then they can just trace it again as it

[11] The one exception to this is the study conducted by Steel et al. (2018). This is unquestionably the best study of behavioral delay produced by procrastination researchers. There are some areas where the study could improve, however; the use of a single summary metric (the area under the work curve) does capture the full range of students' work, but it misses the opportunity to study the internal dynamics of procrastination across the quarter by comparing multiple time points. Also, many real-world opportunities for procrastination are not broken into dozens of piecemeal modules with discrete stopping points or "milestones." For essays, presentations, technical reports, and skilled-labor tasks, there is usually a beginning, an end, and a blur of work between; knowing more about this blur matters.

repeats ten more times on the record.

In comparison, studies that operationalize a single time point cannot capture the shape of work at all. They can only capture a single temporal moment and see whether it moves back and forth in time. This leads to some substantial gaps in the record for someone looking to understand procrastination. What if a psychological variable like trait procrastination or trait anxiety did not cause the end-point of students' work to budge at all? What if it simply caused students' work to pile up next to the end point? That would certainly constitute delay in the purest sense. A measure of students' end time, or worse, their submission time (which places a gap between the final bit of work and the actual time the work is turned in) could theoretically miss this shift completely.[12]

A related problem is that the events in the middle can easily have their own internal structure that is independent from the endpoints. A good example of this is circadian rhythms. Anxiety and procrastination are both associated with eveningness, or the tendency to stay up late and be more alert and active at later times in the day (Hess et al., 2000; Willis et al., 2005). In addition to the within-person psychological effects of circadian rhythms, the world has circadian rhythms of its own, manifesting in events like sunrise, job schedules, socializing, family time, and evening rituals. Each of these can impact students' situations, making work easier or more difficult. These influences can alter the distribution of work throughout the day as well as students' qualitative experience of that work, and likely would show up in the full record of work done on a

[12] It is likely that something like this does happen, although the well-established correlation between procrastination and almost all measures of delay (see Svartdal et al., 2018; Van Eerde, 2013) suggests strongly that procrastination does cause every phase of work to shift forward in time. However, the basic principle remains; psychological variables can affect the middle of a work session as surely as the edges, and the middle is where most of the lived experience of a phenomena occurs.

project, if such work could be measured.

Assessing Work

Many of the logistic problems associated with measuring work are related to the problem of scalability. A highly invested researcher who wants to gather a great amount of detailed data on academic work might persuade a student to agree to a work session in the library where the researcher could watch and take notes. This would not be practical for measuring the work patterns of fifty students, however, because the researcher has a limited amount of time and cannot spend all of it on data collection. Roe (2014) acknowledged this tradeoff. Generally, a researcher must face the question of whether to prioritize collecting data on within-person trajectories, where the focus is on gathering data on as many instances in time as possible, or to prioritize collecting data on between-person differences, where the focus is on gathering a large, representative sample.

However, this tradeoff is not always necessary, especially when the researcher is able to leverage technology to facilitate the data collection process.[13] In the case of studying work, the advent of personal computing has made a wealth of data available to researchers that allows for far more detailed temporal records than was previously thought possible. The data from course management software has enabled high-quality studies of procrastination like the one conducted by Steel et al. (2018), and it has also opened up the ability to study aspects of student work that were previously inaccessible.

Assessing Writing with Google Docs Revision Data. The present study focuses

[13] Skinner's first stroke of brilliance was in leveraging technology in this way. His description of his discovery of response curves is simultaneously a description of how he invented the mechanical apparatus that measured them (Skinner, 1956). Leveraging technology was not Skinner's only virtue as a researcher, but it was the foundation upon which many of the other virtues were built.

on one aspect of students' academic work in specific; essay writing. The writing process has long been ignored in studies of procrastination because it was difficult to observe. Technological developments in the last two decades, however, have made it a viable target of research, and it is ideal for multiple reasons. First, it is in many ways the quintessential procrastination behavior; aside from last-minute cramming for an exam, it is hard to imagine a situation more emblematic of academic procrastination than a student working on an essay the night before it is due. Second, academic writing also has the virtue of being generalizable beyond college; life does not contain many multiple-choice tests after a student leaves the stage with their diploma. It does, however, have many more opportunities to write. Third, academic writing is also a useful target of study because it is a single task that is both complex and creative. Unlike Steel et al. (2018), whose study assessed the pattern of completion for many small learning tasks across a quarter, the study of essay writing generalizes more easily to real-world situations where a person must produce a complex piece of work by a fixed deadline while maintaining a high level of creative quality.

The earliest attempts to assess the temporal features of composition started in the 1930's; at that time, the typewriter was relatively new technology, and the business world had an interest in leveraging it for productivity, fueling a small surge of organizational research on the topic of how best to learn the skills and train new typists. In this context, Harding (1933) rigged a machine to move a roll of paper tape through a typewriter at a constant rate and had typists repeat a pre-specified phrase multiple times in order to study the rhythmic components of typing and how they related to work speed. In doing so,

Harding likely created the first true temporal record of writing at the level of the individual actions (such as keystrokes) that make up a larger unit of composition. Later attempts to assess the writing process in greater detail were conducted by Matsuhashi (1981), who used video to record the production of text. The first modern attempt, however, was conducted by Bridwell, Sirc and Brook (1985), who used a computer program, "Recording WordStar," to monitor the typing behavior of students at the keystroke level as they composed passages of text.

The study of writing has, for the most part, remained the purview of a very narrow discipline lying at the intersection of psychology and linguistics that studies the process of speech and language production (see Lindgren & Sullivan, 2019, for an overview of recent research on the topic). In 2009, however, developments in Silicon Valley began unintentionally expanding the scope of available data on writing. This process largely occurred as a side-effect of other endeavors; as Somers (2010) details. In 2008 a small group consisting of independent developers and former Google employees constructed one of the first truly collaborative online word processors, known as EtherPad. One of the problems that the EtherPad development team had to solve was creating a basic structure for the software that would allow multiple people to edit a document simultaneously without accidentally overwriting each other's changes. The solution to this problem was to structure the data of the document as an event log that recorded what an individual typed and when. One consequence of this data structure became quickly evident; in an early version of the program, the developers created a sliding bar at the top of the EtherPad document interface that an author could use to slide

back and forth through the full history of the text that they were writing. This ability to access previous versions of a document at leisure has been a feature of many online, collaborative writing word processors ever since.

Ultimately, EtherPad did not gain much traction; shortly after its debut, the rights to EtherPad were purchased by Google and folded into their Google Wave initiative (Somers, 2010), which in turn evolved into the commonly used Google Docs platform of today. Google Docs utilizes similar architecture to EtherPad and has the same capabilities for reconstructing the history of a document. The fundamental unit of a Google Doc is an "edit" that localizes an event by assigning it a timestamp, accurate to the millisecond. Events can consist of anything from the typing of an individual keystroke to the copy-pasting of a full document, and the ledger containing the event history of a Google Doc can be used to explore the temporal features of a written document such as an essay. Access to the history of edits can be obtained via the Google Docs API[14] by the owner of a document as well as those who have been granted access to co-edit the document.

Since Google Docs was created it has seen modest use in the research field, primarily in the context of visualizing the writing process. The most pertinent development for the present research is the creation of the Draftback program (Somers, 2014). The program is a freely available app that can be downloaded via the Google Play store. The app allows for a user to play back a document so that they can watch their own writing history, and it also allows users to generate a visual showing a timeline of their

[14] API is an acronym for "Application Programming Interface," and refers to the software that allows one to interact with the data of an online application. In this case, accessing the data via the API can be accomplished using the address bar in a normal Google Chrome browser so long as one has been granted permission by the owner of the document.

own writing. Additional programs have been developed to allow researchers to interface with Google Docs data; Wang et al. (2015) designed a program called DocuViz that utilizes raw Google Docs data to visualize the collaboration of multiple authors on a project. Similar attempts to utilize Google Docs data to visualize various aspects of the writing process include the WriteProc framework (Southavilay et al., 2010) and more recent research on visualizing the branching process of writing conducted by Perez-Messina et al. (2018). To date, however, it does not appear that any attempt has been made to take high-resolution data on the writing process and use it to study psychological constructs.

The Present Research - Overview and Hypotheses

The present study assesses the writing process of students as they composed two essays during a normal academic term. The class was unique because the structure of the two essays was identical; both required the students to conduct a literature review of a topic that interested them, writing a paper of five to eight pages in length. Aside from the requirement to choose a different topic for each essay, the instructions for the papers were the same. Therefore it was possible not only to examine students' writing process on a single assignment, but also to compare it with a follow-up assignment once the students had learned what was required of them and had become familiar with the process.

Data Collection and Processing. The necessary steps for downloading Google Docs data are described by Somers (2014). The process involves determining the number of edits of which a document consists using the Draftback software and then accessing

the Google API using the address bar in Google Chrome. With the correct syntax entered into the address bar, specifying the document as well as the range of edits that one wants to download (the range can go up to the total number of edits), the website will return the data as a text file, formatted using Javascript Object Notation (JSON). This file requires further processing in order to access the event log, which was accomplished using the "jsonlite" package (Ooms, 2014). The event log contains the individual "edits" that comprise the document. Each edit consists of several key pieces of data including the timestamp, the classification of the edit[15], the text of the edit (if text is being added), and the location of the edit. Of the various forms of data, the only one pertinent to the present research is the raw timestamp information; none of the other forms of data from the Google Docs are used, and will not be discussed further.

Once the raw Google Docs timestamp data has been collected via the Google API, the next step is to convert it to metrics that are behaviorally and psychologically meaningful. In the field of machine learning this process is often referred to as *feature engineering* (Zheng & Casari, 2018), but in practice it is a familiar process to psychological researchers; faced with the noisy data of the real world, a psychologist's job is to find a meaningful way to operationalize some aspect of it as a numeric measure. For example, faced with the variety of differences in human shape and size, a researcher might decide that the features most pertinent to their research are height and weight. Similarly, faced with the vast spread of timestamps taken from a Google Doc, a

[15] This classifier denotes the specific behavior the user is doing; the four most common classes of edits denote adding text, deleting text, altering text, or a specialty "multi" category that denotes doing more than one edit behavior at a time.

researcher may decide to compute the mean average, or the median, or some other measure. The specific word "feature," here is a useful descriptor; in its earliest usages it denoted something that was shaped or fashioned from raw material (Harper, n.d.c). Following this definition, the present research focuses on three types of metrics fashioned from the raw Google Docs timestamp data; summary metrics, timeline metrics, and integral metrics, each of which are detailed further here.

Summary Metrics

The most basic features that can be constructed from the data are simple summary metrics like measures of range and central tendency. In keeping with the findings of recent researchers that emphasize the importance of clearly delineating between the separate phases of projects (e.g. Svartdal et al., 2020), the summary metrics here are selected to capture the full range of a project, from the time it is initiated to the time it is submitted. They include the following:

Mean. This is a simple metric computed by summing the timestamps for every edit in a students' record and dividing by the total number of edits.[16]

Median. This metric corresponds to the timestamp of the edit at the midpoint of a student's work record. If there was no single midpoint (i.e. if the student had an even number of edits in their record), the median was computed by averaging the two middle edits.

Mode. This corresponds to the midpoint of a student's most productive hour. This

[16] The edits in a Google Doc are expressed in Unix Standard Time, which is the time elapsed since January 1st, 1970, 12:00:00am. In the case of Google Docs data the timestamps are expressed in milliseconds. This property of Google Docs timestamps makes mathematical transformations such as computing the mean a simple, uncomplicated process.

was computed by dividing the timeline into five-minute increments and finding the increment that had the greatest number of edits in the range of +/- 30 minutes surrounding it.

Adjusted Start/End. The start and endpoint were defined as the timestamps marking the 1st and 99th percentile of a student's work record, respectively. Thus for a student whose work record consists of 10,000 edits, the start and end would be operationalized as the 100th and 9900th timestamps in the sequence. This was done to eliminate dithering and accidental keypresses when creating the document and also when submitting it to the research team; some students, for example, accidentally typed a few keystrokes into the document prior to sharing it with the research team, several weeks after they had actually finished it. The adjusted start and end times are a method of trimming such errors.

Submit Time. Students' essay submission times were collected from the online course portal for the class.

Previous literature has shown that, in general, most metrics of behavioral delay correlate positively with self-reported procrastination (Steel, 2007, Van Eerde, 2003). Svartdal et al. (2018) elaborated on this, suggesting that procrastinators adhere to the relatively simple rule of "later" when faced with many common situations and conflicts. The basic hypothesis for how self-reported procrastination should relate to the above summary metrics, then, is as follows:

Hypothesis 1. Self-reported procrastination will correlate positively with the summary metrics constructed from both essays.

Timeline Metrics

As a second metric, a timeline of students' work was constructed by taking the two weeks leading up to the deadline and breaking them into units of one hour, and then computing the number of edits that students in the class completed during each hour.

This timeline data can be used in two ways, both of which are employed in the analyses in this chapter. The first way is that the edits that the class typed each hour can be summed, both to visualize the work of the class as a whole, and also to model the sum of the class's work as a function of the hour on the timeline. The second way is that the students' work each hour can be normalized by converting it into a proportion of their total work. These hourly proportions can then be correlated with an external measure of students' trait procrastination to determine if there are temporal changes in the relationship between self-reported procrastination and work.

Once again drawing on the basic principle that procrastinators will tend to work later than non-procrastinators (Svartdal et al., 2018), and also drawing on previous findings demonstrating that work against a deadline tends to be shaped as a positively accelerated curve (Howell et al., 2006), two hypotheses can be derived predicting the relationship of students' self-reported procrastination to the timeline of work constructed from the Google Docs data.

> ***Hypothesis 2.*** Students' work on each essay will take the form of a positively accelerated curve, and will be better described by a curvilinear regression model than a linear one.
>
> ***Hypothesis 3.*** When students' self-reported procrastination is correlated with the

proportion of work that students completed for each hour on the timeline, the correlations will grow stronger and more positive as they approach the deadline.

Integral Metrics

The final form of analysis used in this dissertation is irregular, but it is based on sound psychometric principles of cumulation that are well established in the literature. It has long been known that single instances of behavior do not correlate as strongly with broad summary variables as multiple instances of behavior do when they are averaged together (e.g. Abelson, 1985). This is roughly analogous to the use of items in survey questionnaires; single items are "noisier" and predict outcome criteria less well than multiple related items aggregated together. This property of statistical measurement has a history tracing all the way back to Galton (1907). Curious to see how accurate people were at estimating quantities, Galton tallied data from a crowd of fairgoers who entered a competition to guess the dressed weight (i.e. weight of edible meat) of a prize ox being sent to the butcher. Predictably the fairgoers diverged wildly in their estimates as individuals but, when averaged, the crowd's overall guess was less than 1% off of the actual weight of meat gotten from the ox.[17]

Whether it is estimations, survey items, or instances in time, it appears to be a general principle that aggregate estimates are stronger and more accurate than individual estimates alone, so long as each new estimate contributes relevant information. This notion of relevant information can be leveraged to examine the dynamic relationship between procrastination and time. Following the basic hypothesis that procrastinators

[17] The dressed weight of the ox was 1198lbs, while the average guess of the crowd was 1207lbs. They overshot the true weight by 0.75%

tend to work later, it is reasonable to predict that there is a span of time close to the deadline for each essay that contains "procrastination- relevant information." People working at that time are more likely to be procrastinators, and the proportion of work they are completing in that time span should correlate with their self-reported procrastination. The size of the "procrastination-relevant" span of time, however, is unknown.

Starting with a reasonable assumption—that the hour immediately before the deadline should be part of the "procrastination-relevant" timespan—one can use a slowly-growing "window of aggregation" to find the bounds of the timespan. If the amount of students' work in the hour before the deadline correlates with their self-reported procrastination, then the amount of students' work in last *two* hours should correlate more strongerly. The amount of students' work in the last three hours should correlate more strongly still, and each hour added to the window of aggregation should increase the strength of the correlation between procrastination and work. This should continue happening up until information gets added to the window that is not procrastination relevant, at which point the correlation should remain the same or start decreasing. That basic logic informs the last hypothesis of this study.

> ***Hypothesis 4.*** There will be a span of time towards the end of the timeline where students work correlates positively with self-reported procrastination, and aggregating information from within this timespan will produce a stronger correlation. The bounds of this window are unknown.

Method

Data Collection Procedure

Data was collected from students in an upper division psychology class at a large western university. At the beginning of the quarter the lead researcher gave a presentation to the class detailing the study. Students who were interested in participating for extra credit signed up for the study via a sign-in sheet circulated to the class or by emailing the researcher after the class was over. Students who participated in the study completed three separate tasks; first, they wrote their two course essays in Google Docs in order to track their essay writing. Second, they completed an online survey. Third, they filled out study logs in the two weeks leading up to each essay deadline indicating their schedules, their self-reported work times, and their types and levels of emotions while working. The data from the student's study logs is not included in the present analyses and will not be discussed further.

Students were free to opt out of any part of the study in which they did not want to participate. To incentivize participation, extra credit was offered for each of the major tasks that students were asked to complete. An alternative extra credit assignment was offered to students who did not want to participate in all or part of the study, but still wanted to get an equivalent amount of extra credit. At the end of the quarter the lead researchers gave a presentation to the class explaining the study in greater detail and showing the students some preliminary findings from the data, including the work distribution for the class.[18] After the presentation the researcher circulated a final

[18] See Figure 4 below. The students thought it was hilarious.

debriefing and data release form to the students that explained the Google Docs data and allowed them to select which parts of their data they would allow researchers to use.

If a student indicated that they did not want the research team to use one or more portions of their data, that data was deleted. Additionally, a students' data was removed from analyses if the student indicated in their online survey that they had been inattentive or dishonest in filling out the survey. Inattentiveness and dishonesty were assessed by asking participants at the end of the survey if they had made a good-faith effort to be attentive and honest during the survey and notifying them that their answer would not affect the credit they received.

Participants

In all, 178 students completed the personality survey. Of those, 143 submitted data for the first essay, and 142 submitted data for the second. The sample was predominantly female, consisting of 135 (75.8%) women, 41 (23.0%) men and 2 (1.1%) who were either nonbinary or declined to state. The sample was highly diverse, and representative of the population of the university in which the study was conducted in: 4 (2.2%) students were African-American, 48 (27.0%) were Asian, 17 (9.6%) were Caucasian, 85 (47.8%) were Hispanic/Latinx, 12 (6.7%) were Pacific Islander, 2 (1.1%) were Middle Eastern, and 10 (5.6%) identified as either multiriacial or another ethnicity not accounted for in the options. Participants were, on average, 21.28 years old (*SD* = 3.17). Most students were upper division; there were 92 juniors (51.7%) and 81 seniors (45.5%), and only 5 sophomores (2.8%). Participants had an average GPA of 3.18 (*SD* = 0.42).

Measures

Objective Delay. After the timestamp data was extracted from students' Google Docs records, they were transformed into metrics for each student following the guide discussed earlier in this chapter. Timestamps were used to compute students' mean, median, and modal work times on each essay as well as their adjusted start and end times (i.e., the 1st and 99th percentiles of their work record). Additionally, the online course portal was used to gather data on students' essay submission times. Finally, the raw timestamp data was used to compute timelines of the number of edits that students made to their document each hour during the two weeks leading up to the deadline for each of their two essays.

Self-Reported Procrastination. Procrastination was assessed using three separate survey measures. The General Procrastination Scale (GPS; Lay, 1986) consists of 20 items that assess the tendency for people to procrastinate across a broad range of life domains (example items: "I generally return phone calls promptly," "I do not do assignments until just before they are to be handed in"). The Irrational Procrastination Scale (IPS; Steel, 2010) consists of 9 items that specifically assess the tendency to postpone work when one knows that it is irrational (example item: "I put things off so long that my well-being or efficiency unnecessarily suffers"). The Pure Procrastination Scale (PPS; Steel, 2010) is the result of a factor analysis used to extract the items from a broad range of procrastination questions that load highest on a primary procrastination factor. It can be thought of as a measure of procrastination that is uncorrupted by overlapping constructs such as punctuality and consistency (example item: "In

preparation for some deadlines, I often waste time by doing other things). All questionnaires were answered using a five-point Likert scale; participants were asked how representative each item was of them, with a "1" indicating a low match and a "5" indicating a high match. The Cronbach's alpha values for the GPS (α = .86), the IPS (α = .85) and the PPS (α = .92) all indicated high reliability for their respective scales.

After computing the scores for each individual measure, all three measures were converted to *Z*-scores and then averaged together to create a composite score for procrastination. This was done to simplify some of the later analyses by having a single, representative procrastination score for each participant. The Cronbach's alpha value for the composite measure was α = .91, indicating a high degree of reliability.

Results

All analyses were conducted using the basic statistics package in the R statistical computing language, version 4.1.0 (R Core Team, 2021), run in the RStudio environment (RStudio Team, 2021). Several analyses drew on functions from the 'psych' package, version 2.1.6 (Revelle, 2021). All figures were created using the 'ggplot2' package (Wickham, 2016).

Summary Metrics

The first hypothesis was that the measures of self-reported procrastination used in the study would be positively correlated with the summary metrics of delay created from students' Google Docs data. To test this hypothesis the intercorrelations between all the study variables were generated and tested for significance.

The resulting correlations, along with the means and the standard deviations for

each variable, can be seen in Table 3. The results overwhelmingly supported the hypothesis. Most of the correlations tested were statistically significant at the $p < .001$ level with only a few exceptions. The exceptions themselves are notable, as they align with empirical findings in the procrastination literature. Svartdal et al. (2020) identified three separate phases—goal onset, goal striving, and timeliness—that correspond roughly to the initiation of a project, the focused effort required to see it through to completion, and the tendency to actually complete the project on time. These three separate phases guided the choice of summary metrics for the present study. Measures were chose to represent the beginning, middle, end, and submission time of a paper.

The weakest intercorrelations among the procrastination measures are predominantly related to students' adjusted start times, suggesting that self-reported procrastination does not predict when students initiate their project as well as it predicts their sustained effort and timeliness in submitting the project. There is also a tendency for the measures of self-reported procrastination to correlate slightly less with students' completion times and submission times for the second essay, suggesting that the facets of students' work records that represent timeliness may also behave differently than measures of central tendency.

Timeline Metrics (Frequency)

The second hypothesis was that, consistent with what has been found in other research literature on procrastination (e.g. Moon & Illingworth, 1997), the general "shape" of students' work on the two essays would take the form of a positively accelerated curve. This hypothesis was tested at the class level by taking the timeline data

Table 3

Correlation Matrix of Variables in Study Two

			Measure				Essay One						Essay Two					
Measure	M	SD	GPS	IPS	PPS	COM	Start	Mean	Med	Mod	End	Sub	Start	Mean	Med	Mod	End	Sub
GPS	3.17	.61																
IIPS	3.21	.74	.782***															
PPS	2.74	.90	.744***	.802***														
Composite	--	--	.913***	.934***	.920***													
Essay One	Med	MAD																
Start (Trimmed)	36.80	26.45	.136	.075	.175*	.139												
Mean	16.92	13.37	.334***	.325***	.369***	.372***	.672***											
Median	16.81	15.49	.354***	.362***	.377***	.395***	.532***	.932***										
Mode	14.53	18.83	.300***	.273**	.320***	.324***	.467***	.818***	.793***									
End (Trimmed)	2.13	2.86	.296***	.291***	.314***	.327***	.256**	.724***	.686***	.597***								
Submitted	1.17	1.69	.320***	.316***	.365***	.362***	.184*	.607***	.633***	.624***	.810***							
Essay Two	Med	MAD																
Start (Trimmed)	29.21	27.03	.246**	.099	.099	.163	.314***	.419***	.395***	.349***	.147	.362***						
Mean	14.96	13.39	.336***	.269**	.323***	.338***	.191*	.521***	.425***	.416***	.363***	.499***	.738***					
Median	14.59	14.43	.339***	.272**	.337***	.344***	.129	.468***	.376***	.419***	.353***	.484***	.646***	.978***				
Mode	7.4	10.16	.328***	.256**	.336***	.334***	.124	.508***	.421***	.431***	.393***	.508***	.637***	.959***	.975***			
End (Trimmed)	2.56	3.19	.270**	.250**	.306***	.299***	-.072	.217*	.296**	.269**	.363***	.366***	.379***	.653***	.695***	.697***		
Submitted	1.59	2.27	.188*	.205*	.189*	.211**	.150	.333***	.359***	.315***	.331***	.522***	.260**	.372***	.366***	.391***	.440***	

* = p < .05, ** = p< .01, *** = p <.001

Note: Measures of central tendency for Essay One and Essay Two are expressed in terms of hours before deadline. Due to outliers in the dataset, the Median and MAD were used to compute central tendency since they are more robust to large fluctuations. For correlations, outliers were trimmed at +/- 4 *SD* to prevent biased correlations.

Note 2: N's are variable due to missing data. Approximate N's: *N* = 177 for within personality survey correlations, *N* = 120 for between-essay correlations. *N* = 131 for all others. These do not capture minor variations but should be sufficient for weighting correlations for inclusion in meta-analyses.

Note 3: GPS = General Procrastination Scale (Lay 1986), PPS = Pure Procrastination Scale (Steel, 2010), IPS = Irrational Procrastination Scale (Steel, 2010), COM = Composite Procrastination measure

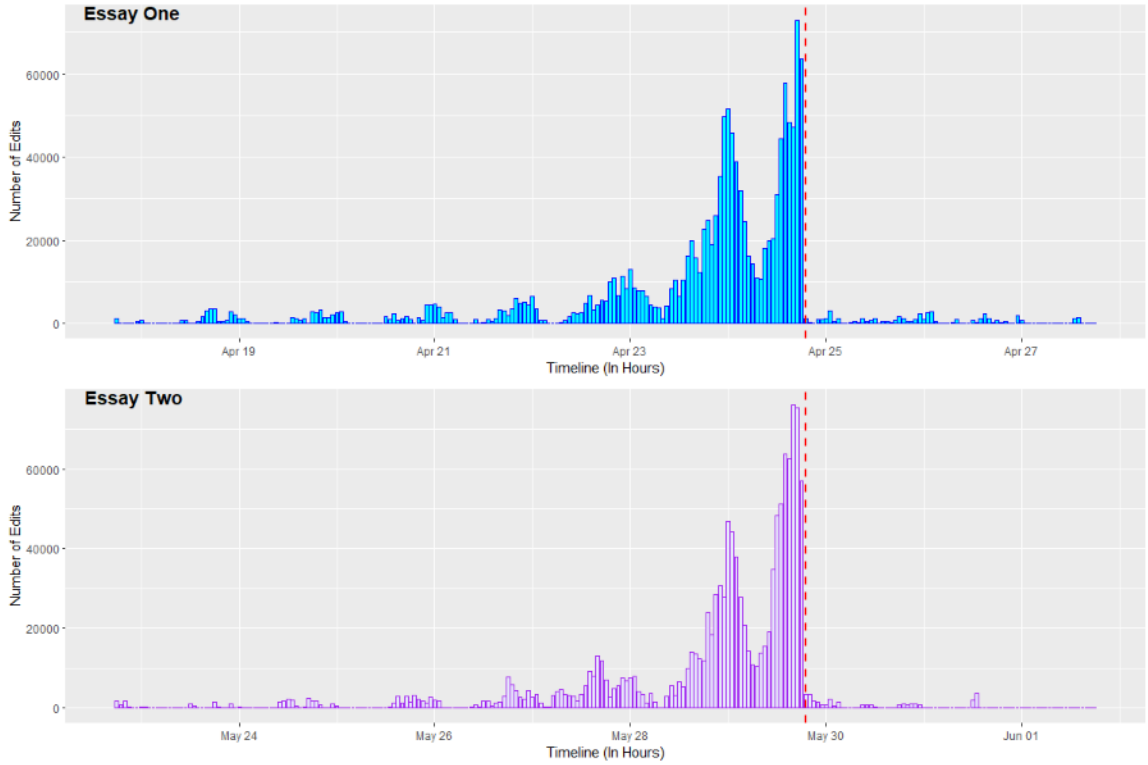
of students' work and summing the work that the class did for each hour of the timeline, and then using stepwise regression to compare two models for each essay. The first model treated students' work as a linear function of time, while the second included a quadratic term. Both time and the amount of work completed were standardized prior to constructing the models. An ANOVA test was then conducted to determine whether the addition of the curvilinear term to the model increased the amount of variance explained. The two essays were completed approximately one month apart. Given this, the parallels between the timeline of edits for each essay are surprising. In all, the students participating in the study produced approximately 1.3 million edits each for the first and second essay, for a total of 2.6 million edits. The average number of edits per essay was approximately 9113 edits for the first essay, and 9119 for the second. The timelines of students work for the two essays can be seen in Figure 4.[19] It is evident from a simple viewing of the timeline that the distributions of work for the two essays are highly similar, but to emphasize exactly how similar they are, a Pearson's correlation was conducted using the specific hour prior to the deadline as the sampling unit, for the two weeks (336 hours) leading up to the deadline. Based on this, the correlation between the two was $r(334) = .956$, $p < .001$.

The regression models supported the second hypothesis. For Essay One, the model predicting the number of edits students completed as a function of time leading up

[19] The two graphs in Figure 4 depict a different time span than the span used for the regression models. While the regression models stretch from two weeks before the deadline up until the deadline itself (a total of 336 hours), the displayed graphs depict the time from one week before the deadline up until two days afterwards. Almost no work was done by students in the period from seven to fourteen days before the deadline, so graphing those days was not useful. In contrast, the two days after the deadline allow for a contrast of the effects of deadline pressure on work with what happens immediately afterwards.

Figure 4

Timeline of Student work for Essay One and Essay Two



to the deadline accounted for a significant portion of the overall variance in the data, $R^2_{adjust} = .277$, $F(1, 334) = 129.6$, $p < .001$. Adding the curvilinear term to the model produced a significant increase in the amount of variance explained, $R^2_{adjust} = .526$, $F(2, 333) = 187.0$, $p < .001$. An ANOVA test of the nested models was statistically significant, $F(2,333) = 176.5$, $p < .001$, supporting the hypothesis that the relationship between work and time leading up to the deadline is best represented by a positively accelerated curve. The same was true for Essay Two. The linear term accounted for a significant portion of the overall variance in the model, $R^2_{adjust} = .236$, $F(1, 334) = 104.7$, $p < .001$. Adding the curvilinear term to the model produced a significant increase in the

amount of variance explained, $R^2_{adjust} = .469$, $F(2, 333) = 149.0$, $p < .001$. An ANOVA test of the nested models was statistically significant, $F(2, 333) = 147.5$, $p < .001$, once again supporting the second hypothesis.

Timeline Metrics (Correlations)

The third hypothesis was that for the timelines of students' work, the correlation between self-reported procrastination and the amount of work completed in a given hour would grow stronger and more positive the closer the hour was to the deadline. To test the third hypothesis, an hour-by-hour work record was computed for each student, following the guide discussed earlier in this chapter. The number of edits that students accomplished each hour was divided by the total number of edits that went into composing their essay to determine the proportion of their total work that was completed during that hour. This was done to remove the potentially confounding variable of how much total work students put into their writing.

The resulting measures were then correlated with students' self-reported procrastination, and the resulting Pearson's *r* values were graphed along with their 95% confidence intervals, defined as the area bounded by the points 1.96 standard errors above and below the *r*-value. Correlations were judged to be statistically significant if their 95% confidence intervals did not include zero. The timelines for both essays can be seen in Figure 5.

On balance, the evidence supports the hypothesis that the correlation between self-reported procrastination and the proportion of work that students complete each hour grows stronger and more positive as the deadline approaches. However, this needs further

Figure 5

Hourly Timeline of Correlations Between Work Completed and Self-Reported Procrastination

Note: Timepoints with a correlation of zero and no accompanying error bar represent times when no students were working

explanation because of the nature of the data. One of the most immediately noticeable features of the timeline graphs for the two essays is that the confidence intervals almost always include zero, suggesting that most hours in the temporal record are not statistically significant by themselves. In other forms of research this may cast doubt on the interpretation of the data, but this is less of a problem in the current analysis for three reasons.

The first reason is the temporal nature of the data. A great deal of research involving the temporal dimension is, of necessity, conducted on small samples (Roe, 2014). Some of the earliest observations of the positively accelerated curve that has come to be associated with procrastination were extracted from visual inspection and comparison of individual records of animal behavior (Ferster & Skinner, 1957). Mapping behavior across temporal dimensions allows for the observation of coherent, replicable trends across time; in the case of the present research the many time points make it possible to see several features that are unlikely to be due to chance even if the confidence intervals are not sufficiently precise to localize the exact strength of the correlation between self-reported procrastination and work. One pronounced trend is that for six of the seven days graphed, the correlations between self-reported procrastination and the amount of work students accomplished each hour are almost invariably negative. They also show a scalloping pattern, with a tendency for correlations to grow stronger near midday and weaken towards the late evening and the hours immediately after midnight (represented in the graphs by the grey dotted lines). The correlations shift abruptly from negative to positive on the day of the deadline; it is difficult to imagine that

such a clear pattern could be produced on a timeline by random fluctuation, even if the correlation between procrastination and work for any given hour is not significantly different from zero.

The second reason is that there are two separate essays. The essays were spaced a month apart and were on different topics but were otherwise identical, meaning that the second essay constitutes a *de facto* replication test of the first. The same temporal features seen on the timeline of correlations for the first essay are also present on the second. The first six days show predominantly negative correlations between work and procrastination. The seventh day shows predominantly positive correlations. And with the second essay, as with the first, there is a scalloping pattern; the negative correlations between work and procrastination during the first six days tend to be stronger at midday and weaker towards midnight. Additionally, if a visual inspection is not sufficient, the question of whether the temporal pattern replicates from one essay to the next can be tested directly by correlating the two timelines. The resulting test is highly significant, $r(155) = .632$, $p < .001$, leaving little doubt that there is a coherent temporal relationship between work and procrastination that replicates from one essay to the next.

The third reason is that while the relationship between self-reported procrastination and any given hour may not be statistically significant, this can be attributed to the granularity of the measure. Abelson (1985) identified a similar paradox in the context of baseball; a baseball player's batting average is, quite literally, the average of how many times they hit the ball over their many times at the plate. And yet when using batting average to predict how a baseball player performs during a single at-

bat, the variance accounted for is equivalent to a correlation of $r = .056$ (see Funder & Ozer, 2019). There is an apparent paradox in the fact that a statistic (i.e. the average likelihood of hitting the ball when at bat) could correlate at such a low rate with one of the units that comprises it (i.e. whether one hits the bat during a single time at the plate). The resolution to the paradox is, once again, the principle of cumulation. A single-at bat will not correlate strongly with batting average, but the sum of a hundred at-bats will. Similarly, the true question of interest in the present research is not whether self-reported procrastination correlates significantly with the work accomplished during a particular hour as the deadline approaches. It is what happens when the hours are aggregated, which is the subject of the next set of tests.

Integral Metrics

The fourth hypothesis was that a clear window of time could be defined towards the end of students' work timeline where their work was "procrastination- relevant" and where aggregating the record of their work in that time window would produce a strong correlation with procrastination. The boundaries of this window were unknown at the time the prediction was formulated, but the results of the third hypothesis test suggests that the window comprises most or all of the final day for each term paper.

To test the fourth hypothesis, then, the timeline of students' work was used to compute the integral of students' work (i.e., the sum of all individual "edits" of a student's essay that occurred in a given time window). Starting with the hour immediately before the deadline, the size of the window was increased in one-hour increments proceeding backwards through the students' full work record. With each

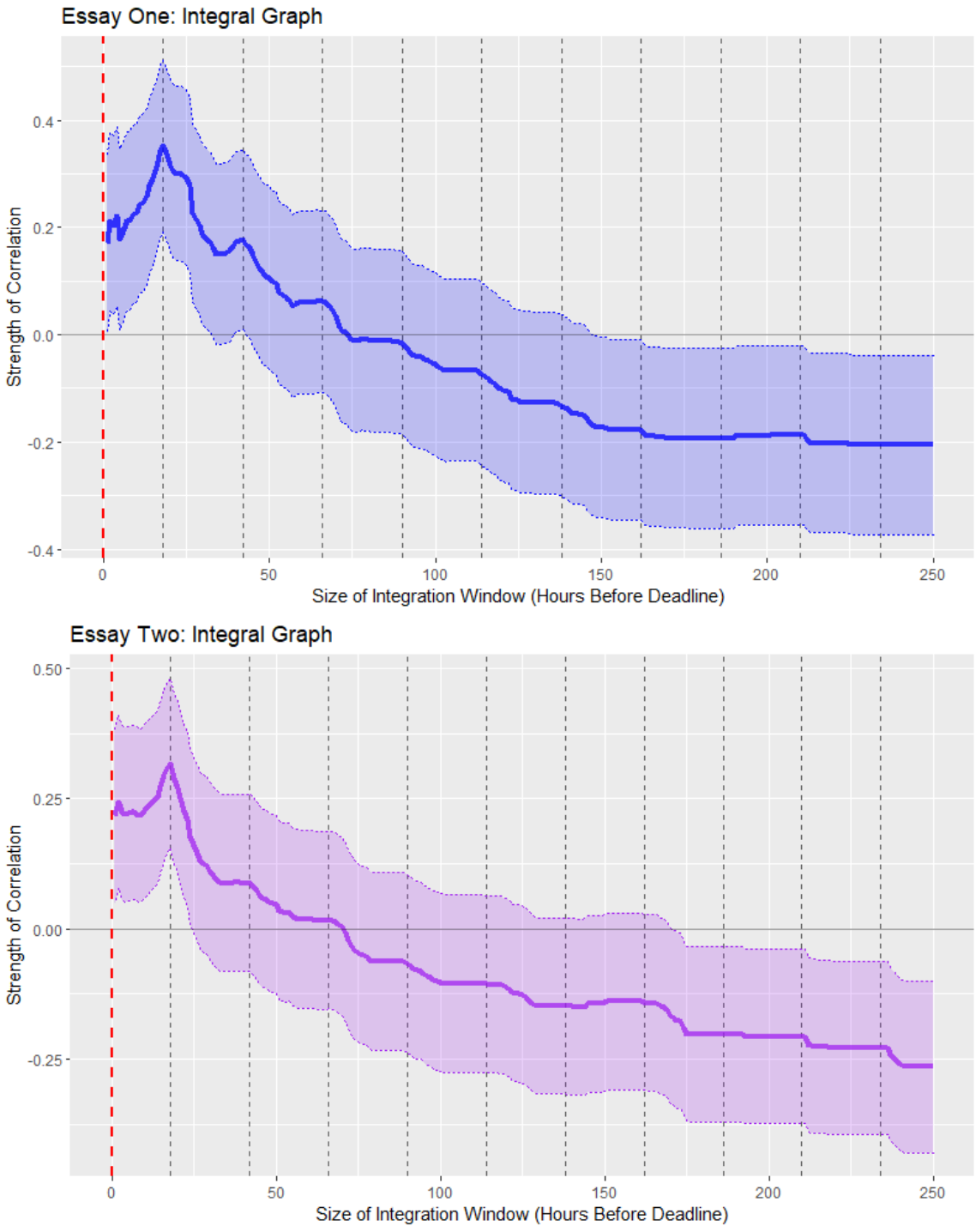
expansion, a new integral was computed for each student, summing the proportion of their work that was completed in the window, and the integral was then correlated with the students' composite procrastination scores. The resulting correlations were graphed, along with their 95% confidence intervals, to demonstrate what happens each time new information was incorporated into the window. Correlations were taken to be significant if their confidence intervals did not include zero. This process was done twice; once for each essay.

The resulting graphs can be seen in Figure 6. The general trend, as well as the inflection point, is the same for both of them. From the graph it is clear that the "procrastination-relevant" window stretches from midnight on the day the essay is due until the time of the deadline.[20] The integral graph is useful primarily because it divides the timeline into two clear periods; the day of the deadline, and every day before that. Incorporating any information from the day of the deadline into the integral window increases the strength of the correlation with self-reported procrastination. Incorporating information from before the day of the deadline into the window decreases its correlation with procrastination. This is most evident when the two periods are split apart and integrated separately. The total proportion of work that students completed on the day of the deadline for the first essay correlates with self-reported procrastination at a rate of $r(132) = .352$, $p < .001$. The total proportion of students' work completed in the full span of time prior to the last day correlates with self-reported procrastination at a rate of $r(132) = -.463$, $p < .001$. Similarly, for the second essay there was a strong positive correlation

[20] And likely beyond the deadline; work completed after the deadline was not included in the integral analysis but future studies using integral metrics should consider incorporating the full range of student work, including late work.

Figure 6

Integral Graph for Essay One and Essay Two (Correlated With Procrastination)



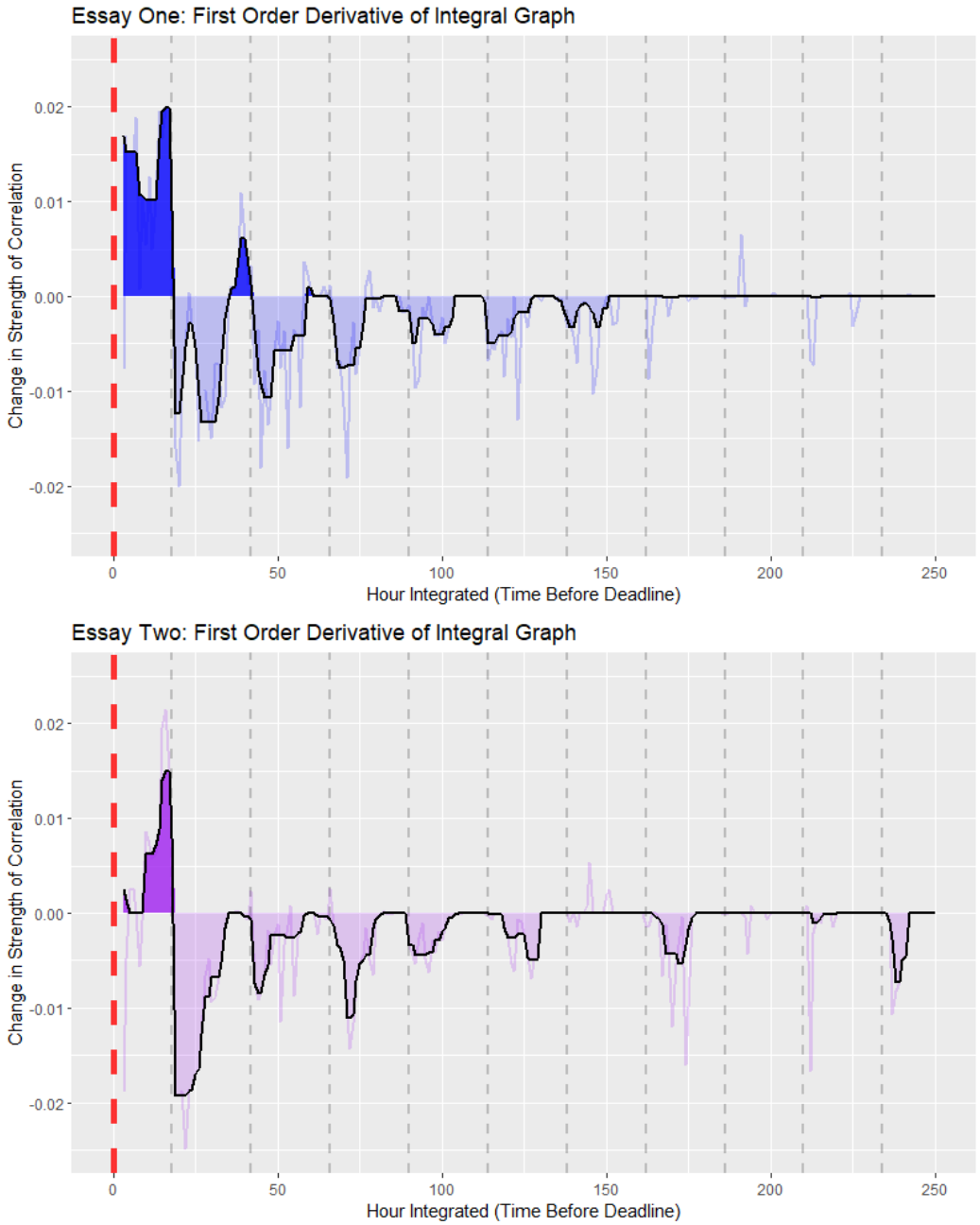
between self-reported procrastination and work done on the last day, $r(131) = .318$, $p < .001$, and a strong negative correlation between self-reported procrastination and all of the work done leading up to the last day, $r(131) = -.477$, $p < .001$.

In order to better visualize the effects of each hour of added information to the correlation between work and self-reported procrastination, the first-order derivative of each integral graph was also plotted in Figure 7. The first-order derivative was computed by subtracting the value of the correlation for each point in the integral graph from the value of the correlation immediately after it. The resulting graph is a visual representation of how much the correlation increased or decreased each time a new hour's worth of data was added to the integral window.

The resulting graphs look somewhat like the timeline of the correlations between work and procrastination shown earlier in Figure 5, except simplified (and reversed, since the graph of the integration starts with the deadline and proceeds backwards). The simplification makes it easier to view certain patterns. In addition to re-emphasizing the fact that procrastination appears to be a last-day phenomenon, it is also worth noting that there appears again to be a circadian pattern in the graphs. Integrating work done in the hours shortly before midnight appears to have contributed more to the overall decrease in the correlation between total work and delay than integrating work done earlier in the day. This pattern is quite noticeable in the graph of the first-order derivative; it is less easy to spot in the original timeline of correlations.

Figure 7

First Order Derivative of Integral Graphs for Essay One and Essay Two



***Note*:** The deadline is represented by the dotted red line. Gray dotted lines represent midnight of each day in the temporal record. The solid black line is a smoothed summary line showing the general trend of the correlations, while the faded colored lines represent the true change value.

Discussion

The purpose of this chapter was to address a methodological gap in the procrastination literature by introducing a novel method of collecting data using a well-known writing platform, Google Docs. This included addressing the history of Google Docs, as well as some of the technical aspects, but the primary focus of the chapter was on taking one of the most basic and well-established findings in the procrastination literature—that procrastinators tend to do their work later than non-procrastinators—and showing how that basic principle maps onto several metrics computed from the raw Google Docs data collected from a class of students. There were two reasons for this approach. The first reason is that mapping an obvious and well-known principle onto a new form of data allows for an easy visual guide to how the analyses work and how the data is used. Ideally this approach should help those unfamiliar with Google Docs data to calibrate their understanding of how it can be used. The second reason is that it also serves as a validation of the measure: readers would have good reason to be skeptical of Google Docs data if it could not be used to replicate a well-established finding.

To this end, the analyses here provide strong evidence validating the use of Google Docs. All four of the major analyses conducted in this chapter confirmed the primary hypotheses. First, most of the basic summary metrics extracted from the Google Docs data (start time, mean, median, mode, end time, and submission time) correlated positively with procrastination across both essays, with the notable exception of student's start times. Second, the frequency distribution of students' work in the weeks leading up to the deadline took the form of a positively accelerated curve, or "scallop." This scallop

pattern is similar to that identified by procrastination researchers (e.g. Howell et al., 2006) and behavioral psychologists (Morris et al., 1978; see also Perrin et al. 2011). Third, when students' work on the essays was broken into a timeline of the amount of work accomplished each hour, the correlations between students' self-reported procrastination and the amount of work they accomplished each hour was negative in the six days leading up to the deadline and positive on the day of the deadline. This finding was especially pronounced when the data was integrated across the timeline.

Interpreting the Findings

Svartdal et al. (2018) demonstrated that across many behaviors procrastinators tend to adhere to the simple rule of "later." It is not surprising that the present study found support for this hypothesis. What is surprising, however, is the strength of the support. The most dramatic finding, perhaps, is from the timeline and the integral analyses, both of which clearly demonstrate that there is a clean demarcation between "procrastinator's time" (the last day) and "non-procrastinator's time" (any day before the last day). Of course, this probably does not mean that only procrastinators are working on the last day. It simply means that the balance of work being completed at that time shifts in their favor. While the main purpose of this chapter was to illustrate how the concept of "later" maps on to data from Google Docs, the analyses conducted also highlight a couple noteworthy additional findings that merit their own discussion.

Procrastination and Starting. The first finding was identified while testing the second hypothesis. Students' self-reported procrastination does not correlate as strongly with the time that students started their essays as it does with measures of central

tendency. This echoes existing research in the literature; Svartdal et al. (2020) demonstrated that the starting (or "onset") phase of a project correlates differentially with self-reported procrastination. What was not mentioned, however, is that the findings in the present study are the opposite of those found by Svartdal and colleagues. Whereas Svartdal et al. (2020) showed that the onset phase correlated stronger with self-reported procrastination than other phases, in the present analyses the onset phase shows a weaker correlation with self-reported procrastination.

Based on this, one might attempt to argue that the findings here provide evidence against those found by Svartdal et al. (2020), but that would be antithetical to the entire primary argument of this dissertation. Svartdal and colleagues measured goal onset using self-report, whereas the present research uses an objective, computer-mediated measure of start time. The difference between self-report and objective measurement is worth discussing here because it highlights the dynamic relationships between the two.

First, it should be noted once again that "start time" in this study was actually students' adjusted start time, or the time that they reached the 1% mark of their cumulative work record. This was done to remove artifacts from the record such as accidental key presses when the students created their Google Doc. It was also done based on the assumption that opening a Google Doc and typing the first few tentative keystrokes was not the same as "starting," but was rather a form of dithering behavior that would make it difficult to form a clear picture of when students actually began their first good-faith effort to complete their work. It could be that cutting off the first 1% of students' work record failed to completely remove such noise, leading to a depressed

correlation between self-reported procrastination and objectively measured start times.

Or, it could be that the dithering is the point. From the perspective of a procrastinating student the actual starting of a project like an essay may be unusually stressful and chaotic, marked by halfhearted and undisciplined attempts to begin. This may increase the "noise" in the objective measure of students' start times, reducing the strength of the correlation. At the same time, the strain felt by the procrastinator during this time period may lead them to report higher levels of difficulty with the goal onset phase. Thus the same strain that reduces the strength of the correlation between self-reported procrastination and actual start times could increase the strength of the correlation between procrastination and self-reported start times.

If true, this is a particularly important point because it offers a slightly different way of looking at procrastination. It may be that procrastination does not only correlate with delay in the temporal record of students' work. It may be that there are certain points where procrastination also correlates with volatility in the temporal record of work. This makes intuitive sense: a procrastinator and a non-procrastinator may submit an essay at the same time, but the procrastinator may have struggled far more to finish it. This may also be similar at the onset phase of work: a procrastinator and non-procrastinator who start at the same time may have taken different routes to get there, with the procrastinator's start marked by previous aborted attempts while the non-procrastinator's start happens exactly at the time and place of their choosing.

Circadian Patterns. The second notable finding, evident across the tests for the second, third, and fourth hypotheses, was the presence of clear circadian rhythms in

students' work data. This fact was unsurprising in regards to the amount of work that students complete, since the evenings when students are sleeping will certainly not see the levels of sustained work production found during midday.[21] It is more surprising that there appears to be evidence of circadian rhythms in the correlation between self-reported procrastination and the amount of work students completed at each hour of the day. Procrastination seems to show the strongest negative correlations with work towards the middle of the day and the early evening: after midnight the correlations diminish in strength substantially, and quickly. Some researchers have drawn connections between procrastination and chronotypes: procrastination has been associated with eveningness, or the tendency to be more awake in the evening hours (Hess, Sherman & Goodman, 2000). Additional research studies have identified a particular form of procrastination, bedtime procrastination, that involves delaying sleep even though it is unnecessary and counterproductive (e.g., Kroese et al., 2014). The same studies have also shown that bedtime procrastination correlates strongly with normal procrastination, once again suggesting that chronotype influences more mundane forms of procrastination like putting off homework.

Limitations

While Google Docs data is promising, it does have limitations. Some broad, global concerns with the use of Google Docs data will be addressed in the final chapter. Here, some more specific concerns are addressed..

[21] For an amusing finding, however, note that the "quiet time" after midnight, which is devoid of any work events for the first several days, suddenly vanishes and becomes a viable work time in the few days before the deadline. This can clearly be seen in Figure 4, for both essays.

The present study focuses on a single type of project—a moderately complex term paper, five to eight pages long. The size of the assignment may have influenced many of the temporal features of the data found here. For example, the class began showing their first signs of work on their essays approximately one week prior to the deadline even though the assignment was available to them for two weeks. The first major surge in action on the paper occurred three days before the deadline. The window where self-reported procrastination was positively correlated with the amount of work students completed was confined exclusively to the last day. Each of these milestones may be sensitive to the size of the assignment. Dissertations and discussion-board postings likely have different temporal features that will influence when students begin to make their first tentative efforts, when they begin to rush, and when procrastinators decide what the "last moment" is, where they must start working to stave off failure. This limits the generalizability of these results, but at the same time it also suggests a promising lead for future research into the temporal windows associated with procrastination, and their relationship to different types of assignments.

A second limitation may be in the method employed for collecting survey data. Students were permitted to fill the survey out at any time during the academic term. Approximately half of the students filled their survey out towards the beginning of the term, while the other half filled it out towards the end. This may have inflated self-ratings of procrastination among those who submitted their paper later because they had the opportunity to reflect on their behavior, having already completed the essays.

Procrastination was significantly correlated with the time that students submitted

their survey, $r(176) = .173$, $p = .002$. Ultimately, however, analyses suggested that any bias due to survey completion times is unlikely. Correlations between self-reported procrastination and the various metrics of delay were indeed biased by the time during the academic term that participants filled out their survey, but this bias was symmetrical and, in the case of most of the measures, not significant. Self-reported procrastination correlated stronger with students' delay scores on the first essay for those who filled out their survey towards the beginning of the quarter, and stronger with students' delay scores on the second essay for those who filled out their survey towards the end of the quarter. Since there was a symmetry to the bias in the correlations, it seems likely that artificially confining the personality survey to a specific part of the quarter, like the beginning, would have introduced an artificial confound (distance from measure of delay) that would have made between-essay comparisons more difficult. As an additional safety check, the class was split into those who submitted the survey early and those who submitted it late, and the timeline and integral graphs were re-inspected for both groups. In both cases the fundamental properties of the temporal graphs were essentially the same: correlations were still negative or neutral in the six days leading up to the day the paper was due, and positive on the due date itself.

Conclusions and Future Directions

In terms of the broader contributions of this chapter, the analyses here have highlighted the sensitivity of correlations between procrastination and delay to the dimension of time. Based on an inspection of the integral graphs it is not at all an exaggeration to say that a researcher who operationalizes delay as the amount of work

that students do on the final day will find a strong correlation with self-reported procrastination. Conversely, a researcher who operationalizes it as the amount of work students do during the last three days will find no correlation at all. This does have some bearing on previous research; Solomon and Rothblum (1984), for example, operationalized delay as the number of quizzes that a student completed during the last third of the academic term; the present results suggest that the selection of such time points should be studied further. In future studies where researchers operationalize delay using the amount of work completed in a specific time window, it should be possible to generate an integral graph and a timeline similar to the ones in this chapter. The integral graph could then be inspected to determine the window representing the peak correlation between procrastination and work. However, this would require some additional work to ensure that researchers are not simply picking the time window most convenient for them; some research studies, for example, could focus solely on identifying the optimal time window so that new studies have a useful point of comparison for their own data.

Beyond that, the circadian rhythms found within the relationship between self-reported procrastination and students' work speaks to the critical importance of time. It is clear that even in the simplest and most basic relationship in procrastination research—the relationship between what a procrastinator says and what their own actions reveal about them—there is still a great deal that needs to be learned. At present, however, the analyses conducted in this chapter fulfill one final purpose, laying the basic methodological groundwork for exploring the temporal relationship between anxiety and delay. This relationship is the subject of the next chapter.

Chapter Four: Exploring Anxiety and Delay Using Google Docs Revision Data

Introduction

Anxiety as a Keystone Construct

Anxiety is one of the most important variables in psychology—a conceptual keystone that props up the psychological understanding of what it means to be human. It is an old construct; some of the earliest psychological treatments of the subject were not even conducted by psychologists. One of the first scientifically authoritative and systematic treatments of anxiety was conducted by Darwin (1872) as part of his research on human emotion, seven years before Wilhelm Wundt founded the first psychological laboratory in Leipzig, Germany. Beyond the simple fact of its history, however, anxiety is important because it sits close to the center of a web of interrelated constructs that tie together many domains of human experience and action, including those related to hierarchy, goals, meaning, effort, motivation, consciousness, memory, desire, health, discipline, physiology, and personality. As Freud once noted, "one thing is certain, that the problem of anxiety is a nodal point, linking up all kinds of most important questions; a riddle, of which the solution must cast a flood of light on our whole mental life" (Freud, 1917/1963, p.401).

It is easy to fall into the pattern of simply categorizing anxiety as an emotion and trying to confine it to that realm. William James, for example, did not devote much attention to anxiety in his *Principles of Psychology* (James, 1910) beyond using it as an example to argue that human emotion was primarily explained by an individual's perception of their own bodily states. However, taking the time to unpack anxiety conceptually shows that it has a complex composition and deep connections to most of

the systems that promote human action. Anxiety is thought to be one of the chief emotions produced by motivational conflicts, a natural byproduct of the executive functions of the brain inhibiting one set of desires in a motivational conflict so that the individual can act to attain another (McNaughton & Corr, 2004). This basic principle of anxiety ties it in deeply with goals, action, and efficacy, as well as the sorts of breakdown in self-regulation and internal conflict management that result in psychopathology. Due to that, and in proper keeping with Freud's observation, it is difficult to imagine any aspect of psychoanalysis, or of counseling psychology more broadly, that is not concerned with anxiety and its associated avoidant behaviors.

Anxiety also overlaps substantially with constructs such as stress, fear, and physiological arousal; while the constructs are not perfectly identical, they nonetheless share an underlying physiological architecture centered around the activity of neural systems such as the amygdala (Davis, 1992) and endocrine systems such as the Hypothalamic-Pituitary-Adrenal (HPA) Axis (e.g. Arborelius et al., 1999). The connections between anxiety and arousal, in turn, further link anxiety to physiological variables such as health (Dickerson, Gruenewald & Kemeny, 2004)[22] and to psychological variables such as motivation (Roelofs, Elzinga & Rotteveel, 2005), memory (Wolf, 2003), and self-regulation (Baumeister, Heatherton & Tice, 1993). Perhaps the simplest way to emphasize the importance of anxiety is to note that it is

[22] Dickerson and Kemeny have identified a particularly pernicious negative association between anxiety and health when anxiety is linked to threat of shame and exclusion. They suggest that the threat of negative self-evaluation is such a powerful stressor that it produces much higher levels of reactivity than other anxiety-inducing situations, and this higher reactivity is associated with negative health consequences. Given the performance implications of work, then, it is possible that high-stakes educational evaluations, which carry with them the threat of shame, may be more damaging to the long-term well-being of students than other, less taxing forms of anxiety.

synonymous with nervousness, which in turn is a reference to the human nervous system, with all of its afferent and efferent responsibilities. Calling someone nervous is the equivalent of suggesting that the basic neurological architecture that moves them through their environment has gotten twitchy. To call someone anxious is to comment on the full range of neurological and physiological systems that enable them to act.

Imagine, then, selecting a domain of human action and suggesting that it is *not* influenced by anxiety. Suppose that someone suggests that anxiety is unrelated to the ability to learn a complex piano piece, or to speak on stage, or to approach a potential lover to say "hello." It would be appropriate to greet such assertions with skepticism. While it is entirely possible that there may be some human actions that are unrelated to anxiety levels, it seems fair to say that when someone suggests that anxiety has no influence on some domain of human action, the burden of proof should rest squarely on the person making the claim—and they should be prepared to provide strong proof.

Researchers who argue against the relationship between anxiety and delay are faced with such a conundrum. As has been mentioned in previous chapters, the balance of evidence collected by procrastination researchers so far offers only weak hints of a relationship between anxiety and delay. It would be tempting to conclude, based on this, that no relationship between the variables exists. Unsurprisingly, then, several researchers have expressed skepticism about the clinical tradition that treats anxiety and its manifestations as a primary driver of procrastination (Lay & Silverman, 1996; Steel et al., 2001; Steel, 2007). However, the burden of providing strong proof should rest on those who claim anxiety does not relate, for two reasons. The first reason, as has already been

discussed, is the ubiquity of anxiety in human action, which makes the lack of a relationship between anxiety and delay an extremely counterintuitive finding.

The second reason is the consequences. Denying the relationship between anxiety and delay leaves an unfortunate crack in one of the keystone variables of modern procrastination research. If anxiety had no meaningful relationship to delay at all, it would make it necessary to reappraise a great many of the findings and conclusions from the past four decades of procrastination research. This is likely the reason that so many researchers ignore the fact that anxiety does not correlate with delay, choosing to focus instead on the fact that it correlates with self-reported procrastination.

Because the weak relationship between anxiety and delay is consequential, it must be addressed. And because the weak relationship between anxiety and delay is counterintuitive, it is inappropriate to conclude that anxiety and delay are unrelated without providing strong proof. At the very least, one should expect an exploration of the most plausible alternative hypotheses for the missing relationship. The present chapter seeks to address this gap in the literature.

Alternative Relationships Between Anxiety and Delay

In previous chapters, some minor references have been made to possible alternative explanations for the depressed correlations between anxiety and delay; it is useful to review them here in slightly more detail, because each one represents an alternative hypothesis that researchers would need to examine before they could make a strong case that anxiety does not predict delay.

Measurement Phase. As demonstrated in Chapter Three, the correlation between a predictor variable (such as self-reported procrastination) and delay can change across the phases of a project. The psychological dynamics underlying the decision to start writing an essay are different from the ones involved in persisting until it is finished, and these in turn are different from the ones involved in submitting it on time. The studies that have looked at the relationship between anxiety and delay have typically measured either the start of a project (i.e. Senecal et al., 1997) or the submission time (e.g. Beswick et al. 1984) and have largely missed the middle phase of the project. The notable exception to this is the study by Steel et al. (2018), although in their case the primary measure was the submission time for discrete units of work (course modules and tests) across a full academic term. It is uncertain, then, if they accurately captured the psychological dynamics of students' actual work, as it occurred in the moment.

This is important, because logic suggests that both start times and submission times can be separated from the actual work done on a project. Two students can start an essay on Sunday evening; one may finish by Monday, and the other could wait until Friday, and a researcher using start times as an operationalization of delay would not know the difference. Conversely, two students could finish the last keystroke of an essay on Friday morning; one could turn it in immediately and the other delay until midnight and, again, the researcher would not know. One reason that researchers may have found a generally weak relationship between anxiety and delay, then, is that the "buffer zone" of space between distinct phases of a project may add noise to the correlation between anxiety and delay, artificially reducing the apparent relationship.

Cumulation. Funder and Ozer (2019) offer an eloquent treatment of the nature of cumulative effects in psychology that has been referred to at multiple points in previous chapters. The principle of cumulative effects has been used previously in this dissertation to argue that researchers should not dismiss a "weak" meta-analytic correlation between an anxiety-related variable (fear of failure) and procrastination as insignificant (Steel, 2007), because a correlation of that size could compound itself across the many hundreds of opportunities that students have to procrastinate during four years of college. The principle of cumulative effects has also been used to argue that a weak correlation between self-reported procrastination and the amount of work that students' complete during a given hour in the weeks leading up to a deadline is not useful compared to an aggregate measure of the work they completed across multiple hours.

The principle can be applied to the relationship between anxiety and procrastination, as well. It may be that if one is searching for a relationship between anxiety and delay, the effect would only become noticeable after a cumulative relationship has had time to build. This could take a couple of different forms; it could be that the relationship between anxiety and delay follows a pattern similar to the one found between self-reported procrastination and delay in Chapter Three, with certain periods of time that are "anxiety relevant" and others that are not. If that is the case, then aggregating students' work record from the period(s) of time that are anxiety-relevant should show a strong overall relationship.

An alternative explanation may be that the relationship between anxiety and delay grows increasingly strong over time. This second possibility is somewhat akin to a race;

imagine a crowd of competitors, some of whom are diligent and disciplined and others who are wild and do not take the principles of distance running seriously. If one were to rank the competitors, they may find that at the start of the race there is no correlation between discipline and position at all. Or, alternatively, they may even find that the disciplined runners lag behind the others. By the end of the race, however, the disciplined runners would pull ahead and the positive relationship between discipline and performance would suddenly become very clear.

A similar effect may happen with anxiety and delay; if there is a positive relationship between the two, it may only appear later in the work process, after students' personalities have had a substantial amount of time to influence how far behind (or ahead of) their peers they are. This explanation would not account for the low correlations that have been found between anxiety and delay when delay is operationalized using students' submission times for their assignments, since in theory the relationship between anxiety and delay should become more clearly pronounced as students approach the end of their project. However, it does offer a plausible explanation for some of the studies in Chapter Two that assessed the relationship between anxiety and delay at multiple time points. The average correlation between negative mood and test-taking delay found by Steel et al. (2001) across the four time points they assessed was $r = .09$, but a closer examination of the correlations shows that they increased across the four measurement points. Similar patterns of increase in the relationship between anxiety and delay can be seen in Moon and Illingworth (2005)[23] as well as Lay and Schouwenburg (1993). Other studies, though

[23] It should be noted that the linear growth effect in the Moon and Illingworth study is small and nonsignificant.

not explicitly showing an increase in the strength of the relationship between anxiety and delay, still show similar patterns of cumulative change in the variables across time that suggest that cumulation is a potentially useful lens through which to understand the variables, in general (e.g. Yerdelen, McCaffrey & Klassen, 2016).

Individual Differences

The above descriptions offer some alternative explanations for the depressed relationship between anxiety and delay, which should be investigated further before researchers conclude that a relationship between the two variables does not exist. However, the evidence supporting either alternative explanation is scant, due primarily to the fact that so few studies have examined the relationship between anxiety and delay in the first place. There is a final alternative, however, that has amassed far more support in the psychological literature, which is that the relationship between anxiety and delay may vary systematically across a population as a function of other personality variables. These variations, in turn, may cancel each other out across the population, depressing the zero-order correlations between anxiety and delay.

McNaughton and Corr (2004) have argued eloquently that the core feature of anxiety is mental conflict; anxiety is produced when an organism is motivated to do conflicting things and must selectively suppress one motivation in order to pursue the other. The most classic example of this is an approach-avoidance conflict, where an organism must approach a threat to resolve or investigate it, repressing its desire to flee.[24]

[24] One representative example of an approach/avoidance conflict is called "burying behavior." In a burying paradigm, a rat receives a nasty shock from an electrode. Anxiety is operationalized as how long the rat spends using the wood shavings in their cage to bury the electrode. Research has shown that the duration of this behavior can be influenced by anxiolytic drugs (Blampied & Kirk, 1983).

One implication of this is that the existence of an anxious state may signal a great deal about the presence of an internal conflict and the readiness to act, but may not provide much information regarding how that conflict will be resolved. It is likely that, in real-world contexts, the resolution of the conflict will be highly sensitive to other variables, such as the situation and personality of the one who is experiencing the anxiety. More simply put, in many cases anxiety may motivate action, rather than directing it, and researchers should anticipate that the effects of anxiety will be dependent on other variables. In extreme situations this may mean that looking at simple bivariate relationships between anxiety and behavioral outcomes may be an entirely inappropriate form of analysis.

Evidence for Individual Differences. There is some precedent in the scientific literature for this assertion. For example, studies outside of the domain of procrastination research have been conducted that show that individuals of varying levels of achievement respond differently to anxiety. A notable early finding in this regard is the research conducted by Spielberger (1962), who found that the performance of superior students seemed to be facilitated by anxiety, while normal and struggling students appeared to be either unaffected or hindered by anxiety. While such studies do not provide direct evidence for the assertion that individual differences moderate the relationship between procrastination and anxiety, they do provide evidence that such moderation is plausible.

Similarly, within the procrastination literature, there have also been studies that show that procrastinators and non-procrastinators differ in their responses to anxiety. Perhaps the best known is the study conducted by Tice and Baumeister (1997), which

showed that non-procrastinators expressed greater anxiety early in the academic term, while procrastinators expressed greater anxiety late in the academic term. A subtler form of evidence comes from studies that show that procrastination is a general preference even in situations where no anxiety is evident. Svartdal et al. (2018) found that procrastinators tend to delay in a wide variety of situations that would normally not be considered effortful or anxiety-inducing; in their research, procrastination was reliably associated with behaviors such as whether a participant rushed for a closing elevator instead of waiting for the next one, whether they brought a lunch to an event instead of buying one there, and whether they signed up for an early seminar instead of a late one. The fact that procrastination relates to these non-triggering situations suggests that preference for late action can be a basic personality disposition rather than a consequence of adversity or negative emotion. It is possible that anxiety triggers such a disposition by presenting an individual with a conflict that needs to be resolved. In such a situation, those who tend to be procrastinators will likely prefer to resolve the conflict by delay, while those who are non-procrastinators will likely prefer to resolve the conflict by action (i.e. acting early).

Perhaps the most compelling single line of argument, however, is the well-established existence of a personality tendency that is the opposite of procrastination. Rosenbaum et al. (2014) demonstrated that a substantive proportion of the population prefers to resolve goals early even if it comes at the expense of extra physical effort. Research has shown that this proclivity, which Rosenbaum and colleagues have termed

precrastination, holds true across a variety of settings, and has also shown that it is a stable preference (see Rosenebaum et al., 2019, for a review of the literature).

More recently, Sauerberger (2019) demonstrated that the tendency to precrastinate correlates positively with the broad personality trait of Conscientiousness, and also shows a mild and mostly nonsignificant negative correlation with the personality trait of Neuroticism. These relationships are significant because they are the conceptual inverse of the relationships found with procrastination, which shows a negative correlation with Conscientiousness and a smaller positive correlation with Neuroticism. Sauerberger (2019) found that the proportion of students who chose to precrastinate was not small; over half of his participants showed a preference for precrastination. Rosenbaum et al. (2019) suggested that a primary reason for precrastination may be the reduction of cognitive load; by their estimation, even though completing tasks earlier may require more up-front physical effort, participants likely considered the reduction of cognitive load associated with starting and completing the task early to be worth the extra effort. This, too, has some parallels in the procrastination literature, with researchers such as Sirois and Pychyl (2013) suggesting that procrastination may serve to regulate negative mood and stress.

Hypotheses

Based on the above, the primary hypothesis of the present study is that a normal classroom is composed of students who have a range of time orientations, with some students who can be classified as precrastinators and others who can be classified as procrastinators. In keeping with the theories advanced by Rosenbaum et al. (2019), if

precrastinators exist, then for them the relationship between anxiety and delay should be negative, such that those who have higher levels of anxiety should resolve it by prioritizing their work and completing it early. For procrastinators, the relationship between anxiety and delay should be positive, such that those who have higher levels of anxiety should resolve it by delaying their work and completing it late.

Functionally speaking, the present analysis does not have a measure of precrastination that makes it easy to identify precrastinators. However, given that Sauerberger (2019) found that over half of his sample chose to precrastinate, it is very likely that precrastinators are the same as those who score on the low end of a normal procrastination scale. Based on this logic, in the present study students are split into three separate groups; low procrastinators, medium procrastinators, and high procrastinators. The relationship between anxiety and delay should map differentially on to these three groups. Based on this principle, the present study takes the sample of students used in the previous chapter and divides it into three groups according to their procrastination level. The measures of student work used in the previous chapter are then correlated with anxiety, both for the sample as a whole and also within each groups. The following specific hypotheses about the relationship between anxiety and delay are derived from the primary hypothesis that high and low procrastinators will show opposite patterns in their relationship between anxiety and delay. The hypotheses are formulated in terms of high and low procrastinators, with the medium procrastinators implied to fall between the two extremes.

Summary Metrics

If anxiety is positively associated with delay for high procrastinators, and negatively associated with delay for low procrastinators, then this should be visible in the correlations between anxiety and the various summary metrics for each of the three groups. There is no reason to believe that the differences between procrastination and the four phases (e.g. start, middle, end, submission) of the summary metrics should be so severe that they negate the group differences. Hence the following hypothesis applies to all of the summary metrics used:

> ***Hypothesis 1.*** There should be a significant difference in the relationship between anxiety and delay across groups such that anxiety will be positively related to delay for high procrastinators (H1a) and negatively related to delay for low procrastinators (H1b).

Timeline Metrics

Regarding the timeline metrics, if high procrastinators tend to respond to anxiety by working later, then it would be reasonable to predict that the high procrastination group should show more positive correlations between anxiety and work as the deadline approaches. Conversely, if low procrastinators respond to anxiety by working earlier, it would be reasonable to predict that they should show more positive correlations between anxiety and work earlier in the timeline, prior to the last day. This leads to the following hypothesis:

> ***Hypothesis 2.*** Groups should distribute their work differentially across time, such that for low procrastinators higher levels of trait anxiety correlate with work

completed earlier (H2a) while for high procrastinators higher levels of trait anxiety correlate positively with work completed closer to the deadline (H2b).

Integral Metrics

The integral graph of the relationship between self-reported procrastination and work showed a straightforward relationship between the two variables; there was a clear window of time on the last day that was positively correlated with self-reported procrastination, while work done on the days prior to that was negatively correlated with procrastination. The current analysis tests the hypothesis that the same will be true of the relationship between anxiety and delay, with the caveat that the relationship is expected to be vary depending on which of the three levels of procrastination is being examined.

Hypothesis 3. There should be a window of time close to the deadline where trait anxiety correlates positively with the amount of work completed for low procrastinators (H3a), and negatively with the amount of work completed for high procrastinators (H3b). The size of this window is unknown.

Method

Participants and Procedures

The present analyses used the same data as the analyses in Chapter Three. Prior to analysis, however, participants were split into three separate groups based on their levels of procrastination. This was accomplished by ranking participants in terms of their procrastination levels, using the composite measure of procrastination from Chapter 3, which was produced by averaging together participant's scores on the three procrastination scales in the study. Once the participants were ranked, they were split into

low, medium, and high-procrastination groups. The low and medium procrastination groups each had 52 participants, while the high procrastination group had 53 participants. In order to ensure that outliers did not confound any of the results, participants were excluded from a given analysis if their score on any of the measures of anxiety or delay were greater than four standard deviations from the mean.

Measures

The current analysis used all of the measures of delay from the previous chapter, including the summary metrics, timeline metrics, and integral metrics derived from Google Docs, and also the assignment submission times gathered from the online course portal. As an additional point of comparison, the self-report measures of procrastination, consisting of the General Procrastination Scale (GPS), Irrational Procrastination Scale (IPS) and the Pure Procrastination Scale (PPS) were also included.

Anxiety. Anxiety was operationalized using the Anxiety facet of the Big Five Personality Inventory's Neuroticism scale (BFI-2; Soto & John, 2017). The Anxiety facet of the BFI-2 consists of items designed to assess a person's tendency to experience nervous or anxious states. It consists of two normal items (example item: "Worries a lot") and two reverse-coded items (example item: "Rarely feels anxious or afraid"). The Cronbach's alpha value for the four items was $\alpha = .71$, indicating acceptable reliability.

Results

Summary Metrics

The first hypothesis was that anxiety would show differential relationships with measures of delay at each of the three levels of procrastination. To test this, students were

split into three groups (low, medium, and high procrastinators) based on their composite procrastination scores from Chapter Three. Correlations were derived for the relationship between anxiety and all measures of both objective delay and procrastination for each group as well as for the full sample. The resulting correlations can be seen in Table 4. Correlations were compared between groups using a simple *t*-test of the *z*-transformed correlation coefficients, making use of the *paired.r* function from the "psych" package in R (Revelle, 2021).

The analyses provide qualified support for the hypothesis. First, there is not a discernible pattern among the correlations between anxiety and the measures of self-reported procrastination. While some correlations are significantly different from zero, and some correlations are significantly different from each other, overall the differences between the three groups do not appear to follow any logical pattern that remains consistent across the multiple measures of procrastination.

When moving from measures of self-reported procrastination to objectively measured delay, however, a strong pattern starts to emerge. First, across almost all measures of delay (with the notable exception of students' start times for Essay One) there is a general pattern of linear increase across the three levels of procrastination; correlations between anxiety and delay are nonsignificant or negative for low procrastinators, and are positive for high procrastinators, while medium procrastinators are in-between.

Due to the low *N* in each of the three groups, the correlations between anxiety and delay are almost all nonsignificant for Essay One, with one lone exception; for those who

Table 4

Correlations between anxiety and delay across levels of self-reported procrastination

	Full Sample	Split By Procrastination Level			Paired Tests	
Measure		Low	Medium	High	Z_{LH}	Z_{MH}
GPS	.262***	-.035	.010	.215	1.254	1.032
IPS	.312***	.116	.318*	.144	0.144	0.909
PPS	.307***	.339*	-.282*	.223	0.623	2.543*
Composite	.318***	.148	.019	.260†	0.579	1.223
Essay One						
Start	.075	.090	-.131	.004	0.396	0.613
Mean	.141	-.003	.015	.130	0.615	0.526
Median	.157†	-.001	.041	.155	0.716	0.519
Mode	.096	-.069	-.054	.151	1.007	0.933
End	.100	-.122	-.067	.315*	2.027*	1.756†
Submitted	.168*	-.140	.105	.214	1.738†	0.539
Essay Two						
Start	-.026	-.287†	-.037	.067	1.628	0.475
Mean	-.039	-.251	-.124	.162	1.888†	1.301
Median	-.040	-.287†	-.145	.208	2.279*	1.613
Mode	-.039	-.289†	-.142	.211	2.300*	1.613
End	-.012	-.359*	-.135	.233	2.760**	1.680†
Submitted	.115	-.133	.018	.186	1.544	0.822

Note: † < .1, * < .05, ** < .01
Note 2*: N's* range from 43 to 49 for correlations between anxiety and summary metrics for Essay One and Essay Two due to missing data. N's for correlation between anxiety and self-report are 59.

are high procrastinators, there was a significant positive correlation between anxiety and adjusted end times. For Essay Two, the correlation between anxiety and adjusted start time, median work time, and modal work time were all near-significant for low procrastinators, and once again there was a significant positive correlation between anxiety and adjusted end times. A series of between-samples significance tests were conducted to determine if the correlation between anxiety and delay was significantly different between low and high procrastinators; for Essay One, the correlation between anxiety and adjusted end times was different between the two groups. For Essay Two, the correlations between median and modal work times, as well as adjusted end times, was different between the two groups. There were no significant differences between medium procrastinators and high procrastinators.

The general pattern of results is consistent with the following conclusions; first, if there is a positive association between anxiety and delay in the group of high procrastinators, the sample size in the present analysis is too small to reliably detect it in either the first or second essay. However, in the second essay, the correlation between anxiety and delay is significantly higher in the high procrastinator group than it is in the low procrastinator group. Additionally, across both essays the correlations between anxiety and procrastination, while not significant, are nonetheless all positive and are of comparable magnitude to each other and to the average correlation between anxiety and delay found in the meta-analysis. The significant correlation between anxiety and students' adjusted end time for Essay One is heartening and offers some mild support for Hypothesis 1a, but should be interpreted conservatively in light of the small sample size.

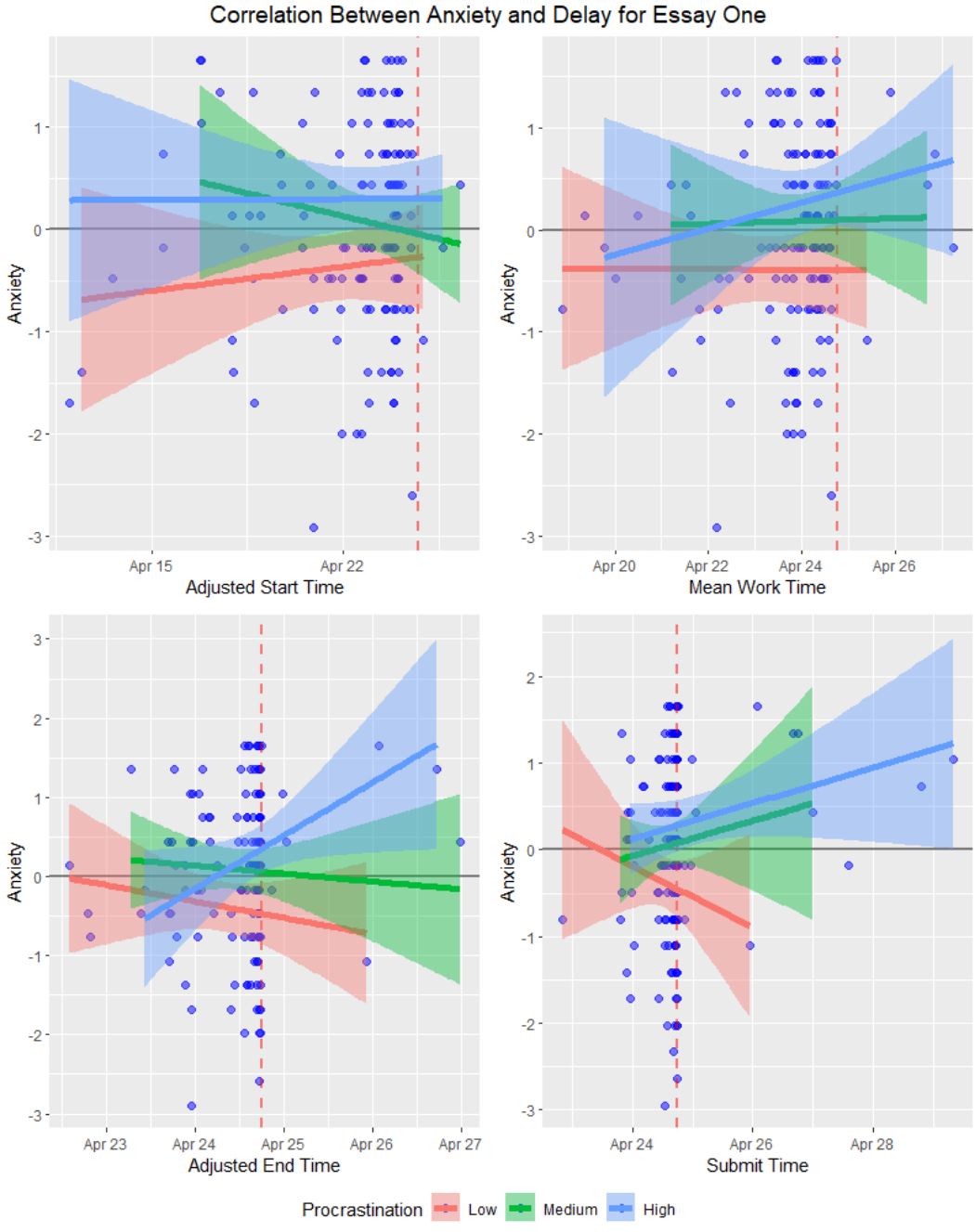
Second, if there is a negative association between anxiety and delay in the group of low procrastinators, the association is not apparent in Essay One. However, there is some evidence for a negative association in Essay Two. There is a significant negative correlation between anxiety and students' adjusted end time for Essay Two, and the correlations between anxiety and students' adjusted start time as well as their median and modal work times are near significant. More than that, it should be noted that the correlations were tested for significance using a two-tailed test, in spite of the fact that the hypothesis about the correlation was directional. With a less-stringent one-tailed test five of the six summary measures used would have been statistically significant.

Finally, the tests of the differences in correlations between anxiety and delay for low and high procrastinators do support the primary hypothesis, somewhat. For Essay One, there is a significant difference between low and high procrastinators for the correlation between anxiety and adjusted end time for Essay One. For Essay Two, there is a significant difference between low and high procrastinators for the correlations between anxiety and median work time, modal work time, and adjusted end time.

Supplemental Analyses. As a final note, there are some subtle patterns worth commenting on as well. For a visual comparison, graphs of the relationship between anxiety and delay have been produced for students adjusted start time, their mean work time, their adjusted end time and also their essay submission times for both Essay One (Figure 8) and Essay Two (Figure 9). One feature worth noting in both the correlation table and the graphs is that the relationship between anxiety and delay does not change much for high procrastinators over the course of the two essays. Low procrastinators,

Figure 8

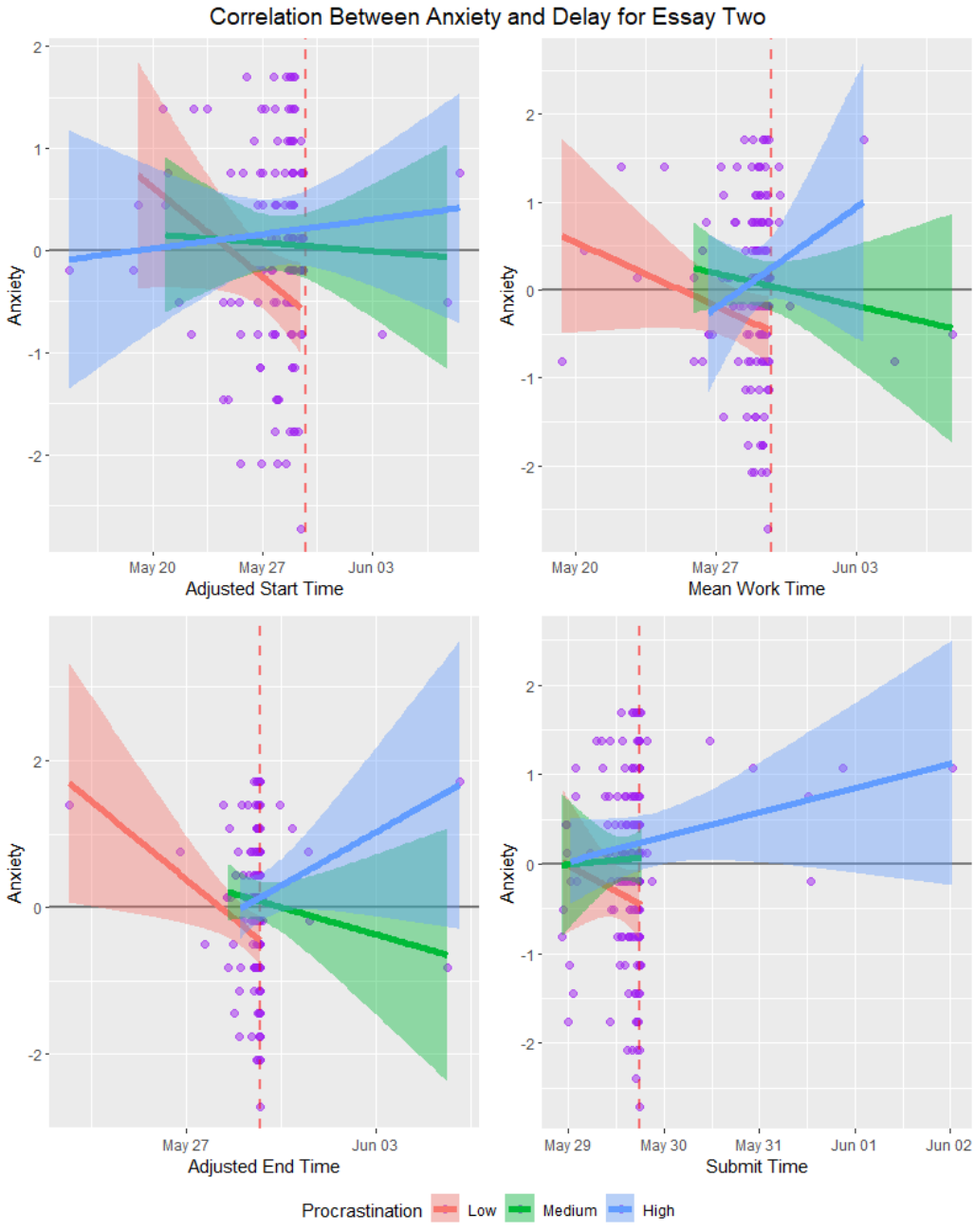
Relationship Between Anxiety and Delay for Essay One Split by Procrastination Level



***Note*:** The shaded area around each line represents the 95% confidence interval of the estimate

Figure 9

Relationship Between Anxiety and Delay for Essay Two by Procrastination Level



***Note*:** The shaded area around each line represents the 95% confidence interval of the estimate

however, show a slow change in the correlations over the course of the two essays, starting with a weak positive correlation at the start of Essay One, and ending with a statistically significant negative correlation at the end of Essay Two. This pattern is worth commenting on because patterns of slow change across time in the strength of the relationship between anxiety and delay do appear elsewhere in the literature (e.g. Steel et al., 2001), suggesting that there may be hidden longitudinal aspects to the relationship between anxiety and delay that have not yet been explored in detail.

This cannot be stated for certain, since in the present analysis it is a found pattern and not a hypothesized one. However, in the interests of exploring it further, one final graph was produced that shows the correlations for each of the three groups in Table 4 arranged ordinally. Trend lines for each of the three groups have been graphed as well. The results, which can be seen in Figure 10, suggest that the correlations for the three groups diverge as time passes.

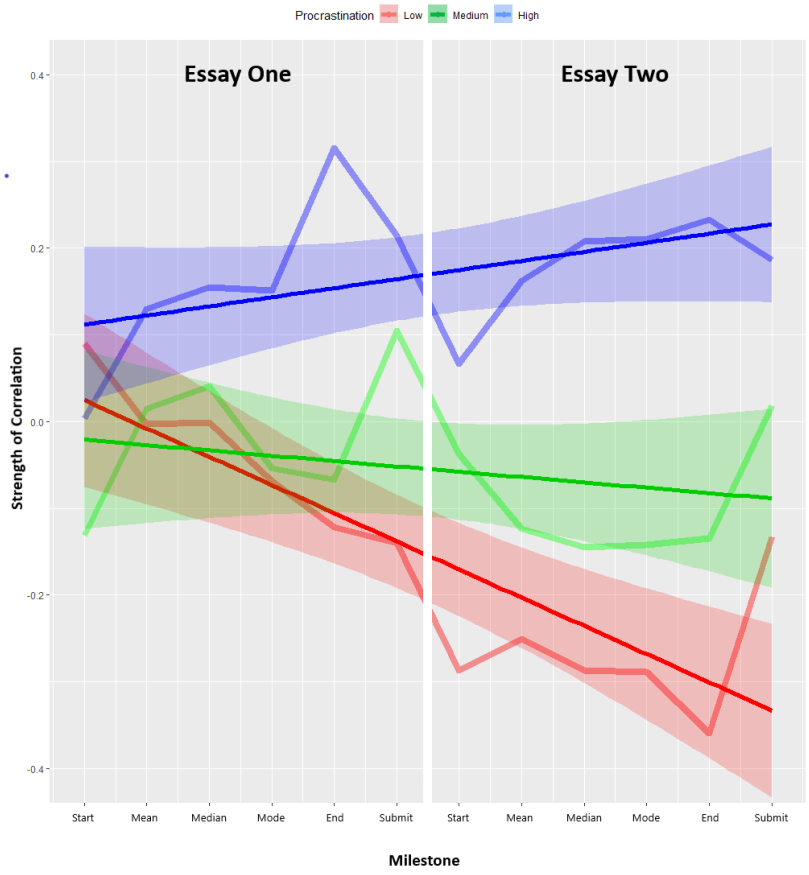
In all, the findings from the summary metrics support the hypothesis that the sample consists of a spectrum of participants, ranging from those who respond to anxiety by working earlier to those who respond to anxiety by working later. However, this pattern is qualified by the fact that it tends to show up later in each essay, and the fact that it is stronger and more consistent in the second essay.

Timeline Metrics

The second hypothesis was that anxiety would be differentially associated with students' work across time. To explore this, the proportion of work students completed

Figure 10

Graph of Relationship Between Anxiety and Summary Metrics, Arranged Temporally



Note: Shaded regions represent standard error of the trend line, not of the individual correlations

for each hour of the two weeks leading up to the deadline of each essay was calculated, and the hour-by-hour results were correlated with students' anxiety scores. The resulting graph of the timeline of correlations, for both Essay One and Essay Two, can be seen in Figure 11. The same process was then repeated for each sub-group of students (i.e. low, medium and high procrastinators), and the correlations were graphed along with their

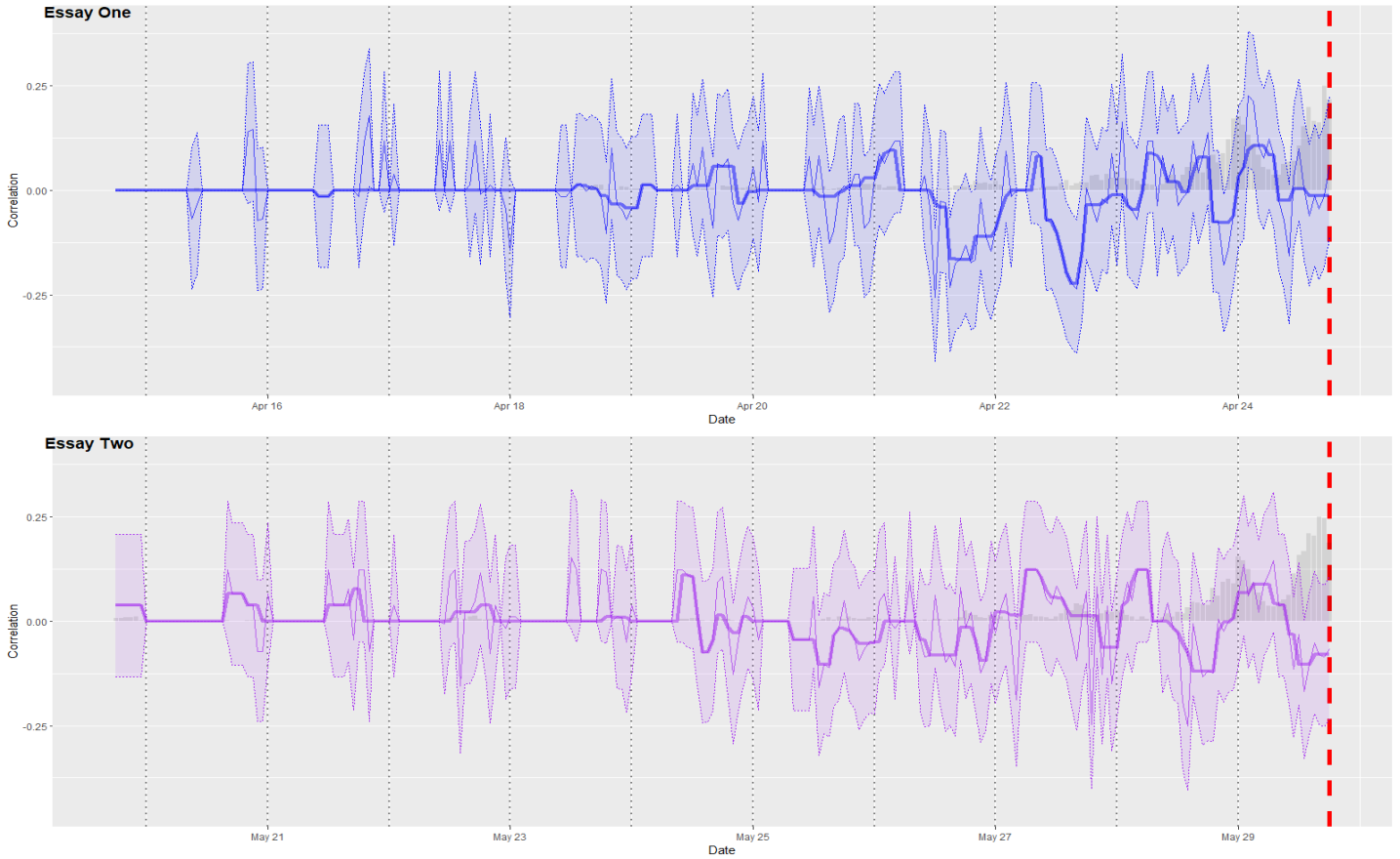
confidence intervals. The timeline of correlations for Essay One can be seen in Figure 12. The timeline of correlations for Essay Two can be seen in Figure 13.

Unfortunately, unlike the timeline analyses from the previous chapter, the timeline of correlations between anxiety and work in Figure 10 does not lend itself to an easy interpretation. The correlations between anxiety and delay across the timeline tend to be small and are only statistically significant in rare cases. There are some hints of a circadian pattern; to test this, the Pearson's *r* values from the timeline were correlated with the hour of the day, coded in military time (midnight = 0, 11pm = 23). There was a statistically significant relationship between time of day and the strength and magnitude of the correlation between anxiety and work; in the earlier hours of the day, anxiety correlated more strongly with the amount of work that students completed than it did in later hours of the day. This correlation was significant for both Essay One, $r(163) = -.240$, $p = .002$, and also for Essay Two, $r(150) = -.268$, $p < .001$.[25] Additionally, while none of the fluctuations are significantly different from zero, the timeline of correlations for Essay One and Essay Two do correlate with each other, $r(239) = .159$, $p = .013$. The correlation is weak but suggests some underlying cohesion in the pattern of students' work across essays. One notable difference between the two essays is that, for students' work on Essay Two, there appears to be a greater amount of work done earlier in the timeline, and this work shows a mild positive relationship with anxiety.

[25] Correlations were computed using only the data from hours where one or more students worked. Hours where no work was done at all were excluded from the analysis. An alternative approach is to treat such hours as having zero correlation with anxiety. When "empty" hours are coded this way, the circadian effect still appears; the relationship between hour-of-day and strength-of-correlation is statistically significant for both essays even though the overall magnitude of the correlation is lower.

Figure 11

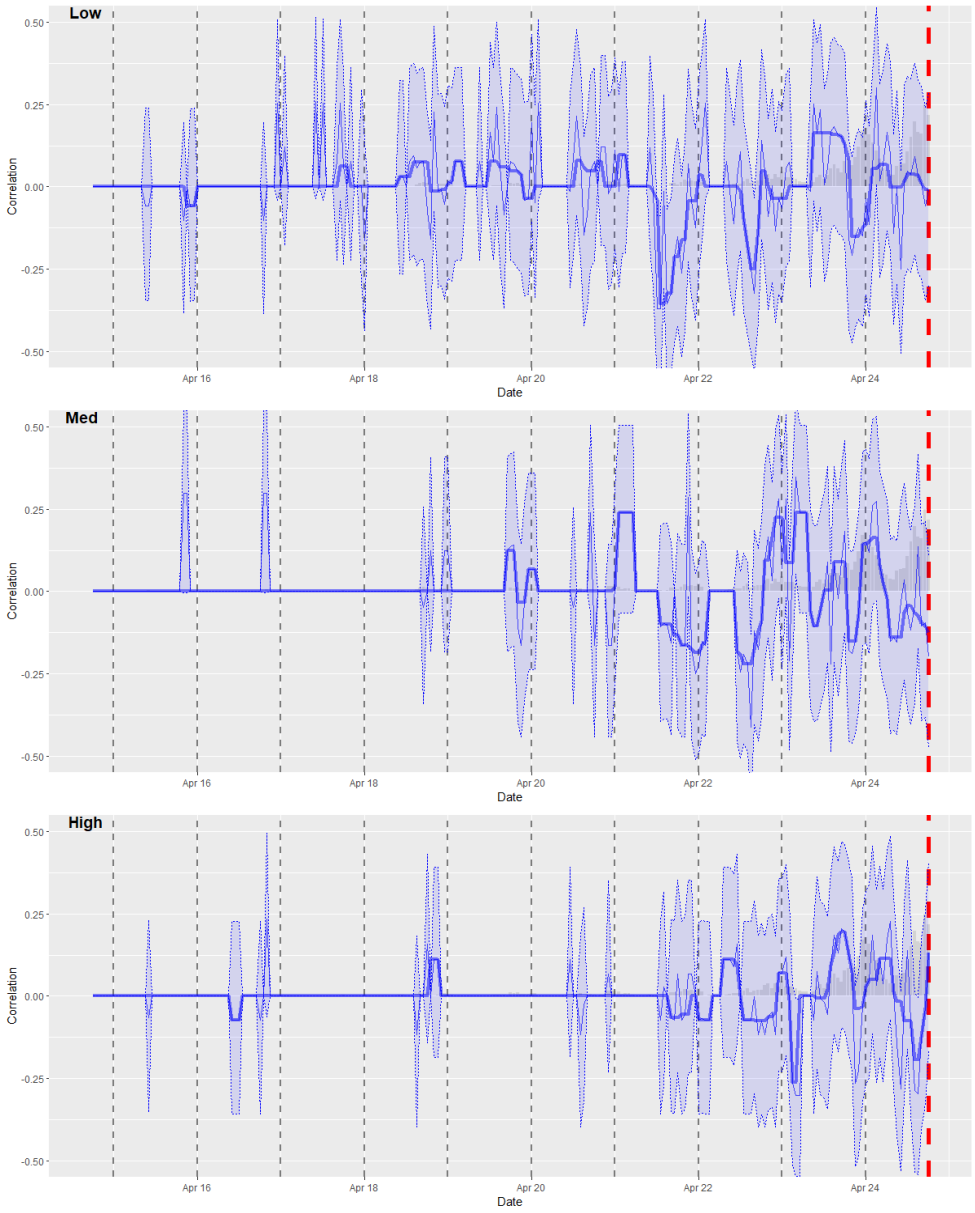
Timeline of Correlations Between Anxiety and Work for Essay One and Essay Two (Full Sample)



***Note*:** Timepoints with a correlation of zero and no accompanying error bar represent times when no students were working.

Figure 12

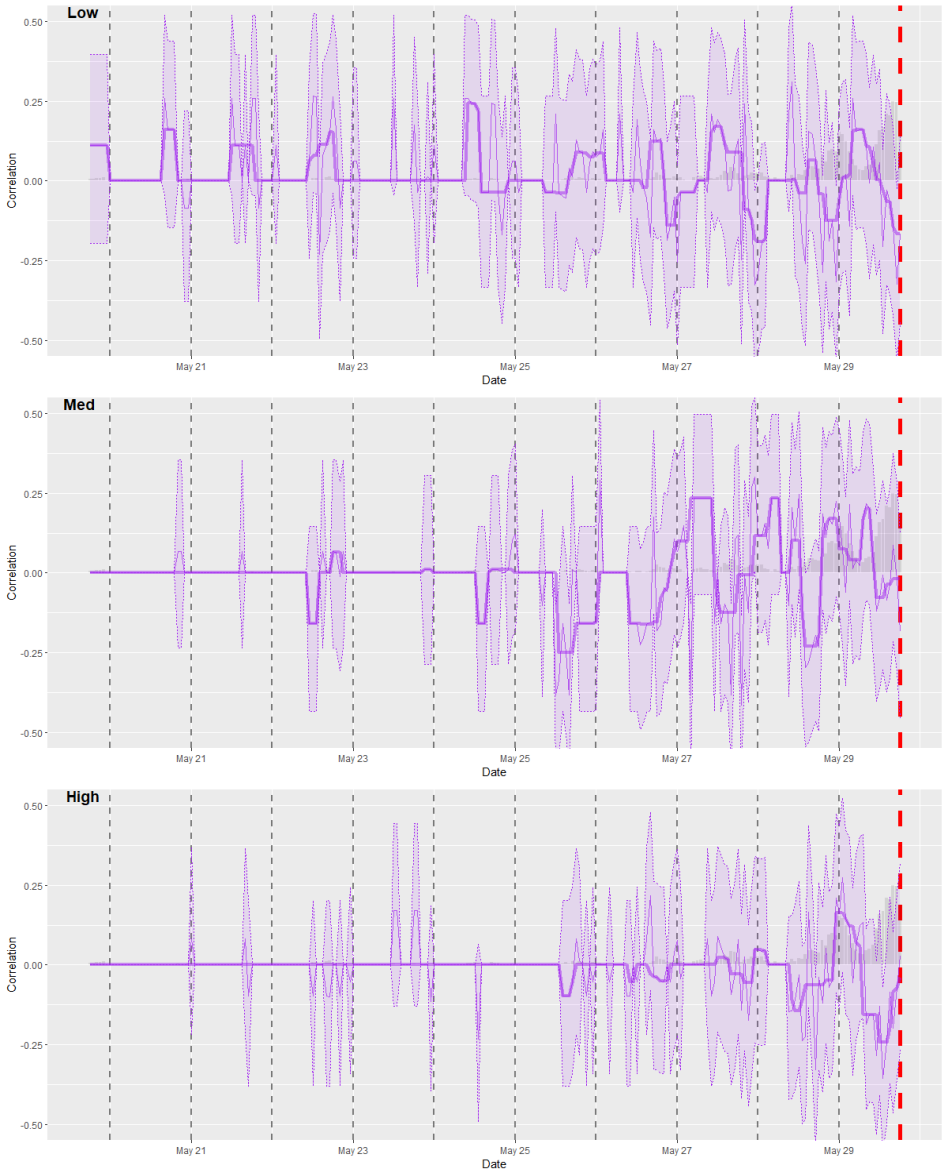
Timeline of Correlations Between Anxiety and Work for Essay One (Split by Procrastination Level)



Note: Points on the graph with a correlation of zero and no accompanying error bar represent times when no students were working.

Figure 13

Timeline of Correlations Between Anxiety and Work for Essay Two (Split by Procrastination Level)



Note: Points on the graph with a correlation of zero and no accompanying error bar represent times when no students were working.

Once the students are broken into groups by their level of procrastination, more substantive trends in the timelines begin to emerge. Anxiety correlates positively with work at some points on the timeline, and negatively at others. These correlations do not appear to be random, either; in Essay One, most of the work completed more than three days before the deadline tends to correlate positively with trait anxiety; it is only within the last few days that there are segments of student work that show strong negative correlations with trait anxiety. This trend is exacerbated in Essay Two; there appears to be a greater amount of work done by students well before the deadline, and this work tends to correlate positively with levels of anxiety. The one notable exception to this is the medium-procrastination group as they worked on Essay Two, whose earlier work correlates negatively with levels of anxiety, and it is not known why this case is discrepant from the general trend.

A final note that should be made regarding these graphs is that high, medium, and low procrastinators all have markedly different ranges of work on the timelines for Essay One and Essay Two. These ranges are exactly what a commonsense understanding of procrastination would predict; high procrastinators tend to work close to the deadline and low procrastinators tend to have a much wider range, with at least a small proportion working well before the deadline. The deadline itself appears to be a highly volatile time period in terms of the correlation between anxiety and work; if anything can be said at all, it is that high-anxious and low-anxious students all seem to be working around that time, and the most notable differentiation between them appears to be the time of day that they prefer to work, following (roughly) the circadian pattern identified earlier. However,

low procrastinators show evidence of work well before the deadline on both Essay One and Essay Two and this work shows a consistent positive association with anxiety levels in both essays.

Integral Metrics

The third hypothesis was that there would be a window of time close to the deadline where trait anxiety correlates positively with the amount of work completed for low procrastinators and negatively with the amount of work completed for high procrastinators. To test this, integral graphs were constructed for the relationship between anxiety and cumulative work for both Essay One and Essay Two for the full sample of students, along with graphs of the first-order derivative of the integral analysis. The graphs can be seen in Figure 14 and Figure 15. The sample was then broken into groups of low, medium, and high procrastinators and a series of comparative graphs for the three groups were created. The comparative integral graphs for the three groups for Essay One can be seen in Figure 16, and the graphs of their associated first order derivatives can be seen in Figure 17. The corresponding graphs for Essay Two can be seen in Figure 18 and Figure 19.

Unfortunately, the results of the integral analysis offered little support for the third hypothesis, with the caveat that this is primarily because they are not interpretable for anxiety in the same way that they were for procrastination. Unlike procrastination there does not appear to be a simple relationship between anxiety and work such that one period is “anxiety relevant” and some other period is not. One possibility is that the integral graph was conducted incorrectly; it may be that the appropriate way to integrate

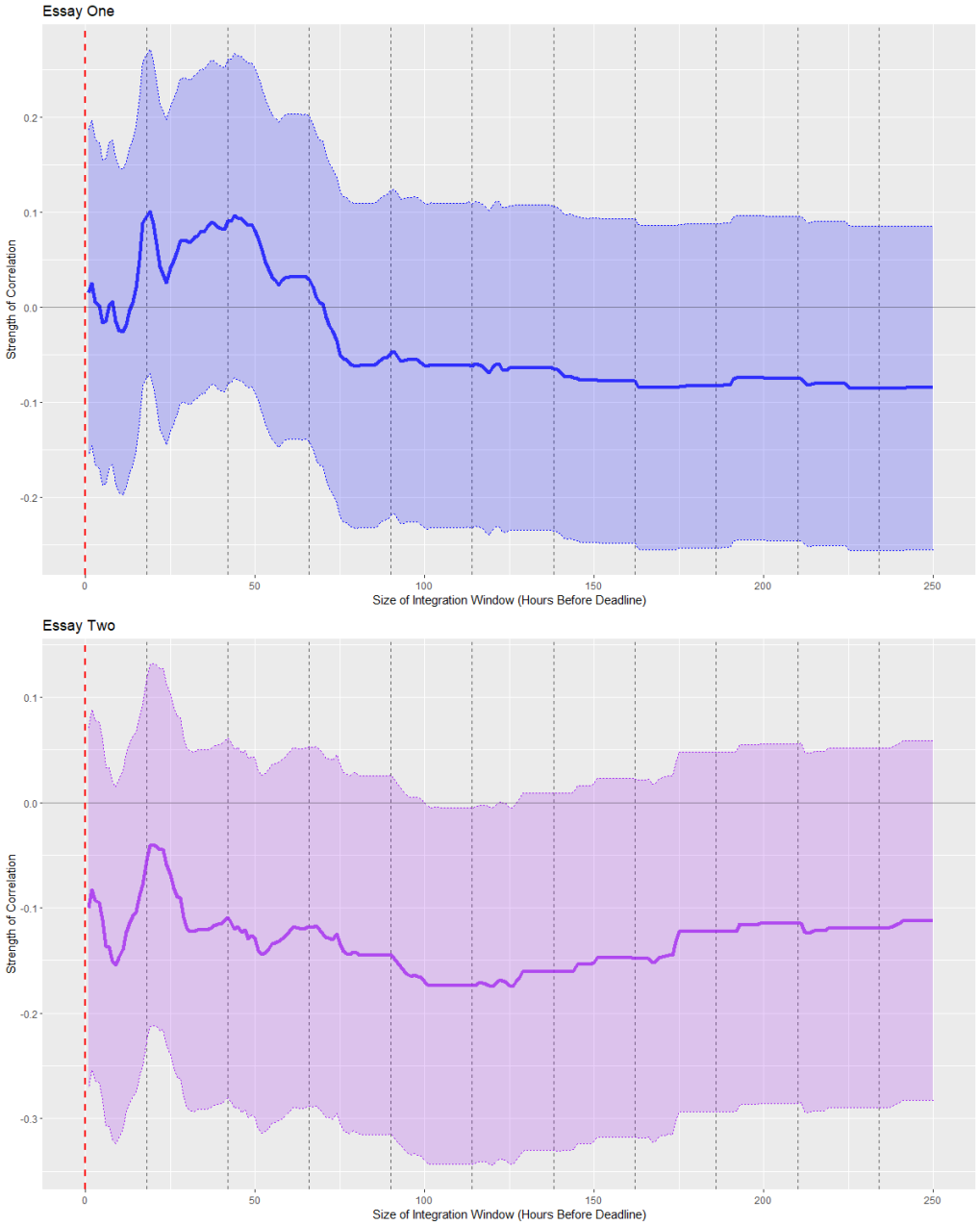
the timeline when dealing with anxiety would be to start from the time the essay is assigned, rather than starting from the deadline and working backwards. However, even in this case, the integral graph suggests that the results would still be difficult to interpret.

This difficulty of interpretation is present when the sample is broken into high, medium, and low procrastination groups as well. The only consistent feature in the integral analysis for the separate groups is that earlier work times tend to correlate positively with anxiety while the period of time closer to the deadline tends to exhibit rhythmic fluctuations, vacillating between positive and negative correlations with work. This is primarily noticeable for the low procrastination group; the trend is much less clear for the medium and high procrastination groups, but this is largely because for those two groups most work is done close to the deadline.

The only consistent conclusions that can be extracted from the timeline and integral analyses in conjunction with each other is that the relationship between anxiety and work has a circadian component, and there appears to be a relatively small group of low procrastinators who work well ahead of the deadline, and these people are marked by higher levels of anxiety. The amount of work accomplished more than three days before the deadline for each essay, however, is very small. Perhaps the best thing that can be said from the present analyses is that if a self-motivated person has managed to do a substantive portion of one of their term papers more than four days before the deadline, they are part of a rare breed.

Figure 14

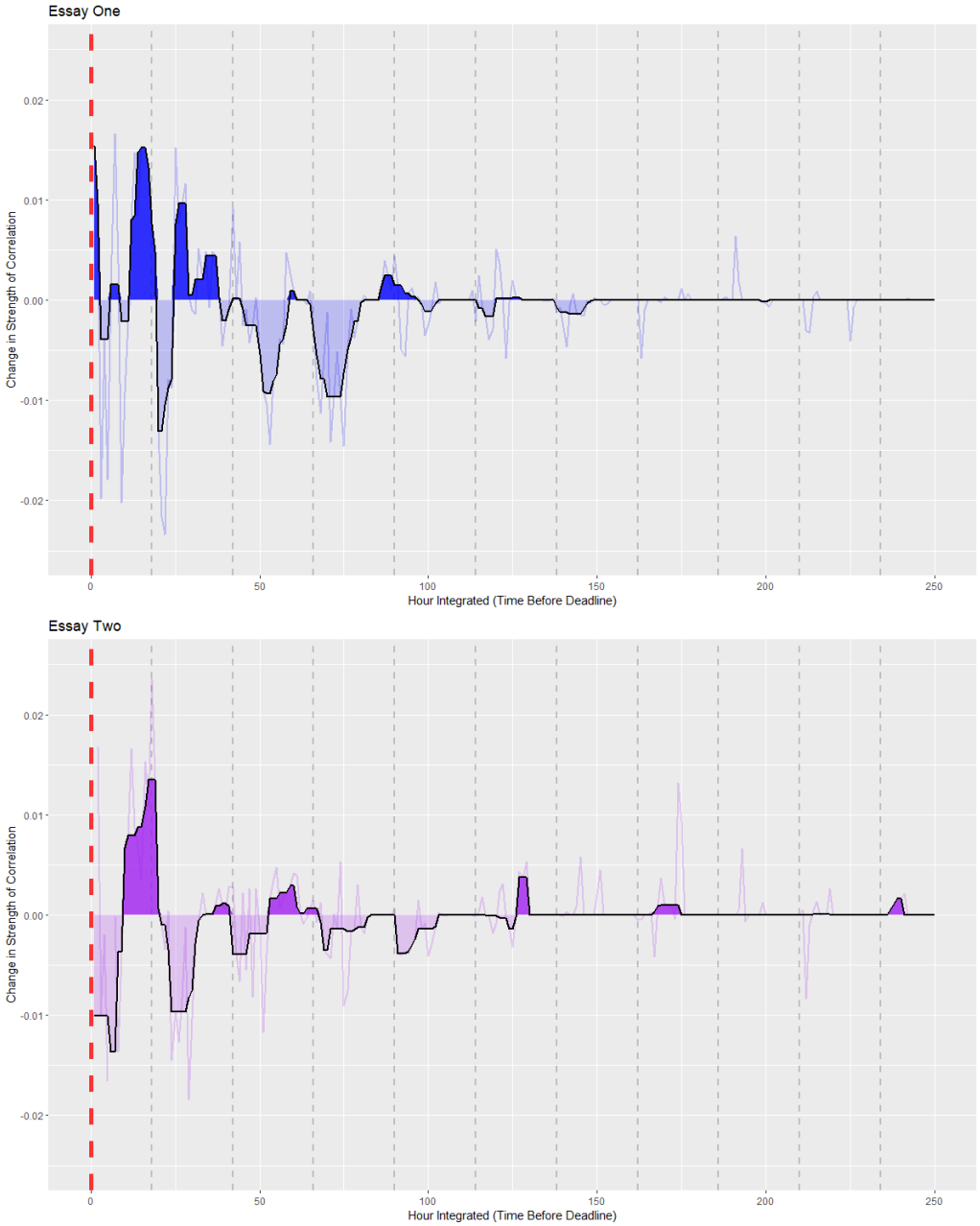
Integral Graph for Essay One and Essay Two (Full Sample)



Note: Shaded regions represent the area 1.96 *SD* above and below the correlation

Figure 15

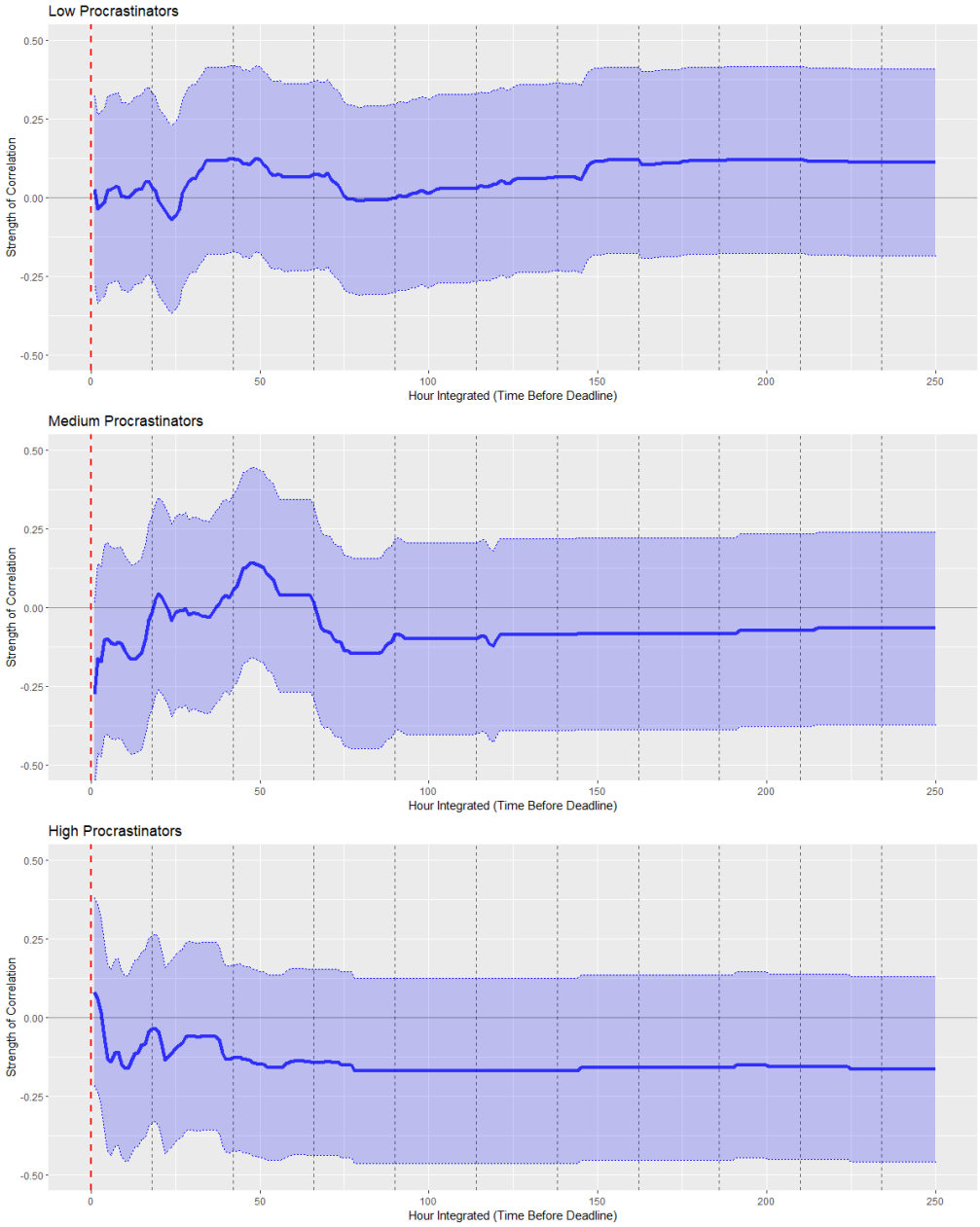
Graph of First Order Derivative of Integral for Essay One and Essay Two (Full Sample)



Note: Solid black line represents smoothed trend; the actual increase and decrease in the integral for any particular hour is represented by the faint line, which was de-emphasized for visual clarity

Figure 16

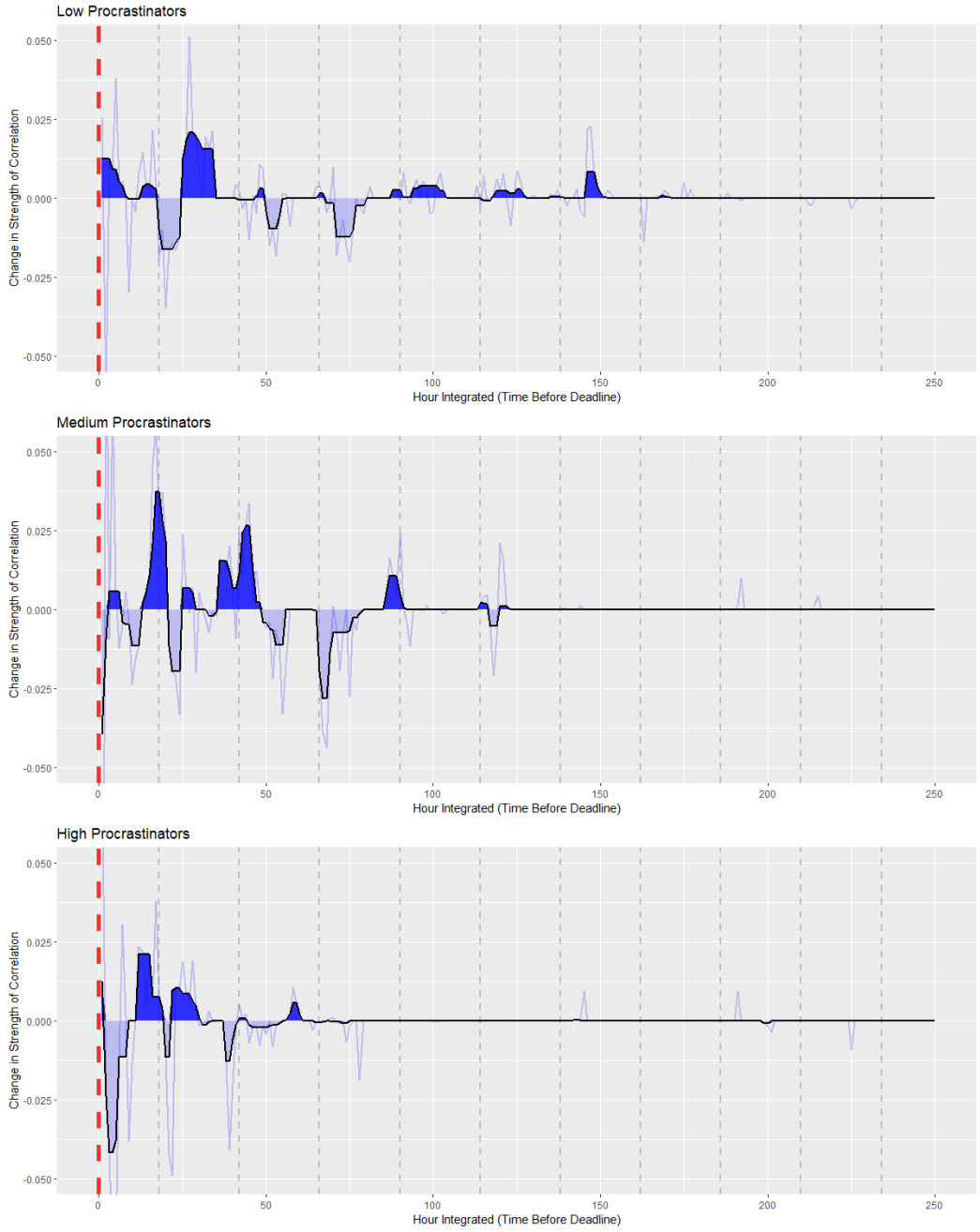
Integral Graph for Essay One (Split by Procrastination Level)



Note: Shaded regions represent the area 1.96 *SD* above and below the correlation

Figure 17

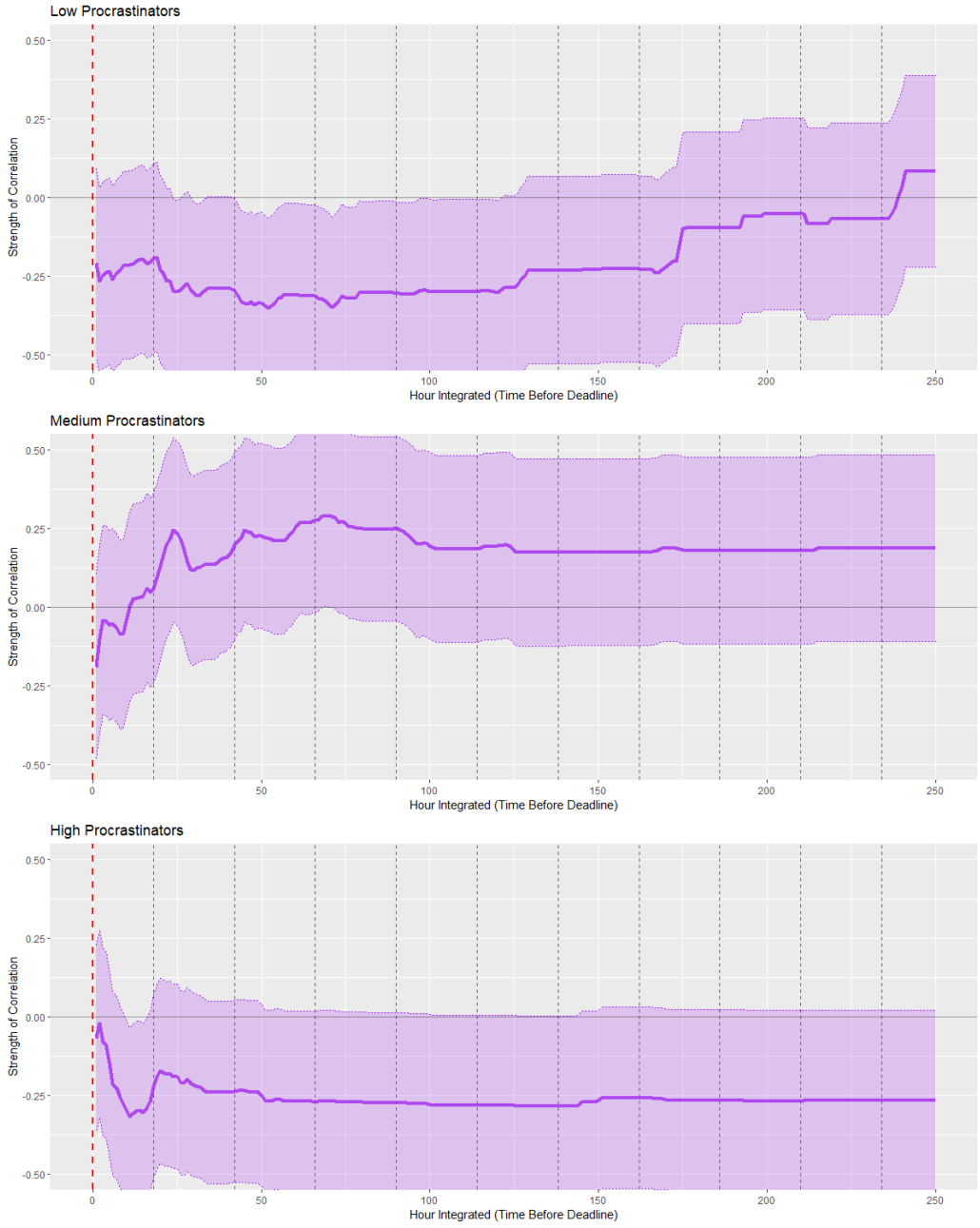
Graph of First Order Derivative of Integral for Essay One (Split by Procrastination Level)



Note: Solid black line represents smoothed trend; the actual increase and decrease in the integral for any particular hour is represented by the faint line, which was de-emphasized for visual clarity

Figure 18

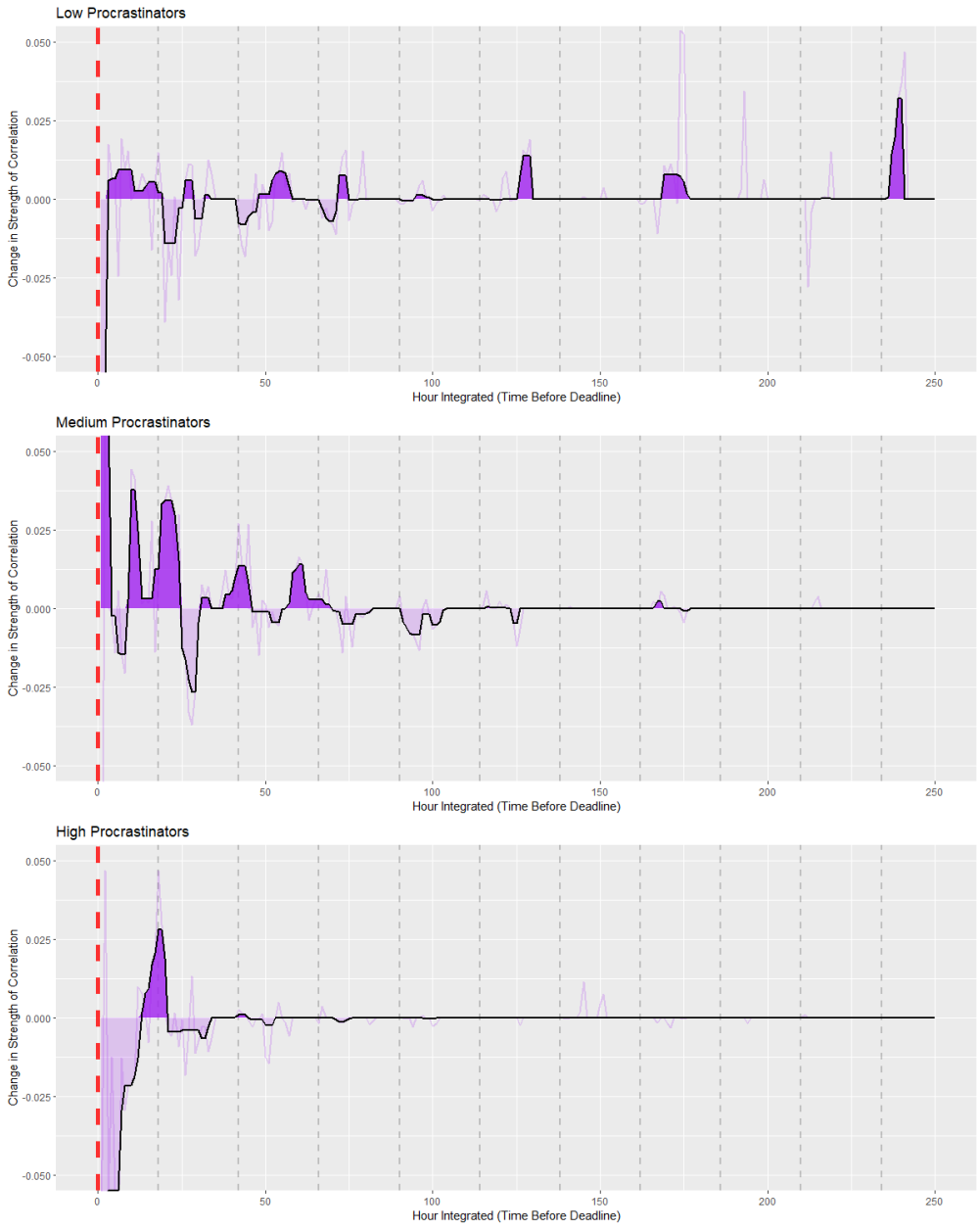
Integral Graph for Essay Two (Split by Procrastination Level)



Note: Shaded regions represent the area 1.96 *SD* above and below the correlation

Figure 19

Graph of First Order Derivative of Integral for Essay Two (Split by Procrastination Level)



Note: Solid black line represents smoothed trend; the actual increase and decrease in the integral for any particular hour is represented by the faint line, which was de-emphasized for visual clarity

Discussion

Interpretation

A basic interpretation of these findings is that anxiety does not simply cause delay. Rather, as Steel (2007) suggested, anxiety and procrastination have a more complicated relationship. Procrastination denotes a trait disposition to shift things later in time when presented with conflict. One can think of it as a decisional style for how one tends to "solve" the problem of dealing with the feeling of being overwhelmed, and this notion is consistent with other recent research that demonstrates that procrastinators tend to prefer delay as a solution across a wide range of behaviors (Svartdal et al., 2020). Meanwhile, while procrastinators tend to solve work conflicts by delaying, non-procrastinators tend to solve similar conflicts by tackling their work earlier in time.

In the analyses for this chapter, the first piece of evidence for this hypothesis is the difference in correlations between anxiety and delay for low and high procrastinators; consistent with theory, high procrastinators tended to show a positive relationship between anxiety and delay across both essays, while low procrastinators tended to show a negative relationship between anxiety and delay. The difference between the two groups was statistically significant for the measures of students' adjusted end times for Essay One, and across multiple measures for Essay Two. Unfortunately, the results of the timeline analyses and integral analyses were not as easy to interpret as the correlations between anxiety and the simple summary metrics for the two essays. However, a visual inspection of the timelines for the two essays does suggest that work done more than three days before the deadline tends to correlate positively with anxiety; the graph is

much noisier as the deadline approaches, but for most of Essay One and Essay Two, negative correlations between anxiety and work tend to happen in the three days preceding the deadline.

The question remains of how to interpret this data. Trait anxiety and state anxiety are not the same thing, so it is not a simple matter of saying that anxiety causes more work at certain times and causes less work at other times. A better way to phrase it is using the language of individual differences; more than three days before the deadline, the balance of the work being done seems to shift in favor of those who are predisposed to being anxious. Both the anxious and the non-anxious are working and the balance between the two of them seems to oscillate with the time of day, although the pattern is chaotic and does not adhere closely to a circadian pattern.

One way to explain this may be to borrow the language of "cognitive load" used to describe motives for precrastination by Rosenbaum et al., (2019). This has parallels in the literature on procrastination, as well, where it is commonly assumed that one of the reasons that people procrastinate is that it serves the purpose of mood repair (Sirois & Pychyl, 2013). While the language differs in each case, the general principle appears to be similar; work taxes the brain both emotionally and in terms of the raw mental effort it demands. Trait anxiety may modulate students' responsiveness to the aversiveness of work, functioning as a sort of threshold variable that determines the level of conflict a person can handle before they feel pressured into addressing it. Those who are low in trait anxiety apparently can handle the pressure of doing a large amount of work close to the deadline and so they do not feel like they have a particular need to "solve" the problem

by arranging things temporally. For that reason, people low in trait anxiety tend to work closer to the deadline whether they are procrastinators or not. People higher in trait anxiety tend to polarize to the extremes, working either earlier or later as their disposition inclines them.

This does not explain everything. For example, the data for the second essay supports this explanation, but the data for the first does not offer the same support. One possible reason for this could be the uncertainty inherent in the first essay; without prior experience, and with too many unknown variables—that is, without knowledge of the teacher's expectations, or the steps they have to take, or how their schedule is going to work out for the quarter, and so on—students' patterns of response are likely more chaotic and less coherent. By the later half of the quarter (and the second essay), however, students are familiar with the process, and they approach the second essay with a strategy that is congruent with their personality. This was demonstrated by graphing the correlations between anxiety and the summary metrics of student work ordinally for each of the essays. There appears to be a general trend of polarization in the correlations, with the correlation between anxiety and delay growing more positive for procrastinators, and more negative for non-procrastinators.

Alternative Explanations. Earlier in this chapter, three possible explanations were offered for why researchers have not found a strong relationship between anxiety and delay. The analyses conducted in this chapter focused on one of the possible reasons, hypothesizing that there were individual differences between students in terms of how they respond to anxiety, with some students who respond to anxiety by working early

while others respond by working later. On balance, this hypothesis appears to have been supported, though it is necessary first to demonstrate that the patterns found here replicate in other samples and contexts before any conclusive statements about individual differences can be made.

It is worth taking a moment, however, to revisit the other two possible explanations for the depressed correlations that researchers typically find between anxiety and delay. One of the explanations advanced was that researchers were examining the wrong phase of student work; most studies focus on the time that assignments were started or submitted, and only one of the studies found for the meta-analysis used a summary metric that took into account the full range of students' work (see Steel et al., 2018). The evidence in the present study offers some support for this hypothesis; notably, students' start times and their essay submission times tend to break pattern from the other summary metrics used, and are often weaker. This is consistent with research from Svartdal et al. (2020) that suggests that the phases of projects are distinct from each other and often correlate differentially with procrastination. While Svartdal and colleagues explored this using self-report methodologies, the same principle seems to apply when using objective temporal measures of delay.

The other explanation was that the relationship between anxiety and delay may show cumulative effects that compound over time. The trend lines of the correlations for high, medium, and low procrastinators in Figure 10 strongly suggests that this is the case, with a twist; the cumulative effects are different across the three groups, with the relationship between anxiety and procrastination growing more positive across time for

procrastinators, and more negative across time for non-procrastinators. Even more interesting, the general trend in the correlations for low procrastinators is stronger than it is for medium or high procrastinators. This suggests that low procrastinators make a greater change in their behavior in the time between the first and second essays; this makes intuitive sense, if only because low procrastinators have more room to make a change. There is a great deal of time before the deadline for low procrastinators to spread their work out if they want to complete a paper early, but high procrastinators can only delay their work so much before they incur late penalties.

Limitations

There are a few notable limitations with this study that should be kept in mind when interpreting the results, and also when designing similar studies in the future. The first one is a matter of sample size. While the number of participants in the study was sufficient for hypothesis testing that utilized the full sample students, splitting the students into three separate groups based on their levels of self-reported procrastination ultimately resulted in sample sizes that were too small to make conclusive comparisons between groups. As a result, many of the conclusions in the current chapter should be taken with some reservation. This is especially true because of the nature of the data; the vast majority of students in the current sample worked on their essay close to the deadline. The group that put in work prior to the last three days was only a very small proportion of participants, as was the group that worked on their essay after the deadline. This is similar to the distribution of students' submission times on various assignments

noted by Beswick et al. (1988), with the vast majority of students turning in assignments close to the deadline, and only a small portion turning them in early or late.

The sparse data, coupled with the distribution, has a couple of effects that should be kept in mind when interpreting the results. The simplest is the inflation of standard error in hypothesis tests, rendering the data more difficult to interpret. The second, and more complex issue, is that the results of many of the analyses are unbalanced because the majority of cases are within close temporal proximity to the deadline. For example, the correlation between anxiety and students' start times has a great many values that are close to the deadline and only a few that are farther away. If a researcher were to estimate the mean anxiety level of students who started their essay early in the timeline they would have a very small number of cases to draw from and new cases could cause the mean to shift substantially. Conversely, if they were to estimate the mean anxiety level of students who started their essay the day before the deadline the resulting calculations would include the bulk of the available sample, giving the researcher a very precise estimate that would likely not be influenced by additional cases. The degree to which this influences some of the results, including the correlation tests, is unknown. Future research studies can address this limitation by employing multilevel modeling techniques that allow for a simultaneous test of the full sample, as well as by employing meta-analytic techniques that aggregate the results of several waves of data collection.

A second limitation is that there are only two essays in the present study. This introduces a confound; while some of the explanations advanced in this chapter assume that the effects of time and repetition influenced students' ability to respond to the second

essay, allowing them to return to it with a more planful approach to dealing with the stress of writing (therefore exacerbating their tendencies either as procrastinators or non-procrastinators), this cannot be known for sure. It could be some other property of the essay or the class that changed in that same timeframe. While the instructions for the two essays were identical, many other things may have changed in the month between the first and second essay deadlines. Future studies should first focus on replicating the results of the present study to verify that the temporal patterns identified here (such as a greater number of students working early during the second essay) replicate. Once that has been established, more creative experimental designs should be employed to start testing hypotheses regarding the source of the changes. Future studies, for example, might consider the role of uncertainty and the ways in which it changes from one essay to the next, and whether this influences anxiety and delay behavior.

A final limitation of this study, and perhaps the reason that the results of the timeline and integral analyses were inconsistent and difficult to interpret, is that the study focused on self-reported trait anxiety, rather than looking at state anxiety. State anxiety has a fairly straightforward interpretation; if a person indicates that they were high in state anxiety during a certain time frame then it is reasonable to interpret that to mean that they were experiencing some sort of physiological arousal or irritation coupled with some cognitive manifestation of anxiety such as worrying or rumination. For those who assert that anxiety causes procrastination, it is often state anxiety that they are referring to when they say that the anxiety is a source of distraction that prevents a student from working. Of the researchers that have studied anxiety and work delay, few have looked at state

anxiety, but those who have examined it have found relationships between the two (see Senecal, Lavoie & Koestner, 1997; Tice & Baumeister, 1997; also see Estes and Skinner, 1941, for a conceptual parallel using mice instead of humans).

Measures of trait anxiety are less certain because they do not indicate the presence of state anxiety, but rather the propensity for experiencing it, as well as a cluster of other related tendencies and behaviors that occur alongside the tendency to be anxious. Interpreting the relationship between trait anxiety and delay, then, is not a simple matter of suggesting that a person is experiencing aversive states that compel them to behave a certain way. A person who rates low on trait anxiety likely still experiences anxiety as a deadline approaches. However, they may not experience it as often, or experience it as far in advance of the deadline as someone who is high in trait anxiety. Similarly, they may not experience the same amount of anxiety. A person who is low in trait anxiety may experience enough anxiety at the correct moment in time to motivate themselves to work under deadline pressure, while a person who is high in trait anxiety may experience too much anxiety to focus and therefore decide to shift their work to a different point in time, either forward (for procrastinators) or backward (for non-procrastinators).

However, all of these are simply hypotheses and speculation; since the present study did not consider state anxiety, but looked at trait anxiety instead, there is little information to determine exactly what participants felt, and when. Rather, their affective state must be inferred, and any conclusive description of students' affective experiences while working on their essays must be relegated to future studies.

Future Directions

The literature on procrastination has long hinted at the fact that students can be split into procrastinators and non-procrastinators; Tice and Baumeister (1997) had students self-select into different groups based on their procrastination tendencies and showed that the two groups experienced anxiety at different times throughout the academic term, with non-procrastinators experiencing more anxiety earlier, and procrastinators experiencing more anxiety later. Based on this alone it should have been possible for researchers to infer that procrastinators and non-procrastinators experience anxiety in ways that would tend to depress the correlation between anxiety and delay if these group differences are not accounted for.

This speaks to a need to expand research on procrastination so that it addresses the presence of people who show a fundamentally different pattern of temporal behavior regarding work. Rosenbaum et al. (2019) have referred to these people as precrastinators, while researchers such as Tice and Baumesiter (1997) have simply referred to them as non-procrastinators. The term *precrastination*, suggested by Rosenbaum et al. (2019), is likely more accurate in some situations because it implies that procrastination is a bipolar phenomenon rather than a unipolar one. Low procrastinators do not simply remain unaffected by anxiety, performing their chosen behaviors with equanimous diligence. Instead, at least some of them appear to be affected by anxiety in a way that is exactly opposite to the way that procrastinators are affected.

One problem with procrastination research is that the theories guiding the psychological understanding of procrastination were not built on this nuanced

understanding of anxiety as a construct that is easily moderated by external factors. This may be due, in part, to procrastination's long-standing association with the clinical tradition (e.g., Ellis & Knaus, 1977). The door to the therapist's office is a powerful filter when it comes to psychological phenomena, especially when dealing with nebulous emotions such as anxiety that can be resolved in multiple ways. Those who walk into the therapists' office for help with procrastination are likely part of a specific subgroup of the population that respond to work stressors maladaptively. Clinically grounded theories of the relationship between procrastination and anxiety that are built on top of counseling practice would, of necessity, be based on interactions with patients for whom anxiety triggers maladaptive behavior, rather than those for whom it triggers more adaptive behaviors.

This filtering effect appears to have influenced clinicians' understanding of the relationship between anxiety and delay, and if that is the case, then it subsequently may have shaped the influential theories of procrastination advanced by clinical psychologists such as Ellis and Knaus (1977). Researchers who study these theories might take away from them the impression that the relationship between procrastination and anxiety is simple and linear. When presented with behavioral evidence that shows little support for a linear relationship, the same researchers might reasonably contrast their evidence with the assertions of a simple causal relationship advanced by clinical psychologists and decide that the evidence does not support their assertion. After all, the close interaction with patients that thoughtful clinicians use as evidence to build their understanding of problems like procrastination is not the same as the empirical evidence demanded by

researchers. When faced with the absence of a quantifiable relationship between anxiety and delay, it is understandable that researchers might simply decide that clinicians are wrong. The other option—that clinicians might be correctly perceiving a simple linear relationship between anxiety and delay in a convenience sample that is biased by the parameters of their occupation, and that this bias disappears when researchers look at a normal class of students—is wilder. However, it is congruent with the current findings.

As a final note, this has some important implications for researchers who are seeking to model delay. It seems evident now that the relationship between procrastination and anxiety unfolds across at least two levels. At the first level, there are variables that determine whether somebody is classified as a procrastinator or a non-procrastinator (or, alternatively, a precrastinator). At the second level, there are variables that determine to what degree individuals in each of these groups will respond to certain situations with a tendency to delay. The existence of these two levels implies strongly that the most appropriate way to model the relationship between delay and variables such as anxiety (and likely many others) is with multilevel modeling techniques that can account for both levels simultaneously. This was not considered at the outset of this dissertation, but in retrospect it seems clearly warranted.

In the absence of complex multilevel modeling techniques, however, how should researchers proceed? One relatively simple procedure would be to mimic the approach used in this chapter, of dividing participants into multiple groups based upon their self-reported procrastination, and then modeling the relationship between delay and whatever variables that the researcher is interested in for each group. This technique is particularly

sensible when one considers that participants who rank themselves high or low on a procrastination scale are providing valuable information to the researcher by announcing that they react either maladaptively or adaptively to work pressure. It makes sense, then, for researchers to hypothesize that individuals at either end of the procrastination spectrum may react to well-known constructs in diametrically opposed ways.

Chapter Five: Possible Futures

Introduction

The Noonday Demon

Writing in the early 5th century A.D., St. John Cassian, a cenobitic monk, created a taxonomy of eight evil thoughts that beset young brethren new to the monastery, distracting them from their contemplative duties. Cassian labeled the sixth evil thought *acedia*, which Cassian defined as a sort of weariness or distress. The term he drew upon was an old Greek word, *akhidi'a*, which implied a lack of care or pain (Merriam-Webster, n.d.). A more modern equivalent might be the word *indolence*, or better still, the phrase "can't be bothered." Over the years the concept fused with other terms and took on the name of *sloth*, one of the seven deadly sins. More recently, it has been associated with depression.[26] However, Cassian's description of *acedia* is remarkably familiar to the modern procrastinator; it describes a state that looks almost nothing like the laziness associated with sloth, and that is far different from the deep pain and crushing anhedonia that modern therapists and researchers associate with depression.

Cassian's *acedia* is best described as a deep listlessness. In his description (see Cassian, 2015), a monk caught up in the throes of *acedia* might find themselves feeling deep emotions of contempt and disgust for their cell and, indeed, their whole life. They might find themselves pacing restlessly around the courtyard, glancing up at the sun and wondering why it seemed to move so slowly. They might deceive themselves into believing that the remedy for their state was socializing with other monks or with the locals who often came to them for counsel and aid. They might despair that they were on

[26] Andrew Solomon's The Noonday Demon, one of the definitive treatments of depression and a finalist for the 2002 Pulitzer prize for general nonfiction, took its title from Cassian's description of acedia. (see Solomon, 2002)

the wrong path, or that all their work and effort would ultimately be for nothing. They might wrestle with a deep confusion about what they should be doing, somewhat akin to brain-fog. One common sentiment among the afflicted was the belief that if only they could go someplace better—to another monastery, perhaps—they would once again feel like they could make progress with their meditations. Whatever they did, the one thing they were sure to avoid was the simple work that they *ought* to be doing, which was sitting in their cell in quiet contemplation. By all accounts, Cassian's *acedia* appears to match modern descriptions of the procrastinator's struggle. One of Cassian's main contributions to the understanding of such behavior was to identify its circadian nature; he noted that it typically struck monks at around noon, and accordingly borrowed from an old proverb, referring to it as the noonday demon.[27] Cassian's proposed remedy for a monk wrestling with the demon was hard physical labor (Cassian, 2015).[28]

But why talk about old sins? The historic treatment of acedia is noteworthy because it illustrates a chief problem with the interpretation of pathologies such as anxiety and depression in relation to procrastination. Historically, procrastination has been treated as a dumping ground for a heap of convenient psychological motives. Later treatments of *acedia* fused Cassian's conceptualization with closely related concepts such as *tristitia* and *melancholia*, more commonly associated with sadness and despair, ultimately culminating in the wholesale assimilation of a cluster of interrelated neurotic

[27] A close glance at the timelines of correlations between anxiety and work in chapter four will show that the correlation between anxiety and work tends to decrease sharply at midday. This implies that those higher in trait anxiety suddenly stop working at around that time. Though this may be fanciful (and surely requires further research), it is entirely possible that the timeline graphs in Chapter Four have effectively captured the noonday demon in action.

[28] Given the well-established ability of hard exercise to lift mood, Cassian's advice seems prescient. Exercise for its own sake is a recent development, historically speaking. For an ancient monk a good aerobic workout may well have consisted of an hour of chopping wood.

constructs into the broader concept of *sloth*, (see Altschule, 1965). Sloth, itself, is a curious concept; while most of the classic deadly sins, such as lust, greed, envy, and wrath, are internally simple and mostly unchanging across time, sloth is complex and has evolved across the ages (Wenzel, 2017). It is an uneasy sin, subsuming the entirety of the many motivational issues underlying the inability to act. Across time, those who have referred to sloth have emphasized different aspects of it to suit their rhetorical purposes. As Wenzel noted, this shifting meaning eventually led to sloth becoming associated with simple laziness. Early understandings of *acedia*, however, hint at deep listlessness and boredom, ennui, despair—the full range of humans' internal experiences in the face of work that has lost its intrinsic meaning.

The multifaceted nature of sloth is important for two reasons. The first reason is that it shows that the neurotic cluster of character traits, including anxiety, depression, listlessness, volatility, and avoidance, has been a substantial aspect of the human struggle with work for millennia. Ancient monks and modern scholars alike have wrestled with the same noonday demon. The language describing the struggle has changed, and each generation sees new facets in it that reflect their own priorities, but the battle is the same.

The second reason sloth is important is that it highlights the moral implications of how procrastination is defined. Under some treatments, procrastination is thought to be a symptom of indolence, apathy, and laziness—classic sloth, in the simplistic sense that modern laypersons understand the concept. Under other treatments it is thought of as a symptom of depression, the result of either a deep anhedonia or an internal pain that leaves a person so preoccupied with the agony of their own inner experience that the

world outside can no longer rouse them to action. Cassian's treatment of *acedia* is more merciful; it is a restless agitation and a deep anxiety, a noonday demon that those who are otherwise deeply devoted to their chosen path must nonetheless wrestle with on a daily basis (Cassian, 2015).

Modern scientific understandings of procrastination no longer assign it moral implications, but the way that procrastination is construed is still of great importance because it has implications for how procrastination is to be addressed. For those in positions of authority, this construal also has implications for whether procrastinators should simply be treated as responsible for their actions, or culpable. If procrastination is laziness, then it should be punished. If procrastination is a form of depressed paralysis, then it requires treatment. If it is the product of someone who wants to work being forced to grapple with their own fears, anxieties, and internal volatility, then suddenly there are no simple answers.

The Present Dissertation

Pressfield (2002), in a well-received book about the challenges facing the modern artist, identified internal conflict as one of the greatest challenges to productivity. He went so far as to anthropomorphize it, labelling it *resistance,* and treated it as a phantom "other" that artists must struggle with in order to accomplish their aims. To the degree that resistance outwits them, the artist's work is delayed, sometimes indefinitely. Completely unaware of his connection to the monastic past, Pressfield effectively resurrected the noonday demon. The same entity that once tormented ancient monks also

torments modern sculptors, authors, poets, and anyone who wants to do a meaningful day's work.

It is not just authorities who must try to decide why people procrastinate; each procrastinating individual must work out for themselves the reason for their own delay. This sounds like a truism, but it is, in fact, immensely consequential; for example, an entire cottage publishing industry has constructed itself around the dubious advice that those who are stuck wallowing in procrastination and ennui only need to find and follow their passion in order to resolve their problem (see Newport, 2016, for a popular critique). While passion is, indeed, important, an old monk like St. John Cassian would have recognized right away that many of those in the follow-your-passion crowd are, in effect, just dreaming of a brighter monastery, hoping that it will make the demon go away.

The way that procrastination is construed by society is important because this construal affects how individuals reckon with their own motivations. Picture a person who is trapped in a longstanding pattern of procrastination in a job they have committed several years of their life to. If they conclude that the problem is their lack of passion, they may move on to another job. If they conclude it is a lack of discipline, they may fight to control themselves. If they believe that it is due to their environment, they may make changes to it, to free themselves from external distractions. If they believe it is due to depression, they may seek medical help, and possibly medication. Their ability to manage the problem is tied directly to their ability to identify important influences on their behavior and address those influences.

What would happen if, through the vehicle of popular opinion, a society removed one or more of these available explanations? It would compromise the ability of individuals to explore those explanations as solutions to their problem. Picture, for example, a society that labels crippling depression as a sin or treats it as a demon instead of an illness. Or, alternatively, picture a society whose main solution to the problem of workplace ennui is to encourage people to leave their job in order to discover their passion, rather than teaching them how to cultivate passion where they are. Each explanation that is removed results in a solution lost to those who may need to understand their experience through the lens of that explanation.

The underlying question driving this dissertation is whether anxiety should be removed as an explanation for procrastination, along with the potential solutions anxiety alludes to. The idea for this dissertation came about when the author discovered a surprising finding in the literature on procrastination, which is that researchers have found little, if any, correlation between anxiety and behavioral delay. This is an incredibly counterintuitive finding, given the long association between procrastination and struggle. Researchers who have identified the problem have begun to question the viability of anxiety as an explanation for procrastination. Some have used the depressed relationship between anxiety and delay to argue that researchers should instead focus on other variables such as self-discipline and conscientiousness, or depression (e.g., Lay & Silverman, 1996; Steel et al., 2001). Some have suggested that anxiety should be relegated to the lesser position of one of the many factors that makes work aversive and unpleasant, arguing that procrastination is a simple function of anticipated utility,

modified by time (see Steel, 2007). However, is it really appropriate to relegate anxiety to a minor role? Theories that remove anxiety from procrastination appear incomplete; rather than a cold, dispassionate reflection of shifting preference, procrastination is often compulsive and raw, driven by "hot" psychological forces like emotion, and angst.

For this reason, the depressed correlation between anxiety and procrastination found by many researchers (e.g., Lay & Silverman, 1996) is an anomaly. If this dissertation has contributed anything to the literature, it is that it has treated the depressed correlation between anxiety and delay as an interesting question, worthy of empirical study in its own right. Other scholars have treated the depressed correlation as a simple fact to be accepted. Certainly, nobody has grown curious enough about it to devote two-hundred pages to the topic. This is unfortunate because if anxiety—and by proxy the neurotic struggle of sloth and *acedia*—is truly unrelated to delay, then that would require a paradigm shift in the historic understanding of the human struggle with work and achievement. The present dissertation addressed the question of the depressed correlation between anxiety and delay, then, because it seemed important. Each chapter offers a unique contribution to this overall goal.

The primary purpose of Chapter One was to trace the history of the relationship between anxiety and procrastination, while the purpose of Chapter Two was to use a meta-analytic approach to verify whether the missing correlation between anxiety and delay was an actual feature of the procrastination literature, rather than an illusion generated by researchers placing too much importance on a few isolated studies. Ultimately, the meta-analysis in Chapter Two showed that a small correlation between

anxiety and delay does exist, but the evidence for it is unconvincing; the fact that it is so much smaller than the relationship between anxiety and self-reported procrastination merited further exploration.

Chapter Three addressed methodological barriers to exploring the reasons for the missing correlation between anxiety and delay, noting that most studies that have assessed delay objectively have focused on measures such as assignment submission times, which do not give the full picture of the student work process. The chapter also proposed an alternative method of measuring work (Google Docs) that would resolve the problem of measuring actual work delay. Chapter Four used data collected via Google Docs to address the relationship between anxiety and delay, providing evidence that anxiety increases delay for procrastinators while decreasing delay for non-procrastinators.

The contribution of each of these chapters to the main argument of this dissertation has been addressed in each chapter's discussion section. However, the findings from each chapter do fit into a larger picture and do have implications beyond the immediate study. This final chapter, then, is intended to complete the picture and to explore those implications further.

Chapter Contributions

Chapter One. The first chapter traced the history of the primary problem (i.e. that of the depressed relationship between anxiety and work delay), noting that it appears to be rooted in a historical division between clinical and behavioral psychology, where each field addressed different aspects of procrastination but neither laid a solid foundation for the integration of their insights. Retrospectively, looking at the results of the analyses

conducted in this article, it seems that the primary casualty of this division is the ability of researchers to maintain a holistic perspective on the relationship between work and anxiety. There are two primary takeaways from Chapter One.

The Other Half. While the first chapter dealt heavily with the division between clinical and behavioral psychology, the findings from Chapter Four suggest new interpretations of that history which may shed light on the reasons for the depressed correlation between anxiety and delay. The particular outlook of clinical psychology in the late 1970's and early 1980's was dominated by a focus on psychopathology (Csikszentmihalyi & Seligman, 2000). Clinical psychologists work with a specific subset of people—those who need help from clinical psychologists—and theories based on the work of clinical psychologists may be over-informed by the behavior of those who respond maladaptively to stress. It is likely, then, that clinical insights may accurately describe the effects of anxiety on procrastinators, but because clinical psychologists lack experience with non-procrastinators, they may have missed other groups of people who respond to anxiety in adaptive ways.[29]

This provides further vindication for the paradigm shift towards positive psychology that was initiated by researchers such as Csikszentmihalyi & Seligman (2000). It is difficult, in fact, to picture an example that better encapsulates the need for such a paradigm shift. Positive psychologists have long argued that excessive focus on

[29] This is a subtle point because researchers such as Ellis and Knaus (1977) have a great deal to say about the behavior of healthy individuals. It is not that clinicians fail to comment on the healthy, or theorize about their behavior. It is that the raw experiential data that they draw on comes from those who struggle with maladaptive behavioral patterns. It is therefore unsurprising that clinicians might imagine a linear relationship where the absence of anxiety solved the problem of procrastination, because they are dealing with people for whom the presence of anxiety is what causes the problem. It is unlikely that therapists would have imagined a more complex pattern, or postulated the existence of a subset of the population who responded to anxiety by working early—because this pattern would have been unlikely to land new patients on their couch that they could observe and build theories off of.

psychopathology has led psychologists to completely miss patterns of adaptive behavior in healthy individuals, instead treating "health" as the simple absence of illness. That appears to be exactly what has happened with procrastination research.

In the traditional model of the relationship between anxiety and procrastination, anxiety is treated as a trigger for a maladaptive behavior (procrastination), and "health" is tacitly defined as the mere absence of maladaptive behavior that comes from either coping with anxiety or feeling less of it (e.g. Ellis & Knaus, 1977). The idea that a second cohort of people (precrastinators) may exist who respond to anxiety with a pattern that is the opposite of procrastination, and far more adaptive, has only emerged recently (i.e. Rosenbaum et al., 2014). However, the over-focus on pathology is so strong that even Rosenbaum and colleagues have still felt it necessary to emphasize possible maladaptive consequences of procrastination (i.e. extra effort; see Rosenbaum et al., 2014). This may be an incorrect approach, given that Sauerberger (2019) has found that precrastination correlates positively with conscientiousness and negatively with neuroticism, indicating a general pattern of relationship to adaptive traits.

Expanding the History of Procrastination. Beyond questions focusing on the relationship between anxiety and delay, the primary takeaway from this chapter is that there is more to the history of procrastination research than is commonly assumed. At present, researchers treat the time period between 1970 and 1990 as the genesis of procrastination research, which in many ways is an appropriate conclusion. However, there has been research conducted prior to that time period, and the insights and biases

from older literature continue to exert an influence on the methods, questions, and conclusions of modern psychologists.

For that reason, it may be beneficial to procrastination researchers to identify historical research that has been overlooked to determine if it has any insights to offer modern researchers. This is not only true of older research programs; it is likely also true of current research programs being conducted in other fields: procrastination is a multidisciplinary topic, drawing interest from economists (O'Donoghue & Rabin, 2001), sociologists (Kosmas, 2003) and historians (Wenzel, 2017), among others. It would certainly help contextualize the field more effectively if researchers were to integrate insights from other times, other fields, and other voices, in order to create a "big picture" of procrastination scholarship. With the relatively recent development of research programs that study precrastination (e.g. Rosenbaum et al., 2014; Rosenbaum et al., 2019; Sauerberger, 2019) , which is the opposite of procrastination, a strong case could be made that the field itself needs to be rebranded as the broader study of industriousness and productivity. This would allow researchers to fuse the insights from multiple fields to develop a complete model of the influence of emotion and personality variables on work.

Chapter Two. The meta-analysis conducted in Chapter Two was intended to explore the relationship between anxiety and delay, and to determine if it differed from the relationship between anxiety and self-reported procrastination. It showed that there is an effect of anxiety on delay, although it should be noted that it was a small relationship, and it is doubtful if the effect will remain statistically significant as future studies are conducted on the linear relationship between anxiety and delay. However, regardless of

the actual size of the relationship between anxiety and delay, there are no questions about the relative size of the relationship; the meta-analytic correlation of the relationship between anxiety and delay was significantly lower than the one found for the relationship between anxiety and self-reported procrastination. In the context of the larger aims of this dissertation, the findings of Chapter Two justified the remainder of the dissertation. The absence of a strong relationship where a reasonable body of theory from converging disciplines suggests that there should be one (e.g., Ellis & Knaus, 1977; Estes & Skinner, 1941; Solomon & Rothblum, 1984; Spielberger, 1962) suggests that there is an anomaly in the research literature in need of further exploration.

Expanding Operationalizations of Procrastination. Outside of its contribution to the present dissertation, the additional contribution of Chapter Two to the research on procrastination is that it postulated an intermediate category—self-reported delay—and demonstrated that the correlation between that category and anxiety was intermediate in size, being neither significantly different from delay or self-report. It is uncertain how this should be interpreted. One possible interpretation is that, as some researchers have asserted, self-reported procrastination is corrupted by self-concept and any correlation between anxiety and common procrastination questionnaires is due to its overlap with self-concept. In this framework, when participants are asked to report on their own delay in specific instances the resulting reports may represent a fusion of their objective recall of their behavior with their subjective evaluations of themselves. This would result in an effect size between the two extremes of self-report and objectively measured delay, as was observed.

There are other plausible explanations, however. One is that self-reports of procrastination may involve the integration of information about an individual's behavior that normal measures of procrastination miss. Another theory, tested in this dissertation, is that classrooms are comprised of multiple groups who respond differentially to anxiety, and their opposing responses to anxiety tend to cancel out, artificially depressing the correlation between anxiety and delay. Evidence was found for this second theory, but that does not invalidate the first theory.

The primary contribution of this chapter, then, is to highlight that a gradient exists between objective measures of delay and self-reports of procrastination. There are intermediate categories of measure, such as verbal reports of one's own behavior, or informant reports of behavior; the relationship between anxiety and procrastination (or anxiety and delay) may be more sensitive to the type of measure selected than initially thought. This in turn suggests that it may be fruitful to explore the subtleties of the ways that procrastination can be operationalized, and how a researcher's choice of operationalization may predict the relationship between procrastination and other variables.

Chapter Three. The contributions of Chapter Three were primarily methodological. It started with the observation that most studies of the relationship between anxiety and delay do not measure behavior with enough detail to appropriately address the question of how anxiety affects work in-the-moment.

To that end, Chapter Three introduced a novel form of measuring assignment level data, with a focus on assessing student writing. The timestamp architecture from a

Google Docs version history makes it possible to track student writing behavior on a second-by-second basis. The methodological implications of this type of data are substantial: with some technological capability and creativity the micro-level data from a Google Doc can be used to assess aspects of student work that were previously invisible. Measures of work rate, measures of the duration of individual writing sessions, measures of peak productivity, circadian rhythms, volatility in initiating work, and break length—all of these are now possible. At the methodological level this offers innovations that may be useful for procrastination researchers, and several of these innovations were explored in the context of this dissertation, such as the use of an hour-by-hour timeline of work history, or summary metrics (such as modal work time) that were previously very difficult to compute. Some of the measures used here are immediately applicable to existing research. For example, while Steel et al. (2018) operationalized students' delay by integrating the area under their cumulative work curve, the final measure that they used was only a single statistic (i.e., total area). A method similar to the integral analysis used in this dissertation could be employed to conduct a re-analysis of Steel et al.'s (2018) data, to see if a similar "procrastination-relevant" time period exists at the level of the full academic term, rather than just at the level of a single assignment.

Phases of Projects. In addition to the methodological contributions, however, there are several points from Chapter Three that merit attention. While the primary purpose of the analyses was to provide a "primer" on the use of Google Docs data, by showing how such data can be used to model the well-known relationship between procrastination and delay, several of the resulting findings are worth further discussion

and exploration in their own right. The first is that the analyses conducted in Chapter Three provide confirmation for Svartdal et al's. (2020) conjectures regarding the phases of projects. It appears that an essay can be meaningfully separated into a few phases that correlate differentially with psychological outcomes. In Chapters Three and Four, work was split into four phases: the start phase, the work phase, the end phase, and the actual submission of the essay. Regarding the relationship of each phase to self-reported procrastination, the analyses in Chapter Three demonstrated that there is a notable difference between the goal initiation stage of a project and later stages. Measures of self-reported procrastination correlate weakly with the start phase. The other phases show stronger and more consistent relationships with procrastination.

Procrastination and the Last Day. A second point is that procrastination appears to be largely a "last day" phenomenon. This is clearly visible on the timeline graphs for Essay One and Essay Two. The strength of the correlation between self-reported procrastination and students' work jumps substantially after midnight on the day of the deadline. This is even more apparent on the integral graphs; all of the work that students completed on the last day was positively correlated with procrastination and integrating it into their cumulative work record increased the positive correlation between their work record and their self-reported procrastination. Conversely, work that students completed prior to the last day was negatively correlated with self-reported procrastination.

Procrastination and Midnight. A final point is that procrastination appears to have a special connection to midnight. Each night, immediately after midnight, the value of the correlation between self-reported procrastination and the amount of work

participants are doing shows a strong positive increase. This suggests that many non-procrastinators may treat midnight as a sort of deadline for the work on any given day, and the correlation between work and procrastination becomes more positive after midnight because the non-procrastinators stop working. There has been a substantial amount of research conducted on the relationship between circadian rhythms and procrastination that connects procrastination to eveningness (Digdon & Howell, 2008). The findings here may be informative for such literature, if only because they provide a remarkably clear picture of the circadian relationship between self-reported procrastination and student work.

Chapter Four. Chapter Four was intended to directly address the question of the relationship between anxiety and behavioral delay. As a starting point, it drew on observations in the literature that suggested anxiety might cause procrastination in procrastinators, while triggering other behaviors in non-procrastinators. This is a subtle distinction, but it has support throughout the literature in various forms. Tice and Baumeister (1997) demonstrated that procrastinators and non-procrastinators differ in the levels of anxiety they experience at different points in an academic term. Research by Rosenbaum et al., (2014) and Sauerberger (2019) identified a group termed "precrastinators" who may respond to anxiety by working earlier, not later. These pieces of evidence suggested that procrastinators and non-procrastinators may respond differently to anxiety. Based on this, Chapter Four tested the idea that high and low procrastinators might show different relationships between anxiety and delay. The results

of the analysis supported this hypothesis. Based on this analysis there are two suggestions that could help guide future research on anxiety and delay.

Differential Models. The first suggestion is that the appropriate tools to examine the relationship between anxiety and delay are ones that adequately differentiate between high and low procrastinators. Multi-level models that estimate the linear relationship between anxiety and delay both within and between levels of procrastination may be most appropriately suited to the task. Similarly, researchers might consider the use of moderation tests, profile analyses, and detailed temporal mapping of work differences between groups. One hypothesis, for example, that may offer an explanation for why anxiety correlates positively with self-report measures of procrastination, but not measures of behavioral delay, is that the relationship between anxiety and delay may unfold across multiple levels. This may be fruitful ground for future research.

Symmetry and Asymmetry. It seems that one of the primary concerns that should be taken into account in future procrastination research is the question of symmetry across different levels of procrastination. A basic paradigm for procrastination research may involve selecting a class of students, using a validated procrastination measure to divide them into two or more groups, and then testing the relationship between delay and whatever other variables the researcher is interested in studying. A primary focus in such research should be demonstrating not only that the two groups differ but identifying which of the two groups is driving the difference. Some variables may affect procrastinators only. Some may affect non-procrastinators only, and others may affect

both. Clearly specifying which of the groups are affected, and how, will go a great way towards cleaning up future confusion.

Edge Cases. As a final note, data on behavioral measures of delay takes a unique form, with the majority of cases for any particular temporal measure of delay falling close to the deadline, and only a small number of cases deviating from the deadline by a significant amount in either direction. These "edge cases" are important to understanding procrastination, but they also have the potential to exert an undue influence on the results of hypothesis tests. Future research should consider methods for addressing this problem. A couple suggestions readily spring to mind.

First, researchers may consider conducting their hypothesis tests on their data with the edge cases included and excluded, comparing the two conditions to see if (and how) they differ. For example, some variables may have a strong relationship with the time that students complete their work on a project even when the only day examined is the last day. Other variables may only have a relationship with delay when distal edge cases (such as cases representing students who turned in their essay a week early, or a week late) are included. Both types of relationships may be valid, but researchers should be prepared to explain why, and also to offer good reasons why relationships driven by edge cases are accurate, and not simply artifacts produced by lucky outliers.

As a second consideration, researchers may consider employing different transformations on their data. Some transformations that may be particularly useful are symmetrical applications of log transformations (i.e., for any given data point, compute

the log of its deviation from the deadline, then assign it a positive or negative value based on whether it was early or late), or rank-order transformations.

A Tentative Conclusion

Based on the results found in Chapter Two and Chapter Four, it is possible to form some tentative explanations for the depressed relationship between anxiety and measures of delay that have commonly been found in the procrastination literature (e.g. Lay & Silverman, 1996).

First, it seems very likely that the relationship between anxiety and measures of self-reported procrastination are artificially inflated due to self-concept "corrupting" self-report measures. The degree to which this is the case is unknown and should be addressed in future research. A very substantive and interesting body of literature already exists detailing the ways that self-report can be corrupted (e.g. Schwarz & Clore, 1983; Schwarz, 1999) and, for a method-minded researcher, this literature could inform a full research program geared towards making survey measures of procrastination more useful and accurate.

However, other explanations are certainly possible and likely also play a role. One is that procrastinators and non-procrastinators are often not distinguished in research. Current research tends to assume that the relationship between delay and anxiety should be a simple linear trend across a population of students. In the absence of that trend, researchers are quick to conclude that no relationship exists (Lay & Silverman, 1996). It is likely better to think of the relationship between anxiety and delay as a complex relationship in which the relationship between anxiety and delay interacts with other

motivational factors to determine whether a person approaches or avoids their responsibilities. These differences in delay may cancel out when researchers treat students in a classroom as a broad, undifferentiated sample, failing to account for moderators.

The precise moderators that researchers should look for are unknown at present, but meanwhile, measures of self-reported procrastination may serve as a useful stand-in for those moderators. A student who identifies as a high procrastinator has announced to the researcher that their particular cluster of motivations is aligned in such a way that adversity prompts them to delay. A student who identifies as a low procrastinator has similarly announced that their own cluster of motivations leads them to respond to challenges more adaptively by completing the work early. Therefore self-reported procrastination measures may be a useful way of separating students with adaptive versus maladaptive responses to work pressure so that they can be studied as separate groups. This may be useful when delay is the outcome variable. It is not known whether this is the case for other variables.

Additionally, based on the research done here, it is highly suggested that researchers treat the relationship between anxiety and delay as one that evolves and becomes more distinct across time. This pattern was not hypothesized in the current research but the evidence for it is striking enough that future researchers are encouraged to explore the possibility further.

Limitations

There are some limitations to this research that merit discussion here in the conclusion, rather than within their respective chapters. This dissertation's purpose was, in part, to introduce a novel methodology, (the use of Google Docs data), as a way of answering complicated questions they were previously difficult to answer because of the lack of detail in behavioral measures. While the analyses in Chapters Two and Three had their own limitations, Google Docs itself has some broader limitations that are worth addressing here.

The primary objection to the use of Google docs data is that there are many things it cannot measure. This is true on two levels. The first one is intrinsic to the work; for a given project, like an essay, there are many things that a student may do for the project that are work, but that do not involve typing in the Google Doc. A pronounced example of this is the present dissertation: while some of the composition (and all of the editing and final draft) were done in Google Docs, the vast majority of the outlining and the initial draft was written with a fountain pen in an old notebook. The analyses were all done using statistical software. Dozens of hours were devoted to researching references, which may be tracked using a web browser but certainly is not trackable using a Google Doc. In all, the author logged hundreds of hours of focused work toward the project, but only a small amount of that was spent typing. This obviously poses a challenge for the use of Google Docs data to track student work hours.

The second level is extrinsic to the work. Whatever the proportion of the work that is done in Google Docs, the event log data cannot tell researchers anything (by

themselves) about why the work was done, what the worker felt, or what they did when they were away from the keyboard. In the first chapter of this dissertation it was noted that the definition of procrastination contains two components: delay and irrationality. Google Docs data can address delay with great precision, but it cannot speak to rationality. One cannot tell from timestamp data if a person stopped writing because they had to leave for work, or because they needed time to think, or because they were so agitated by their work that they had to leave for a walk to calm down.

There are not easy answers to these questions, but it is at least worth attempting to address them. One of the most basic points that should be addressed is that a measure can be flawed and yet still be an improvement over other measures. Other objective measures of delay suffer from similar problems. Some of the best research on procrastination uses self-paced online assignments as the measure of delay by looking at submission times (e.g., Steel et al., 2018). However, the specific time of a submission for an online module says little about the textbook reading that was done, and even if that problem was addressed it still leaves the question of motive untouched.

Some measures such as self-reported study logs or ecological momentary assessment techniques can address these deficiencies but introduce limitations of their own. The chief limitation is, as discussed earlier, the difficulty in applying such measures across a large population. Additionally, such measures assess time with much less precision, and one implication of this research is that small temporal distances and work on the last day may be very important.

However, objections based on the intangible things that Google Docs cannot measure overlook an important point; when using the data from Google Docs, no trade-off actually needs to be made. It is a passive measure that operates automatically as students do a task that they would already be doing. Therefore, a researcher who is concerned about other types of data, such as measures of emotion, or goals, or in-the-moment activities, can simply collect Google Docs data on top of the data that captures the additional information they are concerned about, with almost no additional time or effort required of their participants. One can think of Google Docs data as an extra layer that can be added to existing paradigms with little cost except the additional work and expertise needed to process it on the far end of the data collection phase. It can make other paradigms richer by adding a detailed record of work to the other important psychological variables being studied.

Beyond that, however, another argument can be made in favor of the use of Google Docs data: the overwhelming precision of the data is valuable in its own right, even after fully accepting its limitations. Such precision allows for new types of analysis that can provide valuable new angles on well-known questions. Without the incredible granularity of the Google Docs data used here, for example, several of the analyses would not have been possible. It would not have been possible to compute the mode, localizing the midpoint of a student's most productive hour to a specific five-minute window. For that matter it would not have been possible to compute the mean or median, either; for all their conceptual simplicity, measures of central tendency require access to the full record of a phenomenon to compute, and historically that has not been available for many forms

of complex work. Additionally, without Google Docs it would not have been possible to conduct an integral analysis or to produce an hour-by-hour timeline of the correlation between work and anxiety, although admittedly these two analyses owe more to the ability of Google docs to passively record behavior, not to its precision.

Therefore, while Google Docs data may not directly address many psychological variables, such as intent. Rationality, and goals, its precision still makes it valuable. It is also worth noting that the new methods of research enabled by Google Docs may allow researchers to address psychological questions indirectly by providing a temporal record of work so precise that it allows for the creative construction of new behavioral variables for research—which, in the end, is what this dissertation sought to accomplish.

Future Directions

Chapters Two, Three, and Four each had a section devoted to discussing future directions, and the primary focus of each was on how the specific findings of each chapter might inform new research and the broader discussion on procrastination. This section is devoted to two points of discussion that are broad enough that they do not easily fit within the discussions in previous chapters. They can be considered global points, serving the purpose of situating the full research program of this dissertation in the larger literature. The first point is about the meaning of this research for the study of anxiety, emotion, and procrastination in general. The second is about what the method introduced here—Google Docs—may signify for future research. In the interest of keeping a healthy sense of context it should be noted that the ideas and methods discussed in this dissertation are not new. They exist elsewhere in the psychological

literature and the work addressed in these pages is best thought of as a manifestation of changes that are already well underway.

The Study of Anxiety and Emotion. As it turns out, the absent correlation between anxiety and delay masks a more nuanced and complex relationship. The problem is not that anxiety and delay are unrelated. The problem is that there has been a long historical overfocus on those in whom anxiety causes discipline to break down, increasing delay. This is problematic because it appears that there is a second group of people who do not respond to anxiety with breakdown and delay but rather with a quickening of their pace. St. John Cassian, sitting in his monastery in France in the fifth century, would have identified them as the good monks if he had written a book about them. But books do not often get written about good monks, and by a similar twist of fate it appears that research studies of delay have forgotten about the good students. The failure to account for these group differences is probably why there is a depressed correlation between anxiety and delay; the high and low procrastinators cancel each other out.

It appears that the best way to conceptualize anxiety, then, is as a motivating or an activating "force" for behavior, the direction of which is determined by other factors. These factors are not known for sure but a likely candidate is conscientiousness, which has been shown in recent research to be comprised of personality traits such as reliability, productivity, and organization (Soto & John, 2017) Some previous research has demonstrated that neuroticism and conscientiousness can interact with each other to predict maladaptive behaviors (e.g. Terracciano & Costa, 2004) but thus far, reliable

research supporting the notion of a neuroticism-conscientiousness interaction has remained elusive in most areas where it has been studied. The research here, however, has found an interaction effect between one variable (anxiety) closely related to neuroticism and a second (procrastination) closely related to conscientiousness, providing some credibility for the existence of neuroticism-conscientiousness interactions in some domains of life. Perhaps with recent work on the factor structure of conscientiousness (e.g. Basil, 2021; Roberts et al., 2004) and an increased emphasis on more detailed temporal designs that map the full range of behavior across time (Roe, 2014), research into neuroticism-conscientiousness interactions can be revisited fruitfully in the domain of work and productivity.

With that noted, regardless of the larger implications for personality constructs such as conscientiousness or neuroticism, the results found here do echo a long-standing point that researchers have made about anxiety. Anxiety is a construct that is susceptible to moderation effects from outside variables, and researchers would likely benefit from treating anxiety as a moderated variable by default. This leads to perhaps the boldest claim of this dissertation, which is that when it comes to the relationship between anxiety and behavior the burden of proof should be on researchers who claim that anxiety affects everybody in the population similarly, rather than on researchers who claim that its effects are moderated by individual differences.

For procrastination researchers this should invite some skeptical questions about the current use of anxiety in studying procrastination. At present, anxiety measures are assumed to have a simple bivariate relationship with delay across a population because

they have a simple bivariate relationship with self-reported trait procrastination. This assumption has led to their use in increasingly complicated path models that presume to shed light on the complicated dynamics of why people delay their work.

Unfortunately, based on the data here, it seems that the assumption of a simple bivariate relationship between anxiety and delay across a population may be false. If this is the case, then the nomological network of variables related to self-reported procrastination probably does not behave in the same way as the nomological network of variables related to behavioral delay. They almost certainly overlap and interact, but until researchers know more about the dynamics of the relationship between anxiety, delay, and self-reported procrastination, it should not be assumed that the complicated models that some researchers have built of the relationship between anxiety and self-reported procrastination are useful models of actual behavior (i.e. what people actually do).

The Temporal Study of Behavior. The second point to be made here is about time. Roe (2014) has made a wonderful case for the importance of time in psychological research. Both motivation and behavior evolve across time and across the phases of a project, and this is especially important when considering a phenomenon like procrastination, which is inherently time-bound.

As Roe (2014) notes, prior to World War II, Organizational Psychology was heavily invested in the temporal study of work. However, this changed after the war, and organizational researchers began to favor survey measures and between-persons research because of their simplicity. Between-persons research was easy; it was possible to collect

data from many people, quickly, and the range of topics that researchers could investigate using surveys and questionnaires were limited only by language, not by logistics.

Detailed and insightful research incorporating the temporal dimension was still carried out actively by behaviorists in the lab (e.g., Ferster & Skinner, 1957; Estes & Skinner, 1941) and in real world settings (Semb et al., 1979) but these had some limitations; the more detailed lab studies were limited to low numbers and were not methodologically equipped to address questions of personality and individual differences (and, based on behaviorist theory, were disinclined to do so). By the 1980s behaviorism slowly began to recede as the dominant paradigm of psychology, and with it, the popularity of temporal-based research dwindled further. Roe (2014) noted a minor resurgence of temporally oriented research in the 1980's, marked by a preference for the use of parametric equations to describe temporal trends, but temporal research was hardly popular.

A key reason for this, for many years, has been the difficulty associated with temporal research. A second one is the need for large samples to ensure the statistical power necessary to reliably detect individual differences. Often there is a trade-off between the two; temporal designs are easier with smaller samples.

Technology, however, has eroded this barrier. The advent of online course management systems means that it is no longer necessary to choose between the two. A teacher of an online course, for example, can access a detailed record of assignment submission times and other interactions with the online course management software for hundreds of students (e.g., Coffrin et al., 2014). The data from Google Docs continues

this trend; once the necessary code architecture has been established, processing data for ten participants who wrote a poem over the course of an hour is no different than processing the data for a thousand participants who wrote in an online diary over the course of a year. The only difference on the experimenter's end is that, in the second case, they may have to stare impatiently at their computer screen for a while.

This means that it is now easy to conduct research on individual differences in within-person temporal trends. For anxiety research this may be a particularly relevant development, since the research in this dissertation strongly suggests that the role of anxiety in procrastination is one that unfolds at different points in the development of a project. Generally, then, the research presented here serves as a good illustration of the potential of work that takes temporal trajectories into account. While this is especially true of new, computer-based measures of behavior, it is also important to emphasize that accounting for temporal trajectories may also enrich studies that use self-report. There are few studies of the relationship between anxiety and self-reported procrastination that have made use of longitudinal designs, but those that have done so found results that differ substantially from the majority of studies that only examined single measures of trait anxiety and trait procrastination. Tice and Baumeister (1997), for example, were among the first to note the procrastinators and non-procrastinators differed in their affective experiences across time, using well-designed studies that assessed anxiety for different groups at different time points.

The implications of timestamp-based technology for analyzing behavior goes far beyond what has been discussed in this dissertation, however. The capacity to keep a

digital record of many behaviors has been present since shortly after the advent of personal computing. The first program capable of producing a record of keystrokes was "Recording WordStar," released in the early 1980's (Bridwell et al., 1985), and computers have since moved into every aspect of life.

For many forms of human endeavor there are accompanying forms of digital data that can be accessed if the right program is used. Accessing timestamp records of browsing history is simple enough, as is looking at a student interaction with a course portal (e.g., Marachi & Quill, 2020; Murakami & Hirata, 2004). For someone who wishes to study the process of creating music, digital composition has long been based on a musical instrument digital interface (MIDI) protocol that can be used to derive a temporal record of musical notes and their durations (Loy, 1985). With minor adaptation and an agreement to leave recording software on, it would be easy to keep a record of a student's progress as they worked their way through the steps required to learn a Hanon etude, or to play the Für Elise. Beyond music, digital imaging software often keeps a full image editing log that records every computer action that goes into producing a piece of digital art (Liu, Liu & Munzner, 2020). Also, common digital platforms for coding often include protocols that keep detailed version histories of code as it is being developed, creating a full work record of the development of complex programs across time (Blischak, Davenport & Wilson, 2016).

The point here is that, for researchers who are committed to the inclusion of behavioral measurement in psychological research, it is an opportune time. Those who are willing to take the time to learn how to access it will find that a wealth of data on real-

time human behavior is readily available to them. If there is any one overarching contribution that this dissertation makes to the field of social psychology, then, it is that it points toward this exciting future and hints at some of its possibilities.

References

Abelson, R. P. (1985). A variance explanation paradox: When a little is a lot. *Psychological Bulletin, 97*(1), 129.

Abraham, K. (1923). Contributions to the theory of the anal character. *International Journal of Psycho-Analysis*, *4*, 400-418.

Ainslie, G. (1975). Specious reward: a behavioral theory of impulsiveness and impulse control. *Psychological Bulletin*, *82*(4), 463.

Altschule, M. D. (1965). Acedia: Its evolution from deadly sin to psychiatric syndrome. *The British Journal of Psychiatry, 111(471), 117–119.* doi:10.1192/bjp.111.471.117

American Psychiatric Association, & Committee on Nomenclature and Statistics. (1952). *Diagnostic and statistical manual: mental disorders*. American Psychiatric Association.

Arborelius, L., Owens, M. J., Plotsky, P. M., & Nemeroff, C. B. (1999). The role of corticotropin-releasing factor in depression and anxiety disorders. *The Journal of Endocrinology*, *160*(1), 1-12.

Baron, A., & Galizio, M. (1976). Clock control of human performance on avoidance and fixed-interval schedules. *Journal of the Experimental Analysis of Behavior*, *26*(2), 165-180.

Basil, T. W. (2021). *Conscientiousness: A structural assessment and development of the Facets of Control scales* (Doctoral dissertation, UC Riverside).

Baumeister, R. F., Heatherton, T. F., & Tice, D. M. (1993). When ego threats lead to self-regulation failure: Negative consequences of high self-esteem. *Journal of Personality and Social Psychology*, *64*(1), 141.

Beck, T. (Aug 9, 2020). Why you should write in the nude. *The Writing Cooperative (writingcooperative.com)*. Archived link: https://web.archive.org/web/20210707114005if_/https://writingcooperative.com/why-you-should-write-in-the-nude-5bbd3dc4033b?gi=e1c102b29c13

Beswick, G., Rothblum, E. D., & Mann, L. (1988). Psychological antecedents of student procrastination. *Australian Psychologist*, *23*(2), 207–217.

Blischak, J. D., Davenport, E. R., & Wilson, G. (2016). A quick introduction to version control with Git and GitHub. *PLoS Computational Biology*, *12*(1), e1004668.

Bradburn, N. M., Rips, L. J., & Shevell, S. K. (1987). Answering autobiographical questions: The impact of memory and inference on surveys. *Science, 236*(4798), 157-161.

Bridwell, L., Sirc, G., & Brooke, R. (1985). Computing and revising: Case studies of student writers. in S, Freedman (Ed.) *The acquisition of written language: Response and revision.* Norwood, NJ.: Ablex Publishing Corporation.

Brownlow, S., & Reasinger, R. D. (2000). Putting off until tomorrow what is better done today: Academic procrastination as a function of motivation toward college work. *Journal of Social Behavior and Personality*, *15*(5), 15.

Burka, J. B., & Yuen, L. M. (1983). *Procrastination: Why You Do It, What to Do About It Now*. Da Capo Press.

Carden, R., Bryant, C., & Moss, R. (2004). Locus of control, test anxiety, academic procrastination, and achievement among college students. *Psychological Reports*, *95*(2), 581-582.

Cassian, J. (2015). *The twelve books on the institutes for the Coenobia and the remedies for the eight principal faults* (E.C.S. Gibson, Trans.). Aeterna Press.

Catani, M. & Mazzarello, P. (2019). Leonardo Da Vinci: A genius driven to distraction. *Brain: A Journal of Neurology, 142*(6), 1842-1846. DOI: 10.1093/brain/awz131

Coffrin, C., Corrin, L., de Barba, P., & Kennedy, G. (2014, March). Visualizing patterns of student engagement and performance in MOOCs. In *Proceedings of the Fourth International Conference on Learning Analytics and Knowledge* (pp. 83-92).

Collins, K. M., Onwuegbuzie, A. J., & Jiao, Q. G. (2008). Reading ability as a predictor of academic procrastination among African American graduate students. *Reading Psychology*, *29*(6), 493-507.

Critchfield, T. S., Haley, R., Sabo, B., Colbert, J., & Macropoulis, G. (2003). A half century of scalloping in the work habits of the United States Congress. *Journal of Applied Behavior Analysis*, *36*(4), 465-486.

Csikszentmihalyi, M., & Seligman, M. (2000). Positive psychology. *American Psychologist*, *55*(1), 5-14.

Darwin, C. (1872). *The expression of the emotions in man and animals*. London, UK: John Murray, Albemarle St.

Davis, M. (1992). The role of the amygdala in fear and anxiety. *Annual Review of Neuroscience*, *15*(1), 353-375.

Day, V., Mensink, D., & O'Sullivan, M. (2000). Patterns of academic procrastination. *Journal of College Reading and Learning*, *30*(2), 120–134. https://doi.org/10.1080/10790195.2000.10850090

Dickerson, S. S., Gruenewald, T. L., & Kemeny, M. E. (2004). When the social self is threatened: Shame, physiology, and health. *Journal of Personality*, *72*(6), 1191-1216.

Digdon, N. L., & Howell, A. J. (2008). College students who have an eveningness preference report lower self-control and greater procrastination. *Chronobiology International*, *25*(6), 1029-1046.

Donovan, J. M. (1995). Relating psychological measures to anthropological observations: Procrastination as a field proxy for death anxiety? *Journal of Social Behavior and Personality*, 465.

Duffy, M., (1994). The state of Bill Clinton. *Time*. *143*(6).

Elliot, A. J. (2006). The hierarchical model of approach-avoidance motivation. *Motivation and Emotion*, *30*(2), 111-116.

Ellis, A. (1962). Reason and emotion in psychotherapy. Secaucus, NJ: Lyle Stuart

Ellis, A., & Knaus, W. J. (1977). *Overcoming Procrastination*. New York, NY: New American Library.

Estes, W. K., & Skinner, B. F. (1941). Some quantitative properties of anxiety. *Journal of Experimental Psychology*, *29*(5), 390.

Fee, R. L., & Tangney, J. P. (2000). Procrastination: A means of avoiding shame or guilt? *Journal of Social Behavior & Personality, 15*(5), 167–184.

Ferrari, J. R. (1992). Psychometric validation of two procrastination inventories for adults: Arousal and avoidance measures. *Journal of Psychopathology and Behavioral Assessment*, *14*(2), 97-110.

Ferrari, J. R., Diaz-Morales, J. F., O'Callaghan, J., Diaz, K., & Argumedo, D. (2007). Frequent behavioral delay tendencies by adults: International prevalence rates of chronic procrastination. *Journal of Cross-Cultural Psychology*, *38*(4), 458-464.

Ferrari, J. R., Driscoll, M., & Díaz-Morales, J. F. (2007). Examining the Self of Chronic Procrastinators: Actual, Ought, and Undesired Attributes. *Individual Differences Research*, *5*(2).

Ferrari, J. R., Johnson, J. L., & McCown, W. G. (1995). *Procrastination and task avoidance: Theory, research, and treatment.* New York, NY: Plenum Press.

Ferster, C. B. (1968). Individualized instruction in a large introductory psychology college course. *The Psychological Record*, *18*(4), 521-532.

Ferster, C. B., & Skinner, B. F. (1957). *Schedules of reinforcement.* Appleton-Century-Crofts. https://doi.org/10.1037/10627-000

Freud, S. (1908/1959). Character and anal erotism. In *The standard edition of the complete psychological works of Sigmund Freud, volume IX (1906-1908): Jensen's 'Gradiva' and other works* (pp. 167-176).

Freud, S. (1917/1955). On transformations of instinct as exemplified in anal erotism. In *The standard edition of the complete psychological works of Sigmund Freud, volume XVII (1917-1919): An infantile neurosis and other works* (pp. 125-134).

Freud, S. (1922). The Unconscious. *The Journal of Nervous and Mental Disease, 56*(3), 291-294.

Funder, D. C. (2018). *The personality puzzle* (8th edition). New York, NY: WW Norton & Company.

Funder, D. C., & Ozer, D. J. (2019). Evaluating effect size in psychological research: Sense and nonsense. *Advances in Methods and Practices in Psychological Science*, *2*(2), 156-168.

Gautam, A., Polizzi, C. P., & Mattson, R. E. (2019). Mindfulness, procrastination, and anxiety: Assessing their interrelationships. *Psychology of Consciousness: Theory, Research, and Practice*.

Galton, F. (1907). Vox populi. *Nature, 75*(1907), 450–451. doi:10.1038/075450a0

Harding, D. (1933). Rhythmization and speed of work. *British Journal of Psychology, 23*(3), 262.

Harper, D. (n.d.a) Procrastination. In *The Online Etymology Dictionary*. Retrieved July 8, 2021, from http://etymonline.com

Harper, D. (n.d.b) Anxiety. In *The Online Etymology Dictionary.* Retrieved July 9, 2021, from http://etymonline.com

Harper, D. (n.d.c) Feature. In *The Online Etymology Dictionary.* Retrieved August 9, 2021, from http://etymonline.com

Harper, R., 1904. *The code of Hammurabi, king of Babylon, about 2250 B.C*. Chicago: University of Chicago Press.

Hetherington, E. M., & Brackbill, Y. (1963). Etiology and covariation of obstinacy, orderliness, and parsimony in young children. *Child Development*, 919-943.

Hess, B., Sherman, M. F., & Goodman, M. (2000). Eveningness predicts academic procrastination: The mediating role of neuroticism. *Journal of Social Behavior and Personality, 15*(5), 61.

Houghton-Mifflin (n.d.a). Procrastination. In *The American Heritage online dictionary*. Retrieved July 8, 2021, from www.ahdictionary.com/word/search.html?q=procrastination

Houghton-Mifflin (n.d.b). Anxiety. In *The American Heritage online dictionary.* Retrieved July 9, 2021, from www.ahdictionary.com/word/search.html?q=anxiety

Howell, A. J., Watson, D. C., Powell, R. A., & Buro, K. (2006). Academic procrastination: The pattern and correlates of behavioural postponement. *Personality and Individual Differences, 40*(8), 1519-1530.

Hugo, A. (1864). *Victor Hugo, by a witness of his life*. New York, NY: Carleton. Retrieved from The Internet Archive. https://archive.org/details/victorhugobyawit003274mbp

James, W. (1910) *The principles of psychology.* New York, NY: Henry Holt & Company

Jarmolowicz, D. P., Hayashi, Y., & Pipkin, C. S. P. (2010). Temporal patterns of behavior from the scheduling of psychology quizzes. *Journal of Applied Behavior Analysis*, *43*(2), 297-301.

Johnson, G. (1875). Nervous disorders that result from overwork and mental anxiety. *The Lancet*, *106*, 85-87.

Jones, E. (1918). Anal erotic character traits. *The Journal of Abnormal Psychology*, *13*(5), 261.

Kahneman, D., Krueger, A. B., Schkade, D. A., Schwarz, N., & Stone, A. A. (2004). A survey method for characterizing daily life experience: The day reconstruction method. *Science*, *306*(5702), 1776-1780.

Kasper, G. (2004, March 30). Tax procrastination: Survey finds 29% have yet to begin taxes. Retrieved July 8, 2021, from http://www.prweb.com/releases/2004/3/prweb114250.htm

Keller, F. S. (1967). Engineering personalized instruction in the classroom. *Revista Interamericana de Psicologia/Interamerican Journal of Psychology*, *1*(3).

Keller, F. S. (1968). Good-bye, teacher... *Journal of Applied Behavior Analysis*, *1*(1), 79.

Knaus, W. J. (2000). Procrastination, blame, and change. *Journal of Social Behavior and Personality*, *15*(5), 153.

Ko, C. Y. A., & Chang, Y. (2019). Investigating the relationships among resilience, social anxiety, and procrastination in a sample of college students. *Psychological Reports*, *122*(1), 231-245.

Kosmas, J. M. (2003). The roots of procrastination: A sociological inquiry into why I wait until tomorrow. *Human Architecture: Journal of the Sociology of Self-Knowledge, 2*(2).

Kroese, F. M., De Ridder, D. T., Evers, C., & Adriaanse, M. A. (2014). Bedtime procrastination: introducing a new area of procrastination. *Frontiers in Psychology, 5*, 611.

Lay, C. H. (1986). At last, my research article on procrastination. *Journal of Research in Personality, 20*(1), 474–495. https://doi.org/10.1016/0092-6566(86)90127-3

Lay, C. H. (1995). Trait procrastination, agitation, dejection, and self-discrepancy. in Ferrari, J. R., Johnson, .I. L. & McCown. W. G. (Eds) *Procrastination and task avoidance: Theory, research and treatment* (pp. 97-112). New York: Plenum Press.

Lay, C. H., & Schouwenburg, H. C. (1993). Trait procrastination, time management. *Journal of Social Behavior and personality*, *8*(4), 647-662.

Lay, C., & Silverman, S. (1996). Trait procrastination, anxiety, and dilatory behavior. *Personality and Individual Differences*, *21*(1), 61–67. https://doi.org/10.1016/0191-8869(96)00038-4

Leprohon, R. (2013). A wall for all seasons: The funerary chapel of Pahery at El Kab. *KMT, 24*(13). 49-57.

Lindgren, E., & Sullivan, K. (Eds.). (2019). *Observing writing: Insights from keystroke logging and handwriting*. Boston, MA; Brill.

Liss, E. (1941). Learning difficulties: Unresolved anxiety and resultant learning patterns. *American Journal of Orthopsychiatry*, *11*(3), 520.

Liu, Z., Liu, Z., & Munzner, T. (2020, April). Data-driven multi-level segmentation of image editing logs. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems* (pp. 1-12).

Loy, G. (1985). Musicians make a standard: The MIDI phenomenon. *Computer Music Journal*, *9*(4), 8-26.

Lum, M. K. (1960). A comparison of under-and overachieving female college students. *Journal of Educational Psychology*, *51*(3), 109.

Marachi, R., & Quill, L. (2020). The case of Canvas: Longitudinal datafication through learning management systems. *Teaching in Higher Education*, *25*(4), 418-434.

Markus, H., & Nurius, P. (1986). Possible selves. *American Psychologist, 41*(9), 954.

Martin, F., Sun, T., & Westine, C. D. (2020). A systematic review of research on online teaching and learning from 2009 to 2018. *Computers & Education, 159*, 104009.

Matsuhashi, A. (1981). Pausing and planning: The tempo of written discourse production. *Research in the Teaching of English*, 113-134.

Mawhinney, V. T., Bostow, D. E., Laws, D. R., Blumenfeld, G. J., & Hopkins, B. L. (1971). A comparison of students studying-behavior produced by daily, weekly, and three-week testing schedules. *Journal of Applied Behavior Analysis*, *4*(4), 257.

McCown, W., Johnson, J., & Petzel, T. (1989). Procrastination, a principal components analysis. *Personality and Individual Differences*, *10*(2), 197-202.

McCown, W., Petzel, T., & Rupert, P. (1987). An experimental study of some hypothesized behaviors and personality variables of college student procrastinators. *Personality and Individual Differences*, *8*(6), 781-786.

McNaughton, N., & Corr, P. J. (2004). A two-dimensional neuropsychology of defense: fear/anxiety and defensive distance. *Neuroscience & Biobehavioral Reviews*, *28*(3), 285-305.

Merriam-Webster. (n.d.). Acedia. In *Merriam-Webster.com dictionary*. Retrieved August 26, 2021, from https://www.merriam-webster.com/dictionary/acedia

Michael, J. (1991). A behavioral perspective on college teaching. *The Behavior Analyst*, *14*(2), 229-239.

Milgram, N. (1992). El retraso: Una enfermedad de los tiempos modernos. *Boletín de Psicología*, (35), 83-102.

Milgram, N. A., Dangour, W., & Ravi, A. (1992). Situational and personal determinants of academic procrastination. *The Journal of General Psychology, 119*(2), 123-133.

Moon, S. M., & Illingworth, A. J. (2005). Exploring the dynamic nature of procrastination: A latent growth curve analysis of academic procrastination. *Personality and Individual Differences, 38*(2), 297-309.

Morris, E. K., Surber, C. F., & Bijou, S. W. (1978). Self-versus instructor-pacing: Achievement, evaluations, and retention. *Journal of Educational Psychology*, *70*(2), 224.

Mowrer, O. H., & Ullman, A. D. (1945). Time as a determinant in integrative learning. *Psychological Review*, *52*(2), 61.

Murakami, H., & Hirata, T. (2004). A system for generating user's chronological interest space from web browsing history. *International Journal of Knowledge-Based and Intelligent Engineering Systems*, *8*(3), 149-160.

Nakhnikian, G. (1973). The first Socratic paradox. *Journal of the History of Philosophy*, *11*(1), 1-17.

Nash, S. (1983, May). Writing a building: Hugo's Notre-Dame de Paris. In *French Forum* (Vol. 8, No. 2, pp. 122-133). University of Nebraska Press.

Newport, C. (2016). *So good they can't ignore you: Why skills trump passion in the quest for work you love*. New York, NY: Hachette Book Group.

O'Donoghue, T., & Rabin, M. (2001). Choice and procrastination. *The Quarterly Journal of Economics, 116*(1), 121-160.

Onwuegbuzie, A. J. (2004). Academic procrastination and statistics anxiety. *Assessment & Evaluation in Higher Education*, *29*(1), 3-19.

Ooms, J. (2014). The jsonlite package: A practical and consistent mapping between JSON data and R objects. *arXiv:1403.2805 [stat.CO]*. https://arxiv.org/abs/1403.2805.

Owens, A. M., & Newbegin, I. (1997). Procrastination in high school achievement: A causal structural model. *Journal of Social Behavior & Personality*, *12*(4), 869.

Perez-Messina, I., Gutierrez, C., & Graells-Garrido, E. (2018). Organic visualization of document evolution. In *23rd International Conference on Intelligent User Interfaces* (pp. 497-501).

Perrin, C. J., Miller, N., Haberlin, A. T., Ivy, J. W., Meindl, J. N., & Neef, N. A. (2011). Measuring and reducing college students' procrastination. *Journal of Applied Behavior Analysis*, *44*(3), 463-474.

Powers, R. B., Edwards, K. A., & Hoehle, W. F. (1973). Bonus points in a self-paced course facilitates exam-taking. *The Psychological Record*, *23*(4), 533-538.

Pressfield, S. (2002). *The war of art*. New York, NY: Black Irish Entertainment, LLC

Pychyl, T. A., Lee, J. M., Thibodeau, R., & Blunt, A. (2000). Five days of emotion: An experience sampling study of undergraduate student procrastination. *Journal of Social Behavior & Personality*, *15*(5), 239–254.

R Core Team (2021). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing, Vienna, Austria. URL: https://www.R-project.org/

Revelle W (2021). *psych: Procedures for Psychological, Psychometric, and Personality Research*. Northwestern University, Evanston, Illinois. R package version 2.1.6, https://CRAN.R-project.org/package=psych.

Roberts, B. W., Bogg, T., Walton, K. E., Chernyshenko, O. S., & Stark, S. E. (2004). A lexical investigation of the lower-order structure of conscientiousness. *Journal of Research in Personality*, *38*(2), 164-178.

Roe, R.A. (2014). Time, performance and motivation. In A.J. Shipp & Y. Fried (Eds.), *Time and work: How time impacts individuals* (Vol. 1). New York, NY: Psychology Press

Roelofs, K., Elzinga, B. M., & Rotteveel, M. (2005). The effects of stress-induced cortisol responses on approach–avoidance behavior. *Psychoneuroendocrinology*, *30*(7), 665-677.

Rosenbaum, D. A., Fournier, L. R., Levy-Tzedek, S., McBride, D. M., Rosenthal, R., Sauerberger, K., ... & Zentall, T. R. (2019). Sooner rather than later: Precrastination rather than procrastination. *Current Directions in Psychological Science*, *28*(3), 229-233.

Rosenbaum, D. A., Gong, L., & Potts, C. A. (2014). Pre-crastination: Hastening subgoal completion at the expense of extra physical effort. *Psychological Science, 25*(7), 1487-1496.

Rosenberg, M. (1962). The association between self-esteem and anxiety. *Journal of Psychiatric Research, 1*(2), 135–152. https://doi.org/10.1016/0022-3956(62)90004-3

Rosenthal, R. (1991). *Meta-analytic procedures for social research.* Newbury Park, CA: Sage Publications

RStudio Team (2021). *RStudio: Integrated Development Environment for R.* Boston, MA: RStudio PBC. URL: http://www.rstudio.com/

Sabini, M. S. J., & Silver, M. (1981). Procrastinating. *Journal for the Theory of Social Behaviour, 11*(2), 207-221.

Sauerberger, K. (2019). *When doing things later is the best choice: Precrastination as an individual difference* (Order No. 13897377). Available from Dissertations & Theses @ University of California; ProQuest Dissertations & Theses A&I.

Schwarz, N. (1999). Self-reports: How the questions shape the answers. *American psychologist*, *54*(2), 93.

Schwarz, N., & Clore, G. L. (1983). Mood, misattribution, and judgments of well-being: informative and directive functions of affective states. *Journal of personality and social psychology*, *45*(3), 513.

Semb, G., Glick, D. M., & Spencer, R. E. (1979). Student withdrawals and delayed work patterns in self-paced psychology courses. *Teaching of Psychology*, *6*(1), 23-25.

Senecal, C., Lavoie, K., & Koestner, R. (1997). Trait and situational factors in procrastination: An interactional model. *Journal of Social Behavior and Personality, 12*(4), 889.

Sirois, F. M. (2016). Procrastination, stress, and chronic health conditions: A temporal perspective. In *Procrastination, Health, and Well-Being* (pp. 67–92). Elsevier. https://doi.org/10.1016/B978-0-12-802862-9.00004-9

Sirois, F., & Pychyl, T. (2013). Procrastination and the priority of short-term mood regulation: Consequences for future self. *Social and Personality Psychology Compass*, *7*(2), 115-127.

Skinner, B. F. (1956). A case history in scientific method. *American Psychologist, 11*(5), 221.

Solomon, A. (2001). *The noonday demon: An atlas of depression*. New York, NY: Simon and Schuster.

Solomon, L. J., & Rothblum, E. D. (1984). Academic procrastination: frequency and cognitive-behavioral correlates. *Journal of Counseling Psychology, 31*(4), 503. DOI: 10.1037/0022-0167.31.4.503

Somers, J. (December, 2010). The simple software that could--but probably won't--change the face of writing. *The Atlantic.* Retrieved from: https://www.theatlantic.com

Somers, J. (November, 2014). How I reverse engineered Google Docs to play back any document's keystrokes. Retrieved from: http://features.jsomers.net/how-i-reverse-engineered-google-docs/

Soto, C. J., & John, O. P. (2017). The next Big Five Inventory (BFI-2): Developing and assessing a hierarchical model with 15 facets to enhance bandwidth, fidelity, and predictive power. *Journal of Personality and Social Psychology*, *113*(1), 117.

Southavilay, V., Yacef, K., & Calvo, R. A. (2010, June). Process mining to support students' collaborative writing. In *Educational Data Mining 2010*.

Sowislo, J. F., & Orth, U. (2013). Does low self-esteem predict depression and anxiety? A meta-analysis of longitudinal studies. *Psychological Bulletin, 139*(1), 213.

Spielberger, C. D. (1962). The effects of manifest anxiety on the academic achievement of college students. *Mental Hygiene. New York, 46*(3), 420–426.

Steel, P. (2007). The nature of procrastination: A meta-analytic and theoretical review of quintessential self-regulatory failure. *Psychological Bulletin*, *133*(1), 65–94. https://doi.org/10.1037/0033-2909.133.1.65

Steel, P. (2010). Arousal, avoidant and decisional procrastinators: Do they exist?. *Personality and Individual Differences*, *48*(8), 926-934.

Steel, P., Brothen, T., & Wambach, C. (2001). Procrastination and personality, performance, and mood. *Personality and Individual Differences*, *30*(1), 95-106.

Steel, P., & Ferrari, J. (2013). Sex, education and procrastination: An epidemiological study of procrastinators' characteristics from a global sample. *European Journal of Personality*, *27*(1), 51–58. https://doi.org/10.1002/per.1851

Steel, P., Svartdal, F., Thundiyil, T., & Brothen, T. (2018). Examining procrastination across multiple goal stages: A longitudinal study of Temporal Motivation Theory. *Frontiers in Psychology*, *9*, 327. https://doi.org/10.3389/fpsyg.2018.00327

Svartdal, F., Granmo, S., & Færevaag, F. S. (2018). On the behavioral side of procrastination: Exploring behavioral delay in real-life settings. *Frontiers in Psychology, 9*, 746.

Svartdal, F., Klingsieck, K. B., Steel, P., & Gamst-Klaussen, T. (2020). Measuring implemental delay in procrastination: Separating onset and sustained goal striving. *Personality and Individual Differences, 156*, 109762.

Terracciano, A., & Costa, P. T. (2004). Smoking and the Five-Factor Model of personality. *Addiction, 99(4), 472–481.* doi:10.1111/j.1360-0443.2004.00687.x

Tice, D. M., & Baumeister, R. F. (1997). Longitudinal study of procrastination, performance, stress, and health: The costs and benefits of dawdling. *Psychological Science*, *8*(6), 454-458.

Tuckman, B. W. (1991). The development and concurrent validity of the procrastination scale. *Educational and Psychological Measurement*, *51*(2), 473-480.

Van Eerde, W. (2003). A meta-analytically derived nomological network of procrastination. *Personality and Individual Differences*, *35*(6), 1401-1418.

Viechtbauer W. (2010). Conducting meta-analyses in R with the metafor package. *Journal of Statistical Software, 36*(3), 1–48. https://doi.org/10.18637/jss.v036.i03

Wallace, I., & Pear, J. J. (1977). Self-control techniques of famous novelists. *Journal of Applied Behavior Analysis*, *10*(3), 515–525. https://doi.org/10.1901/jaba.1977.10-515

Wang, Y. (2021). Academic procrastination and test anxiety: A cross-lagged panel analysis. *Journal of Psychologists and Counsellors in Schools, 31*(1), 122-129.

Wang, D., Olson, J. S., Zhang, J., Nguyen, T., & Olson, G. M. (2015, April). DocuViz: visualizing collaborative writing. In *Proceedings of the 33rd annual ACM conference on human factors in computing systems* (pp. 1865-1874).

Watson, J. B. (1917). The effect of delayed feeding upon learning. *Psychobiology*, *1*(1), 51.

Weiner, I. B. (1971). Psychodynamic aspects of learning disability: The passive-aggressive underachiever. *Journal of School Psychology*, *9*(3), 246–251. https://doi.org/10.1016/0022-4405(71)90081-1

Weisberg, P., & Waldrop, P. B. (1972). Fixed-interval work habits of Congress. *Journal of Applied Behavior Analysis*, *5*(1), 93-97.

Wenzel, S. (2017). *The sin of sloth: Acedia in medieval thought and literature*. UNC Press Books.

White, M. J., Brockett, D. R., & Overstreet, B. G. (1993). Confirmatory bias in evaluating personality test information: Am I really that kind of person?. *Journal of Counseling Psychology*, *40*(1), 120.

Wickham H. (2016). *ggplot2: Elegant Graphics for Data Analysis*. New York, NY: Springer-Verlag. ISBN 978-3-319-24277-4. Retrieved from: https://ggplot2.tidyverse.org.

Willis, T. A., O'Connor, D. B., & Smith, L. (2005). The influence of morningness–eveningness on anxiety and cardiovascular responses to stress. *Physiology & Behavior*, *85*(2), 125-133.

Wohl, M. J., Pychyl, T. A., & Bennett, S. H. (2010). I forgive myself, now I can study: How self-forgiveness for procrastinating can reduce future procrastination. *Personality and Individual Differences, 48*(7), 803-808.

Wolf, O. T. (2003). HPA axis and memory. *Best Practice & Research Clinical Endocrinology & Metabolism*, *17*(2), 287-299.

Yerdelen, S., McCaffrey, A., & Klassen, R. M. (2016). Longitudinal examination of procrastination and anxiety, and their relation to self-efficacy for self-regulated learning: latent growth curve modeling. *Educational Sciences: Theory and Practice*, *16*(1), 5-22.

Zell, E., Strickhouser, J. E., Sedikides, C., & Alicke, M. D. (2020). The better-than-average effect in comparative self-evaluation: A comprehensive review and meta-analysis. *Psychological Bulletin*, *146*(2), 118.

Zheng, A., & Casari, A. (2018). *Feature engineering for machine learning: principles and techniques for data scientists.* Sebastopol, CA: O'Reilly Media, Inc.

Appendix A: Studies Included in Meta-Analysis

Argiropoulou, M.-I., & Vlachopanou, P. (2020). The role of psychological distress as a potential route through which procrastination may confer risk for reduced life satisfaction. *Current Psychology*. https://doi.org/10.1007/s12144-020-00739-8

Ashraf, M., Malik, J. A., & Musharraf, S. (2019). Academic stress predicted by academic procrastination among young adults: Moderating role of peer influence resistance. *Journal of Liaquat University of Medical & Health Sciences*, *18*(1), 65–70.

Aziz, S., & Tariq, N. (2013). A web-based survey of procrastination and its outcomes among pakistani adolescents. *Journal of Behavioral Sciences*, *23*(1).

Bentley, K. H., Sauer-Zavala, S., & Wilner, J. (2015). The unique contributions of distinct experiential avoidance domains to severity and functionality of non-suicidal self-injury. *Journal of Experimental Psychopathology*, *6*(1), 40–57. https://doi.org/10.5127/jep.040613

Beswick, G., Rothblum, E. D., & Mann, L. (1988). Psychological antecedents of student procrastination. *Australian Psychologist*, *23*(2), 207–217. https://doi.org/10.1080/00050068808255605

Beutel, M. E., Klein, E. M., Aufenanger, S., Brähler, E., Dreier, M., Müller, K. W., Quiring, O., Reinecke, L., Schmutzer, G., Stark, B., & Wölfling, K. (2016). Procrastination, distress and life satisfaction across the age range – A German representative community study. *PLOS One*, *11*(2), e0148054. https://doi.org/10.1371/journal.pone.0148054

Biella, M. M., de Siqueira, A. S. S., Borges, M. K., Ribeiro, E. S., Magaldi, R. M., Busse, A. L., Apolinario, D., & Aprahamian, I. (2020). Decision-making profile in older adults: The influence of cognitive impairment, premorbid intelligence and depressive symptoms. *International Psychogeriatrics*, *32*(6), 697–703. https://doi.org/10.1017/S1041610219001029

Carden, R., Bryant, C., & Moss, R. (2004). Locus of control, test anxiety, academic procrastination, and achievement among college students. *Psychological Reports*, *95*(2), 581–582. https://doi.org/10.2466/pr0.95.2.581-582

Chowdhury, S. F., & Pychyl, T. A. (2018). A critique of the construct validity of active procrastination. *Personality and Individual Differences*, *120*, 7–12. https://doi.org/10.1016/j.paid.2017.08.016

Closson, L. M., & Boutilier, R. R. (2017). Perfectionism, academic engagement, and procrastination among undergraduates: The moderating role of honors student status. *Learning and Individual Differences*, *57*, 157–162. https://doi.org/10.1016/j.lindif.2017.04.010

Deemer, E. D., Yough, M., & Morel, S. A. (2018). Performance-approach goals, science task preference, and academic procrastination: Exploring the moderating role of competence perceptions. *Motivation and Emotion*, *42*(2), 200–213. https://doi.org/10.1007/s11031-017-9649-z

Dewitte, S., & Schouwenburg, H. C. (2002). Procrastination, temptations, and incentives: The struggle between the present and the future in procrastinators and the punctual. *European Journal of Personality*, *16*(6), 469–489. https://doi.org/10.1002/per.461

Donovan, J. M. (1995). Relating psychological measures to anthropological observations: Procrastination as a field proxy for death anxiety? *Journal of Social Behavior and Personality*, *10*(2), 465.

Drozd, F., Raeder, S., Kraft, P., & Bjørkli, C. A. (2013). Multilevel growth curve analyses of treatment effects of a web-based intervention for stress reduction: Randomized controlled trial. *Journal of Medical Internet Research*, *15*(4), e84. https://doi.org/10.2196/jmir.2570

Eisenbeck, N., Carreno, D. F., & Uclés-Juárez, R. (2019). From psychological distress to academic procrastination: Exploring the role of psychological inflexibility. *Journal of Contextual Behavioral Science*, *13*, 103–108. https://doi.org/10.1016/j.jcbs.2019.07.007

Elhai, J. D., Sapci, O., Yang, H., Amialchuk, A., Rozgonjuk, D., & Montag, C. (2021). Objectively-measured and self-reported smartphone use in relation to surface learning, procrastination, academic productivity, and psychopathology symptoms in college students. *Human Behavior and Emerging Technologies*, hbe2.254. https://doi.org/10.1002/hbe2.254

Fernie, B. A., Bharucha, Z., Nikčević, A. V., Marino, C., & Spada, M. M. (2017). A Metacognitive model of procrastination. *Journal of Affective Disorders*, *210*, 196–203. https://doi.org/10.1016/j.jad.2016.12.042

Flett, G. L., Stainton, M., Hewitt, P. L., Sherry, S. B., & Lay, C. (2012). Procrastination automatic thoughts as a personality construct: An analysis of the procrastinatory cognitions inventory. *Journal of Rational-Emotive & Cognitive-Behavior Therapy*, *30*(4), 223–236. https://doi.org/10.1007/s10942-012-0150-z

Fritzsche, B. A., Rapp Young, B., & Hickson, K. C. (2003). Individual differences in academic procrastination tendency and writing success. *Personality and Individual Differences*, *35*(7), 1549–1557. https://doi.org/10.1016/S0191-8869(02)00369-0

Gautam, A., Polizzi, C. P., & Mattson, R. E. (2019). Mindfulness, procrastination, and anxiety: Assessing their interrelationships. *Psychology of Consciousness: Theory, Research, and Practice*. https://doi.org/10.1037/cns0000209

Glick, D. M., & Orsillo, S. M. (2015). An investigation of the efficacy of acceptance-based behavioral therapy for academic procrastination. *Journal of Experimental Psychology: General*, *144*(2), 400–409. https://doi.org/10.1037/xge0000050

Goroshit, M., & Hen, M. (2018). Decisional, general and online procrastination: Understanding the moderating role of negative affect in the case of computer professionals. *Journal of Prevention & Intervention in the Community*, *46*(3), 279–294. https://doi.org/10.1080/10852352.2018.1470421

Halama, P., & Gurňáková, J. (2014). Need for structure and big five personality traits as predictors of decision making styles in health professionals. *Studia Psychologica*, *56*(3), 171–180. https://doi.org/10.21909/sp.2014.03.658

Haycock, L. A., McCarthy, P., & Skay, C. L. (1998). Procrastination in college students: The role of self-efficacy and anxiety. *Journal of Counseling & Development*, *76*(3), 317–324. https://doi.org/10.1002/j.1556-6676.1998.tb02548.x

Hutchison, T., Murley Penney, A., & Crompton, J. (2018). Procrastination and anxiety: Exploring the contributions of multiple anxiety-related disorders. *Current Issues in Personality Psychology*, *6*(2).

Johnson, J. L., & Bloom, A. M. (1995). An analysis of the contribution of the five factors of personality to variance in academic procrastination. *Personality and Individual Differences*, *18*(1), 127–133. https://doi.org/10.1016/0191-8869(94)00109-6

Kennedy, G. J., & Tuckman, B. W. (2013). An exploration into the influence of academic and social values, procrastination, and perceived school belongingness on academic performance. *Social Psychology of Education*, *16*(3), 435–470. https://doi.org/10.1007/s11218-013-9220-z

Kim, S., Fernandez, S., & Terrier, L. (2017). Procrastination, personality traits, and academic performance: When active and passive procrastination tell a different story. *Personality and Individual Differences*, *108*, 154–157. https://doi.org/10.1016/j.paid.2016.12.021

Klein, E. M., Beutel, M. E., Müller, K. W., Wölfling, K., Brähler, E., & Zenger, M. (2019). Assessing procrastination: Dimensionality and measurement invariance of the General Procrastination Scale – Screening (GPS-S) in a representative sample. *European Journal of Psychological Assessment*, *35*(5), 633–640. https://doi.org/10.1027/1015-5759/a000441

Krause, K., & Freund, A. M. (2014). Delay or procrastination – A comparison of self-report and behavioral measures of procrastination and their impact on affective well-being. *Personality and Individual Differences*, *63*, 75–80. https://doi.org/10.1016/j.paid.2014.01.050

Lay, C. (1992). Trait procrastination and the perception of person-task characteristics. *Journal of Social Behavior & Personality*, *7*(3), 483–494.

Maw, J. A. (2005). *The facilitation of student success: Incorporating affective, behavioral, and cognitive factors into first-year experience programs* [Dissertation]. University of Manitoba.

Milgram, N. A., Dangour, W., & Ravi, A. (1992). Situational and personal determinants of academic procrastination. *The Journal of General Psychology*, *119*(2), 123–133. https://doi.org/10.1080/00221309.1992.9921166

Milgram, N., & Tenne, R. (n.d.). Personality correlates of decisional and task avoidant procrastination. *European Journal of Personality*, *14*(2), 141–156.

Moon, S. M., & Illingworth, A. J. (2005). Exploring the dynamic nature of procrastination: A latent growth curve analysis of academic procrastination. *Personality and Individual Differences*, *38*(2), 297–309. https://doi.org/10.1016/j.paid.2004.04.009

Ocansey, G., Addo, C., Onyeaka, H. K., Andoh-Arthur, J., & Oppong Asante, K. (2020). The influence of personality types on academic procrastination among undergraduate students. *International Journal of School & Educational Psychology*, 1–8. https://doi.org/10.1080/21683603.2020.1841051

Onwuegbuzie, A. J. (2004). Academic procrastination and statistics anxiety. *Assessment & Evaluation in Higher Education*, *29*(1), 3–19. https://doi.org/10.1080/0260293042000160384

Owens, A. M., & Newbegin, I. (1997). Procrastination in high school achievement: A causal structural model. *Journal of Social Behavior & Personality*, *12*(4), 869.

Paechter, M., Macher, D., Martskvishvili, K., Wimmer, S., & Papousek, I. (2017). Mathematics anxiety and statistics anxiety. Shared but also unshared components and antagonistic contributions to performance in statistics. *Frontiers in Psychology*, *8*, 1196. https://doi.org/10.3389/fpsyg.2017.01196

Pitel, L., & Mentel, A. (2017). Decision-making styles and subjective performance evaluation of decision-making quality among hospital nurses. *Studia Psychologica*, *59*(3), 217–231. https://doi.org/10.21909/sp.2017.03.742

Pychyl, T. (1995). *Personal projects, subjective well-being and the lives of doctoral students* [Dissertation]. Carleton University.

Pychyl, T. A., Lee, J. M., Thibodeau, R., & Blunt, A. (2000). Five days of emotion: An experience sampling study of undergraduate student procrastination. *Journal of Social Behavior & Personality*, *15*(5), 239–254.

Reinecke, L., Meier, A., Aufenanger, S., Beutel, M. E., Dreier, M., Quiring, O., Stark, B., Wölfling, K., & Müller, K. W. (2018). Permanently online and permanently procrastinating? The mediating role of Internet use for the effects of trait procrastination on psychological health and well-being. *New Media & Society*, *20*(3), 862–880. https://doi.org/10.1177/1461444816675437

Senécal, C., Koestner, R., & Vallerand, R. J. (1995). Self-regulation and academic procrastination. *The Journal of Social Psychology*, *135*(5), 607–619. https://doi.org/10.1080/00224545.1995.9712234

Senecal, C., Lavoie, K., & Koestner, R. (1997). Trait and situational factors in procrastination: An interactional model. *Journal of Social Behavior and Personality*, *12*(4), 889.

Shirren, S., & Phillips, J. G. (2011). Decisional style, mood and work communication: Email diaries. *Ergonomics*, *54*(10), 891–903. https://doi.org/10.1080/00140139.2011.609283

Sirois, F. M. (2014). Procrastination and stress: Exploring the role of self-compassion. *Self and Identity*, *13*(2), 128–145. https://doi.org/10.1080/15298868.2013.763404

Soysa, C. K., & Weiss, A. (2014). Mediating perceived parenting styles–test anxiety relationships: Academic procrastination and maladaptive perfectionism. *Learning and Individual Differences*, *34*, 77–85. https://doi.org/10.1016/j.lindif.2014.05.004

Steel, P., Brothen, T., & Wambach, C. (2001). Procrastination and personality, performance, and mood. *Personality and Individual Differences*, *30*(1), 95–106. https://doi.org/10.1016/S0191-8869(00)00013-1

Steel, P., & Klingsieck, K. B. (2016). Academic procrastination: Psychological antecedents revisited. *Australian Psychologist*, *51*(1), 36–46. https://doi.org/10.1111/ap.12173

Steel, P., Svartdal, F., Thundiyil, T., & Brothen, T. (2018). Examining procrastination across multiple goal stages: A longitudinal study of temporal motivation theory. *Frontiers in Psychology*, *9*, 327. https://doi.org/10.3389/fpsyg.2018.00327

Šuvak-Martinović, M., & Čarapina Zovko, I. (2017). Procrastination: Relations with mood, self-efficacy, perceived control and task demands. *Suvremena Psihologija*, *20*(2), 165–176. https://doi.org/10.21465/2017-SP-202-04

Tian, L. (2014). *The development and validation of proactive coping* [Dissertation]. University of Missouri.

Tice, D. M., & Baumeister, R. F. (1997). Longitudinal study of procrastination, performance, stress, and health: The costs and benefits of dawdling. *Psychological Science*, *8*(6), 454–458. https://doi.org/10.1111/j.1467-9280.1997.tb00460.x

ul-Malik, A., & Rafiq, N. (2016). Exploring the relationship of personality, loneliness, and online social support with internet addiction. *Pakistan Journal of Psychological Research*, *31*(1), 93–117.

Umeh, K., & Omari-Asor, L. (2011). Emotional vulnerability and coping styles for resolving decisional conflict. *The Journal of Psychology*, *145*(4), 297–312. https://doi.org/10.1080/00223980.2011.565381

Wan, H. C., Downey, L. A., & Stough, C. (2014). Understanding non-work presenteeism: Relationships between emotional intelligence, boredom, procrastination and job stress. *Personality and Individual Differences*, *65*, 86–90. https://doi.org/10.1016/j.paid.2014.01.018

Watson, D. C. (2001). Procrastination and the five-factor model: A facet level analysis. *Personality and Individual Differences*, *30*(1), 149–158. https://doi.org/10.1016/S0191-8869(00)00019-2

Yang, X., Wang, P., & Hu, P. (2020). Trait procrastination and mobile phone addiction among chinese college students: A moderated mediation model of stress and gender. *Frontiers in Psychology*, *11*, 614660. https://doi.org/10.3389/fpsyg.2020.614660

Yang, Z., Asbury, K., & Griffiths, M. D. (2019). An exploration of problematic smartphone use among chinese university students: Associations with academic anxiety, academic procrastination, self-regulation and subjective wellbeing. *International Journal of Mental Health and Addiction*, *17*(3), 596–614. https://doi.org/10.1007/s11469-018-9961-1

Yerdelen, S., McCaffrey, A., & Klassen, R. (2016). Longitudinal examination of procrastination and anxiety, and their relation to self-efficacy for self- regulated learning: Latent growth curve modeling. *Educational Sciences: Theory & Practice*. https://doi.org/10.12738/estp.2016.1.0108

Yu, Y., Hua, L., Feng, X., Wang, Y., Yu, Z., Zi, T., Zhao, Y., & Li, J. (2021). True grit in learning math: The math anxiety-achievement link is mediated by math-specific grit. *Frontiers in Psychology*, *12*, 645793.

Zhang, R., Chen, Z., Xu, T., Zhang, L., & Feng, T. (2020). The overlapping region in right hippocampus accounting for the link between trait anxiety and procrastination. *Neuropsychologia*, *146*, 107571.