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Kinds of Future-Oriented Thought and Their Relations to Well-Being

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Kinds of Future-Oriented Thought and Their Relations to Well-Being

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M.A., Georgia State University, 2011

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An abstract of
a dissertation submitted to the Faculty of the
James T. Laney School of Graduate Studies of Emory University
in partial fulfillment of the requirements for the degree of
Doctor of Philosophy
in Psychology
2017

Abstract

Kinds of Future-Oriented Thought and Their Relations to Well-Being
By Jason S. Shepard

Dozens of studies have found evidence for a positive relation between future-oriented thought and health and well-being (i.e. people who think about the future more tend to be better off). However, due to limitations in how future-oriented thought has been conceptualized and measured, the evidence for this relation may not be as strong as the research suggests. These limitations include the conceptualization and measurement of future-oriented thought as a unidimensional construct that is primarily about goal construction and planning. In this paper, I report the development and validation of an automated, language-based measure of future-oriented thought, the use of machine-learning techniques to discover whether future-oriented thought is unidimensional or multidimensional, and three studies that test the relation between future-oriented thought and well-being. The results indicated that future-oriented thought is a multidimensional construct, and that future-oriented thought is positively related to well-being when measured at the population level (Study 1) and at the individual level (Study 2), but when the multidimensional nature of future-oriented thought is taken into account, the relations between future-oriented thought and well-being are much more complex, yet intuitive (Study 3).

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Acknowledgments

When I was in high school, I was so certain that I was never going to college that I did not even attempt to take the ACT or SAT. When I graduated high school, I went into the workforce still thinking that I would never even step foot on a college campus. Not too long after graduating, I had a child, and I was struggling to meet ends meet. I did not have a sense how to make things better. I just knew something had to change. One day I found myself on the campus of the University of South Alabama selling cellphones when I saw someone I knew. I was shocked. Someone *like me* was in college and doing just fine. I chatted with her for a few minutes, and by the end of the conversation, I made up my mind: I was going to college, too. With my cellphones in hand, I walked straight down to the admissions office to apply. I started college at the University of South Alabama the next semester. And here I am some years later, a doctor. Without this chance encounter, I may never have made it to college, and my life would surely have been very different than what it is today. My memories of who this old friend was has faded. I cannot quite place a face or a name to this friend, at least not without confidence. She changed the course of my life without even knowing she had made an impact.

There are many others who, without their support, my path toward a doctorate would not have been possible. At the top of this list is my family. My mother, Karen Harold, and my step-father, Richard Harold, really stepped up to help me take care of my son while I was in college. Without their help, none of this would have been possible. My wife, LaShaye Shepard, also deserves much gratitude. She has been with me since the hardest of times, and she has been extremely patient with me as we have journeyed down this path toward my PhD. She also deserves all the credit in the world for stepping up and

taking in my son as if he was her own. My son, Jalen Shepard, who is now only a few years away from college himself, deserves many thanks, too. I must admit these teenage years have been a little rough, but overall, he has been a great kid and an amazing person. A father could not ask for anything more. And to my father, David Shepard, thank you for being there for me and believing in me throughout my life. I would also like to thank my aunt, Bonnie Shepard, who really played an important role in my life and who has continued to be an important source of support.

To my academic families at the University of South Alabama, Georgia State University, and Emory University, much is owed to you. To my PhD advisor, Phillip Wolff, thank you for being willing to take a chance on me. I know taking me in as a student came with some risks. I also know that I could be a difficult student at times. Yet you took me in, supported me, and provided me with everything I needed to flourish. I am really glad that I landed at Emory in your lab. Thank you for patience, support, and dedication. To my dissertation committee, Nancy Bliwise, Robyn Fivush, Eddy Nahmias, and Philippe Rochat, many thanks to all of you for the great patience you had with me and the extraordinary level of support you gave to me throughout the whole process. To the neuroethics program, especially Karen Rommelfanger and Gillian Hue, thank you for taking an interest in me early in my career at Emory. It was a great honor to be named one of the inaugural Neuroethics Program Fellows. To my lab mates, Kevin Holmes and Robert Thorstad, thank you being the best lab mates a person could ask for. You have really played a major role in my intellectual development. There are so many other people at Emory deserving thanks, including many of my fellow graduate students,

members of staff, and other faculty members. I am hesitant to list all of you because of fear of leaving out someone. So, just know that you are appreciated, too.

At Georgia State University, where I earned my MA in philosophy, I was greeted each and every day with a challenging, yet friendly, intellectual environment. Every single person who I have ever came into contact with there has a played a meaningful role in my development as a scholar, and more importantly, as a person. While everyone I met at Georgia State genuinely deserves acknowledgments, there are two people that I cannot go without mentioning: Eddy Nahmias and George Graham. Eddy, you have been a great advisor, mentor, colleague, and friend. It has been a pleasure working with you. George, you taught me the importance of being able to communicate the most sophisticated of ideas in a simple-to-understand manner. While I often fall short of being able to do this, your voice is always in the back of my head reminding of the importance of being able to relay my work to a more general audience. You also provided great emotional support to me. Though my years at Georgia State were wonderful, things were still very tough for me. On more than one occasion, I came to your office in tears. You there for me in ways that go well beyond what is required of faculty.

At the University of South Alabama, where I earned BAs in psychology and philosophy, there were so many people who had a great impact on my career trajectory. I entered South Alabama at a time where I still was not convinced that college was for me. I left South Alabama with intentions to pursue a PhD. That kind of radical change in attitude does not occur without enormous positive influence from the entire community. I do want to give special thanks to Ted Poston, who advised me on my first research project. It was doing this work that really convinced me that I wanted to pursue a career

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Chapter 1: Introduction

1.1 The importance of future-oriented thought

In cognitive psychology, great attention has been paid to how humans think about the past including the development and testing of models that detail different ways in which we think about the past (e.g., episodic, semantic, procedural, etc.). However, humans do not just think about the past. We also have a remarkable ability to think about the future, an ability that is likely qualitatively different than other animals (Gilbert & Wilson, 2007; Seligman, Railton, Baumeister, & Sripada, 2016; Sripada, 2016; Suddendorf & Corballis, 2007). We can think much further into the future than other animals. We can even think about futures beyond our lifetimes. We can also consider a wider range of possible futures than other animals. We can consider many different choices (e.g., should I have pizza, pad Thai, shrimp tacos, or ice cream for dinner) and many different possible outcomes for each of those many choices (e.g., if I have ice cream for dinner, my sweet tooth will be satisfied, my kid will be happy, and I will feel sick). Other animals are likely very limited in the number of choices and outcomes they can consider at any one time. Not only do we have remarkable abilities to think about the future, but we spend much of our conscious life doing so. Previous research has indicated that we spend as much time thinking about the future as we do the past (Berntsen & Jacobsen, 2008; Finnbogadottir & Berntsen, 2013), if not more time thinking about the future than the past (Baird, Smallwood, & Schooler, 2011; Baumeister, Vohs, Hofmann, Reiss, & Summerville, 2017; Smallwood, Nind, & O'Connor, 2009).

1.1.1 Important functions of future-oriented thought

Future-oriented thought is common because it serves a number of important functions. Future-oriented thought is essential to our ability to construct goals and develop plans (Baird, et al., 2011; Baumeister, Vohs, & Oettingen, 2016; D'Argembeau, Renaud, Van der Linden, 2011; Schooler, et al., 2014; Szpunar, Spring, Schacter, 2015). In fact, goal construction and planning is commonly considered the primary function of future-oriented thought both in terms of importance (Baumeister, et al., 2016) and in terms of frequency of occurrence (Baird et al., 2011; Baumeister et al., 2017).

Future-oriented thought also plays a role in the development of identity and one's sense of self (D'Argembeau, Lardi, Van der Linden, 2012; Gollwitzer & Wicklund, 1985; Markus & Nurius, 1986; Williams & Gilovich, 2008). The ability to consider potential possible selves, or selves that one might become in the future, plays a role in determining the goals we set and providing motivation to meet these goals (Markus & Nurius, 1986; Oyserman, Bybee, Terry, & Hart-Johnson, 2004). For example, if a high school student was clearly able to envision herself as an occupational therapist, she would be more likely to set goals related to this possible self, which may include graduating high school, doing well in her health and biology courses, seeking out mentors in the field, researching colleges and job opportunities, etc. She would also be more likely to be motivated to meet these goals and would be more likely to achieve her goals.

1.1.2 Future-oriented thought and well-being

There is also support that future-oriented thought is positively related to health and well-being. People who think about the future more tend to have better physical health. For example, people who have stronger future orientations are less likely to

smoke (Adams, 2012), drink heavily (Daugherty & Brase, 2010), or use illicit drugs (Keough, Zimbardo, & Boyd, 1999; Wills, Sandy, & Yaeger, 2001). Young adults who think more about the future are more likely to exercise (Daugherty & Brase, 2010; Ouellette, Hessling, Gibbons, Reis-Bergan, & Gerrard, 2005), as are middle-aged adults (Whaley, 2003) and adults who are in the later stages of life (Kahana, Kahana, & Zhang, 2005). People with stronger future orientations tend to eat healthier (Zimbardo & Boyd, 1999) and are more likely to maintain a healthy weight (Adams, 2012). They also tend to engage in fewer risky behaviors: They tend to be safe drivers (Daugherty & Brase, 2010; Zimbardo, Keough, & Boyd, 1997) and are more likely to engage in safe sex practices (Rothspan & Reed, 1996).

People who think about the future more tend to have better mental health. In a longitudinal study of the mental health of people following the September 11th terrorist attacks, Holman and Silver (2005) found that people with higher future orientations experienced lower levels of psychological distress, higher levels of positive affect, and greater life satisfaction than people with lower future orientations. The effect of future orientation on these indicators of mental health remained even when controlling for degree of exposure to the attacks (Holman, Silver, Mogle, & Scott, 2016; Zimbardo, Sword, & Sword, 2012). Future orientation has been found to act as a buffer against feelings of hopelessness and depressive symptoms following victimization during early adolescence (Hamilton, et al., 2015), has been associated with lower rates of suicidal ideations and attempts in depressed adults over the age of 50 (Hirsch, et al., 2006), and has been associated with lower rates of self-harm for people with personality disorders (McLeod, et al., 2004). Clinical interventions focused on increasing future-orientation

have been found to be effective in treating symptoms of depression (Vilhauer, et al., 2012), including suicidal ideation and attempts (van Beek, 2012; van Beek, Kerkhof, & Beekman, 2009) and for treating symptoms of PTSD (Sword, Sword, & Brunskill, 2015). In general, a strong future orientation may act as a protective buffer in response to adversity and trauma and for people with mental disorders (Holman & Silver, 1998; Holman, et al., 2016; Zimbardo, et al., 2012).

People who think about the future more tend to report higher levels of well-being, including hedonistic well-being, which includes general feelings of happiness and satisfaction, and eudaemonic well-being, which is a more meaningful form of well-being that includes purpose in life, self-acceptance, personal growth, and autonomy (for an overview of the distinction see Ryan & Deci, 2001; Ryff & Keyes, 1995). In particular, future orientation has been found to be positively related with satisfaction in life in American samples (Dwivedi & Rastogi, 2017; Holman & Silver, 2005; Nie, Shepard, Choi, Copley, & Wolff, 2015; Zhang, Howell, & Bowerman 2013; Zhang, Howell & Stolarski, 2013), Indian samples (Dwivedi & Rastogi, 2017), and Russian samples (Boniwell, Osin, Linley, and Ivanchenko 2010). These relations remain even when controlling for personality (Zhang & Howell, 2011). Future orientation has been found to be positively related to positive affect and negatively related to negative affect (Desmyter & De Raedt, 2012; Holman & Silver, 2005; Ruby, Smallwood, Engen, & Singer, 2013; Sheldon & Lyubomirsky, 2006; Zhang, Howell, & Bowerman 2013; Zhang et al., 2013). Future orientation has been found to be associated with higher levels of optimism and hope (Boniwell, et al., 2010; Dwivedi & Rastogi, 2017; O'Brien McElwee, & Haugh,

2010) and having a greater sense of purpose in life (Baumiester, Vohs, Aaker, & Garbinsky, 2013; Boniwell, et al., 2010; Hicks, Trent, Davis, & King, 2012).

Future-orientation has also been found to be related to higher levels of academic achievement (Bowles, 2008; Honora, 2002; Husman & Lens, 1999; Oyserman, Brickman, & Rhodes, 2007; Oyserman, Bybee, & Terry, 2006; Simons, et al., 2004), reduced rates of delinquency delinquents (Oyserman & Markus, 1990a, 1990b; Oyserman & Saltz, 1993), healthier social relationships (Lang & Carstensen, 2002), and improved economic decision-making and greater economic security (Howlett, Kees, & Kemp, 2008; Thorstad & Wolff, 2016, 2017; Webley & Nyhus, 2006).

The positive relations between future-oriented thought and health and well-being have not only been demonstrated at the level of individuals but also at the level of countries and cultures (Preis, Moat, Stanley, & Bishop, 2012; Shepard & Turner, forthcoming). Preis, et al. (2012) found that the future orientation of a country was positively related to the GDP of a country. Using Google Trends, which is a Google service that calculates the frequency of search terms, they calculated the future-orientation for 45 countries by calculating a ratio of how often people in a country searched for a future year (e.g., searches for 2017 in 2016) divided by how often people searched for a past year (e.g., searches for 2015 in 2016). They correlated this index of future orientation with the GDP of the country for three different years, finding strong correlations (rs .53 > .78) between a country's future orientation and the GDP of that country.

In other research using the future-orientation index, Shepard and Turner (forthcoming) examined the relation between the future orientation of a country and the

physical health, life satisfaction, happiness, and financial well-being of the people of the country. They calculated this relation in a sample of 64 countries at three different time points. They found that a country's future orientation was positively related to physical health (rs .41 > .48), life satisfaction (rs .45 > .48), happiness (rs .36 > .45), and economic well-being (rs .55 > .58) of that country's people. They also found that the relation between future-oriented thought and well-being remained robust across multiple potential cultural moderators.

1.2 Measurements and possible problems

In much of the research on the relation between future-oriented thought and health and well-being, future-oriented thought has been construed as a unidimensional construct. It has also been construed fairly narrowly. The two most commonly used tools to measure future-oriented thought are the Considerations of Future Consequences Scale (CFCS; Strathman, Gleicher, Boninger, & Scott, 1994) and the Zimbardo Time Perspective Inventory (ZTPI; Zimbardo & Boyd, 1999). The CFCS was explicitly designed to measure a particular aspect of future-oriented thought: the extent to which people consider the immediate and distant consequences of behavior. Even though the CFCS was explicitly designed to measure this aspect of future-oriented thought, it is often used as a general measure of future-oriented thought.

The ZTPI was explicitly designed to measure future-oriented thought in general, not just an aspect of future-oriented thought (Boyd & Zimbardo, 2005; Zimbardo & Boyd, 1999). Even though the ZTPI was designed to measure future-oriented thought in general, one feature to notice is that the ZTPI primarily focuses on thinking about the future in terms of agency, in particular goal construction and planning. The items from

the CFCS (Stratham et al., 1994), a scale that was only intended to measure an aspect of future orientation, are topically similar to the ZTPI's items. See Table 1. This suggests that the ZTPI might not capture the full range of future-oriented thought. If the ZTPI does not capture the full range of future-oriented thought, caution needs to be taken in interpreting the evidence cited above as evidence that future-oriented thought is, in general, good for you.

Table 1. Example items from the Zimbardo Time Perspective Inventory (ZTPI; Zimbardo & Boyd, 1999) and the Considerations of Future Consequences Scale (CFCS; Stratham et al., 1994).

Scale	Items
ZTPI	I believe that a person's day should be planned ahead each morning.
	When I want to achieve something, I set goals and consider specific means for reaching those goals
	Before making a decision, I weigh the costs against the benefits.
	I make lists of things to do.
CFCS	I consider how things might be in the future, and try to influence those things
	My behavior is influenced by the immediate (e.g., days or weeks) outcomes of my actions
	I consider how things might be in the future, and try to influence those things with my day to day behavior

Intuitively, thinking about the future is not just about goals and plans and not all future-oriented thought is good for you. For example, worry, anxiety, stress, and fear are often future-directed (Borkovec, Robinson, Pruzinksy, & DePree, 1983; Zaleski, 1996). These negative future-directed affective states can have negative impacts on health and well-being, including increases in frequency and duration of negative mood (Stawarczyk, Majerus, & D'Argembeau, 2013), increases in somatic complaints (Brosschot, & van den

Doef, 2007), higher rates of cardiovascular problems (Kubzansky, et al., 1997), decreased academic achievement (Owens, Stevenson, Hadwin, 2012), and poor interpersonal relationships (Borkovec, Ray, & Stober, 1998).

1.3 Open questions and possible answers

1.3.1 Improvements in measuring future-oriented thought?

Question #1. How can we develop better measurements of future-oriented thought?

Hypothesis #1. It is hypothesized that future-oriented thought can be measured by analyzing future-oriented language.

Research on future-oriented thought has been based primarily on scales that require people to think explicitly about their own mental states. There are at least two limitations to such an approach. First, the specific questions used in inventory-based approach are generated by researchers, and hence depend on the researcher's *a priori* expectations about the nature of future-oriented thought. The danger in such an approach is that the results may merely reflect the hypotheses that gave rise to the questions in the first place. A second limitation is that overt scales of future-oriented thought depend on people's explicit awareness of their own mental processes. One of the problems with this assumption is that the processes people use in everyday decision making might be quite different from those they have conscious access to (Nisbett & Wilson, 1977; Sripada & Konrath, 2011).

It may be possible to avoid these problems using a more implicit measure of future-oriented thought. Specifically, it may be possible to measure future-oriented thought by analyzing the manner and degree to which people refer to the future in their everyday free speech. Ordinary free speech may carry signals about the nature of the

human processing, but those signals can easily be lost in the various other signals implied in ordinary free speech. The noisiness of data is a problem, but it is a problem that can be overcome through the use of large quantities of data. Through the use of large quantities of data, the signal of interest can emerge out of the noise. The collection of such large volumes of data is now made possible through the emergence of Big Data techniques. In particular, Big Data techniques allow for the automatic coding of information. A researcher can give a program a coding scheme and that program can search large amounts of text in a relatively short amount of time.

Such an approach can be used to measure future-oriented thought. In this project in particular, 91 rules were developed to identify references to the future. Each rule identifies a different way of referring to the future and, thus, potentially, a different way of thinking about the future. These rules were developed to identify all references to the future, allowing the measurement to cover the full range of ways we think about the future. This provides another advantage over previous measurement tools, as previous measurement tools only picked out certain aspects of referring to the future, including measurement tools like the ZTPI that were intended to cover the full range of ways we think about the future. We call this automated method of picking out references to the future, the temporal orientation parser.

1.3.2 Relation between future orientation and well-being?

Question #2. Is there a relation between future-orientated thought when defined broadly enough to capture the full-range of future-oriented thought and well-being?

Hypothesis #2. It is hypothesized that future-oriented thought is related to well-being, but the relation is not as robust—both in terms of strength of relation and in terms of the number of well-being variables—as previous literature has suggested.

Prior research strongly supports a link between thinking about the future in terms of agency (e.g., goals, planning) and well-being. Thinking about the future in terms of agency is likely the most common way we think about the future (Baird et al., 2011; Baumeister et al., 2017). There may also be other ways of thinking about the future that are good for you. For example, optimism and hope are often future directed. These kinds of positive future-directed affective states may be positively related to well-being. Of course, as reviewed above, negative future-directed affective states such as worry, fear, and anxiety tend to be negatively related to well-being. While thinking about the future may be mixed of good and bad, the prediction is that the overall trend is likely positive, primarily because of the dominance of thinking about the future in terms of agency.

1.3.3 Multiple categories of future oriented thought?

Question #3. Is future orientation a unidimensional or multidimensional construct?

Hypothesis #3. It is hypothesized that future-oriented thought is a multidimensional construct.

A bottom-up, data-driven approach to the measurement of future-oriented thought allows for the *discovery of* possible categories of future-oriented thought. The prior literature suggests several categories of future-oriented thought that might emerge from such an approach. The prior literature suggests that the dimension of agency may figure prominently in people's thoughts about the future. In particular, prior literature has

emphasized the importance of goals and planning (Gollwitzer 1993, 1999; Szpunar et al., 2015).

The prior research has also placed a lot of attention on negative affective states. Thinking about the future in terms of negative affective states, intuitively, seems to be very different from thinking about the future in terms of agency. It also seems to be a very common way of thinking about the future, so it is possible that a negative affective-state category of future-oriented thinking might emerge. Indeed, the expectation for these two categories—an agency-related category and a negative-affective state category—is so strong that failure of these categories to emerge from the analysis would be more likely to place doubt on the analysis rather than doubt on the existence of these as distinct, meaningful categories.

1.3.4 Discovering categories?

Question #4. How can we discover the categories of future-oriented thought?

Hypothesis #4. It is hypothesized that categories of future-oriented thought can be discovered through the use of machine-learning algorithms that are able to recognize patterns of similarities between the different ways of talking about the future.

Pattern-matching rules can be developed to identify references to the future. Once developed, relations between these rules can be examined to see whether the rules tend to fall into clusters. In particular, machine-learning programs can discover how similar any two rules are from each other by learning the context in which the rules appear. The idea here is that if two rules appear in very similar contexts (e.g., the same set of words typically appear around the rule), then the rules are similar. Once a similarity space is built, clustering algorithms can be used to determine if there are sets of rules that are very

similar to each other yet different from other sets of rules. Similar sets will cluster together, providing evidence for categories. Once clusters of rules have been discovered, a topic modeling algorithm can be run to generate a semantic characterization of the clusters.

1.3.5 Relations between the categories and well-being?

Question #5. What is the relation between the categories of future-oriented thought and well-being?

Hypothesis #5. It is hypothesized that the relation between future-oriented thinking and well-being is complex.

As discussed above, while think about the future may be good for you in general, there seem to be some ways of thinking about the future that are bad for you (e.g., worries, anxieties, and fears). Furthermore, the prior research has indicated that future orientation is associated with a range of kinds of well-being (e.g., life satisfaction, purpose in life, positive affect). It is likely that different ways of thinking about the future are related to different kinds of well-being.

1.4 Outline of the remainder of the dissertation

In the remainder of this chapter, I briefly review existing ways of categorizing future-oriented thought and discuss the varieties of well-being. In Chapter 2, I outline the development and validation of a new automated tool for measuring future-oriented thought. In Chapter 3, I report two studies that replicate previous research demonstrating a relation between future-oriented thought and well-being being. In Chapter 4, I discuss how Big Data and machine-learning methods can be used to discover a new model of future-oriented thought. In Chapter 5, I report a third study that re-analyzes the relation

between future-oriented and well-being with respect to the categories that emerged from the analysis reported in Ch. 4. In Chapter 6, I discuss future directions and broader implications of this research.

1.5 Categorization schemes of future-oriented thought

The research reported here is not the first to propose that future-oriented thought is composed of multiple dimensions. In this section, I review some of the categories of future-oriented thought that have been proposed in the literature.Knowing the current proposals will allow us to know how the categories of future-oriented thought that emerges from the research reported in this dissertation compares to those from earlier research.

1.5.1 Unidimensional models of future-oriented thought

The development of the most commonly used measure of future-oriented thought, the Zimbardo Time Perspective Inventory (ZTPI; Zimbardo & Boyd, 1999), gave rise to an empirically derived model of various time orientations, also referred to as time perspectives. The ZTPI is composed of five subscales. Each of the subscales measures statistically dissociable time orientations, also referred to as time perspectives. There are two subscales for past time perspective, past-negative and past-positive; two subscales for present time perspective, present-hedonistic and present-fatalistic; but only one subscale for future time perspective.

Unlike previous scales that were designed to measure a specific aspect of future orientation (e.g., the Considerations of Future Consequences Scale (CFCS, Stratham et al., 1994) and the Future Anxiety Scale (Zaleski 1996)) the future subscale of the ZTPI was explicitly constructed to measure future-oriented thought in general (Boyd &

Zimbardo, 2005; Zimbardo & Boyd, 1999). Of special note is that *a priori* Zimbardo and

Boyd (1999) expected future-oriented thought to be composed of several sub-factors and

"were surprised that the Future factor did not decompose into several subfactors" (p.

1275). Rather than assuming their measurement did not capture the full range of future-

oriented thought, they accepted future-oriented thought as a unidimensional construct and

embraced a unidimensional model of future-oriented thought.

As mentioned in Section 1.2, one feature to notice of the items from the ZTPI

(Zimbardo & Boyd, 1999) is that the items from these scales focus primarily on agency,

and in particular goal construction and planning. The items from the CFCS (Stratham et

al., 1994), a scale that was only intended to measure an aspect of future orientation, are

topically similar to the ZTPI's items. This, along with the strong intuition that there are

other ways of thinking about the future (e.g., worries, fears, and anxieties), suggests that

the ZTPI might not capture the full range of future-oriented thought.

1.5.2 Valence-based models of future-oriented thought

Several researchers have challenged Zimbardo and Boyd's (1999, 2005) conclusion that

future thinking is based on a single dimension. In particular, Carelli Wiberg, and Astrom,

(2015) and Holman and Silver (2005) have proposed that negative affective states, such

as worries, anxieties, and fears, represent a distinct way of thinking about the future.

Carelli et al. and Holman and Silver have proposed a bidimensional model of future-

oriented thought composed of a positive dimension captured by the ZTPI (Zimbardo &

Boyd, 1999) and a negative dimension composed of future-directed negative affective

states.

1.5.3 Memory-inspired models of future-oriented thought

Memory-inspired models of future-oriented thought have primarily come out of the mental time travel literature. Many of the researchers working in this area of research have built their careers conducting memory research prior to their work on future-oriented thought (e.g., Atance & O'Neill, 2001; Suddendorf & Corballis, 2007; Szpunar et al., 2015). When building models of future-oriented thought, they applied concepts from memory to better understand the different ways in which we think about the future. The earliest models of future-oriented thought that emerged from this literature categorized future-oriented thought as being episodic or semantic future-oriented thought (Atance & O'Neill, 2001), while other researchers hypothesized that procedural future-oriented thought represents a distinct kind of future-oriented thought (Suddendorf & Corballis, 2007). A more recent model developed by Szpunar et al. (2015) draws inspiration from memory-based models of future-oriented thought. Szpunar et al.'s model construes future-oriented thought as varying along a continuum from fully episodic to fully semantic future-oriented thought, and this continuum is fully crossed by four categories of future-oriented thought: simulation, prediction, intention, and planning. See Figure 1 for Szpunar et al.'s model of future-oriented thought.

Simulation	**Prediction**	**Intention**	**Planning**

Episodic

Specific autobiographical event

Non-specific autobiographical state

General or abstract state of the world

Semantic
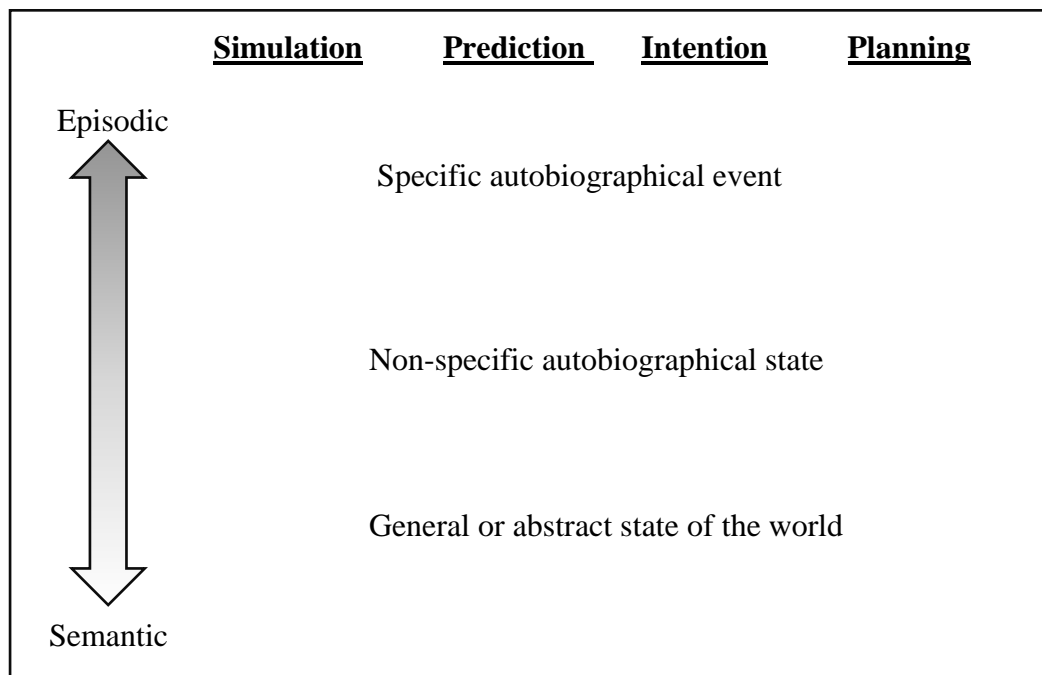
Figure 1. Szpunar et al.'s (2015) model of future-oriented thought

1.5.4 Ad-hoc categorization schemes of future-oriented thought

What I am calling "ad-hoc categorization schemes" are theoretical frameworks developed

to capture particular distinctions of interest for a particular set of studies. One example of

an ad-hoc categorization scheme comes from research by Gollwitzer (Gollwitzer 1993,

1999; Gollwitzer & Oettingen, 2016; Gollwitzer & Sheeran, 2006). Gollwitzer

hypothesized that setting goals does not provide the necessary motivation for goal-related

actions; rather, developing plans to meet these goals is essential for increasing motivation

for goal-related actions, along with increasing the likelihood of goal achievement. Here,

Gollwitzer is proposing a cognitively and behaviorally significant distinction in future-

oriented thought: goals vs. planning. Numerous studies over the last few decades have

borne out this hypothesis. Some research has even indicated that vividly imagining meeting goals may decrease the likelihood of goal achievement (Kappes & Oettingen, 2011).

Another example of ad-hoc categorization schemes are found in checklist approaches. These checklists are typically designed for a single study or a set of studies. These checklists are typically meant to capture the full range of ways we think about the future. For example, Baumeister et al. (2017) developed a checklist of eight categories that were intended to capture the full range of the different ways we think about the future. Their categories were planning, hopes, imagining, intending, other's actions, worries, emotional forecasting, and other. The "other" category was rarely used by participants, providing what Baumeister et al. took as evidence that their checklist captured the full range of future-oriented thought.

1.6 Varieties of well-being

Well-being is often divided into two major kinds: hedonic and eudaemonic (Ryan & Deci, 2001; Ryff & Keyes, 1995). *Hedonic well-being* is associated with pleasure and happiness. Components of hedonic well-being include cognitive judgments of satisfaction with life and positive and negative affective appraisals (Diener, 1984). The cognitive components is commonly assessed using the Satisfaction with Life Scale (SWLS; Deiner, Emmons, Larsen, & Griffen, 1985). Example items from the SWLS include, "I am satisfied with my life," and "So far I have gotten the important things I want in life." Given that affective appraisals are also an important component of hedonic wellbeing, assessments that measure affect (e.g., positive, negative moods, happiness) are commonly

used in conjunction with assessments of life satisfaction to give a more complete picture of hedonic wellbeing.

Eudaemonic well-being is commonly thought of as a more meaningful form of well-being. Rather than being most closely associated with happiness and pleasure, eudaemonic well-being is associated with having purpose, being autonomous, and having the capacity for self-growth. Eudaemonic well-being is commonly assessed using the Psychological Well-Being Scale (PWBS; Ryff & Keyes, 1995). The PWBS is comprised of six subscales: autonomy, environmental mastery, personal growth, purpose in life, self-acceptance, and positive relations. Example items include, "I feel confident and positive about myself," (self-acceptance) and, "I have a sense that I have developed a lot as a person over time," (personal growth).

Future-oriented thought has been found to be related to both hedonic and eudaemonic well-being (Baumiester, et al, 2013; Boniwell, et al., 2010; Hicks, et al., 2012). However, it is likely that certain ways of thinking about the future are more strongly related to aspects of eudaemonic well-being, while others to hedonic well-being. For example, being able to successfully set goals and make meaningful plans to meet those goals increases one's sense of control and has been found to increase feelings purpose in life but not happiness (Baumiester, et al, 2013). Feeling autonomous and having purpose are both forms of eudaemonic well-being, while happiness is form of hedonic well-being. This suggests that a goal- or planning-related category may be strongly related to forms of eudaemonic well-being. However, it is possible that other kinds of future-oriented thought are more strongly related to hedonic well-being.

1.7 Summary of Chapter 1

Future-oriented thought has been found to be related to health and well-being. However, in the research on future-oriented thought and well-being, future-oriented thought is typically measured as a unidimensional construct. Future-oriented thought is likely a multi-dimensional construct, and it is likely that some ways of thinking about the future are good for you (e.g., goals and planning) while others are bad (e.g., worries, anxieties, and fears). If future-oriented thought is a multi-dimensional construct, we may be able to better understand the relations between future-oriented thought and well-being if we looked at the relations between future-oriented thought and well-being with respect to each category of future-oriented thought.

Additionally, the most common measures of future-oriented thought do not measure the full-range of future-oriented thought. Typically, the measurement tools focus on agency-related constructs such as goal construction and planning. However, it is often concluded through use of these tools that future-oriented thought in general is good for you, not just thinking about the future in a particular way. Since the tools do not measure the full range of future-oriented thought, these conclusion may be misleading. In the following chapters I report the development of a new method for measuring future-oriented thought that addresses the limitations of previous measures of future-oriented thought.

Chapter 2: Measuring future-oriented thought

In this chapter, I report the construction and validation of the temporal orientation parser, an automated language-based measure of future-oriented thought.

2.1 Linguistic devices for referring to the future

Picking out language that refers to the future sounds easy enough. Just pick out uses of 'will', and you will be able to capture all, or at least nearly all, references to the future. However, the task is not that simple. English technically does not have a future tense (Copley, 2009). Because of the lack of future tense, English has developed a number of morphological, lexical, and syntactic devices for referring to the future.

Morphological devices for referring to the future include the modal verb 'will' but also include the other modal verbs, such as 'may', 'might', 'should', "shall', 'must', 'can', 'could', and 'would', and semi-modals such as 'has to', 'going to', and 'want to'. Examples of this kind of approach to referring to the future are shown in (1) – (4)

1. Malemma **will** write the introduction to the paper.

2. Tyra **should** easily make the deadline.

3. Aneyn **has to** give a talk on those dates.

4. Rouyuan is **going to** do amazing in grad school.

Each of these sentences refers to the future. The modal verbs in (1) and (2) and the semi-modals in (3) and (4) are morphological devices that indicate that these statements are about the future.

English also has a number of lexical devices that can be used to refer to the future. In other words, many English words have reference to the future built into their meaning. Examples of this kind of approach to referring to the future are shown in (5) – (7).

5. Atlanta United **anticipates** making it to the playoffs.

6. The Braves are excited about the **upcoming** draft.

7. The Hawks play the Hornets **tomorrow**.

Each of these sentences uses the present tense; however, we know that these sentences are about the future because of the lexical devices used. Future orientation is built into the meaning of *anticipates*, *upcoming*, and *tomorrow*.

English also has numerous syntactic devices that can be used to refer to the future. Take the following sentences:

8. I am trying to figure out **what to do** today.

9. We have scuba lessons **this evening**.

10. I am thinking **about taking** a trip to Spain.

Each of these sentences contain syntactic structures that reliably pick out references to the future. Sentence (8) contains a what/where/when followed by 'to' and a verb. Sentence (9) contains 'this' followed by a temporal term. Sentence (10) contains 'about' followed by a verb in the present continuous tense. Note that, while the parts of the syntactic structure typically have to appear in a particular order, the parts typically do not have to directly follow each other. Compare 8a and 8b

8a. I am trying to figure out **what to do** today.

8b. I am trying to figure out **what** on earth **to do** today.

In 8a, the 'to' and a verb follows the 'what'/'where'/'when'. In 8b, the 'to' and a verb follows the 'what'/'where'/'when' but not immediately, yet both of these constructions are equally reliable indicators of future-oriented language.

2.2 Developing the temporal orientation parser

In order to identify the full range of ways we use to talk about the future, a set of rules

was developed that could accurately pick out the full range of ways we talk about the

future. These rules were guided by research in linguistics (e.g., Abney 2002, Chierchia,

1988; Copley 2002, 2008, 2014; Dowty, 1979; Kaufmann, 2005; Lakoff, 1971; Portner

1992; Stowell, 1982; Wurmbrand, 1998, 2014) and refined through empirical testing of

the accuracy of the rules. The resulting set included 91 rules. Rules for picking references

to the past were also developed. The resulting set of rules for picking out references to

the past included 13 rules. The rules were written in TREGEX language, which is a

language used to identify patterns in parsed sentence trees (Levy & Andrew, 2006). For

example, the TREGEX rule (SBAR < WHNP|WHADVP < (S < (VP < TO)) can be used

to identify a future-referring sentences such as *I was thinking about what on earth to do*

today. A full listing of the rules for identifying the future is contained in Appendix A and

the past is contained in Appendix B.

     The next step was to develop a method for automating the process of identifying

references to the future. The Stanford parser (Klein & Manning, 2003) was used to

convert the sentences into parsed trees. With the sentences in parsed trees, the rules could

then be compared to the parsed trees. Whenever the program identifies a match between

the parsed tree and one of the rules, it flags that sentence as containing that particular

rule. We call this automated method the picking references to the future the temporal

orientation parser.

     A demo version of the temporal orientation parser is available at

http://www.mindandlanguagelab.com/futureAnalysis.

2.3 Testing the accuracy of the temporal orientation parser

With the rules developed, the next step was to test the accuracy of the rules. Three

research assistants (RAs) independently coded 1,000 sentences for whether they referred

to the future. The sentences were randomly selected from the annotated corpus of *The

New York Times* (Sandhaus, 2008). The RAs agreed on 86.44% of their ratings. For the

cases in which the research assistants did not agree, the sentence was marked as referring

to the future based on majority rule. The temporal orientation parser agreed with the

majority of the RAs 76.61% of the time, indicating that the rules perform nearly as well

as the human raters.

Another important measure of accuracy is precision and recall. The precision and

recall of the temporal orientation parser was calculated, providing evidence of good

precision (.75) and recall (.90). Comparing the temporal orientation parser to similar

systems for picking our references to the future developed by Nakajima, Ptaszynski,

Honma, & Masui (2014) and Park et al. (2016), we find that the temporal orientation

parser outperforms both of these system on both precision and recall. See Table 2.

Table 2. Precision and recall of the temporal orientation parser, Nakajima et al.'s (2014)

and Park et al.'s system

	The temporal orientation parser	Nakajima et al. (2014)	Park et al. (2016)
Precision	.75	.57	.65
Recall	.90	.89	.48

With the development of an automated system for picking out references to the

future from text, this system could then be used to discover if there are multiple kinds of

ways of thinking about the future, and, if so, what are those ways.

2.4 Summary of Chapter 2

In this chapter, I reported the development of an automated language-based tool that measures future-oriented thought, the temporal orientation parser. This tool was demonstrated to have good accuracy measured in terms of percent agreement, precision, and recall. This tool has two major advantages over existing measure tools: The temporal orientation parser captures the full range of future-oriented thought, not just a specific aspect. The temporal orientation is more flexible. Since it is automated, the temporal orientation parser can code huge bodies of texts. It can also be used an implicit measure that does not require participants to fill out surveys or respond to experimenter prompts.

In the next chapter, I report two studies that test the relation between future-oriented thought, as measured by the temporal orientation parser, and well-being.

Chapter 3: The relation between future-oriented thought and well-being

In this chapter, I report two studies that test whether future-oriented thought is related to well-being. Study 1 tests the relation at a population level, specifically at the level of U.S. states. Study 2 tests the relation on an individual level. For both studies, it was predicted that there will be a relation between future-oriented thought and well-being.

3.1 Study 1

An initial examination of the relation between future-oriented thought and well-being was conducted at the population level. To the extent that language can be used to predict well-being, then it should be possible to predict the average well-being of an area of the country from language generated by people living in that area. One way that language from a particular area can be collected is through the extraction of text from social media services such as Twitter. On Twitter, individuals are able to post short, 140-character messages called "tweets." Recent analyses indicate that Twitter users are generally representative of the population in terms of gender and urban versus rural residence. Twitters users are diverse in terms of age and socioeconomic status; however, they tend to be younger and have higher social economic status than non-Twitter users (Pew Research Center, 2016). Unlike explicit scales, tweets are unsolicited and hence free of the potential biases of explicit rating tasks. They can be collected in large quantities from all over the country (and even worldwide) and their content can be analyzed for references to the future. The messages produced in tweets are produced in a naturalistic communicative setting without the need for experimenter prompting or questioning.

3.1.1 Method

Between April 20, 2015 and Nov. 15, 2015, tweets were collected from all 50

states by "sweeping" the states one-by-one in five minute intervals. The process resulted

in the collection of 8,538,488 tweets with geolocation information, that is tweets where

information about whether the Twitter user was located at the time of the tweet could be

recovered. Once collected, the tweets were run through the temporal orientation parser.

Future orientation for each state was calculated by dividing the number of future rules

matched by the total number of rules matched for all the tweets in each state. For the

measure of well-being, the Gallup-Healthways 2015 "State of the States" well-being

scores for each state (Gallup-Healthways, 2016) was used.

The State of the States measure is a composite of responses to five questions: "Do

you like what you do each day and are you motivated to achieve your goals?"; "Do you

have supportive relationships and love in your life?"; "Do you manage your economic

life to reduce stress and increase security?"; "Do you like where you live, feel safe, and

have pride in your community?"; and "Are you in good health and have the energy to get

things done daily?" In addition to measuring the State of the States measurement, two

other well-being related constructs that have previously been demonstrated to be related

to future-orientation were used: exercise frequency and GDP.

3.1.2 Results

The future orientation of all of the states in the United States is shown in the top-half of

Figure 2. The most future oriented states were Alaska, North Dakota, and Maine, with

Rhode Island, Georgia and New Mexico not far behind. The least future-oriented states

were Montana, Wyoming, Nebraska, and Kansas. Figure 2 shows that future orientation

for states along the eastern seaboard were generally higher than for those immediately interior to those states, including Kentucky, Tennessee, Alabama, and Mississippi.

The bottom half of Figure 2 shows relative concentrations of well-being, as measured by Gallop-Healthways. The overall relationship between well-being and future-orientation was relatively strong, $r = .399$, $p = .004$. States higher in future orientation were also rated higher in well-being. An examination of Figure 2 highlights commonalities. For example, Alaska, Hawaii, and Maine were both very future oriented as well as high in well-being. Also, most of the states on the eastern seaboard were both higher in future orientation and well-being.
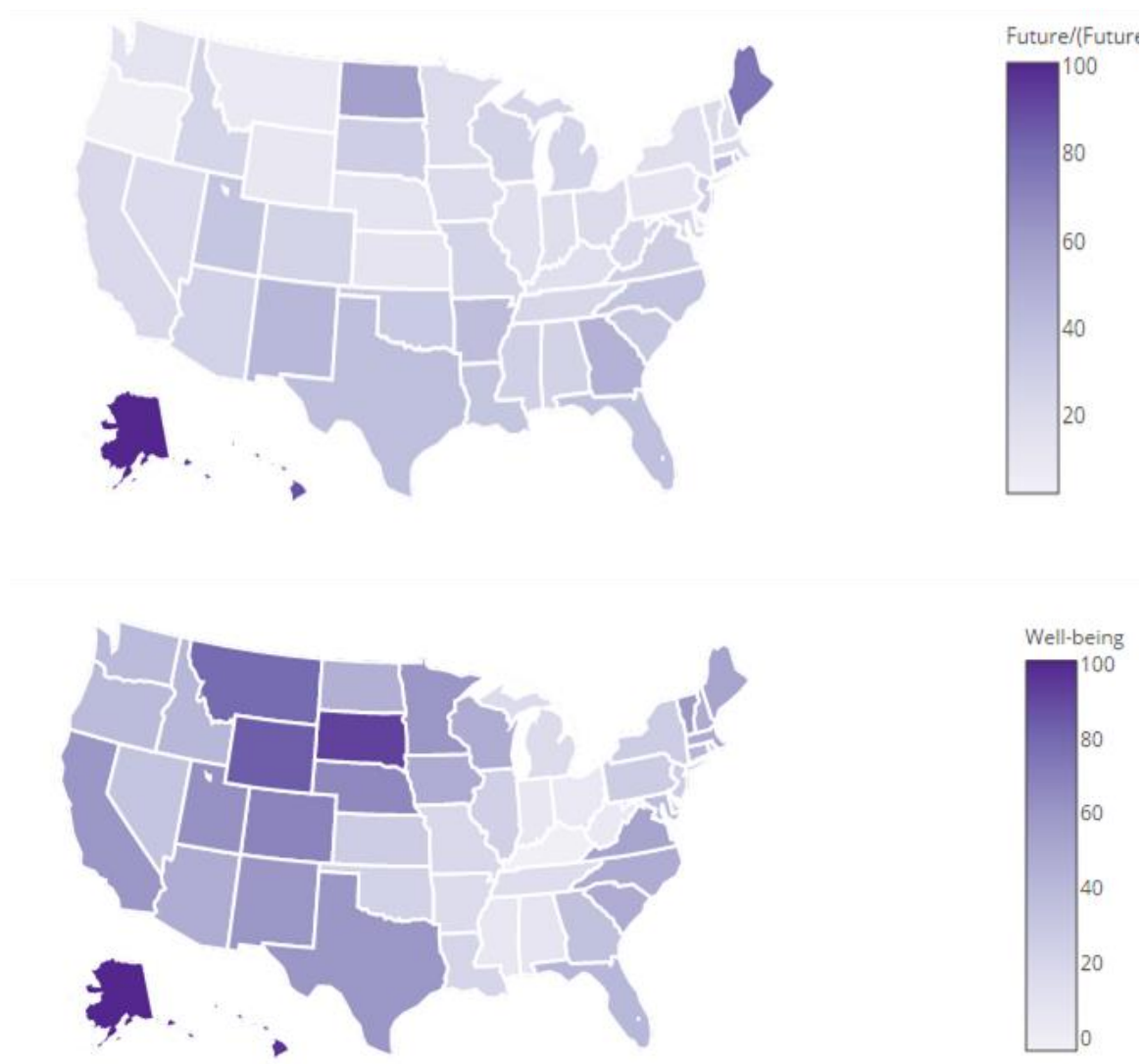
Figure 2. Future-orientation (top) and well-being (bottom) by state.

In addition to well-being, two other state-wide characteristics correlated with future-orientation, including a state's per capita GDP, $r = .305$, $p < .01$ and exercise frequency, $r = .445$, $p < .01$ In finding a relation between future orientation and GDP, research by Preis et al. (2012) was conceptually replicated using the temporal orientation parser as the measurement of future-oriented thought. In finding a relation between future orientation and exercise, research by several research groups (Kahana, Kahana, & Zhang,

2005; Ouellette, Hessling, Gibbons, Reis-Bergan, & Gerrard, 2005; Whaley, 2003) was conceptually replicated using the temporal orientation parser. These additional correlations provide support for the construct validity of the temporal orientation parser

3.2 Study 2

Study 1 provided evidence that future-oriented thought and well-being are related at the population level. Study 2 investigated whether there the relation also extends to the individual level. Study 2 also used a broader range of well-being measures, including measures of hedonistic well-being (e.g., life satisfaction, positive and negative affect), eudaemonic well-being (e.g., purpose in life, personal growth, and autonomy), and dispositions toward being in future-relevant affective states (e.g., anxiety, worry, hope, optimism).

First, participants typed out their mind wanderings. This was done in order to acquire text from each participant that could then be analyzed for its temporal orientation. In the second part, participants completed a series of well-being and personality inventories. The main prediction was that there would be a relation between future orientation and well-being at the individual level.

3.2.1 Method

3.2.1.1 Participants

Ninety-six participants were recruited from Amazon Mechanical Turk (MTurk), which is an Amazon service that allows workers to find "micro-jobs" for which they receive compensation. MTurk is commonly used by psychologists and other social scientists to recruit participants. MTurk workers are much more diverse than the typical college samples, though they are not fully representative of the American population.

Workers tend to be younger (about 30 years old), have higher education, are underemployed, less religious, and more liberal than the general population. Asian Americans are overrepresented and African-Americans and Hispanic-Americans are underrepresented (Berinsky, Huber, & Lenz, 2012; Paolacci, Chandler, Ipeirotis, 2010).

MTurk workers have been found to be as attentive as college student participants (Berinsky, Margolis, & Sances, 2014; Paolacci, et al., 2010) and no more likely to cheat than college student participants (Suri, Goldstein, and Mason, 2011). Additionally, their answers on self-report measures tend to be highly reliable (Buhrmester, Kwang, & Gosling, 2011; Mason & Suri, 2012), and psychometric properties of individual difference measures have been replicated using MTurk workers (Buhrmester, Kwang, & Gosling, 2011). Cognitive tasks that rely on response times (e.g., Stroop, switching, flanker, attentional blink, and subliminal priming) (Crump, McDonald, & Gureckis, 2013) and behavioral measures of economic decision making (Amir, Rand, & Gal, 2012) have been replicated using MTurk workers.

The 96 participants for this study were all geographically located in the United States and spoke English as their first language. The average age of the participants were 31.6 years. Fifty-six percent of participants identified as female. While participants were not asked to report typical SES information such as income, occupation, and education, participants did report information concerning debt, savings, and financial satisfaction. Forty-two percent of participants reported being able to add to savings without taking on new debt, 39% reported not being able to add to savings but not needing to take on new debt, and 19% reported loss of savings and taking on new debt. Forty-two percent of

participants reported being satisfied with their financial situation, 30% were neutral, and 28% reported being dissatisfied.

3.2.1.2 Materials and procedures

Following previous research that used experience sampling methods to study the time perspective of thoughts (Baumeister et al., 2017; Smallwood, et al., 2009; Smallwood, et al., 2011; Stawarczyk, Majerus, Maj, Van der Londen, & D'Argembeau, 2011), participants were asked about their current or recent non-task-related thoughts. Specifically participants were asked, "Other than doing this task, what else are you thinking about?" Participants were required to write for five minutes, producing, on average, over 10 sentences. The participants' future orientation was measured by running their writing through the temporal orientation parser using future and past rules. Future orientation for each participant was calculated by dividing the number of future rules matched by the number of total rules matched.

After completing the writing portion, participants were asked to complete the following individual differences measures: Satisfaction with Life Scale (Diener, et al., 1985), Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegan, 1988), State and Trait Anxiety Inventory (Spielberger, 2010), Life Orientation Test – Revised (Nunn, et al., 1996), Psychological Well-Being Scale (Ryff & Keyes, 1995), Adult Hope Scale (Snyder et al., 1991), and the Penn State Worry Questionnaire (PSWQ; Meyer, et al., 1990). These measures were used in an effort to capture an adequate sample of the forms of well-being (components of hedonistic and eudaemonic), along with forms of future-relevant affective states (anxiety, worry, hope, and optimism), that have been argued to be most relevant to future-oriented thought.

The Satisfaction with Life Scale (SWLS; Diener, et al., 1985) is a 5-item scale designed to measure cognitive judgments, as opposed to affective appraisal, of one's satisfaction with life. Items are rated on a scale of *1 Strongly disagree* to *9 strongly agree*. Example items include "The conditions of my life are excellent," and "If I could live my life over, I would change almost nothing."

The Psychological Well-Being Scale (PWBS; Ryff & Keyes, 1995) is a 42-item inventory designed to measure more meaningful forms of well-being than what is captured through cognitive judgments of life satisfaction or affective appraisals. The PWBS is composed of six subscales: the self-acceptance subscale, which is intended to measure the extent to which someone accepts both the good and bad qualities of self while maintaining on overall positive attitude toward self; the positive relations subscale, which is intended to measure the extent to which one has satisfying and trusting relationships; the autonomy subscale, which is intended to measure the extent to which one can regulate behavior by personal standards and resist social pressures; the environmental mastery subscale, which is intended to measure the extent to which one can manage their environment and take advantage of opportunities; the purpose in life subscale, which is intended to measure the extent to which one's goals give a greater sense of directedness and meaning; and the personal growth subscale, which is intended to measure one's sense of continual development, sense of improvement in behavior over time, and a sense of realizing potential. Items are rated on a scale from *1 strongly disagree* to *6 strongly agree*. Example items include "In general, feel confident and positive about myself" (self-acceptance), "I know that I can trust my friends, and they know they can trust me" (positive relations), "My decisions are not usually influenced by

what everyone else is doing" (autonomy), "I am quite good at managing the many responsibilities of my daily life" (environmental mastery), "I have a sense of direction and purpose in life" (purpose in life), and "For me, life has been a continuous process of learning, changing, and growth" (personal growth).

The Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegan, 1988) is a 20-item measure of positive and negative moods. The measure consists of two subscales: positive affect and negative affect. Each item is a mood that the participant may currently (or recently) be feeling. Examples items of positive affect are "Interested," "Proud," and "Alert." Example items of negative affect are "Hostile," "Guilty," and "Distressed." Participants' responses are recorded on a scale from *1 very slight or not at all* to *5 extremely*.

The State and Trait Anxiety Inventory (STAI; Spielberger, 2010) is a 40-tem measure of state, or current, anxiety and trait, or dispositional, anxiety. Items are rated on a scale from *1 not at all* to *4 very much so* and on the trait version vary from *1 almost never* to *4 almost always*. Example items include "I feel strained" (state) and "I feel nervous and restless" (trait).

The Adult Hope Scale (AHS; Snyder et al., 1991) is a 12-item inventory designed to measure hope. The inventory has two subscales: the agency subscale, which is intended to measure one's confidence in being able to achieve goals; and the pathways subscale, which is intended to measure the extent to which one is able to recognize that there are different ways of reaching the same goal. Items are rated on a scale from *1 definitely false* to *8 definitely true*. Example items include "I meet the goals that I set for myself" (agency) and "I can think of many ways to get out of a jam" (pathways).

The Life Orientation Test – Revised (LOT-R; Nunn, et al., 1996) is a 10-item measure of optimism and pessimism. Items are rated on a scale from *A. I agree a lot* to *E. I disagree a lot*. Example items include "In uncertain times, I usually expect the best," and "I rarely count on good things happening to me" (reverse coded).

The Penn State Worry Questionnaire (PSWQ; Meyer, et al., 1990) is a 16-item measure of the extent a person tends to worry. Items are rated on a scale from *1 not at all typical of me* to *5 very typical of me*. Example items include "I am always worried about something," and "My worries overwhelm me."

3.2.2 Results

The main prediction of the study was confirmed. Participants with higher future orientation reported higher levels of life satisfaction, $r = .285$, $p = .005$. Critically, participants' future orientation was obtained by measuring how often they referred to the future and the past in their text, which was, for all practical purposes, completely unrelated to the various inventories they completed in the second half of the experiment. When people write, they cannot help but reveal features of their psychological well-being in their choice of words and syntactic constructions. These indicators of their well-being can emerge in just a few sentences. These findings also demonstrate that the temporal orientation parser can be effective not only at being used over large bodies of text but also in context in which a researcher is trying to extract meaning from a paragraph of text.

While the main prediction of the experiment was supported, it needs to be acknowledged that no other significant correlations were found across the remaining inventories. The failure to find any other correlations might reflect the absence of any

other relationships between future orientation and well-being. Alternatively, the failure to find any other correlations might point to the need for a finer partitioning of future-oriented thought.

3.3 Summary of Chapter 3

In this chapter, I reported two studies that demonstrated that future-oriented thought as measured by the temporal orientation parser is related to well-being at population level (Study 1) and at an individual level (Study 2). However, Study 2 suggested that future-oriented thought is only related to life satisfaction and no other measure of well-being. The failure to find other correlations could be because future-oriented thought is only related to life satisfaction, or it might point to the need for a finer partitioning of future-oriented thought. In the next chapter, I report a new model of future-oriented thought that was derived through bottom-up, data-driven methods.

Chapter 4: Discovering a model of future-oriented thought

The temporal orientation parser makes use of 91 rules for picking out the various constructions people use to refer to the future. Each rule picks out a different way of referring to the future and, thus, potentially, a different way of thinking about the future. While each rule picks out a different way of referring to the future, it is possible some sets of rules are similar to each other while being sufficiently different from other sets of rules. In other words, it possible that sets of rules form clusters. If so, these clusters might indicate different basic-level categories of future-oriented thought. In this chapter, I report methods and analyses used for determining categories of future-oriented thought. To do this, patterns of language in *The New York Times* was analyzed.

4.1 Preparing the corpus

The corpus used was the annotated corpus of *The New York Times* (Sandhaus, 2008). The corpus contains 1.8 million articles (approximately 853,753,166 words) written between January 1, 1987 and June 19, 2007. In addition to being a large corpus, another advantage is that the corpus contains standardized, well-written bodies of text. Having a well-written corpus helps decrease the amount of non-meaningful variability within the data. Having a large corpus helps minimize the effects of the remaining non-meaningful variability on the results. The corpus was processed using the temporal orientation parser. The temporal orientation parser parsed the corpus using the Stanford parser (Klein & Manning, 2003). When a reference to the future was identified, the text was re-annotated by inserting a rule label directly into the text where the rule was triggered. The process resulted in text like that shown in Figure 3. The text in Figure 3 shows rule labels in red. Putting the rule labels in the text allows the rules to be analyzed as if they were words.

He $R809 said he $R25 would give a little consideration to it but $R809 was more likely to run Auntie Mame in the Matriarch or the Japan Cup
Experts $R809 said that a person in her situation $R25 would be more likely to use orally administered drugs at home away from hospital
But public announcement of those measures eagerly $R809 awaited by international investors and markets $R809 seemed likely to be delayed
In view of West s known club length the diamond finesse $R809 was likely to succeed
If the talks fail he is likely to fall further in the esteem of his people
As long as the surplus lasts the lack of discipline that $R809 characterized the $R60 budgetwriting this year is likely to continue
For years California s death row $R809 was a place where the $R809 condemned $R809 were more likely to die from old age sickness or suicide
And in a thought likely to appeal more to the Vice President than to the minority leader Mr McAuliffe $R809 suggested that a GoreGephardt
But the contradictory testimony is a minefield of old sympathies and vendettas so it is not likely to settle the debate
One of the most critical issues Mr McKeon $R809 said $R809 was the city s $R68 willingness $R6 to provide enough police officers to control
study reported in Nature $R820 last month $R809 found that $R53 plant traits introduced by genetic engineering $R809 were more likely to
Democrats $R6 $R33 are trying to buck that trend however by emphasizing issues that are likely $R6 to encourage their most loyal voters to go

Figure 3. A sample section of text with rule labels (in red) imply references to the future or past inserted in it.

4.2 Building the similarity space

With the rule labels inserted into the text, the next step was to build a similarity space that would allow for the determination of how similar any two rules are to each other. To this end, the corpus was analyzed using a semantic embedding procedure known as Word2vec (Mikolov, Chen, Corrado, & Dean, 2013). Word2vec is a neural network that can be trained on ordinary text. The network has three layers. The first layer encodes all of the words in the corpus and the output layer encodes each words' context. The network learns to predict the context in which a given word will be found by adjusting predictive weights that connect the two outer layers with a hidden layer. Once training is complete, the weights from each input node to each hidden unit are extracted. These weights constitute vectors for each word in the corpus. Importantly, words that appear in similar contexts will have similar vectors. For example, the algorithm may produce similar vectors for the words 'raincoat', and 'poncho' as these words appear in similarity contexts (e.g., contexts that involve rain, weather, wetness, outdoors, etc.). Note that the words do not have to commonly appear together to have similar vectors, as long as the words appear in similar contexts. Since we inserted rule labels into the text, Word2Vec

effectively treated each rule as a word. Similarities between different rules could be investigated in the same way as similarities between words could be analyzed.

4.3 Clustering rules

With the similarity space built, the next step was to cluster rules based on similarities among the rules. For this task, Gmeans (Hamerly & Elkan, 2003) was used. Gmeans extends the k-means procedure for identifying clusters by repeatedly checking whether clusters follow a Gaussian distribution. If the cluster does not follow a Gaussian distribution, the algorithm will split the clusters and repeat the process until it has k clusters with a Gaussian distribution. An advantage of Gmeans over k-means is that Gmeans identifies the number of clusters, whereas k-means alone requires the researcher to choose the number of clusters. Using this algorithm, Gmeans indicated that the future rules fell into five clusters, as depicted in Figure 4.
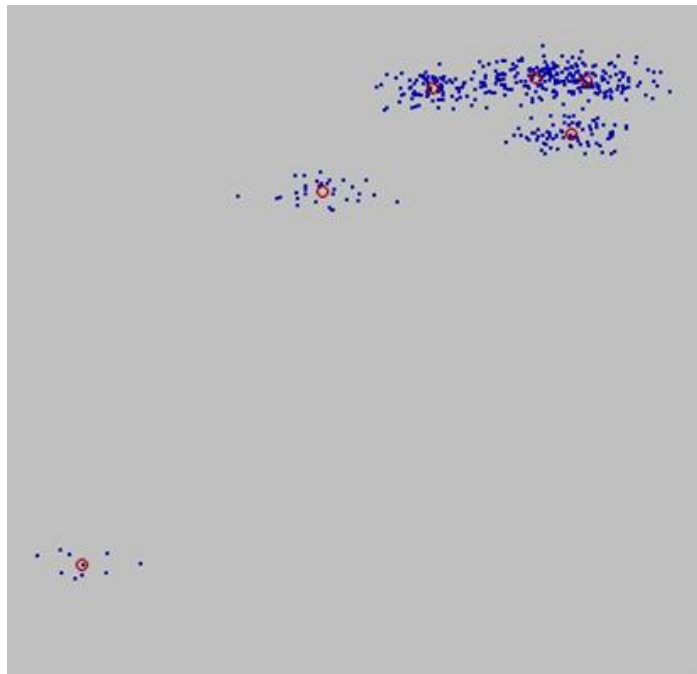

Fig. 4. Five clusters of future rules discovered by Gmeans. Note that this is a 2-dimensional representation of a 200-dimensional space.

4.4 Semantically characterizing the clusters

With the clusters generated, the next step was to semantically characterize the clusters. For this task, a program was written that calculates the similarity between target vectors and all other vectors and then rank orders the similarity of all other vectors to each target vector. Here, the target vectors were the rule vectors, and the program calculated and ranked how similar each word vector was to each rule vector. A second program was written that took the most similar words for each rule as input. The program then organized the rules based on cluster membership. The words that appeared most commonly within a cluster were used to semantically characterize that cluster.

4.4.1 Results

The categories that emerged were a planning category that was semantically characterized by words associated with determining plans of actions and making decisions; a fixed-future category that was semantically characterized by words associated with schedules and following guidelines; a begrudging category that was semantically characterized by words associated with being unwilling, unable, or without control; an anticipation category characterized by words associated with positive future-directed affective states such as excited, enthused, and delighted; and a worry category characterized by words associated with negative affective states such as worries, fears, and anxieties. The five clusters and associated words are shown in Table 3.

Table 3. Sample of the top-20 most closely associated words each category of future-

oriented thought.

Category	Associated words
Cluster 1: Planning AGENT, POSITIVE	figuring, determining, wondering, asking, depends, trying
Cluster 2: Fixed-future AGENT, NEUTRAL	eligible, guarantees, scheduled, mandatory, exemptions, automatically
Cluster 3: Begrudging AGENT, NEGATIVE	can't, won't, nothing, begrudge, sorry, resist
Cluster 4: Anticipation PATIENT, POSITIVE	excited, enthused, thrilled, confident, apprehensive, delighted
Cluster 5: Worry PATIENT, NEGATIVE	worries, fears, anxieties, complaining, alarmed, danger

These five categories appear to vary along two major dimensions: an AGENT vs.

PATIENT dimension and a POSITIVE vs. NEGATIVE dimension. The AGENT

dimension involves thinking about oneself as an agent, or as a doer that has the potential

to cause change. The PATIENT dimension involves thinking about oneself as something

that is affected by others and by situations. Agency is positive when one can plan and

have some control over outcomes, such as in the planning category and to some extent

the fixed future category. Agency is negative when one thinks about one's agency in

terms of what one cannot do and what one does not want to do. Along the PATIENT

dimension, future thought can cause either a positive (e.g., anticipation) or negative (e.g.,

worry) reaction within the thinker.

No other taxonomy of future-oriented thought has fully recognized the distinction

between being an agent projecting oneself into a future situation and being a patient who

is affected by the thought of a future state. The closest researchers have come in making

this distinction is in the valence-based models (Carelli Wiberg, and Astrom, 2015; Holman & Silver, 2005). The valence-based models contain a positive agency category and a negative affective category. However, the explicit emphasis of these models is on the valence of this categories: agency is positive, while worries, fears, and anxieties are bad.

While previous research has stressed the importance of the distinction between future-directed positive affective states and negative affective states, this distinction has not explicitly been codified into a model of future-oriented thought. In this case, the model is explicitly codifying a distinction that had already been recognized.

In the literatures on future-oriented thought, there has not been much discussion about thinking about the future in terms of the fixed futures category (schedules, guidelines) or in terms of the begrudging category (do not want, cannot). A possible reason why the fixed futures category has been neglected as a category of future-oriented thought is that it is reasonable to subsume the fixed-futures category into a planning category. After all, making schedules and meeting guidelines are typically only necessary in pursuit of certain other goals one might have. However, working within the constraints of fixed future does feel like a different way of thinking about the future. For example, there is a difference in the phenomenology of figuring out what to make for dinner tonight versus figuring out, and then planning how to meet, eligibilities for grants.

While conflating a planning category with a fixed future category is reasonable, it is surprising that the literature has not recognized a begrudging category as a distinct way of thinking about the future. One possible reason for this is that the literatures on future-oriented thought primarily discuss agency in terms of being able to exert agency. The one

major exception would be discussions of future-oriented thought in the clinical

literatures, but even in these cases, the focus typically is not on thinking about the future

in terms of lack of agency; rather the emphasis is on the kinds of negative affective states

that accompany thinking about the future in terms of lack of agency.

4.5 Summary of Chapter 4

In this chapter, I reported the use of several computational techniques, including

the use of neural networks to determine similarities among rules and words and the use of

Gmeans to discover clusters of rules based on the similarities. From this process emerged

five categories of future-oriented thought: planning, fixed-futures, begrudging,

anticipation, and worry.

In the next chapter, I reanalyze the relation between these categories of future-

oriented though and well-being.

Chapter 5: Relations between the categories and well-being

With the discovery of categories of future-oriented thought, the relation between future orientation and well-being can be re-analyzed with respect to these categories. The prediction is that this analysis will reveal a much more complex set of relations between future orientation and well-being than what has been previously demonstrated.

5.1 Study 3

5.2.1 Method

The data from Study 2 (reported in Chapter 3) was reanalyzed with respect to the categories of future-oriented thought (reported in Chapter 4).

5.2.2 Results

As shown in Table 4, the finer categories of future-oriented thought provided a much more complex yet intuitive picture of the relation between future orientation and well-being. Consistent with the previous research, in which future-oriented thought was construed in terms of goal construction and planning, we see that the AGENT POSITIVE and AGENT NEUTRAL categories of planning and fixed-future are positively related to well-being, while the AGENT NEGATIVE category of begrudging is negatively related to multiple kinds of well-being and positively related to negative affect and anxiety. In line with what would be expected, the results also indicate that the POSITIVE PATIENT category of anticipation is positively related to well-being, while the PATIENT NEGATIVE category of worry is negatively related to well-being.

Table 4. Correlations between kinds of future-oriented thought and wellbeing.

	Planning	Fixed-future	Begrudging	Anticipation	Worry
PWBS – Personal Growth	.216*				
PWBS – Purpose in Life	.227*				
Life Satisfaction		.244*			
PWBS – Self-Acceptance		.232*			
PWBS – Autonomy			-.251*		
PWBS – Envir. Mastery			-.288**		
PWBS – Purpose in Life			-.198^		
PWBS– Self-Acceptance			-.224*		
AHS – Agency			-.246*		
PANAS – Negative			.219*		
STAI – State Anxiety			.182^		
STAI – Trait Anxiety			.206*		
Life Satisfaction				.237*	
STAI – State Anxiety				-.225*	
STAI – Trait Anxiety				-.254*	
PSWQ				-.256*	
PWBS – Autonomy					–.232*

Note: Only correlations with p-values less than .1 are listed. ^p < .1, * p < .05, ** p < .01.

PWBS – Ryff Psychological Well-Being Scale, AHS – Adult Hope Scale, PANAS –

Positive and Negative Affect Schedule, STAI – State Trait Anxiety Inventory, PSWQ –

Penn State Worry Questionnaire.

The pattern of results also support several more specific relationships between

ways of thinking about the future and well-being. Thinking about the future in terms of

planning and goal construction is positively related to having a purpose in life and with

personal growth. These findings are consistent with the previous research that has

indicated that the ability to set goals and carry out plans to meet those goals is associated with a greater sense of control, meaningfulness, and self-growth (Baumeister et al., 2013; Ryff & Keyes, 1995). This research stresses how the ability of being able to *successfully* set goals and make plans to meet those goals, so perhaps not all thinking about the future in terms of goals is necessarily good for you (e.g., thinking about the future in terms of not being able to effectively carry out plans and meet goals). Here, it is important to note that the planning category picked out by our analysis tends more toward success in planning, especially when contrasted with the begrudging category, which focuses on loss of control and challenges with meeting goals and carrying out plans.

Thinking about the future in terms of fixed futures was associated with life satisfaction and self-acceptance. Though fixed futures place some constraints on agency, they are not all constraining forces. The types of fixed futures highlighted in this category reflect requirements that have to be met to achieve some goal. These goals are likely self-generated goals. Additionally, the types of fixed futures highlighted in this category reflect having higher degrees of certainty (e.g., things that are guaranteed, are automatic, and are set by schedule). Having certainty in a world fraught with uncertainty can be satisfying.

The results indicate that thinking about the future begrudgingly (i.e., in terms of not wanting or being able to do) is by far the worst way to think about the future. People who view the future in a begrudging fashion may be resentful that the future they might aspire to is beyond their reach. It is these kinds of thoughts that are typically associated with feelings of hopelessness, depression, and even suicidal ideation. Many therapies (e.g., CBT) concentrate treatment around changing these begrudging thoughts into more

productive thoughts, for example, a way of thinking that is consistent with the planning category. Thus, it is not surprising that this category was found to be negatively related with several forms of eudaemonc well-being that focus on having control and purpose, negatively related with hope and positively related with negative affective states and with anxiety.

Thoughts about the future associated with anticipation were associated with high life satisfaction, as well as negatively associated with state and trait anxiety. On the whole, then, those who look forward to the future tend to have positive well-being. Finally, those who worry about the future tended to be those who feel they have little autonomy, as measured by the Ryff-Autonomy scale. This finding makes intuitive sense to the extent that worry is associated with lack of control. In sum, the different categories of future-thinking—as revealed by the large-scale analysis of the NYT corpus—help reveal an interesting pattern of relations between how one thinks about the future and well-being.

Chapter 6: Discussion

6.1 Summary of findings

The first question this research attempted to answer was: How can we develop a better measurement of future-oriented thought? The proposed answer was that this could be done by looking at language. To measure future-oriented thought from language, the temporal orientation parser was developed. Through an automated process, the temporal orientation parser identifies references to the future in text by matching any of 91 rules to the text being analyzed. The temporal orientation parser identified references to the future with good accuracy in terms of percent agreement, recall, and precision. The temporal orientation parser has several major advantages over other measurement tools. Other measurement tools only measure particular aspects of future-oriented thought. Even tools that were designed to measure the full-range of future-oriented thought, such as the Zimbardo Time Perspective Inventory (Zimbardo & Boyd, 1999), tend to focus on certain aspects of future-oriented thought while neglecting others. Additionally, the temporal orientation parser identifies a much broader-range of future-oriented thoughts than previous measurement tools.

The temporal orientation parser is a flexible tool. Being that the temporal orientation parser is automated, it can measure future orientation over large bodies of text—text so large that a single person could not hand code it in a lifetime. It can also be used as an implicit measure of future-oriented thought. With the temporal orientation parser, there is no need to rely on self-report or survey measures. While the temporal orientation parser is not the first automated tool for measuring future-oriented thought

(c.f., Nakajima et al., 2014; Park et al., 2016), the temporal orientation parser has better recall and precision than existing automated tools.

6.1.2 Relation between future-oriented thought and well-being

The second question this research attempted to answer was: Is there a relation between future-oriented thought and well-being?. The results from two studies provided evidence indicating that there is a strong relationship between future orientation and well-being. This relation was found when examining the relation at the population level (Study 1) and at the individual level (Study 2).

6.1.3 Identification of categories of future-oriented thought

The third and fourth question this research attempted to answer was: Are there multiple categories of future-oriented thought, and, if so, what are the categories? The proposed answer was: There are multiple categories of future-oriented thought. There was a strong expectation for the discovery of an agency-related category and for worry category. Machine learning algorithms (Word2Vec) and clustering analysis (G-means) were used to discover how many categories of future-oriented thought there are. The analysis indicated five categories. Next, a topic analysis was conducted, which produced semantically coherent categories. The categories were characterized as planning, fixed-futures, begrudging, anticipation, and worry.

It is reassuring that the data-driven discovery approach produced semantically coherent categories. The production of semantically coherent categories was not a given. Data-driven discovery approaches sometimes produce results that are difficult to interpret. Obtaining uninterruptable results is sometimes the result of not having enough data to extract signal from noise. In this research, very large data sets were taken

advantage of in order to maximize the changes of being able to extract the signal. The production of semantically coherent categories suggests that the methods used here were successful at extracting the signal from the noise.

It is also reassuring that the discovered categories accord with previous research. It would be unusual if all the previous research was wrong; rather, if the data-driven model did not have any overlap with previous research, it would be more likely that the data-driven model was wrong. The data-driven approach produced a planning category, which is a category of future-oriented thought that dominated much research on future-oriented thought (Gollwitzer, 1993, 1999; Schooler, et al., 2014; Stratham et al., 1994; Zimbardo & Boyd, 1999; Zimbardo & Boyd, 1999) and plays an explicit role in several models of future-oriented thought (Holman & Silver, 2005; Szpunar, et al., 2014). This approach also produced a negative affective category, which has been recognized as a major category of future-oriented thought (Carelli Wiberg, and Astrom, 2015; Holman & Silver, 2005; Zaleski, 1996). Both of these results—coherency of categories and convergence with prior research—provides evidence for the validity of the model.

It is exciting that the data-driven approach led to the discovery of a unique model with dimensions that had not previously been considered. While other models have considered goal construction and planning, not other models have identified the category of fixed events.. While it seems reasonable to place fixed events into a broader planning category, having to deal with fixed futures does seem to be a different way of thinking about the future. The fixed-schedule category is not just about agency, it is also about meeting schedules, following guidelines, checking eligibilities, and meeting other responsibilities and obligations. Not only does thinking about the future in terms of fixed-

futures seem to be a distinct way of thinking about the future, it is also a very common way of thinking about the future. We all have to deal with schedules, we all have to navigate schedules, obligations, and responsibilities.

The model also produced a category associated with lack of agency, or a category composed of thoughts about not wanting to do or being unable to do This was the begrudging category. Whereas the other two AGENCY categories leave room for the exertion of agency, the begrudging category reflects thinking about situations in which one lacks control. This is clearly a unique way of thinking about the future that can often dominate people's future-oriented thoughts. Given the distinctness of this category, how common these kinds of thoughts are, and the psychological significance of thinking about the future in this manner, it is surprising that this category has not appeared in previous models of future-oriented thought. I have to admit that it is not a category that I thought of prior to this research project, either.

While positive affective categories have been discussed in the literature on future-oriented thought, this way of thinking about the future has not been formalized as a category within any of the major models of future-oriented thought.

6.1.4 Relations between categories and well-being

It was hypothesized that application of specific categories of future thinking would provide a more complex view of the relationship between future-oriented thought and well-being. This hypothesis was confirmed in this research. Correlations between how people talked about the future during a mind-wandering task and various measures of well-being were conducted. Results indicated a complex relation with planning, fixed-

futures, and anticipation being positively related to well-being, while begrudgingly and worry were negatively related to well-being.

Previous research has indicated that thinking about the future in terms of goal construction and planning is good for you, in particular, for having a greater sense of control, meaningfulness, and self-growth (Baumeister et al., 2013; Ryff & Keyes, 1995). The results reported here are consistent with this research. In particular, the planning category was positively related with two forms of eudaemonic well-being: personal growth and purpose in life.

The fixed-future category was also positively associated with well-being, including life satisfaction and self-acceptance. While we commonly think of schedules, guidelines, requirements, etc. as being external constraints that negatively impact agency and control, the kinds of fixed-futures that are most closely associated with this cluster leave room for the exertion of agency and control. Words associated with this category included "eligible," "guarantee," "mandatory," "exemptions." Each of these terms typically deals with obligation and responsibilities one has to meet *in order to achieve some goal*. Think about the college student who is trying to finance the cost of college. She has to determine if she is *eligible* for grants or scholarships. If she is eligible, there are steps she needs to take to *guarantee* she will receive them. She may need to determine what steps in the process are *mandatory* and if there are any *exemptions*. While each of these steps are externally-controlled, relatively fixed steps, there is still plenty of space for her to exert her agency and have some control over the situation. She can decide to change her goals or find alternative ways of meeting those goals. This category also includes terms like "scheduled." While schedules pose some external constraints,

schedules are not typically all-constraining forces. There is typically some degree of flexibility in schedules. So, in the context of the kinds of fixed futures this category refers to, there is still plenty of room to exert some agency and control.

Not only is there still room to exert agency, but there can be satisfaction in having fixed futures. Knowing that if certain eligibilities and requirements are met, then an outcome is guaranteed can be refreshing in a world fraught with uncertainty. The same can be said about schedules. Knowing that one goes into work at certain times on certain days is a benefit, especially compared to situations in which one does not have a set schedule and can be called into work on a moment's notice. Having a set schedule helps eliminate uncertainty and allows one to make plans, which are good for well-being and health.

In addition to the categories of planning and fixed futures, cluster analyses indicated a new category of future thinking, begrudging. This category is characterized by words associated with not wanting to, being unable to, or having no control. As one would expect, this category was negatively associated with well-being. We have all experienced not having control over our futures. Not having control can be frustrating, and if these feelings persist, the thought of not having control can negatively impact health and well-being.

On the affective side of thinking about the future, one would expect that looking toward the future with anticipation and excitement is good and that looking toward the future with worry and despair is bad. This is exactly what was found: The anticipation category was positively associated with well-being, and the worry category was negatively associated with well-being.

From this research, we can see that future-oriented thought is a multi-dimensional construct and that the relations between future-oriented thought and well-being are much more complex than indicated by previous research. The differences in relations between the different categories and well-being also provide evidence of the psychological significance of the categories. With a more nuanced understanding of these relations, researchers and clinicians may be able to develop more precisely targeted interventions aimed at changing patterns of future-oriented thought in an effort to decrease unhealthy behaviors and increase well-being (Sword, et al., 2015; van Beek, 2012; van Beeket al., 2009; Vilhauer, et al., 2012).

6.2 A new way of doing psychology?

The methods used in this research, along with the sheer amount of volume of data analyzed, represents a new way to do psychology. Psychologists have always employed data-driven methods in their research, but in the past, it would have been difficult to gather and analyze data sets the scale of 20 years of *The New York Time*. Today psychologists have ready access to extremely large and very rich data sets, and the amount of data is growing larger and larger by the second. The annotated corpus of *The New York Times* (Sandauhs, 2008) is but one corpus readily available, and it is far from the largest. While the annotated corpus of *The New York Times* contains 1.8 million articles, this is only a fraction of the 13 million articles available through *The New York Times* archive (NYT archive, 2017). The English Wikipedia is larger than the annotated corpus of *The New York Times*. If you include the discussion pages in Wikipedia, the size of the English Wikipedia would dwarf the size of *The New York Times*. The English Wikipedia is only one of 296 Wikipedias, each written in a different language or dialect.

In the realm of social media, Facebook has 1.28 billion daily active users and 1.94 billion monthly active users from around the globe. These users produce 2.5 billion pieces of content and over 500 terabytes of data each day (Facebook newsroom, 2017). Twitter has 100 million daily active users and 313 million monthly active users. These users generate 500 million tweets a day. These tweets come from around the globe and many are geotagged (Twitter, 2017). There are also blogs, financial information, business websites, personal websites, product review websites, and much more.

Not only has the amount and kind of data available to researchers exploded, but new methods have been developed that allow sophisticated analysis of very large data sets. These methods are primarily being built within the computer science and artificial intelligence communities. Over the last few years, psychologists have started to take advantage of these methods in their research; however, to date, almost all applications of these methods have been used for predictive tasks: for example, predicting demographic information from Facebook posts (Bachrach, et al., 2014); predicting personality traits from Twitter (Golbeck, Robles, Edmonson, & Turner, 2011), Facebook (Farnadi, Zoghbu, Moens, & De Cock, 2013), and Instagram (Ferwerda, Schedl, & Tkalcic, 2015); predicting economic decisions (Thorstad & Wolff, 2016, 2017); predicting onset of psychosis (Bedi, et al., 2015), and predicting suicide risk (Poulin, et al., 2014). The research reported here is one of the first to use big data to uncover conceptual structure of a cognitive domain, thus providing an example of how psychology can use these methods beyond prediction.

6.3 Limitations and future directions

There are several important limitations that should be noted. One possible worry is that the categories discovered in this research are categories of future-oriented thought in *The New York Times* and not of future-oriented thought in general. Relying on a single source of data is not sufficient to make strong claims about generalizability. A natural next step would be to run the analysis reported in Chapter 3 on other corpus of text. As was required here, the text need to be large and be well-written. It would also be a benefit to use more naturalistic text. To this end, I am currently exploring the possibility of building corpuses of narratives and journal entries.

Another way to address the worry of generalizability of the categories would be to bring this research back to the lab. Instead of using sophisticated analysis of text to discover the categories, participants could sort the rules and these sorts could be analyzed for whether they form clusters similar to the ones reported in this research. In early piloting of such a study, the categories discovered using the data-driven methods reported here are largely being replicated with human sorting of the rules. The planning, fixed futures, and the positive and negative affect categories are being replicated. Differences between the human sorts and the computer include the split of the planning category into a goal construction category and a planning category. Additionally, the begrudging category did not appear. However, these results are based on early analysis of data from a pilot study that only includes a randomly selected subset of the rules. Most of the rules from the begrudging category were not included in the pilot study. A future version of the study should either include all rules, or if that is not feasible for a study with human

participants, a stratified random sample in which a represented amount of rules from each category are sampled.

Another possible worry is whether the discovery tools used here are really revealing categories of psychological significance. While data-driven methods are excellent discovery tools that can be used to inspire new models and new theories, there are reasons why experimental testing in a carefully controlled environment is the gold standard for testing the psychological reality of models and the psychological importance of particular distinctions picked out by these models. I believe that some of the data reported here helps address this worry. The coherence and intuitive nature of the categories, along with the overlap of categories with previous models, provide some support for the psychological reality of the model. Perhaps more important is the specificity in the relations between the categories and well-being. These findings indicate that these categories are psychologically important. Research that addresses the generalizability of the categories may also help alleviate these concerns. Though the research reported here does help address these worries, there is definitely much more research needed to be done.

A third possible worry may be the generalizability of the relations between future-oriented thought and well-being. Even though the MTurk sample used in this research is much more representative of the general population of the U.S. than the typical sample of college students, the sample is still not representative. MTurk workers tend to be slightly younger, more educated, and underemployed to a higher degree than the U.S. population. Replicating this research using other samples would help secure the generalizability of this research.

Even greater caution needs to be taken when generalizing to non-U.S. populations, especially cultures in which there is a heavy emphasis placed on emphasizing the importance of the past. While there is some research that indicates that a relation between future-oriented thought and well-being is consistent across cultures (e.g., Boniwell, Osin, Linley, and Ivanchenko 2010; Dwivedi & Rastogi, 2017; Shepard & Turner, forthcoming), the cultures surveyed remain limited or, in cases in which a broad range of cultures were surveyed, the participants were not representative in ways that would limit confidence in generalizability. Though there is potential for the development of applications of this research (e.g., in clinical interventions, positive psychology interventions), because of these limitations, caution needs to be taken when undertaking applications of this research. Even more caution would need to be taken in developing applications of these findings in non-Western cultures.

A fourth possible worry is that language is extremely rich and the relation between language and aspects of our psychologies cannot be fully appreciated with a measure that does not capture this richness. In this research, we are measuring a single aspect of our psychology: the extent to which people think about the future, and this single aspect is being used to make inferences about well-being. While this research reports a much richer measurement of future-oriented thought, applying this tool to gain insight into health and well-being may be limited if not used in conjunction with other measures. One place to start is by extending the temporal orientation parser to include references to the present and references that are not directly tied to a specific temporal orientation (e.g., facts that are generalizable across time such as "birds fly"). While the research reported here, along with large bodies of prior research, indicate that people who

think about the future tend to be healthier and have higher levels of well-being, previous research has suggested that a balanced time orientation (i.e., having the right balance between future, past, and present) is more strongly predictive of health and well-being than future orientation alone (Boniwell, et al., 2010; Schooler et al., 2014; Zhang, et al., 2013). Without being able to measure present orientation, the temporal orientation parser cannot be used to further explore the effects of a balanced perspective on health and well-being. There are great challenges to building a language-based measure of present orientation in English. However, this is a task that needs to be done in order to create a richer measurement tool. In addition to building richer measurements through including a measurement of present orientation, future research should also combine measurements of sentiment analysis and content analysis in order to determine what variables may moderate the relations between future-oriented thought and well-being.

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Appendix A

Tregex patterns that can be used to identify sentences referring to the future.

Label	Tregex patterns
FMSinf2	ADJP < (JJ < likely|excited) < (S < (VP < TO < VP))
FMSinf3	S|VP|ADJP|ADVP < (IN|RB < about) $ (S < (VP < TO))
FMSinf4	S < (RB < about) < (VP < (TO < to))
FMSinf5	NP < (S < (VP < TO < VP))
FMSinf6	SBAR < WHNP|WHADVP < (S < (VP < TO))
FMSinf7	VP !< (__ < /seem|appear|happen|used|begin|began|love|like/) < (S < (VP < TO < VP))
FMSfut1	MD < will|'ll
FMSfut2	VP < (VB|VBG|VBP|VBZ|VBD|VBN < go|going|goes|went|gone) < (S < (VP < TO < VP))
FMSfut3	VBG < gon ->
FMSfut4	MD < wo
FMSfut5	MD < shall
FMSfut6	VP < ((MD < would|'d) $ (VP!<(VB<have|had)))
FMSmod1	VP < ((MD < may) $ (VP!<(VB<have|had)))
FMSmod2	VP < ((MD < might) $ (VP!<(VB<have|had)))
FMSmod3	VP < ((MD < should) $ (VP!<(VB<have|had)))
FMSmod4	MD < can
FMSmod5	MD < ca
FMSmod6	VP < ((MD< could) $ (VP!<(VB<have|had)))
FMSmod7	VP < ((MD< must) $ (VP!<(VB<have)))
FMSqua1	VP < (VB|VBD|VBG|VBN|VBP|VBZ < /need/) < (S < (VP < TO))
FMSqua2	VP < (VB|VBD|VBG|VBN|VBP|VBZ < /need/) < NP -> FMSqua2
FMSqua3	VP < (VB|VBD|VBG|VBN|VBP|VBZ < /hav|had|has/) < (S < (VP < TO))
FMSqua4	VP < (VBN < supposed) < (S < (VP < TO))
FMSqua5	VB|VBD|VBG|VBN|VBP|VBZ < /want/
FMSqua6	VBP < wan
FMSqua7	S < (NP $ (RB < better) $ VP)
FMSqua8	S < (NP $ (ADVP <<# better) $ VP)

FMSqua9	VP < (MD < /ought/) < (S < (VP < TO))
FLadj1	VBG|JJ < upcoming
FLadj2	VBG|JJ < pending
FLadj3	VBN|JJ < /worr/
FLadj4	VBN|JJ < excited
FLadj5	ADJP < (JJ < due) !< (PP < TO)
FLadj6	JJ < imminent
FLadj7	JJ < future
FLadj8	JJ < impending
FLadj9	JJ < ready
FLadj10	JJ < potential|possible
FLadj11	JJ < eligible
FLadj12	JJ < patient|impatient
FLadj13	JJ < next
FLadv1	RB < soon
FLadv2	RB < ahead
FLadv3	RB < sometime
FLadv4	RB < potentially|possibly
FLadv5	RB < finna|funna
FLadv6	RB < patiently|impatiently
FLnoun1	NN|NNS < need
FLnoun2	NN|NNS << /hope/
FLnoun3	NN|NNS < /goal/
FLnoun4	NN|NNS < /choice/
FLnoun5	NN|NNS < /consequence/
FLnoun6	NN|NNS < /plan/
FLnoun7	NN|NNS < /schedule/
FLnoun8	NN|JJ < future
FLnoun9	NN|NNS < /due/
FLnoun10	NN|NNS < eligibility|eligibilities
FLnoun11	NN|NNS < fancy|fancies
FLnoun12	NN|NNS < ban|bans
FLnoun13	NN|NNS < /budget/
FLnoun14	NN|NNS < /deadline/

FLnoun15	NN|NNS < /expectation/
FLnoun16	NN|NNS < /guarantee/
FLnoun17	NN|NNS < /need/
FLnoun18	NN|NNS < necessity|necessities
FLnoun19	NN|NNS < /option/
FLnoun20	NN|NNS < possibility|possibilities
FLnoun21	NN|NNS < /will/
FLnoun22	NN|NNS < worry|worries
FLnoun23	NN|NNS < /ambition/
FLverb1b	VP < (MD < cant) < (VP < (VB < wait)) -> FLverb1b
FLverb2b	VP < (MD < could) < (RB < n't|not) < (VP < (VB < wait))
FLverb14	VP < (MD < can) < (RB < not) < (VP < (VB < wait)) -> FLverb14
FLverb3	S < VP << /look/ << forward
FLverb4	VB|VBD|VBG|VBN|VBP|VBZ << /hope|hoping/
FLverb5	VB|VBD|VBG|VBN|VBP|VBZ < plan|plans|planned|planning
FLverb6	VB|VBD|VBG|VBN|VBP|VBZ < /choos/
FLverb7	VB|VBD|VBG|VBN|VBP|VBZ < /schedul/
FLverb8	VB|VBD|VBG|VBN|VBP|VBZ < /consider/
FLverb9	VP < (VB|VBD|VBG|VBN|VBP|VBZ < /figur/) < (PRT < (RP < out))
FLverb10	VB|VBD|VBG|VBN|VBP|VBZ < /ban/
FLverb11	VB|VBD|VBG|VBN|VBP|VBZ < fancy|fancies|fancying|fancied
FLverb12	VB|VBD|VBG|VBN|VBP|VBZ < /guarantee/
FLverb13	VB|VBD|VBG|VBN|VBP|VBZ < worry|worries|worrying|worried
FLverb14	VB|VBD|VBG|VBN|VBP|VBZ < /expect/
FLverb15	VB|VBD|VBG|VBN|VBP|VBZ < /envision/
FLverb16	VB|VBD|VBG|VBN|VBP|VBZ < /anticipate/
FLverb17	VB|VBD|VBG|VBN|VBP|VBZ < /predict/
FLverb18	VB|VBD|VBG|VBN|VBP|VBZ < /foresee/
FLverb19	VB|VBD|VBG|VBN|VBP|VBZ < /await/
FLverb20	VB|VBD|VBG|VBN|VBP|VBZ < /doom/
FTunfiltered1	NN|RB < tomorrow
FTunfiltered2	(for, (time !, good|bad|right|best)) !<< VBD!<< (VP [< (VB < have) | < (VBP [< have | < 've]) | < (VBZ [< has | < 's])] < (VP < VBN))
AAtempo1	NP < (JJ < coming) < (NN|NNS|NNP < TN|TC)

AAtempo2	S <+ (!S) (PP < (IN < in|for) < (NP <, DT|CD|JJ < (NN|NNS|NNP < TN|TC))) !<< VBD !<< (VP [< (VB < have) | < (VBP [< have | < 've]) | < (VBZ [< has | < 's])] < (VP < VBN))
AAtempo3	S <+ (!S) (PP < (IN < on|for) < (NP < (NN|NNP|NNS < TN|TC))) !<< VBD !<< (VP [< (VB < have) | < (VBP [< have | < 've]) | < (VBZ [< has | < 's])] < (VP < VBN))
AAtempo4	S <+ (!S) (ADVP < (NP < (NN|NNS|NNP < TN|TC)) < (RB < away)) !<< VBD !<< (VP [< (VB < have) | < (VBP [< have | < 've]) | < (VBZ [< has | < 's])] < (VP < VBN))
AAtempo5	PP < (IN < by) < (NP < (NN|NNS|NNP < TN|TC))
AAtempo6	PP < (IN < by) < (NP < (DT < the|this)) !< past|last|previous < (NP < (NN|NNS|NNP < TN|TC))
AAtempo7	S <+ (!S) (RB < later) !<< VBD !<< (VP [< (VB < have) | < (VBP [< have | < 've]) | < (VBZ [< has | < 's])] < (VP < VBN))
AAtempo8	S <+ (!S) (PP < (IN < at) < (NP < CD)) !<< VBD !<< (VP [< (VB < have) | < (VBP [< have | < 've]) | < (VBZ [< has | < 's])] < (VP < VBN))
AAtempo9	PP < (IN < by) < (NP < (DT < the|this)) < (NP < (NN|NNS|NNP < TN|TC))
AAtempo11	NP < (RB|JJ < Later|later) < (NN|NNP|NNS < TN)
AAtempo12	S <+ (!S) (VP < (NP < (NN|NNS|NNP < TN|TC))< (ADVP < (RB < away))) !<< VBD !<< (VP [< (VB < have) | < (VBP [< have | < 've]) | < (VBZ [< has | < 's])] < (VP < VBN))
AAtempo13	(PP < (IN < from) < (NP|ADVP < (RB < now)))
AAtempo14	S <+ (!S) (NP < ((DT < this) . (NN|NNS|NNP < TN|TC))) !<< VBD !<< (VP [< (VB < have) | < (VBP [< have | < 've]) | < (VBZ [< has | < 's])] < (VP < VBN))
AAtempo15	S <+ (!S) PP < (IN < in) < (NP < (DT . (NN < couple))) . (PP < (IN < of) << TN|TC) !<< VBD !<< (VP [< (VB < have) | < (VBP [< have | < 've]) | < (VBZ [< has | < 's])] < (VP < VBN))
AAtempo16	NP < (RBR|RB|JJ < later) < (DT < this)
AAtempo17	NP|VP < (NP|ADVP < ((RB|JJ < later) . (NP|NN|NNS < today)))
AAtempo18	NP < (JJ < next) < (NN|NNS|NNP < TN|TC)
AAtempo19	S <+ (!S) tonight !<< VBD !<< (VP [< (VB < have) | < (VBP [< have | < 've]) | < (VBZ [< has | < 's])] < (VP < VBN))
AAtempo20	PP < (IN < by) &< (NP < (NP < DT) &< (PP << TN|TC))

Appendix B

Tregex patterns that can be used to identify sentences referring to the future

Label	Tregex patterns
P1	VBD
P2	VP [< (VB < have)	< (VBP [< have	< 've])	< (VBZ [< has	< 's])] < (VP < VBN)
P3	S < (when < VBD) << MD < would'
P4	VP [< (VB [< remember | < miss | < regret | < recall | < recollect])	< (VBP [< remember | < miss | < regret | < recall | < recollect])	< (VBZ [< remembers | < misses | < regrets | < recalls | < recollects])] < NP
P5	forgets|forgot|forgotten|forget !.to
P6	VP [< (VB < thank)	< (VBP < thank)	< (VBZ < thanks)	< (VBG < thanking)] < (PP < (IN < for))
P7	VP << wish|wishes|wished|wishing'
P8	NP < (JJ|NN < past)
P9	NP < (NP < (NNS [< thanks | < congratulations | < congrats | < props | < kudos | < praise])) < (PP < (IN < for))
P10	NP << regret|regrets
P11	yesterday
P12	NP < (JJ < last) < (NN < week|weekend|month|year)
P13	NP < (JJ < last) < (NNS < weeks|weekends|months|years)
P14	proud . of|former|previous
P15	ago
P16	so.far