Every dark cloud has a colored lining
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Chapter 1

General Introduction
Background

“Every dark cloud has a colored lining”: this proverb is derived from the existing English saying “Every cloud has a silver lining”, which means that every hard or distressing situation has a comforting or more hopeful aspect, even though this may not be immediately apparent. I like this saying, but I have slightly changed the words to illustrate the central topic of this thesis: the importance of paying attention to both darkness, a metaphor for negativity or unpleasantness, and colorfulness, a metaphor for positivity or pleasantness. Until now, most attention has been paid to negative affect and negative events. Although interest in positive affect and positive events has increased over the last decades, they are still under researched. This thesis brings, after the focus on black, the color back in the literature, and aims to investigate (1) the relation between positive and negative affect, and (2) the association between factors that are associated with increased risk for depression, on the one hand, and reactivity to positive and negative events, on the other hand.

In this thesis, I focus on individuals aged between 10 and 25 years, which I roughly indicate as adolescents. They are an interesting group to investigate our research topics in for several reasons. First, this group is characterized by large fluctuations of affect over the course of a day (e.g. Larson, Moneta, Richards, & Wilson, 2002). Second, they are exposed to major physical, personal, social and academic changes simultaneously or in quick successions (e.g. Larson & Ham, 1993). All these changes, fueled by feelings of loss of control and emotional distress, could result in the onset of psychopathology (e.g. Costello, Copeland, & Angold, 2011; Holmbeck, Friedman, Abad, & Jandasek, 2006; Wilens & Rosenbaum, 2013). Previous studies have found that the onset of depression increases considerably during adolescence (e.g. Kessler, Avenevoli, & Merikangas, 2001), and that specifically in adolescence depression has far-reaching consequences because of the wide variety of concurrent problems that hinder the development in important areas of life (Birmaher et al., 1996). In addition, adolescents with depression have an increased risk of recurrent depressive episodes in adulthood (e.g. Jonsson et al., 2011; Lewinsohn, Rohde, Klein, & Seeley, 1999; Pine, Cohen, Cohen, & Brook, 1999).

The life of adolescents is not all doom and gloom: although they show increased rates of depression, they also display increased pleasure during rewarding situations (for a review see Forbes & Dahl, 2012). This knowledge may have important implications for identifying (risk of) depression in adolescents. It suggests that the experience of both
depressed affect and anhedonia (i.e. lack of pleasure) is a better indicator of depression than the experience of depressed affect alone. That is, the experience of depressed affect at times may be a typical characteristic in adolescence, whereas anhedonia appears to be abnormal and therefore perhaps more useful to distinguish between normative emotional processes and (early) signs of depression. Unfortunately, little is known about whether adolescents who are at risk for depression indeed experience less pleasure in daily life. Previous studies in adults have indicated that individuals high in depressive symptoms experience a lower number of or less intense positive events, but benefit more from these events than individuals low in depressive symptoms (Bylsma, Taylor-Clift, & Rottenberg, 2011; Peeters, Berkhof, Rottenberg, & Nicolson, 2010; Thompson et al., 2012). As I mentioned before, this thesis does not focus on adults, but on adolescents, and one aim was to investigate whether adolescents with depressive symptoms, low positive affect, or high negative affect experienced fewer positive events and showed divergent affect reactivity patterns to negative and positive events as well.

In this General Introduction, I first explain different concepts that are used throughout this thesis. Next, I discuss the current state of knowledge about the relation between positive and negative affect. Subsequently, I provide information about three underlying processes that drive affect and about the specific influence of minor and major events on affect. All these processes are subject to individual differences, and I therefore then discuss the relation between depression, neuroticism and extraversion and these affective processes. This chapter ends with an overview of the aims, the study designs and the samples used to investigate short-term (i.e. over hours) and long-term (i.e. over years) effects.

The concepts valence and arousal

Valence and arousal are important concepts to describe events and affect. The term valence originates from the Latin word ‘valentia’, which means ‘power, competence’ (Hornby, 2010), and has often been used in chemistry with respect to electrons and charges. It was introduced in the 1930s in psychology and was primarily used as a synonym for ‘psychological charge’ (Colombetti, 2005). Nowadays, valence is a popular term in psychology to indicate how dark (i.e. unpleasant) or colorful (i.e. pleasant) events are or affect is: from very unpleasant (i.e. negative valence) to very pleasant (i.e. pleasant...
positive valence) (Colombetti, 2005).

The term arousal generally refers to the degree of physiological or psychological activation (Duffy, 1957). Physiological arousal is expressed by increased heart rate, blood pressure, breathing rate, and pupil dilation. Psychological arousal is the subjective experience of feeling activated. Negative events almost always evoke arousal (Pfaff, Martin, & Ribeiro, 2007). Positive events differ extensively in their degree of arousal: for example, taking a relaxing bath results in low arousal, whereas riding a rollercoaster results in high arousal.

Valence and arousal are considered to be the fundamental building blocks of affect. Several studies measured core affect with an affect grid (Russell, Weiss, & Mendelsohn, 1989) in accordance with Russell’s two axis circumplex model (Kuppens, Oravecz, & Tuerlinckx, 2010; Russell, 1980; Timmermans, Van Mechelen, & Nezlek, 2009). This model places valence and arousal as two orthogonal axes on which different affective states could be rated. See Figure 1.1 for examples of the rating of different affective states along the valence and arousal axis.

Given the orthogonal positioning, it is assumed that valence and arousal are two independent dimensions of affect. In other words, the rating of how pleasant I feel gives

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**Figure 1.1: Examples of affective states rated along the valence and arousal axis in Russell’s two axis circumplex model (Russell, 1980)**

![Diagram showing the valence and arousal axes with various emotional states plotted on it.](image-url)
General Introduction

no information about how activated I feel. This independence, however, is a matter of debate. For example, Kuppens (2008) observed large individual differences in the relation between valence and arousal. In some individuals, highly pleasant or unpleasant feelings co-occur with low levels of arousal (e.g. relaxed/ sad), whereas in other individuals these feelings co-occur with high levels of arousal (e.g. excited/ nervous).

**The relation between positive and negative affect**

As mentioned before, valence is a continuum from very negative (i.e. very unpleasant) to very positive (i.e. very pleasant) affect. In other words, positive and negative affect are two opposite poles of one scale (i.e. the correlation between positive and negative affect is -1.0\(^1\)). However, the assumption that positive affect and negative affect are two opposite poles of one dimension is not shared by all researchers. Several researchers consider positive and negative affect as independent dimensions that are related to distinct psychobiological systems (e.g. Watson, Wiese, Vaidya, & Tellegen, 1999).

Positive affect is related to the BAS (i.e. behavioral approach/ activation system), which initiates and regulates approach (i.e. reward-related) behavior. The BIS (i.e. behavioral avoidance/ aversive system) is related to negative affect to a greater extent, and inhibits goal-oriented behavior and elicits withdrawal behavior (e.g. Carver, 2006; Gray, 1987)\(^2\). The brain structures that are mainly involved in the experience of positive affect are the striatum and orbitofrontal cortex, whereas the amygdala, hippocampus and insula play a focal role in the experience of negative affect (e.g. Ernst, 2014).

Recent studies have indicated that the distinction in psychobiological systems between positive and negative affect is not as clear as previously thought. For example, a meta-analysis by Lindquist and colleagues (2015) found no distinct brain areas for positive and negative affect. In addition, it has been shown that positive and negative affect are not measured with a strictly bipolar response scale. For example, a respondent who scores a 1 on a positive affect scale ranging from 1 (not at all) to 7 (very) could feel neutral or negative. Due to this loss of information, the actual correlation indicating bipolarity will be lower (i.e. \(r = -.47\)), but could be inflated by systematic measurement errors (Barrett et al., 2009; Russell et al., 1999).

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1 In most cases, a correlation of -1.0 is actually not a gold standard for bipolarity, because the positive and negative affect dimensions are not measured with a strictly bipolar response scale. For example, a respondent who scores a 1 on a positive affect scale ranging from 1 (not at all) to 7 (very) could feel neutral or negative. Due to this loss of information, the actual correlation indicating bipolarity will be lower (i.e. \(r = -.47\)), but could be inflated by systematic measurement errors (Barrett et al., 2009; Russell et al., 1999).

2 This is based on the original version of the reinforcement sensitivity theory of Gray (1982), that is still used by several researchers. In a revised version of this theory (Gray et al., 2000), the BIS system detects and resolves conflicting stimuli by stimulating either the BAS system or the Fight Flight and Freezing system (FFFS). The latter is regarded as the system that is sensitive to aversive stimuli and initiates withdrawal behavior in this revised version of the theory.
affect also share the same neurotransmitter systems; dopamine and opioids modulate both pain and pleasure (Leknes & Tracey, 2008), and the former ‘stress’ neurotransmitter serotonin has been associated with changes in positive affect as well (Barrett et al., 2009). Another indication that positive and negative affect are related to each other is that deficits in negative affect often co-occur with deficits in positive affect in depression (Lewinsohn, Pettit, Joiner, & Seeley, 2003). These findings suggest that positive and negative affect are dependent on each other.

Taken together, the relation between positive and negative affect is still a controversial but important topic, because it could give insight into whether a change in positive affect will co-occur with a change in negative affect after the occurrence of positive or negative events. In addition, it is vital to know whether experiencing low positive affect increases the risk of experiencing high negative affect or vice versa at the same moment or later in time. Therefore, the first aim of this thesis is to investigate the relation between positive and negative affect. In chapter 2, I investigate the cross-sectional and longitudinal relation between anhedonia and depressed affect specifically. In addition, this chapter examines the course and stability of anhedonia and depressed affect during adolescence, taking possible gender differences into account.

There is also accumulating evidence that a person’s context, such as the degree of stress, plays a role in whether positive and negative affect should be regarded as independent or dependent from each other (Davis, Zautra, & Smith, 2004; Pruchno & Meeks, 2004; Reich, Zautra, & Davis, 2003; Williams, Peeters, & Zautra, 2004; Zautra, Reich, Davis, Potter, & Nicolson, 2000). I elaborate further on this topic in chapter 3, where I examine the role of perceived arousal in the relation between positive and negative affect. The specific objective of this chapter is to clarify within-person and between-person effects of arousal on the relation between positive affect and negative affect in daily life.

**The concepts emotion, mood and affect**

In the previous paragraphs I consistently used the word ‘affect’, which literally means “to produce a change” (Barrett & Bliss-Moreau, 2009). Affect is used as an umbrella term for an internal state without further specifying the content or time frame, and therefore both emotions and mood are covered by this term (Kringelbach & Phillips, 2014).
The concept ‘emotion’ is originally derived from the Latin word ‘emovere’, which means ‘that which moves us to action’ (Hornby, 2010). Dozens of definitions of emotions have passed the revue over the years to make this vague description more comprehensible; from Socrates’ definition ‘Emotions are pleasures and pains of the soul’ in 430 BC, to Scherers’ definition ‘Emotion is a cultural and psychobiological adaptation mechanism which allows each individual to react flexibly and dynamically to environmental contingencies’ in 2009 (Scherer, 2009). These frequent attempts to define emotions highlight the difficulty in providing one clear definition of emotion that comprises all aspects (Kringelbach & Phillips, 2014).

The functional definition of an emotion is a state that helps an individual to cope with threats and challenges of the environment. For example, fear initiates a flight response to escape the threatening environment, and joy indicates that the environment is challenging and stimulates approach behavior (Kuppens et al., 2010). Given that emotions are adaptive responses to the environment, it is not surprising that emotions have a transient character: they are present as long as they are needed, and are quickly followed by a return to the set point level (i.e. baseline levels) around which emotions fluctuate (Kuppens et al., 2010).

The concept ‘mood’ is often used as a description of this set point level. Usually, mood states are described as more diffuse, longer-lasting states that are less specifically influenced by a trigger from the environment than emotions (Kringelbach & Phillips, 2014). The American Psychiatric Association used an attractive metaphor to explain the distinction between emotion and mood: “emotions are fluctuating changes in emotional weather, whereas mood is the pervasive and sustained emotional climate” (APA, 1994; as described in Gross, 1998). These definitions appear clear at first sight, but the boundary between emotions and mood sometimes remains fuzzy.

In the rest of this thesis, I continue to use the umbrella term affect. Strictly speaking, the focus is on mood in the chapters in which we examine long-term effects (chapter 2 and 4), whereas emotions are central in the chapters in which we examine short-term effects (chapters 3, 5, 6 and 7).
Central processes that drive affect

As we are living in a world with a constant stream of changes in the environment, it makes sense that affect is often viewed as a dynamic system to adaptively react to environmental changes. Kuppens et al. (2010) have identified three underlying processes in this system: (1) baseline affect, (2) affective variability, and (3) attractor strength. Differences in affective experiences between individuals could be explained by differences in these basic processes (Kuppens et al., 2010).

Baseline affect
Baseline affect (i.e. the set point level) refers to affect in normal situations. In other words, it is the typical affective state of an individual; the point to which affect returns after an increase or decrease in reaction to internal and external events. Kuppens et al. (2010) described baseline level of affect as “a particular combination of valence and arousal that reflects the affective home base; the baseline functioning of the affective system (i.e. the affective comfort zone of an individual)”. This baseline level of affect appears to be consistent and pervasive over time, reflecting a trait characteristic of a person, but it possibly loses its stability when important changes in the environment occur (Kuppens et al., 2010). In general, the baseline level of affect is mildly positive (Diener & Diener, 1996; Kuppens et al., 2010), although there is large variation in baseline affect levels across individuals, which could be explained by biological, personality and age factors (e.g. David, Green, Martin, & Suls, 1997; Ito & Cacioppo, 2005; Norris, Larsen, Crawford, & Cacioppo, 2011; Pinquart, 2001). Baseline affect is traditionally measured with a questionnaire addressing the experiences of certain affective states ‘in general’. However, rapid consecutive measurements of affect in daily life provide a more reliable measure of baseline affect, because they enable the researcher to calculate the point to which affect returns or the mean level of affect across the measurements.

Affect variability
Affect variability refers to the fluctuations of affect around the baseline level. These fluctuations are reactions upon internal or external factors including hormone levels (e.g. Oinonen & Mazmanian, 2001), alcohol use (e.g. Simons, Wills, & Neal, 2014), the weather (e.g. Denissen, Butalid, Penke, & van Aken, 2008; Klimstra et al., 2011), the time of the day or week (e.g. Egloff, Tausch, Kohlmann, & Krohne, 1995; Harvey et
al., 2015; Stone, Schneider, & Harter, 2012), positive and negative events (e.g. Zautra, Affleck, Tennen, Reich, & Davis, 2005), social interactions (e.g. Berry & Hansen, 1996), physical activity (e.g. Wichers et al., 2012), and music (e.g. Juslin, Liljeström, Västfjäll, Barradas, & Silva, 2008). Individuals differ in the extent to which their affect fluctuates in response to these factors (Eaton & Funder, 2001; Kuppens, Van Mechelen, Nezlek, Dossche, & Timmermans, 2007; Penner, Shiffman, Paty, & Fritzsche, 1994; Timmermans, Van Mechelen, & Kuppens, 2010).

By measuring affect variability in individuals, it is possible to investigate whether individuals differ in the combined impact of these factors. Affect (in)variability has been measured in different ways: by calculating the (1) standard deviation (SD), (2) autocorrelation, and (3) mean square successive difference (MSSD) of affect. Each measure examines a different aspect of (in)variability (Ebner-Priemer, Eid, Kleindienst, Stabenow, & Trull, 2009; Jahng, Wood, & Trull, 2008; Koval, Pe, Meers, & Kuppens, 2013; Thompson et al., 2012). Most researchers calculate the SD of affect, but the SD only reflects the overall range of fluctuations in affect, that is the average deviation from one's own average affect score, and provides no information on whether affect changes from moment to moment (i.e. temporal dependency). The temporal dependency of affect could be measured by the autocorrelation of affect (i.e. the correlation of affect between two consecutive measurements). This measure is frequently labeled as ‘inertia’ (Koval et al., 2013). High affective inertia means that the level of affect at a previous moment predicts the level of affect at the next moment. In other words, affect is likely to persist from one moment to the next; it reflects slow changes of affect. Inertia, however, does not reveal knowledge about the amplitude of fluctuations (Ebner-Priemer et al., 2009; Jahng et al., 2008; Koval et al., 2013; Thompson et al., 2012). The examples provided in Figure 1.2 help to clarify the differences in meaning between general affect variability (i.e. SD) and inertia (i.e. autocorrelation of affect). The calculation of the mean square successive difference (MSSD; see Jahng et al., 2008 for the formula) incorporates information about both the amplitude of fluctuations and temporal dependency. All three measures of affect variability will be used in chapter 5, in which we examine, amongst others, whether depressive symptoms are related to positive affect variability.
Attractor strength

The attractor (originally derived from the Latin word ‘attrahere’ that means ‘draw to’) strength reflects the regulatory processes that are activated to regulate affective states that deviate from the baseline level (Kuppens et al., 2010). In other words, it echoes the processes that ‘repair’ elicited negative or positive affect. The speed of ‘repair’, that is, how long it takes for positive or negative affect to return to baseline levels, is dependent on the use of cognitive strategies, such as rumination or reappraisal (Kuppens et al.,

**Figure 1.2: Distinction between general variability (i.e. SD) and inertia (i.e. autocorrelation)**

- **Figure 1.2a**: low variability, low inertia
- **Figure 1.2b**: low variability, high inertia
- **Figure 1.2c**: high variability, low inertia
- **Figure 1.2d**: high variability, high inertia

General variability (i.e. SD) reflects the overall range of fluctuations. Inertia reflects the autocorrelation between two consecutive states (i.e. temporal dependency). In other words, inertia is a reflection of the frequency/ speed of change: high inertia indicates that a state persists from one moment to the next (i.e. slow changes). Figure 1.2a shows an attraction characterized by only small changes in height, but the attraction goes very fast. It reflects frequent, but small changes in height. Figure 1.2b shows a ‘rollercoaster’ for very young children. The change in height again is really small. In contrast with Figure 1.2a, the speed is slow; the car is stacked at the same place frequently, because the child often leaves the car. It reflects slow and small changes in height. Figure 1.2c demonstrates a rollercoaster with large loops, and the train of the rollercoaster goes very fast. It reflects frequent and large changes in height. Figure 1.2d shows the same rollercoaster as in Figure 1.2c, but this rollercoaster is defect. During a ride, the train stagnates frequently. It takes time to go from one loop to another loop. It reflects slow but large changes in height.

**Attractor strength**

The attractor (originally derived from the Latin word ‘attrahere’ that means ‘draw to’) strength reflects the regulatory processes that are activated to regulate affective states that deviate from the baseline level (Kuppens et al., 2010). In other words, it echoes the processes that ‘repair’ elicited negative or positive affect. The speed of ‘repair’, that is, how long it takes for positive or negative affect to return to baseline levels, is dependent on the use of cognitive strategies, such as rumination or reappraisal (Kuppens et al.,
Rumination refers to focusing on negative emotions and the events that elicited these emotions, and to repetitively thinking about possible causes and consequences (Nolen-Hoeksema, 1991). Reappraisal is a cognitive strategy that reduces the emotional impact of an event by reinterpreting the situation in a less negative or more positive way (Gross & John, 2003).

**The influence of minor and major events on affect**

The main focus of this thesis is on the role of (the subjective appraisal of) positive and negative events on affect, because they are one of the most important and robust influences on affect, and to some degree modifiable. It is important to distinguish between minor and major positive and negative events. Minor positive events (i.e. uplifts) and minor negative events (i.e. hassles) influence affect on a daily basis; they cause fluctuations in affect and therefore influence the above described affect variability measures. Major events, such as a marriage or the death of a loved one, have the capacity to change baseline levels of affect over a couple of months (e.g. Headey, 2010), but could also influence the daily pattern of affect by creating new uplifts and hassles (Kanner, Coyne, Schaefer, & Lazarus, 1981).

The vast majority of studies have examined the influence of major life events on health and psychopathology (Monroe, 2008). However, some researchers have proposed that it is just as important to investigate the influence of uplifts and hassles on daily affect patterns, because the accumulation of hassles in the relative absence of uplifts is also important for health status (e.g. DeLongis, Coyne, Dakof, Folkman, & Lazarus, 1982; Kanner et al., 1981; Klumb & Baltes, 2004; Monroe, 1983; Pillow, Zautra, & Sandler, 1996). This idea is reflected by a poem of Charles Bukowski (1980) quoted in Kanner (1981):

“It is not the large things that send a man to the madhouse....
No, it’s the continuing series
of small tragedies that send
a man to the madhouse
Not the death of his love
but a shoelace that
snaps with no time left.”
Individuals not only differ in the exposure to major and minor events, but also in the degree to which they are affected by these events. The majority of studies showed individual differences in the sensitivity to negative events in line with the diathesis stress theory (e.g. Monroe & Simons, 1991). This theory puts forward that individuals who are vulnerable to psychopathology, because of specific behavioral, physiological or genetic factors, are at increased risk of being adversely affected by negative events. The influence of positive events is outside the scope of the diathesis stress theory, and therefore many studies based on this model did not assess positive events. There is, however, also empirical support for theories that did pay attention to positive events: the more recently developed differential susceptibility theory (Bakermans-Kranenburg & van IJzendoorn, 2007; Belsky & Pluess, 2009; Ellis, Boyce, Belsky, Bakermans-Kranenburg, & van IJzendoorn, 2011; van IJzendoorn & Bakermans-Kranenburg, 2012) and the vantage sensitivity theory (Pluess & Belsky, 2013). The differential susceptibility theory proposes that certain behavioral, physiological or genetic factors, such as 5-HTTLPR or DRD4 polymorphisms or negative emotionality (Bakermans-Kranenburg & Van IJzendoorn, 2011; Li, Berk, & Lee, 2013), make individuals differ in their ‘generalized’ sensitivity to events (i.e. highly sensitive to both negative and positive events). The vantage sensitivity theory postulates that some factors lead to individual differences in the sensitivity to exclusively positive events (Pluess & Belsky, 2013). It is important to note that studies investigating the theories of diathesis stress, differential susceptibility and vantage sensitivity have largely been based on major events, such as disruptive family functioning and maltreatment. Only few studies examined whether these findings extend to minor positive and negative events in the realm of daily life. Therefore, we examined whether high affect reactivity to hassles reflects a generalized sensitivity to environmental influences, and thus co-occurs with high affect reactivity to uplifts in daily life. The findings are presented in chapter 6.

**The relation between depression and affect**

**Depressive symptoms**

Many psychiatric disorders are characterized by disturbances in affect, but abnormal patterns of affect are most prominent in depression (i.e. Major Depressive Disorder), a highly prevalent disorder and one of the leading causes of disability (Mathers &
Loncar, 2006; Ormel et al., 2008; Whiteford et al., 2013; World Health Organization, 2008). By definition, negative affect is increased or positive affect is decreased, because a diagnosis of depression according to the Diagnostic and Statistical Manual of Mental disorders (DSM-V, American Psychiatric Association, 2013) requires the presence of at least one of the two core symptoms: depressed mood (i.e. negative affect) or anhedonia (i.e. lack of positive affect). In total, five out of nine symptoms have to be present on a daily basis for more than two weeks and have to cause significant impairments in multiple domains. The other seven symptoms besides the core symptoms are: significant weight loss or weight gain (changes in appetite), insomnia or hypersomnia, fatigue or loss of energy, reduced ability to concentrate or make decisions, psychomotor agitation or retardation, feelings of worthlessness or excessive or inappropriate guilt, and recurrent thoughts of death or suicidal ideation. In this thesis we made a distinction between neurovegetative-somatic symptoms (i.e. appetite or weight change, sleep problems, fatigue) and cognitive-affective symptoms (i.e. depressed mood, anhedonia, feeling worthless, guilt, suicidal ideation) (Lux & Kendler, 2010).

The association between major positive and negative events and depression

There is ample evidence that major negative events, such as serious illness, are associated with the onset of depression (Brilman & Ormel, 2001; de Graaf, Bijl, Ravelli, Smit, & Vollenbergh, 2002; Friis, Wittchen, Pfister, & Lieb, 2002; Kessler, 1997; Ormel & Wohlfarth, 1991; Stroud, Davila, & Moyer, 2008). Approximately 70% of individuals with a first onset of depression have recently experienced a major life event (Monroe & Harkness, 2005).

The results of studies investigating the relation between major positive events, such as marriage, and depression are mixed. Some studies found that major positive events are negatively associated with depression (Cohen, McGowan, Fooskas, & Rose, 1984; Cohen, Burt, & Bjorck, 1987; Dixon & Reid, 2000; Gledhill & Garralda, 2011; Kessler, 1997; Needles & Abramson, 1990; Oldehinkel, Ormel, & Neeleman, 2000), whereas other studies did not find a relation between major positive events and depression or even a positive relation (de Graaf et al., 2002; Overbeek et al., 2010).

The study described in chapter 4 was set up to explain these inconsistent findings by decomposing life events into a valence (i.e. the number of domains with positive life changes minus the number of domains with negative life changes) and an amount
of change (the total number of life changes irrespective of valence) component. We examined whether an excess of major positive life events predicted (clusters of) depressive symptoms while controlling for the total number of life events.

The association between depressive symptoms and affect variability and affect reactivity to minor positive and negative events

Depression is not only associated with low baseline positive affect and high baseline negative affect. It has also been related to the degree of fluctuations in affect, and the influence of minor positive and negative events on affect. Studies consistently found that negative affect variability is positively associated with depressive symptoms (e.g. Koval et al., 2013; Kuppens et al., 2007; Thompson et al., 2012; Wichers et al., 2010). The findings with respect to positive affect variability are mixed: some studies did find a relation with depressive symptoms (e.g. Gruber, Kogan, Quoidbach, & Mauss, 2013; Kuppens et al., 2007), whereas other studies did not (Thompson et al., 2012; Wichers et al., 2010).

The results of studies investigating the relation between depressive symptoms and affect reactivity to minor positive and negative events are also inconsistent. A meta-analysis of experimental studies using different mood induction procedures in artificial settings demonstrated that depressed patients are characterized by an insensitivity to both positive and negative events (Bylsma, Morris, & Rottenberg, 2008). Studies in daily life, however, found that depressed individuals showed higher reactivity to positive events compared with individuals without depressive symptoms (Bylsma et al., 2011; Peeters, Nicolson, Berkhof, Delespaul, & de Vries, 2003). With respect to reactivity to negative events the results of the studies were also mixed: Bylsma et al. (2011) found no differences between the groups, whereas Peeters et al. (2003) found blunted reactivity to negative events in the group with major depression. High reactivity to positive and, counterintuitively, negative events was found to have positive outcomes in individuals with a diagnosis of depression; it predicted lower depressive symptom severity (Peeters et al., 2010). Until now, studies have mainly focused on adults. In chapter 5 the focus is on adolescents. We investigated whether depressive symptoms are related to positive events, positive affect variability, positive affect reactivity to minor positive events, and reactivity to positive affect (i.e. whether positive affect elicits positive events) in daily life. We also examined whether this relation is different for early and late adolescents.
The relation between personality and affect

Definition of neuroticism and extraversion

Neuroticism and extraversion belong to the personality Big Five alongside conscientiousness, openness to experience, and agreeableness. This thesis solely focused on neuroticism and extraversion, because they have shown to be the strongest predictors of affect (e.g. DeNeve & Cooper, 1998). High neuroticism and low extraversion have been associated with an increased risk of depression, functional impairment, and low well-being (e.g. Backenstrass et al., 2006; Cuijpers & Smit, 2004; Cuijpers et al., 2007; Cuijpers et al., 2010; Kotov, Gamez, Schmidt, & Watson, 2010; Ormel et al., 2013; Ormel, Laceulle, & Jeronimus, 2014; Steel, Schmidt, & Shultz, 2008).

Neuroticism is a heterogeneous concept (e.g. Ormel, Rosmalen, & Farmer, 2004; Ormel et al., 2013). It is frequently conceptualized as the tendency to have problems to cope with threat, frustration or loss, and to experience negative emotions frequently (e.g. John, Robins, & Pervin, 2008). Therefore, neuroticism is often referred to as negative emotionality or negative affectivity. Extraversion is defined by a tendency to seek social attention and to be outgoing, assertive, talkative and enthusiastic (e.g. Ashton, Lee, & Paunonen, 2002). Extraversion is associated with experiencing high levels of positive affect (Izard, Libero, Putnam, & Haynes, 1993; Lightsey, Gharibian Gharghani, Katz, McKinney, & Rarey, 2013; Shiota, Keltner, & John, 2006; Steel et al., 2008), and is therefore also often described as positive emotionality or positive affectivity.

Affect level versus affect reactivity hypothesis

As mentioned before, neuroticism and extraversion are strong predictors of affect, but to which underlying processes of affect the two personality traits are related is still a subject of debate. Two hypotheses dominate the literature. First, the affect level hypothesis states that neuroticism is related to the experience of high baseline levels of negative affect (and not positive affect), whereas extraversion is related to the experience of high baseline levels of positive affect (and not negative affect) in general, regardless of the environment (e.g. Gross, Sutton, & Ketelaar, 1998). There is empirical support for this hypothesis, although neuroticism has also significantly been associated with positive affect in some studies (Longua, DeHart, Tennen, & Armeli, 2009; Zautra et al., 2005). Mitte and Kämpfe (2008) showed that the form of positive affect matters. For example, extraversion related most strongly to joy (i.e. positive affect high in arousal), whereas
neuroticism related, inversely, most strongly to contentment (i.e. positive affect low in arousal).

The second hypothesis, the affect reactivity hypothesis, postulates that neuroticism and extraversion are associated with how strongly individuals react to negative and positive events, respectively (Howell & Rodzon, 2011). Studies showed mixed empirical support for this hypothesis. The majority of studies found that individuals high in neuroticism react more strongly to hassles (e.g. Bolger, 1990; Bolger & Schilling, 1991; Bolger & Zuckerman, 1995; Gross et al., 1998; Larsen & Ketelaar, 1991; Longua et al., 2009; Marco & Suls, 1993; Ng, 2009; Rusting & Larsen, 1997). However, several other studies failed to find an association between neuroticism and affect reactivity to minor negative events (e.g. David et al., 1997; Fredrikson & Georgiades, 1992; Jacobs et al., 2011; Schwebel & Suls, 1999), and between neuroticism and affect reactivity to minor positive events (e.g. David et al., 1997; Gross et al., 1998; Jacobs et al., 2011; Ng, 2009; Rusting & Larsen, 1997). Findings with respect to extraversion are also inconsistent (e.g. David et al., 1997; Howell & Rodzon, 2011; Zautra et al., 2005). This thesis contributes to former studies by exploring whether specific facets of neuroticism are differentially associated with affect reactivity to minor positive and negative events in daily life (chapter 6).

Furthermore, it is known that neuroticism and extraversion are associated with rumination and emotion regulation strategies (Bryant, 2003; Gentzler, Ramsey, Yi, Palmer, & Morey, 2014; Gresham & Gullone, 2012; Livingstone & Srivastava, 2012; Merino, Ferreiro, & Senra, 2014; Wood, Heimpel, & Michela, 2003; Yoon, Maltby, & Joormann, 2013), which are factors that are associated with attractor strength (i.e. how long it takes for positive or negative affect to return to baseline levels after a change) (Kuppens et al., 2010). This evokes interest in whether neuroticism and extraversion predict prolonged effects (i.e. effects over a couple of hours) rather than direct effects of minor positive events on positive affect. Chapter 7 is devoted to this topic.

**Overview of aims and different study designs**

As mentioned before, the central aim of this thesis is twofold. First, the relation between positive and negative affect is examined in chapters 2 and 3. Second, an attempt is made to gain more insight into the relation between depressive symptoms, neuroticism and
extraversion, on the one hand, and reactivity to positive and negative events, on the other hand in chapters 4, 5, 6 and 7.

The longitudinal cohort study TRacking Adolescents’ Individual Lives Survey (TRAILS) was used to measure the relation between positive and negative affect (chapter 2) and the effect of major events on depressive symptoms (chapter 4). A longitudinal study is an observational study in which participants are followed over long periods of time (i.e. years) using repeated measurements. In TRAILS more than 2000 adolescents were measured from age 11 to age 23 (for more details see Table 1.1 and the corresponding chapters). The benefits over cross-sectional designs, which compare individuals at one point in time, is that changes within individuals can be studied.

### Table 1.1: Overview of studies with relevant characteristics used in the different chapters

<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Participants</th>
<th>Procedure</th>
<th>Chapters</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRacking Adolescents’ Individual Lives Survey</td>
<td>Longitudinal cohort</td>
<td>N = 2230 Age: 10-23 years</td>
<td>5 assessment waves Intervals of approximately 2.5 years</td>
<td>2, 4</td>
</tr>
<tr>
<td>(TRAILS)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uncovering the Positive Potential of Emotional</td>
<td>Experience Sampling</td>
<td>N = 74 Age: 18-25 years Only females</td>
<td>14 days x 5 measurements per day Fixed time points Intervals of 3 hours</td>
<td>3, 5, 6, 7</td>
</tr>
<tr>
<td>Reactivity (UPPER)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Swinging Moods</td>
<td>Experience Sampling</td>
<td>N = 303 Age: 13-16 years</td>
<td>6 days x 9 measurements per day Random time points On average intervals of 90 minutes</td>
<td>5, 7</td>
</tr>
</tbody>
</table>

Note. The actual number and age of the participants in the chapters can slightly differ from the information in this table, because of the specific selection of participants.

Two daily life studies were used to investigate the relation between positive and negative affect and affect reactivity to positive and negative events over short periods of time. Daily life studies, as the name suggests, capture “life as it is lived” (Bolger, Davis, & Rafaeli, 2003). In other words, daily life studies investigate relations between variables in their natural, spontaneous contexts. Other terms to describe daily life studies are intensive longitudinal, ecological momentary or experience sampling (ESM) studies. There are large differences between daily life studies in the frequency of measurements (e.g. once a day or 10 times a day) and the length of the measurement period (e.g. a
couple of days or months). Another difference is that some studies use an event-based design in which measurements are based on the occurrence of certain events, whereas other studies adopt a signal-based design with measurements at fixed or random time points. In contrast with longitudinal cohort studies, daily life studies are characterized by a high number of repeated measurements of interested variables over time. As a result, this design enables researchers to examine the temporal order of effects and to reliably examine within-subject processes. Another important advantage of daily life studies is that the variable of interest is measured directly or within a short time span after the occurrence of a certain event, and daily life studies are therefore not (or less) limited by retrospective memory biases (Shiffman, Stone, & Hufford, 2008). I used two different daily life studies in this thesis: the Uncovering the Positive Potential of Emotional Reactivity (UPPER) study (chapters 3, 5, 6, and 7) and the Swinging Moods study (chapters 5 and 7). For more information about these studies see Table 1.1 and the corresponding chapters.

Table 1.2 gives an overview of the specific subjects of the different chapters. In addition, it highlights which chapters examine effects over years using a longitudinal cohort study and which chapters investigate affective patterns over hours in daily life.

<table>
<thead>
<tr>
<th>Table 1.2: Overview of the different chapters divided in long-term (years) and short-term (hours) effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>The relation between positive and negative affect</td>
</tr>
<tr>
<td>The relation between factors that are associated with increased risk of depression on the one hand, and reactivity to positive and negative events on the other hand</td>
</tr>
<tr>
<td><strong>Depressive symptoms:</strong></td>
</tr>
<tr>
<td><strong>Chapter 5:</strong> Associations between depressive symptoms and experience of pleasure in daily life in early and late adolescence</td>
</tr>
<tr>
<td><strong>Neuroticism/ Extraversion:</strong></td>
</tr>
<tr>
<td><strong>Chapter 7:</strong> Prolonged effects of positive events on positive affect: The impact of neuroticism and extraversion</td>
</tr>
</tbody>
</table>
Part 1

The relation between positive and negative affect