Being in Balance or Stuck in Time:
Exploring Facets of Time Processing in Relation to Mental Health

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Umeå 2018
For Agnes and Frank
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Appendix
Abstract

Time is central in human functioning and crucial for adaptive behavior. The aim of the current thesis was to investigate aspects of people’s subjective experience of time and their relationship with mental health, specifically anxiety and subjective well-being. Two time concepts were of key interest in the thesis: time estimation, which refers to the ability to estimate time durations; and time perspective, which refers to people’s habitual way of relating to the past, the present, and the future.

The thesis comprehends four studies. In the first three studies, time perspective and time estimation were investigated in persons with varying degrees of anxiety, ranging from mild symptoms to anxiety disorders. The results of these studies showed that in particular negative past time perspective and negative future time perspective were associated with anxiety. These time perspectives were further strongly associated with the tendency to ruminate and worry. Time estimation did not largely deviate between persons with anxiety and healthy controls, although there was some evidence that subcomponents of anxiety might be differentially related to time estimation. More specifically, state anxiety was moderately related to retrospective time estimation, such that higher levels of state anxiety was associated with judging time intervals in retrospect as longer.

In the final study of the thesis, balanced time perspective (BTP) was examined in relation to subjective well-being and age. BTP can be described as an optimal way of relating to the past, the present and the future and has been suggested to facilitate mental health and well-being. However, there are several ways to measure BTP, and there are also indications that what constitutes a BTP is not completely age-invariant or equally associated with well-being across age. The fourth study of the thesis thus aimed at examining three methods of measuring BTP, and each methods distinct association with subjective well-being and age were examined. The study was conducted in a population-based sample of older adults (age range 60 – 90 years of old). Results of this study indicated subjective well-being is strongly related to BTP, particularly methods of measuring BTP that incorporates negative future time perspective. However, the strong (and inverse) relationship between negative future time perspective and subjective well-being diminished with increasing age. Instead, and among the oldest participants in the sample (80+ years), fatalistic views of the present had more bearing on subjective well-being.
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<td>Absolute Error</td>
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<td>AGM</td>
<td>Attentional Gate Model</td>
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<td>BAI</td>
<td>Beck’s Anxiety Inventory</td>
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<td>BTP</td>
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<td>SCL-90</td>
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<td>SET</td>
<td>Scalar Expectancy Theory</td>
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<td>SST</td>
<td>Socioemotional Selectivity Theory</td>
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Introduction

Psychological time is a highly complex notion that constitutes a wealth of concepts (Fraisse, 1984). Time is an integrated part of our everyday behaviors, such as the timing of motor behavior when walking or driving a car, and estimations of durations in concrete actions, such as, waiting for the elevator versus taking the stairs (Wittmann, 2009). Yet another aspect of psychological time is how the temporal frames of past, present and future help people to make sense of and organize their life histories, everyday experiences and expectations (Zimbardo & Boyd, 1999). Time is thus vital for understanding human behavior, and some scholars (e.g., Suddendorf & Corballis, 1997) have even argued that the importance of monitoring time has likely contributed to the evolution of the human mind.

Chronometric time, or clock time, moves linearly and at constant rate; however, human processing of time is highly subjective and may vary substantially depending on social context, attention, and mood. For example, emotions are closely tied to how time is experienced and processed. When people are bored, they feel that time is passing slowly, whereas when they are engaged in pleasant activities, time appears to pass more quickly. Furthermore, people with mental health problems experience distortions in time processing (Allman, Yin, & Meck, 2014; Droit-Volet, 2013; Lehmann, 1967). The main focus of this thesis was thus to study these two important aspects, which are associated with an altered sense of time. More specifically, the aim was to study facets of time processing in relation to anxiety. Anxiety disorders are among the most common mental health problems world-wide (World Health Organization, 2017), and they are associated with high costs for the suffering individual as well as for society (Lenze & Wetherell, 2011). Studying factors that can provide a better understanding of anxiety and anxiety disorders is thus of high societal relevance. Given the fundamental role that time processing plays in everyday human experience and adaptive functioning, studies of how anxiety and temporal processes interact can provide more insights into the mechanisms that might underlie anxiety; it can also provide insight into emotion-related time distortions (Lake, 2016).

The aspects of time processing of key interest in this thesis were time estimation and time perspective. These temporal processes were investigated in persons with mild to moderate anxiety as well as in those with severe anxiety (Study I-III). The relationships between cognitive impairments (e.g., repetitive negative thinking and executive dysfunction), and the facets of time perspective that may underpin anxiety, were also investigated (Study II). The final aim of the thesis was to study temporal processes in relation to mental health at the other side of the spectrum, in terms of subjective well-being. In this context, participants’ balanced time
perspective (BTP; Boniwell & Zimbardo, 2004; Zimbardo & Boyd, 1999) was studied. The specific aims of the last and fourth study in the thesis were to compare three methods for measuring BTP and to examine each method’s associations with subjective well-being and age.

**Time Estimation: Definition, Theoretical Models, and Methodology**

Time estimation (also called *duration judgments* or *interval timing*) is a crucial aspect of human behavior; people estimate time several times per day. They utilize this capacity, for instance, when they make a decision about whether to brake for a yellow light or whether to cross a busy street.

Researchers usually make an important distinction between two paradigms: prospective and retrospective time estimation (for reviews, see Block & Zakay, 1997; Grondin, 2010; Wittmann, 2009). Prospective time estimation occurs when an individual is aware that he or she should estimate the length of a certain interval, and the estimation is made within a time interval that is presently experienced (Block & Zakay, 1997). Retrospective time estimation occurs when the individual estimates the duration of a time interval that has already elapsed and that the individual did not actively attend to. This estimation is thus based on memory.

Given these fundamental differences between prospective and retrospective time estimation, researchers are in relative agreement that these paradigms are based on different cognitive processes (although see Brown & Stubbs, 1992, for a different view). Prospective time estimation is dependent on an internal clock mechanism and on attentional processes (Grondin, 2010; Wittmann, 2009; Zakay & Block, 1997), whereas retrospective time estimation is based on memory processes and contextual change (Block, 1982). When scholars have directly compared prospective and retrospective time estimation, they have typically found that prospective duration judgments are longer and less variable than retrospective duration judgments (see Block & Zakay, 1997, for a meta-analysis).

**Theoretical Models Explaining Prospective and Retrospective Time Estimation**

There are several models for explaining prospective time estimation (Grondin, 2010). The most dominant model is scalar expectancy theory (SET; Gibbon, 1977; Gibbon, Church, & Meck, 1984). SET posits an internal clock or pacemaker that emits pulses (or subjective time units) through a switch in an accumulator. This accumulator stores and counts the pulses, which gives the brain a way of estimating time. When more pulses are accumulated, a longer time is perceived.
When the length of a duration is judged, the switch is closed, and pulses are let through into the accumulator. The accumulated pulses are then continuously compared with the stored representations of that duration. When the number of accumulated pulses match the stored representation of the target interval, a response is made. Importantly, the rate of the pacemaker can be modified, by for example increased arousal, which has been suggested to increase the speed at which the pacemaker emits pulses (Lui, Penney, & Schirmer, 2011).

A criticism of SET is that it does not clearly address the role of attention. Many researchers have shown that attention plays a central role in prospective time estimation and that the amount of attention allocated to processing time is a major influence on prospective time estimation (for a review, see Brown, 2008). To the degree at which an individual’s attentional resources are limited, prospective time estimation is mediated by the amount of simultaneously processed temporal and nontemporal information. Based on this potential weakness of SET, Zakay and Block (1996, 1997) developed a model of prospective time estimation, the attentional gate model (AGM, see Figure 1), which highlights attentional resources to time. AGM is a modification of SET with an additional component: a hypothetical attentional gate. This gate is located after the pacemaker, and it widens or narrows depending on how much attention is devoted to time. If more attention is paid to time, the gate widens, and more pulses are let through the switch and into the accumulator. If less attention is focused on time, the gate narrows and fewer pulses reach the accumulator.

![Figure 1. Attentional gate model.](image-url)

Figure 1. Attentional gate model. Adapted with permission from Zakay and Block (1996).
AGM predicts that when a lot of attentional resources are devoted to time processing, the duration will be perceived as longer because the attentional gate is wider and more pulses are being let through to the accumulator. On the contrary, when fewer attentional resources are devoted to time (such as when a difficult second task is performed), the duration is perceived as shorter because the attentional gate narrows and fewer pulses reach the accumulator. These predictions of AGM is supported by studies showing that the length of prospective duration judgments decreases when the difficulty of a simultaneously performed secondary task increases (Block & Zakay, 1997; Zakay & Block, 2004). Support for the AGM also comes from a study manipulating how much attention subjects allocated to estimate time (Zakay, 1998). In this study, Zakay (1998) found that the length of prospective duration judgments varied according to whether subjects treated a time estimation task as primary or secondary to a concurrent task. When subjects treated the time estimation task as primary, their estimations were longer and less variable than when they treated time estimation as secondary to the concurrent task.

Scholars have usually explained retrospective time estimation as relying on memory processes, contextual change, and incidentally coded temporal information (for a review, see Zakay & Block, 2004). Two influential models of retrospective time estimation are Ornstein’s storage size hypothesis (Ornstein, 1969) and Block’s contextual change model (Block, 1982). According to Ornstein’s model, retrospective time estimation is based on the amount of, or the complexity of, the stimuli encoded in memory during a given time interval. If a greater number of stimuli have been encoded in memory during a time interval or if those stimuli have been encoded in a more complex fashion, the interval will be judged as longer (Ornstein, 1969).

Block criticized Ornstein’s model based on his observation that stimulus complexity does not necessarily lengthen retrospective duration judgments (Block, 1974). After a series of experiments (Block, 1978; Block & Reed, 1978), Block (1982) came to the conclusion that a more plausible account is that retrospective time estimation is a function of the amount of contextual changes that occurs during a time interval. Critically, in this view, retrospective time estimation is dependent on the amount of contextual changes that can be retrieved from memory during a given time interval; the duration judgment is thus inferred from the number of retrieved contextual changes. Consequently, when an individual can retrieve more contextual changes, he or she perceives time in retrospect as longer. Another important aspect of this model is that contextual change applies broadly, including both external changes (e.g., changes in environment) and internal changes (e.g., shifts in emotion or cognition).
Methods for Studying Prospective and Retrospective Time Estimation

Scholars have traditionally studied prospective time estimation in the range of milliseconds up to a few minutes range, whereas scholars who have examined retrospective time estimation have used longer intervals, from a few minutes to several hours. Furthermore, even though retrospective time estimation is easily applicable to everyday situations, it has been studied much less than prospective time estimation. One reason for this is that (in contrast to prospective time estimation) it is only possible to ask participants for a retrospective time estimate once during an experimental session, as they need to be unaware that they will be asked to estimate a certain interval.

There are many methods for studying prospective time estimation, but researchers have usually distinguished between four general ones (for reviews, see Grondin, 2010; Zakay & Block, 1997):

1. In verbal estimation tasks, a target interval is presented and participants provide a verbal estimation of that interval, usually in terms of seconds or minutes.

2. In time reproduction tasks, participants reproduce a target interval by some sort of continuous stimulus, for example, pressing a button at the beginning and the end of the interval.

3. In time production tasks, participants have to indicate when a time interval, given to them in conventional time units, has elapsed.

4. Finally, in time discrimination (or duration discrimination) tasks, participants discriminate between two time intervals that are presented successively and the participant has to decide which one is longer. There are several variations of this method, but a common one is the temporal bisection task, in which the shortest and longest intervals (referred to as "anchors" or "standards") are first presented several times (the learning phase). During the test phase, participants judge whether subsequent intervals are longer, shorter, or equal to the intervals that were presented during the learning phase.

Within the retrospective paradigm, variations of verbal estimation tasks, time discrimination tasks, and time reproduction tasks are used (Block, 1982; Grondin, 2010). The critical factor is that the participants estimate time unintentionally, that is, they must be unaware of the need to estimate a certain interval until after the interval has ended. For this reason, time production tasks
are not applicable within the retrospective paradigm, because in a time production task, participants are asked beforehand to produce a certain interval.

**Time Perspective: Definitions, Theoretical Models, and Measurement**

This section focuses on the other time construct that is of key interest in this thesis: time perspective. In relation to time estimation, time perspective is on a completely different scale, as it is connected to how individuals habitually relate to and make sense of the past, the present, and the future, as well as how this in turn can influence their thoughts, emotions, and behavior.

Frank (1939) and Lewin (1951) were the first psychology scholars to discuss the importance of time perspective, and they both emphasized that an individual’s views of the past and the future have a profound impact on the present: “The behavior of an individual does not depend entirely on his present situation. His mood is deeply affected by his hopes and wishes and by his views of his own past” (Lewin, 1951, p. 75). Lewin further defined time perspective “as the totality of an individual’s view of his past and his psychological future at a given time” (Lewin, 1951, p. 75). In Lewin’s view, the past and the future are always present on the cognitive level of human functioning, thereby directly influencing the present moment.

It should be noted that there is no universally accepted definition of time perspective. Researchers have used time perspective to refer to various constructs. One common conceptualization is the idea that time perspective is a broader term that includes several interrelated constructs (for a review, see Lasanne & O’Donnell, 2005). Time perspective, in this view, refer to “the composite cognitive structures that characterize the way an individual projects, collects, accesses, values and organizes events that reside in distinct temporal loci [past, present, and future]” (Lasanne & O’Donnell, 2005, p. 12). One example of this way of conceptualizing time perspective is Mello and Worrell’s (2015) conceptual model of time perspective in adolescence. In this model, time perspective is the overarching term for five constructs: attitude, orientation, relation, frequency, and meaning (Mello & Worrell, 2015). *Time attitudes* are defined as one’s positive or negative feelings towards the past, the present, and the future. *Time orientation* is one’s focus on the past, the present, and/or the future. *Time relation* is defined as the extent to which one views the past, the present, and the future as being related to one another. *Time frequency* refers to how frequently one reports thinking about the past, the present, and the future. Finally, *time meaning* refers to one’s personal definition of the past, the present, and the future.
An influential theory that integrates time perspective is socioemotional selectivity theory (SST; Carstensen, 2006; Carstensen, Isaacowitz, & Charles, 1999). This theory’s main focus is the future time perspective, defined here as whether one views the future as either limited or open-ended in terms of the time left before a perceived ending and how this in turn profoundly affects socioemotional goalsetting. Originally, scholars studied perceived endings in terms of the time left until death, and as such, there has been significant SST research on age-related changes in time perspective. These scholars have reported that younger adults generally perceive their future as open ended, and hence, younger adults are more likely to pursue goals with the purpose of optimizing their future than are older adults, who perceive their future as more limited and who are therefore more prone to pursue goals optimizing the present moment (Carstensen et al., 1999; Lang & Carstensen, 2002). SST has implications for research involving other kinds of important life events that occur regardless of age but that can change one’s future time perspective toward becoming more limited (such as a graduation, geographical moves, or terminal illness) (for a review, see Löckenhoff, 2011). Other constructs related to time perspective include episodic foresight or prospective future thinking (Miloyan, Bulley, & Suddendorf, 2016; Suddendorf, Addis, & Corballis, 2009), which involve the capacity for mental time travel so as to imagine possible future events or predict the consequences of one’s actions (Suddendorf et al., 2009).

**Zimbardo and Boyd’s Time Perspective Theory**

Zimbardo and Boyd’s time perspective theory, which extends Lewin’s early definition of time perspective, guided research on time perspective in this thesis. Zimbardo and Boyd regarded time perspective as a cognitive framework in which the ongoing flows of personal and societal experiences are assigned to temporal frames (past, present, or future) that give meaning and structure to everyday experiences and life histories. The focus and emotional valence placed on each time frame are central to this theory.

Furthermore, time perspective is individually varying, so the overuse or underuse of one or more of the temporal frames can become a relatively stable disposition that influences cognition, emotion, and behavior (Zimbardo & Boyd, 1999). The tendency to overuse or underuse specific temporal categories is referred to as a biased time perspective or time perspective bias. This is in contrast to BTP, which is the ability to flexibly switch between past, present, and future according to contextual demands, which has further been associated with higher levels of well-being and adaptive functioning (e.g., Boniwell, Osin, Linley, & Ivanchenko, 2010; Zhang, Howell, & Stolarski, 2013; Zimbardo & Boyd, 1999). On the other hand, to have a biased time perspective including, for example, an exaggerated focus on negative aspects of the past, have been associated with psychological distress and
maladaptive functioning (e.g., Holman & Silver, 1998; van Beek, Berghuis, Kerkhof, & Beekman, 2011).

Zimbardo and Boyd (1999) operationalized their theory of time perspective in the Zimbardo Time Perspective Inventory (ZTPI), a self-report instrument that measures time perspective though five factors (subscales):

1. **Past Negative scale.** This factor reflects a generally negative and pessimistic view of the past. Items in this factor include: “I think about the bad things that have happened to me in the past”, “I think about the good things that I have missed out on in my life”.

2. **Past Positive scale.** This factor reflects a warm and nostalgic attitude toward the past. Items on this scale include: “It gives me pleasure to think about my past”, “I get nostalgic about my childhood”.

3. **Present Hedonistic scale.** This factor comprises a pleasure-seeking and risk-taking attitude toward the present and toward life in general. It covers an orientation toward immediate pleasure and rewards with little concern for future consequences and includes items such as: “Taking risks keeps my life from becoming boring”, “I often follow my heart more than my head”.

4. **Present Fatalistic scale.** This factor reveals a fatalistic, helpless, and hopeless attitude toward the present in which present behavior is largely unrelated to future costs or benefits. Items on this factor include: “My life path is controlled by forces I cannot influence”, “You can’t really plan for the future because things change so much”.

5. **Future scale.** This factor measures goal-oriented behavior and positive anticipations. The items in this factor include: “I complete projects on time by making steady progress”, “I am able to resist temptations when I know that there is work to be done”.

**Future Negative Scale and the Swedish Zimbardo Time Perspective Inventory**

The ZTPI’s Future scale is mainly associated with a positive and constructive approach to the future. Although the future is often associated with positive attributes such as hope and goal achievement, it may have other associations, such as preoccupation, uncertainty, and worry (Zaleski, 1996). Positive versus negative future thinking can further have opposite relationships with adjustment and mental health. As Holman and Silver (2005) noted: “focusing on future goals
can help us to adapt to life’s main changes, but having fears about an ambiguous future may also take a toll on our enjoyment of life and render us vulnerable to the negative impact of chronic stress” (p. 407). There are further indications that the Future scale of ZTPI might not cover an important dimension of how individuals approach the future; for instance, there is a lack of association between the Future scale and either stress or anxiety (Papastamatelou, Unger, Giotakos, & Athanasiadou, 2015; Zimbardo & Boyd, 1999), both of which include future oriented thinking. Relatedly, in Zaleski’s concept of future anxiety, a negative future time perspective is central and precedes the development of anxiety (Zaleski, 1996).

Thus, to consider both negative and positive aspects of the future is clearly important if the goal is to have a refined and comprehensive view of how individuals relate to the future. Based on the idea that the future is associated with both positive and negative aspects, Carelli, Wiberg and Wiberg (2011), in the Swedish version of the ZTPI (S-ZTPI), dichotomized the future into two separate scales: Future Positive and Future Negative. Future Positive is essentially identical to the original Future scale of ZTPI, whereas Future Negative measures negative views of the future (i.e., “Thinking about the future makes me sad”).

**Why study anxiety in the context of time?**

There are several ways, particularly from a cognitive perspective, in which anxiety could be associated with deviations in time estimation and time perspective. Below, I will provide a description and definition of anxiety and anxiety disorders, before briefly describing how anxiety can be understood from a cognitive perspective. Finally, I will elaborate on cognitive maladies through which anxiety may be associated with deviations in time processing.

**Anxiety and Anxiety Disorders**

Anxiety is often described as a state of apprehension, tension, and anticipation of future danger or discomfort (Rachman, 2004). A central factor is that anxiety is evoked as a response to an upcoming potentially negative situation or event that is perceived as unpredictable or uncontrollable (Barlow, 2000). Anxiety is a natural and adaptive reaction that can motivate people to prepare for challenges, such as taking a difficult test, or alert them to possible threats (Barlow, 1988). Thus, anxiety serves a protective function that helps people to adjust and plan for the future. An influential conceptualization of anxiety is the state/trait model (e.g., Spielberger, 1966; 1985). State anxiety is a transient emotional reaction (involving physiological arousal and tension) that is evoked as a response to a stressful situation or a potentially threatening stimulus. After such a stressful or threatening stimulus disappears, state anxiety quickly returns to the baseline.
Trait anxiety, on the other hand, is continuous, and it exists without the presence or absence of a given stimuli, and is a predisposition to respond with anxiety.

Although anxiety may be an adaptive reaction, many individuals experience excessive anxiety, to the extent where it is no longer adaptive. When anxiety disables or interferes with everyday life, it can fall under the category of an anxiety disorder. Anxiety disorders are among the most common categories of mental disorders worldwide (Baxter, Scott, Vos, & Whiteford, 2013). In Sweden, anxiety disorders have an estimated life-time prevalence of around 29% (Statens Beredning för Medicinsk Utredning, 2005) and are substantially more common in women than in men (Johansson, Carlbring, Heedman, Paxling, & Andersson, 2013). Anxiety disorders often have an early onset in adolescence or young adulthood, can be recurring or chronic in nature (Barlow, 2002; Garner, Möhler, Stein, Mueggler, & Baldwin, 2009), and are associated with great impairments in quality of life for the suffering individual (Wittchen & Jacobi, 2005). In the fourth edition of the Diagnostic and Statistical Manual for Mental Disorders (DSM-IV)¹, the seven main anxiety disorders included panic disorder (with or without agoraphobia), agoraphobia (without a history of panic), social anxiety disorder, specific phobia, posttraumatic stress disorder, generalized anxiety disorder, and obsessive-compulsive disorder (American Psychiatric Association [APA], 2000/2002). A description of these disorders can be found in Table 1.

¹ The reader might be confused as to why anxiety disorders are defined according to DSM-IV are defined rather than the 5th edition of DSM. The reason for this is that DSM-5 was unfortunately not available in Swedish when data collection for this thesis began. The participants were thus diagnosed according to DSM-IV criteria.
<table>
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<th>Anxiety Disorder</th>
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<tr>
<td>Agoraphobia</td>
<td>Fear of being in public places or situations from which escape might be difficult (or embarrassing) or in which help might not be available if anxiety symptoms develop rapidly. A person with agoraphobia often avoids certain places or seeks the company of a few trusted people. In severe cases, individuals with agoraphobia can become completely housebound.</td>
</tr>
<tr>
<td>Panic Disorder with or without agoraphobia</td>
<td>Repeated episodes of intense fear with a rapid onset. At least some of the episodes should appear unexpected. Panic disorder with agoraphobia refers to panic attacks that are followed by excessive avoidant behavior, particularly of public places or public transports.</td>
</tr>
<tr>
<td>Generalized Anxiety Disorder</td>
<td>Characterized by persistent and excessive worry about possible misfortunes, for example, the welfare of a significant other, financial losses or one's health. The excessive worry is accompanied by physiological symptoms such as autonomic arousal, restlessness, and muscle tension.</td>
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<tr>
<td>Obsessive Compulsive Disorder **</td>
<td>Repetitive, intentional, stereotyped behaviors, for instance, compulsive hand-washing or repetitive, intrusive thoughts, which are experienced as unacceptable for the affected person.</td>
</tr>
<tr>
<td>Posttraumatic Stress Disorder **</td>
<td>Includes several symptoms: anxiety, memory disturbances, elevated arousal level and flashbacks. Symptoms should be persistent for a prolonged period of time after exposure to a traumatic event. An individual cannot be diagnosed with PTSD without an identifiable traumatic event after which symptoms began.</td>
</tr>
<tr>
<td>Social Anxiety Disorder</td>
<td>Intense and persistent anxiety towards social situations, especially if the situation involves being judged by others. Social fears are relatively common in the general population, the distress associated with social situations should be unreasonable and disproportionate to fall within the category of social anxiety disorder.</td>
</tr>
<tr>
<td>Specific Phobia</td>
<td>Persistent and irrational fear and a strong desire to avoid a specific object or place (such as an extreme fear of reptiles or enclosed spaces).</td>
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</table>

*Note. **Not Categorized as Anxiety Disorder in DSM-5*
The Cognitive Perspective of Anxiety

Cognitive theories explain anxiety as a complex pattern of cognitive, affective, physiological, and behavioral correlates (Beck & Emery, 1985; 2005). The fundamental idea of this perspective is that anxiety is triggered as a result of the ways in which situations (or events) are interpreted or appraised. The meaning of the situation, rather than the situation itself, triggers the anxious reaction. (Beck & Clark, 1997; Beck & Emery, 1985). Specifically, anxiety involves selective processing of information that is perceived as a threat to one’s safety. In addition, the anxious person may underestimate either his or her own coping resources or the safety and rescue features in the environment. Consequently, the central problem of maladaptive anxiety or pathological anxiety lies, not in the affective system, but in the cognitive schemata through which reality is perceived as being dangerous. The interpretation of the situation depends on the context in which it occurs, the mood individual’s mood at the time it occurs, and the individual’s past experiences.

Cognitive Processing in Anxiety

Anxiety is associated with impairment in several aspects of cognitive processing, including memory, attention, and executive functioning (Castaneda, Tuulio-Henriksson, Marttunen, Suvisaari, & Lönnqvist, 2008; Derakshan, Ansari, Hansard, Shoker, & Eysenck, 2009; Eysenck, Derakshan, Santos, & Calvo, 2007; Eysenck, Payne, & Derakshan, 2005; Ferreri, Lapp, & Peretti, 2011). Cognitive dysfunctions have been reported in non-clinical populations (such as college students with high trait anxiety, see Derakshan, et al 2009; Miguel, 2012) as well as in clinical populations (i.e., persons with anxiety disorders, see Castaneda et al., 2008). A full review of the relationship between anxiety and various cognitive functions is nonetheless not within the scope of this thesis. The focus in the following section is instead on two aspects of anxiety-related cognitive maladies: repetitive negative thinking and deficits in executive functioning. Scholars have shown both repetitive negative thinking (e.g., Calmes & Roberts, 2007) and executive deficits (e.g., Bardeen et al., 2015) to be risk factors for developing pathological anxiety, and potentially important targets in the treatment of anxiety disorders (Snyder, Miyake, & Hankin, 2015). Several studies have also reported that repetitive negative thinking and executive functioning are linked, in the sense that poor executive functioning may underlie repetitive negative thinking (Crowe, Matthews, & Walkenhorst, 2007; Heeren, Maurage, & Philippot, 2015; Joormann, Yoon, & Zetsche, 2007; Koster, De Lissnyder, Derakshan, & De Raedt, 2011; Mills et al., 2016). Importantly, in Study II of the thesis, time perspective was introduced as an additional component that may mediate the relationship between executive dysfunctions and repetitive negative thinking.
Repetitive Negative Thinking and Anxiety

Repetitive negative thinking (or unconstructive repetitive thinking) is an umbrella term for relatively uncontrollable and repetitive thought processes with negative emotional content (Ehring & Watkins, 2008). These processes may precede as well as exacerbate mental distress (Ehring & Watkins, 2008). Two common forms of repetitive negative thinking are rumination and worry, both of which have been associated with subclinical anxiety (Hong, 2013) and with more severe anxiety (Olatunji, Naragon-Gainey, & Wolitzky-Taylor, 2013; Olatunji, Wolitzky-Taylor, Sawchuk, & Ciesielski, 2010). Worry is commonly defined as a set of repetitive, uncontrollable thoughts focused on potential harm or negative events in the future (for a review, see Olatunji et al., 2010). Worry has been studied extensively in relation to anxiety and anxiety disorders. Many individuals with anxiety suffer from extensive worry (Olatunji et al., 2010), and worry is a common and potentially disabling feature in all anxiety disorders (Barlow, 1988; 2002). Rumination is a similarly negative and repetitive thought process (Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008). It is typically focused on symptoms and their consequences, coupled with passivity and reduced problem-solving (Nolen-Hoeksema, 1991; Nolen-Hoeksema et al., 2008). Rumination is less studied in relation to anxiety, most likely because it has been considered to be more specific to depression (for a review, see Nolen-Hoeksema et al., 2008). More recently, however, researchers have shown that rumination is associated with several anxiety disorders (Dar & Iqbal, 2015; McEvoy, Watson, Watkins, & Nathan, 2013) and with sub-clinical anxiety (McLaughlin & Nolen-Hoeksema, 2011).

Rumination and worry are closely related psychological mechanisms with overlapping features, but they can nonetheless be separated in several respects (Papageorgiou & Wells, 1999; Watkins, Moulds, & Mackintosh, 2005). In general, worry and rumination differ in terms of content. Worry is more focused on problem-solving, whereas rumination often involves thinking about failures and losses. Worry also seems to generate anxiety to a larger extent, and rumination seems to generate depressive feelings. Lastly, and critical for this thesis, rumination and worry differ in terms of **temporal focus**. Worry is more focused on the future, in terms of anticipation of future aversive events or threats; rumination, by contrast, is more focused on past difficulties.

Executive Functions and Anxiety

Executive functions are a set of higher order cognitive processes that guide and regulate lower-level processes. Executive functions are involved in many behaviors that are vital for successfully navigating everyday activities, including self-regulation and self-directed behavior, decision making, planning, problem-solving and coping with novel situations (Diamond, 2012; Friedman & Miyake, 2017; Gilberg & Burgess, 2015). At date, there is relative agreement that there are...
three core executive functions: inhibition, updating or working memory and shifting (or set shifting). These processes underlie more complex actions such as those described above (Diamond, 2012; Miyake et al., 2000). Inhibition refers to the ability to focus one’s attention, thoughts, behavior, and emotions to override internal or external distractions; updating is the ability to monitor and rapidly add or delete contents of working memory; and shifting is the ability to flexibly switch between different mind-sets.

Research on college student samples comparing individuals with high versus low trait anxiety, have found that high trait anxiety is associated with lower performance on tasks measuring executive functioning (Derakshan & Eysenck, 2009; Miguel, 2012). Deficits in executive functions have particularly been found with regard to inhibition and shifting (Eysenck, Derakshan, Santos, & Calvo, 2007; Miguel, 2012), however, updating appears relatively intact at least under non-stressful conditions (Eysenck, et al., 2007; although see Gustavson & Miyake, 2015, for a different view). It has also been suggested that worry is the specific component of anxiety associated with inhibition and/or shifting abilities (e.g. Eysenck et al., 2007).

Research including patient samples have reported executive deficits in several anxiety disorders, such as obsessive compulsive disorder (Benzina, Mallet, Burguière, N’Diaye, & Pelissolo, 2016), posttraumatic stress disorder (Polak, Witteven, Reitsma & Olff, 2012), generalized anxiety disorder (Tempesta et al., 2013), and social anxiety disorder (Moore, Gómez-Ariza, & Garcia-Lopez, 2016; Moriya & Sugiura, 2013). Whether panic disorder is associated with executive deficits remains unclear, two recent reviews (Alves, Pereira, Machado, Nardi, & Silva, 2013; O’Sullivan & Newman, 2014) reported no systematic impairments in executive functioning. Alves et al., (2013), however, pointed out that the area is not well-studied and existing research is based on very small sample sizes.

Importantly, compromised executive functioning may temporally precede or underlie repetitive negative thinking. According to the disengagement hypothesis, poor executive functioning may contribute to rumination in the sense that it may impair the ability to disengage and to redirect attention away from negative thought material, causing a repeated pattern of recurring negative thoughts and images (Joormann et al., 2007). Given the commonalities between worry and rumination, a similar process might underlie worry.
Time Processing and Anxiety

**Time Estimation and Anxiety**

Compared to other psychopathological conditions, such as depression or schizophrenia, the influence of anxiety and especially anxiety disorders on time estimation has received relatively little attention. This is somewhat surprising, given that anxiety is generally associated with features that (at least within the framework of AGM; see Figure 1) may influence time estimation, such as increased physiological arousal (Rachman, 2004), and attentional deficits (Eysenck et al., 2007). In particular, research concerning retrospective time estimation is virtually nonexistent.

Concerning the relationship between prospective time estimation and anxiety, explanations in terms of AGM have been put forward. Anxiety could affect prospective time estimation at the pacemaker level, as well as in terms of attentional resources devoted to process time. Anxiety is associated with increased physiological arousal, which could potentially increase the frequency of the pacemaker (e.g., Bar-Haim, Kerem, Lamy, & Zakay, 2010). This in turn could result in judging time intervals as longer than they objectively are. In other words, time will be perceived as passing more slowly (Bar-Haim et al., 2010).

With regard to attentional mechanisms involved in prospective time estimation, two hypotheses exist as to how and why anxiety can affect time estimation. The first hypothesis was put forward by Wittmann and colleagues (Wittmann, Vollmer, Schweiger, & Hiddemann, 2006). They suggested that mental distress in terms of for example anxiety, results in less meaningful thoughts and activities, thus causing attention to automatically be drawn to time. Within the framework of the AGM, this results in the attentional gate opening more widely, and consequently, more pulses pass through to the accumulator, which results in that time is perceived as passing more slowly. The second hypothesis is that because anxiety is associated with attentional problems (Eysenck et al., 2007), fewer attentional resources are available to process time, leading to more variable time estimation and possibly to the perception that time is passing more quickly (Mioni, Stablum, Prunetti, & Grondin, 2016). This would be particularly evident in time estimation tasks that put higher demands on attention or working memory, such as time reproduction tasks (as the interval to be reproduced has to be kept in working memory) or dual-task situations (Mioni et al., 2016).

Using anxiety-evoking stimuli as the stimuli to be timed, Bar-Haim and colleagues (Bar-Haim et al., 2010), compared time estimation in college students with high versus low trait anxiety, on tasks in which the participants reproduced
the duration of fearful faces that were presented at 2s, 4s and 8 s. Bar-Haim and colleagues (2010) showed that high trait-anxious students overestimated the shortest duration (2 s), which they explained as resulting from short and transient arousal-induced effect on the pacemaker. At longer intervals (4s and 8 s) arousal returned to baseline and no longer affected pacemaker speed (Bar-Haim et al., 2010). Moreover, Jusyte, Schneidt and Schönenberg (2015) found a similar effect of arousal-induced time overestimation of angry faces (stimuli presentation ranging from 600 to 1200 ms) in college students with clinical symptoms of social anxiety disorder (Jusyte, Schneidt, & Schönenberg, 2015).

Although studies using anxiety-evoking stimuli have provided important insights as to how time judgment is affected by emotional stimuli, they say little about how individuals with anxiety generally perceive time (i.e., whether baseline time perception is affected). Accordingly, Mioni and colleagues (2016), investigated both time reproduction and time production in patients with anxiety or depression, and healthy controls. Mioni and colleagues’ findings revealed that, compared to depressed patients and controls, patients with anxiety underestimated time in time reproduction tasks. This observation was explained in terms of attentional deficits among anxiety patients, in the sense that the patients had difficulties in sustaining attention and keeping the target interval in working memory for subsequent reproduction (Mioni et al., 2016). Wittmann and colleagues also examined baseline time perception in relation to anxiety, but of a much longer interval (13 min verbal estimation task). Wittmann and colleagues (Wittmann et al., 2006) found that anxiety symptoms among cancer patients were associated with overestimates of the time interval. Here, the findings were explained in terms of increased attention to time due to mental distress.

To summarize, prospective time estimation and anxiety is not a well-studied area, and it is difficult to draw substantial conclusions from the extant literature due to differences in the methodology and diversity of samples (e.g., patient samples vs. clinical cutoffs in normal samples). What can be concluded is that arousal affecting the pacemaker is possibly only evident at shorter durations and is dependent on whether the stimuli to be estimated is anxiety evoking. For longer durations and when stimuli to be estimated is not anxiety evoking, attention may play a larger role.

To my knowledge, very few researchers have investigated retrospective time estimation in anxiety and results are inconclusive. In an older study, Sarason and Stoops (1978), found that individuals with high test anxiety, compared to individuals with moderate or low test anxiety, made longer retrospective time judgments, both of a time period when they were waiting to take a test and of the time it took to perform the actual test. Even though Sarason and Stoops did not place their findings within a theoretical model of retrospective time estimation,
they attributed their findings to high levels of self-preoccupation in subjects with high test anxiety, which made the time intervals for these participants seem longer in retrospect. In a more recent study, Lueck (2007) induced state anxiety in one group of participants by instructing them that they had to give a speech in front of an audience, whereas another group of participants were instructed to be the audience. After the instructions, all participants watched a video of a recorded speech and were afterwards asked to estimate its duration. Although state anxiety was successfully induced in participants who thought they had to give a speech compared to those who were asked to be the audience, participants in the two conditions did not differ in time estimation (Lueck, 2007). It should though be highlighted that participants in this study were not asked to remove write watches or other clock-devices, which opens up for the possibility that participants were actually aware of how much time that had passed. The high accuracy that was observed among participants (their estimates only deviated on average 5% from the actual time interval) could be indicative of such a possibility.

**Time Perspective and Anxiety**

There are several indications that anxiety might be related to deviations or biases in time perspective. For example, anxiety has been described as a future oriented emotion (Barlow, 2002), and anxiety is associated with rumination and worry, which both have a clear temporal component (past focus for rumination and future focus for worry). Systematic research of anxiety and particularly anxiety disorders within the time perspective framework, however, is sparse.

Early theoretical contributions and empirical work on the relationship between time perspective and psychopathology in general suggested the existence of a connection between distortions in the two (for a review, see Wallace & Rabin, 1960). For instance, depression was reported to be associated with an inability to conceptualize the future in terms of anticipating goals and possibilities and an exaggerated focus on the past (Wallace & Rabin, 1960). Anxiety, on the other hand, was described as strongly future-oriented (Wallace & Rabin, 1960). However, as pointed out by Wallace and Rabin (1960), these early accounts of the relationship between time perspective and psychopathology are difficult to synthesize due to vast methodological and conceptual differences.

More recent and systematic research, utilizing ZTPI as the instrument to study time perspective, has shown that individual differences in time perspective are associated with several forms of psychopathology and mental health problems. In general, individuals with poor mental health show a biased time perspective profile, particularly by being “stuck” in one or more of the negative valence time perspective dimensions. For example, higher Past Negative or Present Fatalistic have been linked to anxiety (Anagnostopoulos & Griva, 2012; Zimbardo & Boyd,
depression (Desmyter & De Raedt, 2012; van Beek et al., 2011; Zimbardo & Boyd, 1999), suicidal ideation (Laghi, Baiocco, D’Alessio, & Gurrieri, 2009) and neuroticism (Shipp, Edwards, Schurer, & Emerson, 2009; Zhang & Howell, 2011). The magnitude of associations with Present Fatalistic and these variables are generally smaller.

More important, the Future scale has shown little involvement in mental health, apart from weak negative associations with depression (Zimbardo & Boyd, 1999) and/or anxiety (Papastamatelou et al., 2015; Zimbardo & Boyd, 1999) in a few studies. This highlights the issue of how future time perspective is measured by the ZTPI. As already mentioned, researchers from various theoretical fields have associated anxiety with negative views of the future (e.g. Barlow, 2002; Miloyan et al., 2016). These aspects, however, do not seem to be captured in the future dimension of ZTPI. It further underlines the importance of using S-ZTPI with its addition of the Future Negative scale to get a better understanding of how persons with anxiety view, in particular, the future.

Also lacking in this research area are studies on the relationship between underlying mechanisms of anxiety, such as rumination and worry, and their associations with time perspective. It has though been hypothesized, although not empirically tested, that Past Negative time perspective may partly underlie why individuals get “stuck” in rumination (Webster & Ma, 2013), and it is reasonable to believe that Future Negative might similarly underlie worry. As touched upon in previous sections, in this thesis time perspective was studied as a mechanism that separately or together with poorer executive functioning, contribute to rumination and/or worry (Study II).

Balanced Time Perspective and Subjective Well-Being

This section is devoted to the final aim of this thesis, which regards BTP and its relation to subjective well-being. BTP is a concept that has gained more attention among researchers in recent years. Zimbardo and Boyd originally proposed that BTP is the mental ability to flexibly switch between temporal frames according to, for instance, situational demands (Boyd & Zimbardo, 2005; Zimbardo & Boyd, 1999). In concrete terms, the behavior of an individual with a BTP would be determined by compromising between past experiences, present desires and evaluations of future consequences. According to Zimbardo and Boyd (1999), BTP is adaptive across situations, and is beneficial for both psychological and physical health.

Several attempts have been made to operationalize BTP (e.g., Boniwell, Osin, Linley, & Ivanchenko, 2010; Stolarski, Bitner, & Zimbardo, 2011; Wiberg, Sircova, Wiberg, & Carelli, 2012; Zhang, Howell, & Stolarski, 2013), and all have both
strengths and drawbacks. Common to all is that none of these operationalizations are fully in line with Zimbardo and Boyd’s original proposition of BTP. Instead they opt to capture an optimal time perspective profile that facilitates well-being and mental health. To date, Stolarski and colleagues’ deviations from balanced time perspective (DBTP; Stolarski, Bitner, & Zimbardo, 2011; Zhang, Howell, & Stolarski, 2013) is the most widespread and researched method to measure BTP. Their method is based on cumulative deviations from optimal scores on each scale of the ZTPI, as suggested by Zimbardo and Boyd (1999, 2008), including low scores on Past Negative and Present Fatalistic, moderately high scores on Future and Present Hedonistic and high scores on Past Positive. The closer a participant’s overall score is to zero, the more balanced the participant is, as it indicates that the participant’s deviations from optimal scores are lower. The advantages of DBTP are that it is sample independent, that it measures DBTP as a relative, rather than absolute construct (c.f. Drake, Duncan, Sutherland, Abernethy, & Henry, 2008), and that is has superior predictive validity for well-being compared to other methods (for a review, see Stolarski, Wiberg & Osin, 2015).

One criticism of DBTP is that it needs to be further examined whether the ideal scores for each scale recommended by Zimbardo and Boyd (2008) indeed reflect true ideal scores (Stolarski et al., 2015). Another disadvantage is that the future time frame has less contribution to the overall DBTP score than past or present, because ZTPI only has one Future scale. An alternative in this regard is Wiberg and colleagues’ (2012) method of measuring BTP. This method is based on S-ZTPI, and thus gives equal weight to past, present, and future time frames. The central idea behind Wiberg and colleagues’ method is to measure the level of balance. Level of balance is computed as a total balance score (from 0, unbalanced, to 6, fully balanced) that corresponds to the number of S-ZTPI subscales for which the individual’s ratings concur with the proposed optimal profile (i.e., a high score on Past Positive; moderate scores on Future Positive and Present Hedonistic; and low scores on Past Negative, Present Fatalistic, and Future Negative). A limitation of this method is that its construct validity remains unclear, because it has not been systematically examined in relation to other related constructs, such as subjective well-being.

Although the aforementioned measurements of BTP are all based on ZTPI, Webster (2011) took another approach, developing a new self-report questionnaire to assess BTP, the Balanced Time Perspective Scale (BTPS; Webster, 2011). BTPS only measures an individual’s positive perceptions and views about the past or the future but not the present. The present time frame is seen as a “fulcrum, or balancing point” (Webster, 2011, p. 111) between the past and the future. Balance is by the BTPS measured by comparing scores on past vs. future oriented items. If a person scores below or above the median split (in the
study sample) on both future and past oriented items he or she is categorized as balanced, but either “time restrictive” (below the median split) or “time expansive” (above the median split). Time expansive appears to be the more favorable category in light of its stronger relations with subjective well-being and happiness (Webster, 2011). The main limitations of this method are twofold. First, it does not take into account views of the present. Second, it is sample dependent, because the categorizations are made on median splits in the specific study sample.

It should be noted that the vast majority research on time perspective in general (and BTP specifically), in relation to correlates of well-being is based on young and/or middle-aged adults. However, given that for example SST (e.g. Carstensen, 2006; see also under section Time perspective: Definitions, theoretical models and measurement) posits that a more present focus might be adaptive for socioemotional well-being in older adults, it is not fully clear whether the abovementioned observations are valid across the life span. Particularly in light of a previous finding that older adults tend to be less balanced than younger but equally high on subjective well-being (Webster, Bohlmeijer, & Westerhof, 2014), the factors that constitute BTP do not appear to be completely age-invariant.

Taken together, BTP is a thriving new area in time perspective research, but it has several caveats. One is that there is no consensus as to how BTP is best operationalized. Another concern is that in methods that are based on the ZTPI, the future time perspective (compared to the past and the present perspectives) has less weight on overall BTP because negative views of the future (i.e., Future Negative) are not taken into account. A final limitation is that BTP may not be equally associated with well-being across all ages.
Aims of the Thesis
The overarching aim of this thesis was to explore prospective and retrospective time estimation and time perspective in relation to anxiety. Another aim was to examine factors that may contribute to anxiety problems (executive dysfunction and repetitive negative thinking), and the ways in which they might be associated with time perspective. The final aim was to explore BTP by comparing three methods for measuring BTP and those methods’ distinct associations with subjective well-being and age. A schematic overview of the studies included in the thesis can be found in Table 2.

Specific Aims

Study I
In Study I, the overall aim was to investigate prospective and retrospective time estimation and time perspective in persons with mild to moderate symptoms of anxiety compared to nonanxious controls.

Study II
Study II was an investigation of the associations among dimensions of time perspective, executive functioning (shifting and inhibition), worry and rumination in psychiatric patients with anxiety disorders and in healthy controls.

Study III
Study III aimed at investigating prospective and retrospective time estimation in psychiatric patients with anxiety disorders and if deviations in time estimation were differentially associated with state anxiety and worry.

Study IV
In Study IV, the aim was to compare three operationalizations of BTP as well as their distinct associations with subjective well-being, in a relatively large, population-based sample of older adults (60 – 90 years of age). This study also includes an investigation of age-related variations in time perspective and BTP.
<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Participants</th>
<th>Variables Instrument/task</th>
<th>Anxiety Symptoms</th>
<th>Depressive symptoms</th>
<th>Statistical Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study I</td>
<td>Between-subjects design</td>
<td>Participants recruited from a waiting list for psychotherapy and through flyers (Study Ia: N = 56; Study Ib: N = 44)</td>
<td>Time estimation Time reproduction (4, 8, 24, 32 s) Time production (2 mins) Retrospective time estimation (12 and 17 mins)</td>
<td>Beck Anxiety Inventory (BAI; Beck et al., 1988), Symptom Checklist-90 (SCL-90; Derogatis, 1973),</td>
<td>Beck's Depression Inventory-II (BDI-II; Beck et al., 1996)</td>
<td>ANOVA, ANCOVA</td>
</tr>
<tr>
<td>Study II</td>
<td>A combination of between-and within-subjects design</td>
<td>Psychiatric outpatients (n = 36) and healthy controls (n = 44)</td>
<td>Time perspective S-ZTPI (Carelli et al., 2011)</td>
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<tr>
<td>Study III</td>
<td>A combination of between-and within-subjects’ design</td>
<td>Psychiatric outpatients (n = 36) and healthy controls (n = 44)</td>
<td>Time estimation Time production (2 mins) Verbal estimation (2 mins) Retrospective time estimation (14 mins)</td>
<td></td>
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</tr>
<tr>
<td>Study IV</td>
<td>Within-subject’s design</td>
<td>Older adults (N = 447) from the Betula study (Nilsson et al., 1997; 2004)</td>
<td>Time Perspective S-ZTPI</td>
<td>Subjective Well-Being</td>
<td>Ratings of perceived happiness and life satisfaction; four items measuring “Joy” from the Perceived Stress Questionnaire (PSQ; Levenstein, 1977; Rönnlund et al., 2015)</td>
<td>Hierarchical linear regression, confirmatory factor analysis, Pearson’s correlation analyses</td>
</tr>
</tbody>
</table>
The Empirical Studies

An overview of the four studies included in the thesis can be found in Table 2. All studies followed the Declaration of Helsinki and all participants provided their written informed consents prior to participation. The studies were approved by the regional ethical commission at Umeå University.

Study I

Background and Aim
Although several studies have shown that negative emotions can alter the sense of time (Droit-Volet, 2013), less is known about how time processing is affected by anxiety. The aim of this study was to explore several aspects of time processing, including time perspective, prospective and retrospective time estimation, in persons with varying degree of anxiety symptoms. Study I consisted of two substudies, henceforth referred to as Study Ia and Study Ib.

Participants
In both studies, participants were recruited from a waiting list for psychotherapy at a training clinic for psychology students at the local university and through flyers. Study Ia included 56 persons, and Study Ib included 44 persons. Participants were post-hoc sorted into two groups (anxious and nonanxious) according to their scores on inventories measuring anxiety symptoms.

In Study Ia scores on SCL-90 subscales for anxiety (Anxiety, Phobic Anxiety and Obsessive Compulsive Disorder) were used as a screening tool. Participants scoring above the threshold for clinically significant symptoms (Fridell, Cesarec, Johansson & Thorsen, 2002) were assigned to the anxiety group (n = 22; 17 females; age: M = 29.7 years, SD = 11.19; SCL-90 score, M = 1.45, SD = 1.07) and remaining 34 participants (25 females; age: M = 25.3 years, SD = 5.31; SCL-90 score, M = 0.43, SD = 0.25) were assigned to the control group.

In Study Ib, Beck’s Anxiety Inventory (BAI; Beck & Emery, 1988) was used to measure anxiety symptoms. Participants scoring above the threshold for mild anxiety (BAI score ≥ 8; Beck et al., 1988) were assigned to the anxiety group (n = 19; 15 females; age: M= 25.58, SD = 5.18; BAI score, M = 16.11, SD = 6.04) and
participants scoring below the threshold were assigned to the control group \((n = 25; 18 \text{ females}; \text{age: } M = 26.36, SD = 7.37; \text{BAI score, } M = 3.60, SD = 2.02)\)

**Materials and Procedure**

The instruments used are summarized in Table 2. All participants were tested individually in a quiet room and were asked to remove wristwatches. Participants first did a prospective time reproduction task, in which participants had to reproduce four time intervals \((4 \text{ s, 8 s, 24 s, and 32 s})\) twice (Carelli, Forman, & Mäntylä, 2008), and then a two min time production task (prospective paradigm) during which participants also performed a distracting task that consisted of reading aloud the numbers \(1\) through \(9\) that appeared randomly on a computer screen. Participants also performed a retrospective verbal estimation task, in which participants estimated how much time that had passed since they first sat down in the room. The interval to be judged was 17 min. Lastly, the participants filled out the questionnaires.

Study Ib had a similar method and procedure except that the time reproduction task was dropped and the retrospective time estimation task was shorter \((12 \text{ min})\) but had the same instructions. The participants also filled out Beck’s Depression Inventory-II in order to control for depressive symptoms.

**Statistical Analyses**

A ratio of subjective to objective time \((\text{relative errors, RE})\) was calculated for performance on each time estimation task. In this procedure, each participant’s subjective estimation of duration is divided by the actual duration of the same condition. A coefficient less than \(1\) indicates underestimation, a coefficient greater than \(1\) indicates overestimation of the time interval, and a value equal to \(1\) indicates a perfectly calibrated estimation. Analysis of variance (ANOVA) was carried out to examine differences between the groups. Cohen’s \(d\) (Cohen, 1988) were calculated to assess the effect sizes for all group differences (adjusted for unequal sample sizes). In Study Ib, analysis of covariance (ANCOVA) was performed with depressive symptoms as a covariate to control for the effect of depressive symptoms on time perspective scores.

**Results and Discussion**

Results were consistent across both studies. Beginning with time estimation, we did not find any clear patterns of time estimation deficits in the anxiety group compared to the control group. Concerning time perspective, the anxiety group was significantly more Past Negative and Future Negative compared to the control group. These results remained significant even after controlling for the effect of depressive symptoms in Study Ib.
In summary, results indicated that in persons suffering from anxiety in the mild to moderate range, time perspective was the only time variable that reliably differed between the groups. With regard to time estimation, we could not rule out the explanation that the lack of significant findings were because the participants in the anxiety group were not anxious during the experimental session to the extent that it would affect time estimation. Within the framework of the AGM, participants were possibly not anxious enough (at least not during the experimental session) for it to either affect the pacemaker (Bar-Haim et al., 2010) or attention to time (Wittmann, 2009). A methodological feature that could have addressed this limitation would have been to include a measure of participants’ anxiety levels during the experimental session. Another alternative would be to include participants suffering from severe anxiety.

**Study II**


**Background and Aim**

The aim of Study II was to examine the relationships between dimensions of time perspective, repetitive negative thinking (rumination and worry) and executive functioning (shifting and inhibition). In this study, we also crucially included patients with anxiety disorders to enhance the clinical generalizability of the findings in Study I. A major aim of the study was to test a hypothetical model in which executive functioning and dimensions of time perspective (specifically Past Negative and Future Negative) were treated as underlying mechanisms of rumination and worry. Both worry and rumination are repetitive, negative, and relatively uncontrollable thoughts that are associated with anxiety, which may lead to more prolonged and elevated problems (Ehring & Watkins, 2008; Hong, 2007). Furthermore, both rumination and worry may reflect underlying difficulties in executive functioning (Joormann et al., 2007; Zainal & Newman, 2017). Although rumination and worry have many similarities, past research has separated them in terms of temporal focus, in the sense that rumination is more past focused, and worry is more focused on the future (MacLeod et al, 2005; Nolen-Hoeksema et al., 2008). In this study, we tested the joint influence of executive functioning and time perspective on rumination or worry. Our primary hypotheses were that poorer executive functioning and higher Past Negative would predict rumination; whereas, poorer executive functioning and higher Future Negative would better predict worry.
**Participants**
The study included 36 psychiatric outpatients (age: $M = 30.83, SD = 11.74$; 30 females) diagnosed with one or several anxiety disorders according to DSM-IV criteria, and 44 healthy controls (age: $M = 28.89, SD = 9.54$; 24 females) recruited through flyers. Patients with a history of substance use disorder, psychotic disorders and neuropsychiatric disorders ($n = 13$) were excluded and three participants dropped out before completing the study. Control participants were included according to the following inclusion criteria: (a) not experiencing mental health problems of any kind (b) not under treatment for mental health problems of any kind.

**Materials and Procedure**
For a description of the tasks and measurements included in the study, see Table 2. All patients first went through a structured clinical interview with two trained clinical psychologists to assure they fulfilled inclusion criteria for the study. The participants were tested individually in a quiet room under similar conditions, and the test order was the same for all participants. The participants first completed the tasks measuring executive functions and then filled out the questionnaires. Participants also completed two prospective time estimation tasks (directly after the executive tasks), and a retrospective time estimation task, which are not reported here (see Study III). The experimental session took approximately 60 min.

**Statistical Analyses**
Independent sample’s $t$-tests (two-tailed) were performed to assess between-group differences on all variables. Cohen’s $d$ (corrected for unequal sample sizes) was used to assess effect sizes of group differences on the study variables. In the next step of the analyses we performed multiple regression analyses using the forced entry method with rumination and worry as outcome variables, and executive functions, and Past Negative and Future Negative as predictor variables. Multicollinearity was assessed by inspection of tolerance values for all predictor values (a value > 0.20 indicates no issues with multicollinearity; Menard, 1995).

**Results and Discussion**
Results showed that the patient group differed significantly from controls in all time perspectives. Patients were significantly more Past Negative, Present Fatalistic and Future Negative, and less Past Positive, Present Fatalistic and Future Positive. The largest effect sizes were observed for Past Negative ($d = 1.77$), Past Positive ($d = 1.37$), and Future Negative ($d = 2.17$). Patients also scored significantly higher on inventories measuring rumination and worry. Baseline
performance on the executive tasks differed significantly between the groups, but indexes of shifting and inhibition did not differ between the groups.

Next we examined Past Negative, Future Negative and executive functioning as predictors of rumination and worry. Past Negative was the best predictor of rumination, whereas Future Negative was the strongest predictor of worry (see Table 3). Executive functioning was, however, not a significant predictor of either rumination or worry.

Table 3. Multiple Regression with Past Negative, Future Negative and Executive Functions as Predictors and Rumination and Worry as Outcomes.

<table>
<thead>
<tr>
<th>Variable</th>
<th>β</th>
<th>p</th>
<th>F</th>
<th>df</th>
<th>p</th>
<th>R²</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rumination</td>
<td></td>
<td></td>
<td>66.65</td>
<td>4.75</td>
<td>.00</td>
<td>.77</td>
<td>.55</td>
</tr>
<tr>
<td>Past Negative</td>
<td>.55</td>
<td>.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.55</td>
</tr>
<tr>
<td>Future Negative</td>
<td>.41</td>
<td>.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.56</td>
</tr>
<tr>
<td>Shifting</td>
<td>-.02</td>
<td>.77</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.98</td>
</tr>
<tr>
<td>Inhibition</td>
<td>.08</td>
<td>.17</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.98</td>
</tr>
<tr>
<td>Worry</td>
<td></td>
<td></td>
<td>53.03</td>
<td>4.75</td>
<td>.00</td>
<td>.74</td>
<td></td>
</tr>
<tr>
<td>Past Negative</td>
<td>.22</td>
<td>.01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Future Negative</td>
<td>.70</td>
<td>.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Shifting</td>
<td>-.01</td>
<td>.94</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Inhibition</td>
<td>.03</td>
<td>.57</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-</td>
</tr>
</tbody>
</table>

In summary, the results from Study II confirmed and further extended findings of Study I to patients with severe anxiety (diagnosed anxiety disorders). In accord with Study I, differences between patients and controls were especially marked in Past Negative and Future Negative. Interestingly, patients were also significantly less positive toward their past (Past Positive) compared to the control group, which was not the case in Study I. However, it mirrored the results from a study of time perspective in psychiatric patients (van Beek et al., 2011). This indicates that low Past Positive is not specific to persons with anxiety disorders, but that higher Past Positive potentially serves as a buffer against developing more severe mental distress. Regression analyses (Table 3) further confirmed the temporal components in rumination and worry. However, looking at the regression weights for Past Negative and Future Negative on rumination and worry respectively, it seems that the future focus in worry is more prominent than the past focus in rumination.
Study III

Background and Aim
The aim of Study III was to examine prospective and retrospective time estimation in persons with anxiety disorders in comparison to a healthy control group. The study was designed in order to allow comparison with Study I, in which one unresolved issue was whether the lack of significant findings was because the anxious group was not sufficiently anxious to affect time estimation. A further aim was to investigate whether possible deviations in time estimation were associated with state anxiety and/or worry.

Participants
The participants in this study were part of the same data collection as Study II (see Participants under Study II) and included 36 psychiatric patients with anxiety disorders and 44 healthy controls.

Materials and Procedure
For a description of tasks included in Study III see Table 2. Participants first a prospective verbal estimation task (2 mins) and then a time production task (2 mins). After these tasks, the participants filled out questionnaires. When participants started filling out the questionnaires, the experimenter started a concealed stopwatch, and participants were asked after 14 mins to estimate how much time that had elapsed passed since they started filling out the questionnaires (retrospective time estimation task). The Penn State Worry Questionnaire (PSWQ; Meyer, Miller, Metzger, & Borkovec, 1990) was used to measure worry, and state anxiety was measured by three purpose-made visual analogue scales (VAS) by which participants were asked to indicate how nervous, tense, or anxious they felt on an 11-point scale (from 0, not at all, to 10, severely). Participants’ ratings of state anxiety were transformed into a mean composite score of all three scales.

Statistical Analyses
Absolute errors (AEs) and ratios of subjective-to-objective time (relative errors, REs) were first calculated on the time estimation tasks. AEs were calculated by dividing the absolute difference between the target duration and participants’ estimations with the target duration (Mioni, Stablum, McClintock, & Grondin, 2014). REs were calculated by dividing each participant’s estimated duration by the target duration (Mioni et al., 2014). To assess group differences in time
estimation performance, independent samples t-tests (two-tailed) were used, and Pearson correlations were used to assess relationships between performance on time estimation tasks and symptom measures, across all participants and within the groups.

**Results and Discussion**

Mean group performance on all time estimation tasks can be found in Figure 2 (AEs) and Figure 3 (REs). As can be seen in Figure 2, patients were overall less accurate in their performances on all tasks. Examination of group differences showed that none of the group differences were significant (ps > .05) although the effect size for retrospective time estimation (d = .27) exceeded what is conventionally considered a small effect (d > .20; Cohen, 1988).

![Figure 2. Mean absolute errors for each group in the time estimation tasks.](image)

Concerning REs, Figure 3 illustrates that relative to the target value (i.e., RE = 1), the control group underestimated time in the verbal estimation task, and the retrospective time estimation task, and under-produced time in the time production task. The patient group similarly underestimated time in verbal estimation and retrospective estimation, whereas they over-produced in the time production task. Analyses of group differences, using independent samples t-tests showed that none of the group differences were significant. However, there was a trend towards significance (p = .06) between the groups in time production.
Lastly, we examined correlations between aspects of anxiety (worry and state anxiety) and performance on the time estimation tasks. These analyses showed that in the entire sample, RE on the retrospective time estimation task correlated both with state anxiety ($r = .29, p < .01$) and worry ($r = .27, p = .01$). Correlational analyses within the anxiety group, revealed that retrospective time estimation and state anxiety was significantly correlated ($r = .40, p = 0.01$); higher levels of state anxiety was related to judging the retrospective time interval as longer. In the control group, the correlation between worry and retrospective time estimation was close to significant ($r = .29, p = .053$). No other significant correlations were found.

In summary, differences between anxiety patients and healthy controls in time estimation appears to be fairly small, irrespective of paradigm (retrospective or prospective). Interestingly, within the anxiety group, state anxiety was moderately related to retrospective time estimation. Retrospective time estimation is a function of the amount of retrieved contextual changes (Block, 1990). Perhaps state anxiety functions as a contextual event, thereby influencing the number of retrieved contextual changes under a given time period.

![Figure 3. Mean relative error for each group on the time estimation tasks.](image)
Study IV

Background and Aim
BTP has gained increasing attention recently, and researchers have suggested that it is beneficial for good mental health and well-being (Boniwell et al., 2010b; Zhang et al., 2013; Zimbardo & Boyd, 1999). BTP is difficult to measure, and there are many ways to operationalize it, most of which provide a composite measure of an optimal way of relating to the past, present, and the future. The overarching aim of this study was to compare three methods of measuring BTP in terms of their separate relationships with subjective well-being and age.

Participants
The study included 447 older adults from the Betula prospective cohort study (Nilsson, et al., 1997; 2004). Participants were 60 to 90 years old (M = 70.23 years, SD = 7.65) and 53.5% of the sample was female.

Materials and Procedure
For a summary of included measures see Table 2. All data was from the sixth test wave when S-ZTPI was first part of the test battery. Three methods were used to assess balance (or deviations from balance). All methods were based on participants’ scores on ZTPI (or S-ZTPI). The first was DBTP (Stolarski et al., 2011, 2013), which is measured by the difference between participants’ ratings (referred to as empirical scores), and proposed optimal scores (Zimbardo & Boyd, 2008) on each of the five original scales of ZTPI. The optimal scores suggested by Zimbardo and Boyd are based on data from their large, cross-cultural database on time perspective (Zimbardo & Boyd, 2008). A score closer to zero indicates less deviation and thus more balance. DBTP is calculated according to the following formula:

$$\sqrt{(oPN - ePN)^2 + (oPP - ePP)^2 + (oPF - ePF)^2 + (oPH - oPH)^2 + (oF - eF)^2}$$

0 = optimal score, e = empirical score; oPN = 1.95, oPP = 4.6, oPF = 1.5, oPH = 3.9, oF = 4

The second method, S-BTP (S for Swedish; Wiberg et al., 2012), is calculated as levels of balance. S-BTP is based on S-ZTPI, and it includes scores for Future Negative. According to this operationalization, a person is classified as either not
balanced (0) or balanced (1) based on their mean scores on each time perspective subscale. For Past Negative, Present Fatalistic and Future Negative a person should score low (i.e., a mean value ≤ 2.5 for each subscale) to be categorized as balanced. A person should further obtain moderate Present Hedonistic scores (2.7 ≤ ≥ 3.3), moderately high Future or Future Positive scores (3.0 - 4.0 points), and high scores on Past Positive (3.5 - 5 points). Balance scores on each time perspective scale are summed to get an overall balance score (from 0, not at all balanced, to 6, fully balanced). The third method was an extension of DBTP (called DBTP-E), in which participants’ distance from a proposed optimum value on Future Negative is added to the original formula (oFN - eFN). The proposed optimal score for Future Negative was set to 1.8 (corresponding to the 10th percentile in the sample and in accordance with Past Negative).

Subjective well-being was measured by two 11-point ratings of life satisfaction and happiness and four items loading on a subfactor (“Joy”) in the Swedish version (Rönnlund et al., 2015) of PSQ (Levenstein et al., 1993).

**Statistical Analyses**
Hierarchical regression analyses with forced entry were used to examine age-related changes in time perspective and measures of BTP. Age was entered at the first step, and in the second step, in the next step, a quadratic age term (age²) was entered and significant $F$-change/$\Delta R^2$ ($p < .05$) was used to test for a nonlinear trend. In the final step, education was entered. Confirmatory factor analyses (CFA) were used to establish a measurement model of subjective well-being. Three competing models were compared: (a) unitary model (all items on a single factor), (b) two-correlated-factor model (life satisfaction/happiness vs. joy) and (c) second-order factorial model (all factors correlating on a global, higher order factor). Three indices were used to assess model fit: $\chi^2$ (a nonsignificant $p$-value suggests a well-fitting model), Root Mean Squared Error of Approximation (RMSEA) and Comparative Fit Index (CFI). Established criterions for good fit are for RMSEA ≤ .06, and for CFI ≥ .95 (Hu & Bentler, 1999). The unitary model demonstrated poor fit, whereas the two-correlated-factor model and second-order-factorial model demonstrated the same levels of excellent fit. We decided to use the latter model to facilitate comparison between BTP and a global subjective well-being factor.

**Results and Discussion**
Beginning with analyses of age-related variations in time perspective, Past Negative, Present Fatalistic and Future Negative all demonstrated trends toward increased scores with advancing age, which was especially marked in Present Fatalistic. In the next step we examined age-related variations in the three measures of BTP. A significant age-related decrease in balance was observed for
the three measures of balance. This finding makes sense given that Past Negative, Future Negative, and Present Fatalistic in particular, increased with age and higher score on any of these subscales will contribute to less overall balance.

Finally, we examined relations between the three measures of BTP and subjective well-being. S-BTP and DBTP-E were more closely related overall to subjective well-being than DBTP, with DBTP-E having the highest value. Analyses of separate age groups (60-65, 70-75, and 80-90 years) revealed a significant relationship with subjective well-being across age for DBTP and DBTP-E, whereas S-BTP was not significantly related to subjective well-being in the oldest group. Furthermore, the association between DBTP-E and subjective well-being decreased with increasing age. To better understand these patterns, we additionally examined associations between S-ZTP subscales and subjective well-being across the entire sample and within the age groups (60-65, 70-75, and 80-90 years). These analyses yielded a strong, negative correlation between Future Negative and subjective well-being for the entire sample ($r = -.68, p < .001$), whereas it was only weakly related to subjective well-being in the oldest age group ($r = -.12$).

In summary, aging appears to be related to a loss of BTP, driven in particular by an increase in Present Fatalistic with advancing age. Interestingly, negative views of the future appeared to have little relation with subjective well-being for the oldest old (80+), but was more strongly related to subjective well-being in the younger olds.
General Discussion

The main aim of this thesis was to broadly examine aspects of psychological time, i.e., prospective and retrospective time estimation, and time perspective in relation to anxiety. Another aim was to explore time perspective (and, specifically, BTP) in relation to subjective well-being and age. In the following sections, I give a brief summary of the results and then discuss and synthesize the main findings of the thesis. I address the primary limitations, strengths, and practical implications of the thesis, and, finally, I provide some suggestions for future research.

Brief Summary of the Results

In Study I, we examined time estimation and time perspective in persons with mild to moderate symptoms of anxiety. We found that persons with anxiety was more Past Negative and Future Negative compared to controls, whereas no significant differences were found in time estimation. In Study II, we moved on to investigate time perspective in patients with anxiety disorders. As in Study I, Past Negative and Future Negative were the dominant time perspectives in the anxiety group. However, in contrast to Study I, the anxiety group was also less positive toward their past (lower Past Positive), more Present Fatalistic, less Present Hedonistic, and less Future Positive. In this study, we further tested time perspective (specifically Past Negative and Future Negative) and executive functioning (shifting and inhibition) as predictors of repetitive negative thinking (rumination and worry). Results showed that, as predicted, Past Negative more strongly predicted rumination, and Future Negative was a stronger predictor of worry. In Study III we again investigated prospective and retrospective time estimation, but in a sample consisting of psychiatric outpatients with anxiety disorders compared to healthy controls. We further examined associations between performance on the time estimation tasks, worry, and state anxiety. There were no significant differences in time-estimation performance between anxiety patients and healthy controls. Within the anxiety group, state anxiety was moderately related to retrospective time estimation, such that higher levels of state anxiety correlated with longer retrospective time estimates. Finally, in the fourth and last study, BTP was examined in association with subjective well-being and age. We examined three methods to measure BTP and found that those that included Future Negative (i.e., DBTP-E and S-BTP) were more strongly related to subjective well-being in the full sample. However, when we examined age-related variations in BTP, we found that DBTP-E and S-BTP were less correlated with subjective well-being than DBTP in the oldest age group, driven in particular by a decreased association between Future Negative and subjective well-being in this
age group. Advancing age also correlated with a decrease in BTP, primarily due to higher Present Fatalistic in the oldest participants.

Is Anxiety associated with Deviations in Time Estimation?
Synthesizing the results from Study I and Study III, it appears that the effects of anxiety on time estimation are relatively small and depend on which aspect of anxiety that is being considered. An interesting comparison with some of the previous studies might help to highlight these results. I took the liberty of calculating some effect sizes (Cohen’s $d$) concerning between-group differences (anxiety vs. controls) in some of the prior studies, and it appears that they are similarly in the small to moderate range. For example, in the study by Bar-Haim and colleagues (Bar-Haim et al., 2010), in which students with high vs. low trait anxiety reproduced the duration of fearful faces, the largest between-group difference in any of the trials according to effect size is $d = 0.18$. Similarly, in Jusyte and colleagues’ study (Jusyte et al., 2015), in which students with social anxiety disorder and healthy controls estimated durations of angry faces by means of a temporal bisection task, the largest effect size is $d = 0.27$. Lastly, Wittmann et al. (2006), compared participants with high anxiety versus low anxiety on a 13 minutes long verbal estimation task. In this study, the effect size is larger, $d = 0.48$. Comparing the results of the studies in this thesis with the foregoing results, it seems that our findings are overall in line with prior work. In comparison with findings from a related field, time estimation and depression, a recent meta-analysis showed that depression is not associated with any clear deficits in time estimation, apart from a trend toward poorer performance in depressives on time discrimination tasks (Thönes & Oberfeld, 2015). Hence, emotional disorders overall (anxiety disorders as well as depressive disorders) appear to be associated with quite small deviations in time estimation.

However, a relevant finding from Study III is that different subcomponents of anxiety might have differential effects on time estimation performance. In Study III we attempted to disentangle the effects of state anxiety (during the session) and worry on prospective and retrospective time estimation. It appeared that only state anxiety is related to time estimation and, specifically, retrospective time estimation. Moreover, the association between state anxiety and prospective time estimation was only significant in the patient group, not in the control group. It is intriguing that state anxiety was not associated with prospective time estimation, whereas it was significantly associated with retrospective time estimation. Putting this finding in the framework of the contextual change model, which stipulates that an interval will appear longer in retrospect if more contextual changes have been encoded in memory during a given time interval, it could be that state anxiety potentially functions as a contextual change. According to the contextual change model, a contextual change does not only have to occur
externally but can occur internally. In this case, the emotional experience of state anxiety might potentially has functioned as an additional contextual change.

**Past Negative and Future Negative Bias: Cause or Consequence of Anxiety?**

The most consistent result in this thesis, is the tendency among individuals who suffer from anxiety to view their past with aversion (Past Negative) and their future with negative anticipation (Future Negative). This pattern raises several interesting and important questions. One question is whether high Past Negative and high Future Negative are specific to anxiety or found in other conditions of mental ill-health. Prior work has shown that Past Negative is related to other aspects of mental health problems and psychopathology, such as depressive symptoms (e.g. van Beek, Berghuis, Kerkhof, & Beekman, 2011; Zimbardo & Boyd, 1999) suicidal ideation (Laghi et al., 2009), and perceived stress (Papastamatelou et al., 2015). These observations indicate that Past Negative is not specific to anxiety. The association between Future Negative and psychopathology has so far only been examined in one study of time perspective in patients with ADHD. This study found that patients with ADHD were slightly more Future Negative in comparison to healthy controls, although the main time perspective that distinguished patients from controls were lower scores on Future Positive (Carelli & Wiberg, 2012). Clearly, more research is needed to determine whether the Future Negative bias is an aspect that distinguishes sub-clinical anxiety and anxiety disorders from other forms of mental health problems.

Another important issue is whether higher Past Negative and/or higher Future Negative are consequences of anxiety or are potential vulnerability factors for developing anxiety. If the latter is the case, Past Negative and Future Negative could be important targets in preventive measures but may also be important targets in the treatment of anxiety disorders. There has been some research on how to use time perspective theory as a foundation for psychotherapeutic interventions (e.g. Sword, Sword, Brunskill, & Philip, 2014; Zimbardo, Sword, & Zimbardo, 2012). In this therapy (called Time Perspective Therapy, TPT), the focus is to decrease time perspective biases and move towards a more balanced time perspective, through use of cognitive-behavioral interventions (Zimbardo, Sword & Sword, 2012). TPT has demonstrated effectiveness in treatment of for example PTSD (Sword et al., 2014), but the efficacy of TPT has yet to be systematically evaluated.

Related to the issue of whether Past Negative and/or Future Negative precede the development of anxiety is the question of whether time perspective is a trait or a state. In their seminal paper, Zimbardo and Boyd (1999) made a strong claim when they stated that an individual’s time perspective is stable and trait-like:
When a tendency develops to habitually overemphasize one of these three temporal frames [past, present, future] when making decisions, it serves as a cognitive temporal “bias” toward being past, future, or present oriented. When chronically elicited, this bias becomes a dispositional style, or individual differences variable, that is characteristic and predictive of how an individual will respond across a host of daily life choices. (p. 1272)

Since then, researchers have shown that personality traits, as conceptualized by for example the Big Five (Costa & McCrae, 1992), are correlated with aspects of time perspective (for a review, see Kairys and Liniauskaite, 2015). Other scholars have shown that individual differences in time perspective, even after controlling for personality traits (according to Big Five), have additional prognostic value for several health behaviors (Daugherty & Brase, 2010) as well as life satisfaction (Zhang & Howell, 2011). These studies’ results indicate that time perspective is a construct that is separate from personality, and perhaps rather serves as a mediator between personality and various psychological outcomes. Nevertheless, to assess the stability or malleability of time perspective, longitudinal studies examining time perspective over time are of critical value. In a rare longitudinal study, Holman, Silver, Mogle, and Scott (2016) examined time perspective and well-being in individuals (age range: 18–91) exposed to a collective trauma (9/11 terrorist attacks), 12 and 24 months after the initial exposure. Intriguingly, Holman et al. reported that time perspective seems to have both dispositional and situational qualities. Specifically, present and future time perspectives appeared to be relatively unaffected by ongoing stress, whereas ongoing stress was related to an increase in Past Negative time perspective, but only among younger adults. Taken together, there is some empirical support of the dispositional character of time perspective, but there are also observations that time perspective might be affected by situational factors (i.e., trauma) and malleable with psychotherapeutic interventions. Hence, the extant literature is still a long way from giving any conclusive answers to the question of whether time perspective is a trait or a state.

**Developmental Trajectories of Past Negative and Future Negative?**
Given that anxiety is often described as inherently future oriented (e.g. Barlow, 2000, 2002; Rachman, 2004), it is to some extent surprising that anxiety appears to be equally associated with Past Negative and Future Negative. Is Past Negative then a prerequisite of Future Negative? Intuitively, one might assume that the development of Past Negative temporally precedes Future Negative in the sense that individuals “carry” their negative past into the future. However, the exact link between these time perspectives remains an empirical question, because
longitudinal studies examining these time perspectives over time are nonexistent. Research in a related field, episodic foresight (Miloyan et al., 2016), can though offer some suggestions. It appears that individuals with anxiety are both more prone to simulate negative and threat related future events, and to reconstruct more negative and threat-related past events (Miloyan et al., 2016). Importantly, anticipated negative future events need not to be exact deductions of past experiences. Instead, memories of past experiences can serve as “building blocks”, which can be flexibly recombined in order to envision novel future events (Schacter & Addis, 2007). Although not in the framework of time perspective, these findings offer some insight into how Past Negative and Future Negative might be related.

**Balanced Time Perspective and Subjective Well-Being**

The results of the last study in this thesis revealed some interesting aspects about the relationship between BTP and subjective well-being. First, it appears that the inclusion of Future Negative in measurements of BTP (i.e., DBTP-E and S-BTP), increases the prognostic value of BTP on subjective well-being. Second, this pattern of results is not completely age-invariant. In fact, among the oldest participants in the study sample, there was a clear decline in the association between subjective well-being and BTP as measured by S-BTP and DBTP-E, primarily due to a diminished association between subjective well-being and Future Negative. Intriguingly, it appears that although the oldest participants are actually slightly more Future Negative than their younger counterparts, Future Negative has little significance for subjective well-being. Perhaps this reflects that negative anticipations of the future is natural tendency in ‘old-old’ age, which is dealt with by acceptance (c.f., Baltes, 1998) and thereby does not influence mood in any substantial way. To further validate this finding, future research should investigate whether the same age-related pattern would emerge in regard to Future Negative and aspects of poor mental health. For instance, if we would see diminished association between Future Negative and anxiety in late adulthood.

**Primary Limitations of the Thesis**

The most evident limitation of Study I, II, and III are small samples sizes, which precludes drawing strong conclusions from the findings. Especially with regard to anxiety and time estimation, the results from the studies in the thesis indicate that anxiety has minor effects on time estimation, and small effects might go unnoticed if the sample size is small. Needless to say, the findings of the thesis need to be replicated in larger samples. A second limitation is comorbidity, which is often an issue in clinical research (Beuke, Fischer, & McDowall, 2003). Even though we controlled for the effects of depressive symptoms and obtained similar
results, it is still possible that results are confounded by other co-occurring mental disorders.

A third limitation concerns the use of cross-sectional data in all the included studies, which precludes making any consistent claims on the direction of causality between the included variables. This might not be an issue concerning the relation between anxiety and time estimation, because it is far-fetched that poorer time estimation abilities lead to anxiety, but it is a larger problem when considering the association between anxiety and time perspective. It is quite possible that an individual’s responses to items on S-ZTPI are influenced by current distress. For example, being in an acute state of mental distress will potentially make an individual recall the past with more negativity as well as perceive the future as less bright. Hence, there is a tremendous need to study the stability of time perspective over time and how an individual’s time perspective might change across the course of illness and upon remission. Furthermore, in Study 2, we suggested a hypothetical causal model in which executive functioning and time perspective predict repetitive negative thinking. However, the design was cross-sectional, so the temporal precedence of any of these variables on one another remains unclear.

A fourth limitation is the use of self-report instruments to assess several of the constructs included in this thesis, including time perspective, anxiety symptoms and repetitive negative thinking. There are several limitations of relying on individuals self-perceptions through self-report questionnaires, rather than directly observing overt behavior (e.g., Baumeister, Vohs, & Funder, 2007; Paulhus & Vazire, 2005). The most obvious issue is that one cannot be sure that how people present themselves according to items on a questionnaire is credible and corresponds to how they actually think, feel, and behave in real life (Paulhus & Vazire, 2005). With regard to time perspective, it is difficult to think of other means of investigating this complex construct. State anxiety, on the other hand, which was also self-reported, has more alternative measurements. In Study III of the this thesis, we were interested in the effect state anxiety has on the pacemaker through increased arousal, so one option could have been to complement self-reported state anxiety with a more objective measure of physiological arousal (such as changes in skin conductance). Finally, I need to highlight that the majority of participants in Studies I, II, and III were women, which means that the results might be more applicable to women than to men.

**Strengths of the Thesis and Practical Implications**

The thesis extends prior work in several respects: (a) the measurement of time perspective included a factor that takes into account negative attitudes and views of the future (i.e., Future Negative), which has not been considered in previous
research of time perspective and anxiety. This methodological aspect might be particularly important to get a full comprehension of time perspective in anxiety, given that both theoretical perspectives and empirical work have emphasized the close association between anxiety and negative anticipations of the future. (b) Anxiety was investigated by a dimensional approach, meaning that the studies in the thesis include individuals that experience anxiety from mild to severe. It enabled a more refined understanding of how aspects of time processing are related to anxiety in sub-clinical cases as well as patients with anxiety disorders. (c). Conceptual and methodological contributions were made by comparing three methods of measuring BTP, each method’s associations with well-being and age, and how they differed across old age.

Some of the results presented in the thesis clearly indicate the importance of differentiating between positive and negative outlooks on the future. The results from Study I and Study II provided support for the Future Negative scale, and add to the clinical usability of time perspective as a basis for psychological interventions. Furthermore, this gives a more nuanced understanding of how individuals relate to the future and should be included in future work if time perspective is to be used as a foundation in clinical work with patients. However, the way in which to concretely implement this finding in clinical work needs to be investigated further.

Due to the aging population, maintenance of good health in the older population is of great concern. In Study IV, we showed that time perspective may have important links to subjective well-being in the older population. Concerning old age, scholars have stressed that time perspective is important to consider in psychological counseling with older patients (Shmotkin & Eyal, 2003). The results reported in this thesis imply that in ‘old-old’ age, Present Fatalistic attitudes are important to take into account, as they might have a more negative relation with subjective well-being than is the case in younger adults. In contrast to younger adults, negative views of the future (Future Negative) might instead be easier to adapt to in late senescence.

Retrospective time estimation is easy applicable to everyday situations. The ability to accurately recall how long it took to perform a certain task, is important for planning and time management in everyday activities. The results of Study III suggest that individuals with state anxiety might, in retrospect, judge time as longer, could be important in terms of how individuals who easily respond with state anxiety manage time in their everyday lives (e.g., use available time less effective).
Future Directions

This thesis provided some answers, but it has also generated more questions. First, we know from a wealth of research that aspects of time perspective are associated with many important psychological outcomes. This thesis has further shown that time perspective can provide meaningful information about how individuals with anxiety relate to the past, the present and the future, which implies that individual differences in time perspective may have clinical implications. Nevertheless, a huge limitation of this whole research field is the lack of longitudinal studies about how time perspective co-varies over time with other psychological variables in general and, in the context of this thesis, with mental distress specifically. Are time perspective biases, such as the strong Past Negative–Future Negative bias found in anxiety, a risk factor for developing more severe anxiety, and does this bias persist after remission? Furthermore, if time perspective is to be a meaningful aspect in clinical work, its use as a target in psychotherapy needs to be further researched and systematically evaluated.

As concerns time estimation, the results in Study I and II indicate that baseline time estimation is not largely affected in persons with anxiety, and rather that effects are relatively small and determined by what aspect of anxiety that is considered. An interesting venue for future research would be to, if possible, take this research “out of the lab” so as to examine the ecological validity of these findings. Performance in laboratory settings does not always reflect individuals’ functioning in everyday life. In fact, it is not unusual that a person might perform relatively well in the lab, but still experience major problems with this ability in “real life” (Chaytor & Schmitter-Edgecombe, 2003). Related to this is the anecdotal evidence that I have acquired during my testing of anxiety patients. Many of the patients that I have assessed, reported major problems with time keeping in their lives, which they, in turn, experienced had an effect on their daily functioning. The major challenge is to come up with more ecologically valid tasks that can better capture these people’s everyday experiences.
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Acknowledgments

Going through a doctoral education sure makes one aware of time. In the beginning, the five years that I had in front of me felt like an ocean of time, whereas when I approached the pressing deadline to submit the thesis, I wondered where all the time had gone. Does this mean that time flew because I was having so much fun? Well, perhaps not all the time. Being a doctoral student includes both highs and lows, but one thing is for sure: There are many people that deserve to be acknowledged, because without them, I would not have been able to write this thesis.

First of all, I would like to thank all the participants, without you there would be no thesis. Thank you for the time and the effort you invested participating in this research program.

To Maria Grazia Carelli, my main supervisor, you have been an outstanding mentor. I cannot thank you enough for how you have generously shared your scientific knowledge, the invaluable advice you have given me about the academic world, and for constantly trying to improve my scientific communication (which undoubtedly has been tough at times). Thank you also for lifting my spirit when my “Future Negative” tendencies have taken over. Britt Wiberg, my co-supervisor, my heartfelt thanks goes to you for so openhandedly sharing your clinical knowledge. Thank you for your support, scientific as well as emotional. And above all, without your encouragement, I would not even have applied for a position as a doctoral student in the first place. Michael Rönnlund, although not formally my supervisor, you have undeniably been a great mentor. Thank you for generously sharing your outstanding methodological and statistical expertise. I would also genuinely like to thank my co-authors, Marie Wiberg, Anna Sircova, and Ali Seif, and John Andersson, thank you for your assistance in data collection for the control group.

Eva Elgh, Johan Eriksson, Lars-Gunnar Lundh, Steven Nordin and Carola Wiklund-Hörnqvist, I am very grateful to all of you for insightful and constructive comments and suggestions on earlier versions of this thesis.

To the former and current directors of the doctoral education at the Department of Psychology, Anna S-N and Mia N, thank you for all your support, and for your tireless efforts to improve the education for us doctoral students.

I also want to take this opportunity to thank Professor Frank C. Worrell at Graduate School of Education, UC Berkeley. The semester I spent learning from
you and your research group at UC Berkeley was the most rewarding learning experience I had as a doctoral student.

I would also like to thank The Graduate School in Population Dynamics and Public Policy for financial support that enabled me to attend courses that helped me in my doctoral studies. I would especially like to thank Johan Lundberg, director of the graduate school, for organizing the workshop in Brussels, which was a great learning experience as well as a lot of fun.

Thank you to the psychiatric clinics in Umeå, Lycksele, Sollefteå and Kramfors. I would especially like to thank Mikael Vallin for his assistance in recruiting participants, and Ann-Christine Strindlund and Leila Jansson for their assistance recruiting participants for the pilot study. I would also genuinely like to thank Eva Carlehed for help with the logistics, and above all, for all the encouragement and support. To Rolf Adolfsson and Annelie Nordin Adolfsson, thank you for your help and for sharing your expertise on the Betula study.

Bo Molander, who better than anyone can describe the despair of a person from Ådalen when driving across the field of Röbäck. Thank you for providing me with the poem “Tin” (see appendix) and for being a great mentor for doctoral students.

Mattias Viberg, thank you for creating the “betskylizer”, it saved me hours of having to manually transform SPSS-format into the proper ASCII-format.

One of the best things about being a doctoral student, is to be a member of the doctoral student group. It has been wonderful to be part of a group of such creative, intelligent, and fun people. I would like to thank all former and current members.

Olympia, the best guide of Thessaloniki and the best officemate. Thank you for all the good times, emotional support, all the interesting time-related discussions, and for being a great friend! Carola, the most well-organized and driven person I know. Thank you for all the fun chats, all the support, and for being a great friend. You have made my time as a doctoral student so much better! Hanna, soon we will come up with that groundbreaking idea and when we do.. Thank you for your good friendship and the good times! Daniel and Markus a.k.a. “Mr Moody”, how we got in to Selhurst Park (and that Daniel and I came out of it alive) is a saga of its own. Thank you for your friendship, support, and for all the good times! Eva, did we ever battle on a football field? If we did, I am sure you won. Thank you for the good times. Petra, always friendly and always helpful, you are a great person!

Maria V, one late night I wished I had four hands so that I could simultaneously finish a manuscript and hold a 3 weeks old baby. Then you came to the rescue.
Thank you for being a great person. Your sense of humor and refreshing cynicism are something I truly appreciate.

Ylva and Moa, thank you for being the best sisters one could ask for. Thank you for all the support, and for patiently listening to my complaints from time to time. To my mum and dad, thank you for always supporting me and believing in me. You are the best parents one would ask for. Thank you mum for baby-sitting in times of crisis. Thank you dad for taking the time to design the cover of my thesis, it is a shame I got none of your artistic talents.

Finally, To Frank and Agnes. Frank, I know I probably have not been the best partner in the past year and during the writing of this thesis. Thank you for putting up with my absentmindedness and probably, at times, difficult temperament. ☺️ Without your calm and steady support, I would not have made it. Agnes, my daughter, and objectively the most wonderful person in the world. Thank you for reminding me about what matters most in life.
Appendix

Tin
Fo tin å gå?
Du språke som du ha förstänne tell,
dä höre ja’ dä.
Sanna mina ol,
dä sling å bär å.
Tin ä en spärkar.

Hennen va såga.
Därdennan låg fabriken.
Ja’ hördde ’n Angur
bläste sistganga.
Båta for å.
Kajen smûla ihop.
Addra väx över alltihop.

Nä, gosse, lean täla om,
gråstråna sägne’:
tin stå allrin still.

Tin ä en spärkar.
I utförsbacken.
På blåhalka.

Löne int å rabbe.

Birger Norman
ur Utanikring, Dikter på Ångermanländska